ARUP

HSE Ireland

Operation Zero: Health Service Executive Decarbonisation Roadmap

Decarbonsation Roadmap Report

V2 | 2nd September 2025

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306817-00

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Document Verification

Project title	Support services to Operation Zero – Health Service Executive Ireland National Roadmap
Document title	Operation Zero: Health Service Executive Decarbonisation Roadmap
Job number	306817-00
Document ref	
File reference	V2

Revision	**Date**	**Filename**	2025-08-08 HSE Ireland Decarbonisation Roadmap_V1_DRAFT_ISSUE		
1	08th August 2025	**Description**	Draft Issue shared for review and comment		
			Prepared by	**Checked by**	**Approved by**
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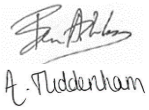
Revision	Date	**Filename**	2025-09-02 HSE Ireland Decarbonisation Roadmap_V2_FINAL_ISSUE		
2	02nd September 2025	**Description**	Final Issue shared after comments addressed within the report		
			Prepared by	Checked by	Approved by
		Name	Jamie Atkinson	Ben Ashby Anna Tuddenham	Christopher Pountney
		Signature			

Issue Document Verification with Document ✓

Contents

Tables

Figures

Acronyms and Initialisms

Acronym or Initialism	Definition
BAU	Business-as-usual
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEFRA	The UK Government Department for Environment, Food and Rural Affairs
DESNZ	The UK Government Department for Energy Security and Net Zero
EEIO	Environmentally-extended input output (EEIO) model
GLEC	Global Logistics Emissions Council
GHG	Greenhouse gases
GHGP	The Greenhouse Gas Protocol
HSE	The Health Service Executive
MDI	Metered Dose Inhalers
N_2O	Nitrous oxide
SEAI	Sustainable Energy Authority of Ireland

Glossary

Term	Definition
Assets	A collective term to refer to all physical assets, including vehicles, buildings, equipment.
Baseline	A detailed assessment of the health sector emissions for the defined geographical scope, covering the core components of the footprint. The baseline provides the basis for future projections and the quantification of emissions mitigation measures.
Bottom-up method	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	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	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.
Decarbonisation	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.
Environmentally-extended input output model	Input-Output 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.
Global Logistics Emissions Council	Led by Smart Freight Centre, GLEC is a multi-stakeholder initiative 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 centres. The "GLEC Framework for Logistics Emissions Methodologies" combines existing methods into one framework.
Greenhouse gases	Gases in the atmosphere that trap heat and contribute to global warming. Key GHGs include carbon dioxide, methane, nitrous oxide, and fluorinated gases. Their impacts are expressed as carbon dioxide equivalents.
The Greenhouse Gas Protocol	The GHGP is the world's most widely used standard for greenhouse gas accounting and reporting.

Term	Definition
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.
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	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.
Methane	Methane is a potent greenhouse gas with a global warming potential significantly higher than CO_2 over a 20-year period.
Net zero	Net-zero greenhouse gas (GHG) emissions are achieved at a point in time when anthropogenic emissions have been reduced to the lowest feasible level, and any remaining residual emissions are balanced by an equivalent amount of anthropogenic removals, ensuring no net increase of GHGs in the atmosphere.
Nitrous Oxide	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.
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.
Sustainable Energy Authority of Ireland	The 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.
Top-down method	Top-down emissions calculation methods use Input-Output Analysis 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.

Executive Summary

Climate change is the greatest public health challenge of our time, with profound implications for the health and wellbeing of people in Ireland and worldwide. Alongside this, healthcare is responsible for roughly 5% of greenhouse gas emissions globally[1]. In mitigating the extent and impact of climate change, the health sector has a dual role to play; reducing its own contribution to greenhouse gas (GHG) emissions while also leading by example in promoting wider climate action. In Ireland, the Health Service Executive (HSE), as the country's largest public body and a major energy user, plays a pivotal role in the sector's decarbonisation, making its transition essential for delivery of national climate targets and advancing more sustainable models of care. This roadmap sits within that strategic context, complementing the obligations detailed within the Climate Action and Low Carbon Development (Amendment) Act 2021 and aligning with the HSE Climate Action Strategy (CAS).

This roadmap sets out a quantified decarbonisation scenario for the HSE, addressing sources of emissions not already covered by existing statutory targets, mandated disclosures, and dedicated HSE decarbonisation roadmaps, thereby informing a more comprehensive approach towards achieving net zero emissions in the health sector. The roadmap provides a detailed picture of these greenhouse gas (GHG) emissions linked to healthcare delivery out to 2050, whilst identifying the potential impact of targeted interventions to reduce those emissions.

This roadmap and its Revised Baseline cover HSE operations only. Emissions from Section 38 and 39 organisations are excluded as the required data was not available within this study. These bodies represent a significant share of healthcare delivery in Ireland, meaning that the results here reflect the HSE's operational footprint, and not that of the full health sector. To avoid duplication and maintain alignment with the HSE Capital & Estates Infrastructure Decarbonisation Roadmap, Scope 1 and 2 building-related emissions, capital goods, and upstream fuel- and energy-related activities for buildings have also been excluded here.

This roadmap provides a foundation for HSE's decarbonisation journey, supplementing existing work to address knowledge gaps and identifying the most impactful interventions and outlining the governance, data, and engagement steps needed to transition towards net zero by 2050. Importantly, many of these actions carry significant health co-benefits, from improved air quality and increased physical activity, to reducing unnecessary care and more efficient use of resources, helping to advance both climate and health outcomes together.

[1] Health Care Without Harm. (2023). The role of the health care sector in climate change mitigation.

Approach:

This work was delivered using the approach shown in Figure 1.

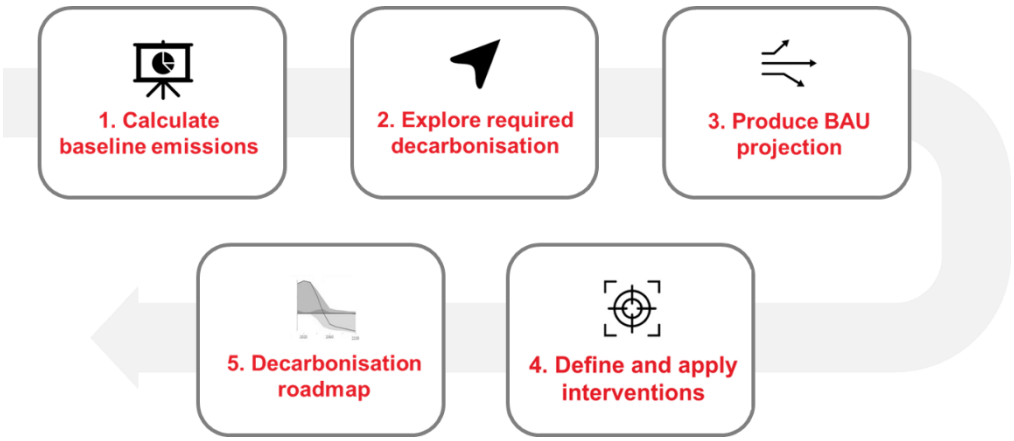


Figure 1: Key steps in the development of the decarbonisation roadmap

The analysis followed a five-stage process aligned with Health Care Without Harm's (HCWH) Designing a Net Zero Roadmap for Healthcare: Technical Methodology and Guidance[2], as shown in Figure 1 and as detailed below:

1. Establishing a **Revised Baseline of 2019 HSE emissions**, refined from the Full Baseline scope and reflective of emissions not already managed within the HSE Capital & Estates Infrastructure Decarbonisation Roadmap.
2. Defining a **reference target trajectory** aligned with Ireland's national climate targets, HSE's own targets and international best practice in net-zero target setting.
3. Developing a **Business-as-Usual (BAU) projection** showing future emissions without targeted action to be used as the basis for further scenario analysis.
4. Modelling the impact of a **suite of decarbonisation interventions** and develop future decarbonisation scenarios.
5. Compiling these outputs into a **decarbonisation roadmap** summarising findings and highlighting high-impact decarbonisation opportunities for HSE.

[2] 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

Key findings:

The decarbonisation roadmap is summarised in Figure 2. In developing this analysis, interventions have been framed within four of the HSE CAS's six Priority Areas of Focus: Transport and Mobility, Greener Models of Healthcare, Waste and Water Management, and Sustainable Procurement. The reduction impact of the individual interventions are shown by the individually coloured wedges, which are grouped by shading based on their respective Priority Area of Focus.

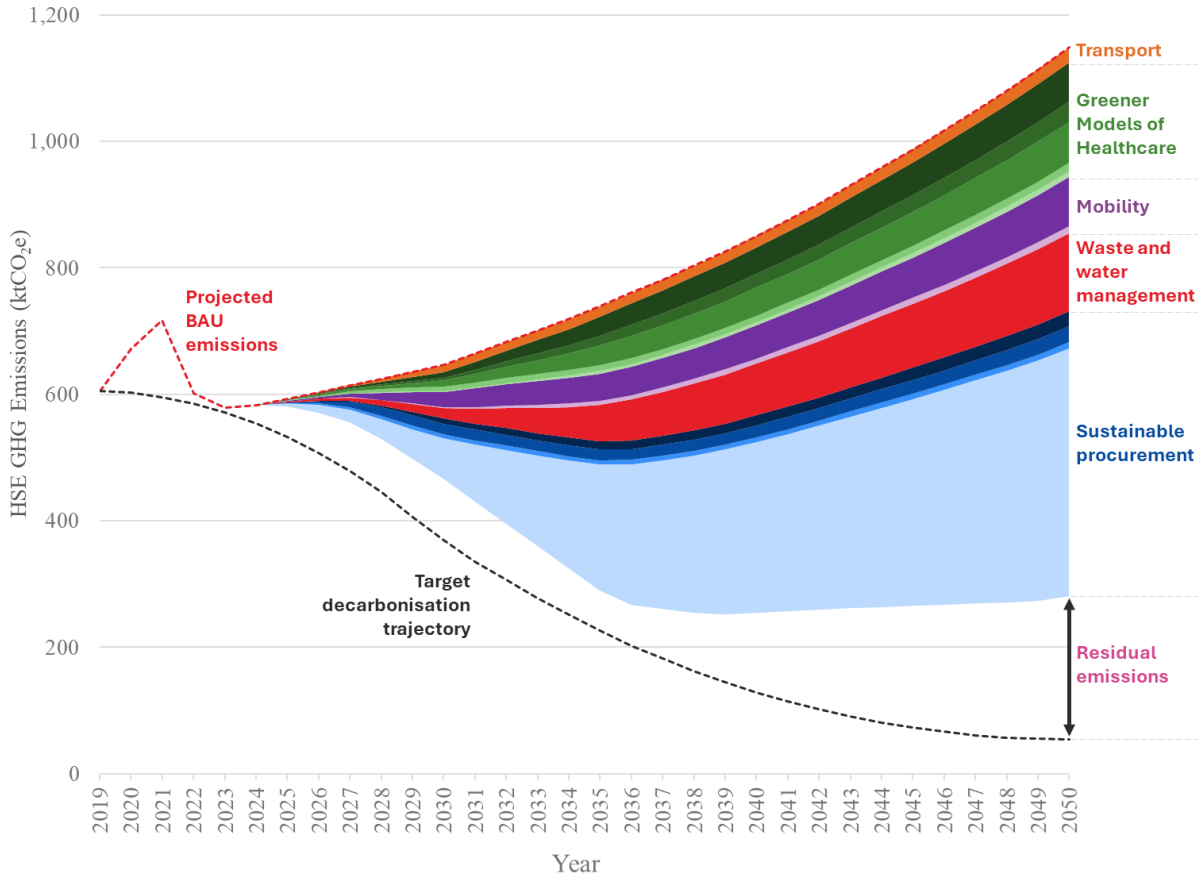


Figure 2: Decarbonisation roadmap

Based on this analysis the following observations have been made:

- The Full Baseline for the HSE in 2019 was 881 $ktCO_2e$, whereas the Revised Baseline considered within this roadmap was 605 $ktCO_2e$.
- Without targeted action on these emissions, following the BAU scenario would result in a ~90% increase in emissions by 2050 relative to 2019.
- Full implementation of modelled interventions would reduce emissions by 76% relative to BAU, or 54% relative to the 2019 Revised Baseline.
- In the decarbonisation roadmap scenario, the cumulative emissions savings due to modelled interventions between 2019 and 2050 by Priority Area were as follows:
  - Sustainable Procurement: 6,467 $ktCO_2e$.
  - Greener Models of Healthcare: 2,408 $ktCO_2e$.
  - Waste and Water Management: 1,650 $ktCO_2e$.
  - Mobility: 1,306 $ktCO_2e$.

  - Transport: 400 $ktCO_2e$.
- In this roadmap scenario, 280 $ktCO_2e$ of residual emissions would remain in 2050.

Recommendations and next steps:

Following this exercise, a number of recommendations are made to build upon this evidence base as part of an emissions monitoring and management programme across HSE:

- Establish a **forward programme of emissions measurement and management** in alignment with the CAS and related strategic Frameworks. This should detail the approach for re-baselining and improving data collection, target setting, and repeating the roadmap process as new opportunities arise.
- Implement the **recommendations from the Emissions Baseline report** to improve granularity and reliability of emissions tracking. This will enable more targeted mitigation measures.
- Set and formalise **organisational decarbonisation targets**, including near term reduction targets, which can be used to measure progress and catalyse action.
- Prioritise the **high mitigation potential actions** detailed in this roadmap, namely:
  - **Transport:** Pursue vehicle electrification in line with expanding charging infrastructure.
  - **Greener Models of Healthcare:** Prioritise less GHG-intensive inhalers and low-impact anaesthetic techniques including nitrous oxide mitigation. Target reusable equipment, extended equipment lifespans, and improved prescribing efficiency.
  - **Mobility:** Promote active travel and explore options to encourage EV uptake across the HSE workforce; assess strategies to reduce patient travel emissions, e.g., through eHealth solutions.
  - **Waste & Water Management:** Invest in standardised waste reporting and classification to target reductions more effectively. Develop waste reduction targets based off improved data.
  - **Sustainable Procurement:** Strengthen supplier engagement, embed sustainability criteria in tenders and contracts, and align with national/EU policy.

1. Introduction and background

1.1 Introduction to this report

This report presents the findings of a detailed modelling and analysis exercise that, for the first time, quantifies the greenhouse gas (GHG) emissions associated with healthcare delivery in all facilities directly operated by the HSE across Ireland. 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** (see Box 1)**.** Using this evidence base, this report sets out a decarbonisation roadmap (hereafter referred to as "the roadmap") to assess the future business-as-usual emissions projection and to identify actionable interventions to reduce emissions not already being managed and mitigated through existing HSE programmes.

This document summarises the approach taken to co-develop the roadmap between the HSE, Health Care Without Harm, and Arup. This includes data inputs, methodology, and modelling assumptions, alongside key insights and recommendations. It is supported by technical annexes, which offers further detail on methods.

Box 1: Scope of Coverage - Exclusion of Section 38 and 39 Organisations

This roadmap has been developed on behalf of the HSE and is based on a Revised Baseline of GHG emissions covering HSE operations only. Emissions associated with the operations and value chains of Section 38 and Section 39 organisations have been excluded from the analysis. This reflects the fact that detailed Scope 3 data for these bodies was not available to the project team, and robust estimation would have required dedicated engagement with these organisations. Given the risk of producing inaccurate or misrepresentative extrapolations, these emissions were considered outside the scope of this study.

It is important to acknowledge, however, that Section 38 and 39 organisations account for a significant share of healthcare provision in Ireland, and by extension, will represent a material portion of the sector's total emissions. The baseline and decarbonisation scenario presented in this roadmap should therefore be understood as reflecting the HSE's operational footprint, rather than the full emissions profile of the Irish health sector. It is anticipated that many of the decarbonisation opportunities, and conclusions, presented within this work would apply to Section 38 and 39 organisations despite excluding their operations from modelling and analysis due to operational similarities with HSE facilities.

This report is structured as follows:

- **Section 1** introduces the purpose and context of the roadmap, outlines the HSE's existing climate strategies, and defines the emissions sources within scope of the modelling.
- **Section 2** describes the methodology used to develop the evidence base for the roadmap. This includes how baseline emissions were calculated, how future scenarios were modelled, the application of reduction interventions, and a summary of key assumptions and uncertainties.
- **Section 3** presents the modelling results: the baseline emissions profile, business-as-usual projections, reference target trajectory, and the outcomes of modelled intervention scenarios.
- **Section 4** highlights in more detail the interventions across four of the six 'Priority Areas of Focus' as delineated by the HSE Climate Action Strategy and identifying priority actions for aligning the HSE with a transition towards net zero.
- **Section 5** offers final reflections and observations based on the analysis and modelling.
- **Annex A** details the key actions and support programmes established and by the HSE Capital & Estates team, as laid out under the Infrastructure Decarbonisation Roadmap.
- **Annex B (Technical Annex)** provides a detailed explanation of the modelling approach, including baseline calculations, emissions projections, target trajectory, reduction measures, and associated assumptions and limitations.

1.2 HSE decarbonisation and net-zero targets and initiatives

1.2.1 Targets, reports and initiatives

Ireland's commitment to addressing climate change is underpinned by the Climate Action and Low Carbon Development (Amendment) Act 2021, which legally mandates a 51% reduction in greenhouse gas (GHG) emissions by 2030 (relative to 2018 levels) and achieving net-zero emissions by 2050. In support of these national goals, the Government's Climate Action Plan 2021 (CAP21) introduced binding requirements for the public sector to lead by example, including a target for all public bodies to reduce energy-related GHG emissions from owned and leased assets by 51% by 2030[3].

At COP26, Ireland also joined the Alliance for Transformative Action on Climate and Health (ATACH), committing to develop a climate-resilient, low-carbon health system, set a pathway to net zero (by 2050 at the latest), and prepare an action plan covering areas such as healthcare supply chains and air pollution. These commitments reinforce Ireland's national climate legislation and the HSE's own climate strategy

In response, the Health Service Executive (HSE) has set out an ambitious climate response through the publication of its **Climate Action Strategy (CAS) 2023–2050** and the accompanying Infrastructure Decarbonisation Roadmap[4]. These documents formally commit the HSE to:

- Reduce Scope 1 and 2 energy-related GHG emissions by 51% by 2030, using a 2016–2018 baseline;
- Reduce thermal (heating and transport) emissions by 51% by 2030;
- Achieve net-zero GHG emissions by 2050.

The HSE Climate Action Strategy defines ten strategic objectives across six thematic areas, referred to as 'Priority Areas of Focus':

- Sustainable buildings & green environments
- Transport & mobility
- Sustainable procurement
- Greener models of healthcare
- Water & waste management
- Adaptation & resilience

These objectives are now being progressed through a suite of Strategic Frameworks, which translate high-level goals into practical implementation plans[5].

In parallel, the HSE Capital & Estates team has developed and published its **Infrastructure Decarbonisation Roadmap**, which focuses on decarbonising the HSE's built estate[6]. This roadmap primarily addresses Scope 1 and 2 emissions from stationary fossil fuel use (e.g. building heat and electricity) and Scope 3 emissions from capital goods (e.g. construction and refurbishment). The Infrastructure Decarbonisation Roadmap sets out a path to reduce energy-related GHG emissions by 50% by 2030, and to achieve net zero across the estate by 2050, in line with Ireland's Climate Action Plan 2023.

1.3 Scope of this study

This study has been designed to inform emissions management approaches across areas of HSE operations not already addressed and managed by other decarbonisation roadmaps, such as the Infrastructure Decarbonisation Roadmap. This section describes the scope and coverage of the

[3] Department of the Environment, Climate and Communications. (2021). Climate Action Plan 2021.
[4] HSE. (2023). HSE Climate Action Strategy 2023-2050.
[5] HSE. (2025). Climate Change and Health: Related Documents.
[6] HSE. (2024). HSE Capital & Estates: Infrastructure Decarbonisation Roadmap.

existing Infrastructure Decarbonisation Roadmap, before defining the scope of this study and emissions included in our analysis.

1.3.1 The strategy and action proposed under the Infrastructure Decarbonisation Roadmap

The Infrastructure Decarbonisation Roadmap (IDR), published by the HSE Capital & Estates team in 2022 and updated in 2024, serves as the core implementation pathway for reducing emissions from the HSE's built estate and capital projects. It operationalises delivery of Ireland's mandated public sector decarbonisation targets, specifically in relation to the built estate and associated capital and energy systems. Rather than setting new, separate targets, the IDR establishes a framework to deliver the HSE's share of the Climate Action Plan 2023 commitments, particularly the requirement to achieve a 51% reduction in energy-related GHG emissions by 2030, and to reach net-zero emissions across the estate by 2050.

The roadmap outlines a multi-year strategic programme organised across seven Action Areas, which address both technical mitigation interventions and supporting governance and capacity-building structures. While all Action Areas contribute to enabling decarbonisation, **Action Areas 2, 3, 4, and 5** most directly target emissions reductions through infrastructure, design, and energy management. Key activities under these three Action Areas include:

- Action Area 2: Regional Energy Bureau, Energy Management Teams, Green Teams and Shallow Retrofit Programme
- Action Area 3: Energy Efficient Design (EED) and Net Carbon Zero Ready Design
- Action Area 4: Deep Energy and Carbon Retrofit Programme
- Action Area 5: Metering, Modelling, Reporting and Energy Management Systems

A range of initiatives have been established based on this and these are outlined in detail in the HSE Capital & Estates Infrastructure Decarbonisation Roadmap and summarised in 0.

Since 2011, Public Sector bodies have been required to report to the Sustainable Energy Authority of Ireland (SEAI) annually on their energy usage and actions taken to reduce consumption in accordance with SI 426 of 2014 (and previously with SI 542 of 2009). This allows SEAI to track progress towards national energy reduction targets. The HSE reports annually on energy consumption for all fuel types (electricity, thermal fuels and transport fuels (including fossil and renewables)) at an organisational level. By the end of 2023, the HSE had achieved a 34% improvement in energy efficiency, adjusted to account for changes in activity levels, against a 2009 baseline. Over the same period, it recorded a 20% reduction in energy-related carbon dioxide emissions and a 12.2% reduction in fossil fuel-related emissions. All of these reductions are measured against the 2016–2018 average baseline. Future iterations of the IDR will continue to track delivery against these actions, refine the approach based on new data and pilot learnings, and set out further steps towards the HSE's 2030 and 2050 goals.

1.3.2 The scope and of this decarbonisation roadmap and the Revised Baseline

To ensure strategic alignment with the HSE's Infrastructure Decarbonisation Roadmap and avoid duplication or conflicting target-setting, this roadmap intentionally excludes certain emissions categories, particularly those associated with buildings, facilities and capital works. The decision reflects the ongoing development of new national targets by the Irish Government for capital goods and embodied carbon, which are expected to shape future public sector obligations. In anticipation of these targets, the HSE Capital & Estates team has confirmed that such emissions will be incorporated into future iterations of the Infrastructure Decarbonisation Roadmap, alongside continued reporting to SEAI under existing Scope 1 and 2 energy-related targets.

As such, **this roadmap excludes**:

- Scope 1 emissions from **onsite fossil fuel combustion in buildings**,

- Scope 2 emissions from **purchased electricity** for HSE-operated facilities,
- Scope 3 emissions from **capital goods** (including construction and refurbishment), and
- Scope 3 emissions from **upstream fuel- and energy-related activities** relating to fuel and energy consumed in **buildings and facilities**.

These emissions sub-categories, and the corresponding IDR Action Areas responsible for their mitigation, are summarised in Table 1 below.

Table 1: GHG emission categories excluded from the scope of this decarbonisation roadmap

Emissions scope	Emissions Scope sub-category	*Infrastructure Decarbonisation Roadmap* 'Action Area' that covers this emissions category
Scope 1	Onsite fossil fuel combustion	• Action Area 2: Regional Energy Bureau, Energy Management Teams, Green Teams and Shallow Retrofit Programme • Action Area 3: Energy Efficient Design (EED) and Net Carbon Zero Ready Design • Action Area 4: Deep Energy and Carbon Retrofit Programme
Scope 2	Purchased electricity for HSE-operated buildings	• Action Area 2: Regional Energy Bureau, Energy Management Teams, Green Teams and Shallow Retrofit Programme • Action Area 3: Energy Efficient Design (EED) Process and Net Carbon Zero Ready Design; • Action Area 4: Deep Energy and Carbon Retrofit Programme • Action Area 5: Metering, Modelling, Reporting and Energy Management Systems
Scope 3	Category 2: Capital goods	• Action Area 3: Energy Efficient Design (EED) Process and Net Carbon Zero Ready Design
	Category 3: Upstream fuel- and energy-related activities relating to buildings energy and fuel consumption	• Action Area 2: Regional Energy Bureau, Energy Management Teams, Green Teams and Shallow Retrofit Programme • Action Area 3: Energy Efficient Design (EED) Process and Net Carbon Zero Ready Design; • Action Area 4: Deep Energy and Carbon Retrofit Programme • Action Area 5: Metering, Modelling, Reporting and Energy Management Systems

As a result, this roadmap is based upon a **Revised Baseline**, including all material emissions excluding those shown in the table above. This is shown in Figure 3, where the emissions categories excluded from the Revised Baseline are faded. The **Revised Baseline includes 68.6% of total emissions from the Full Baseline**.

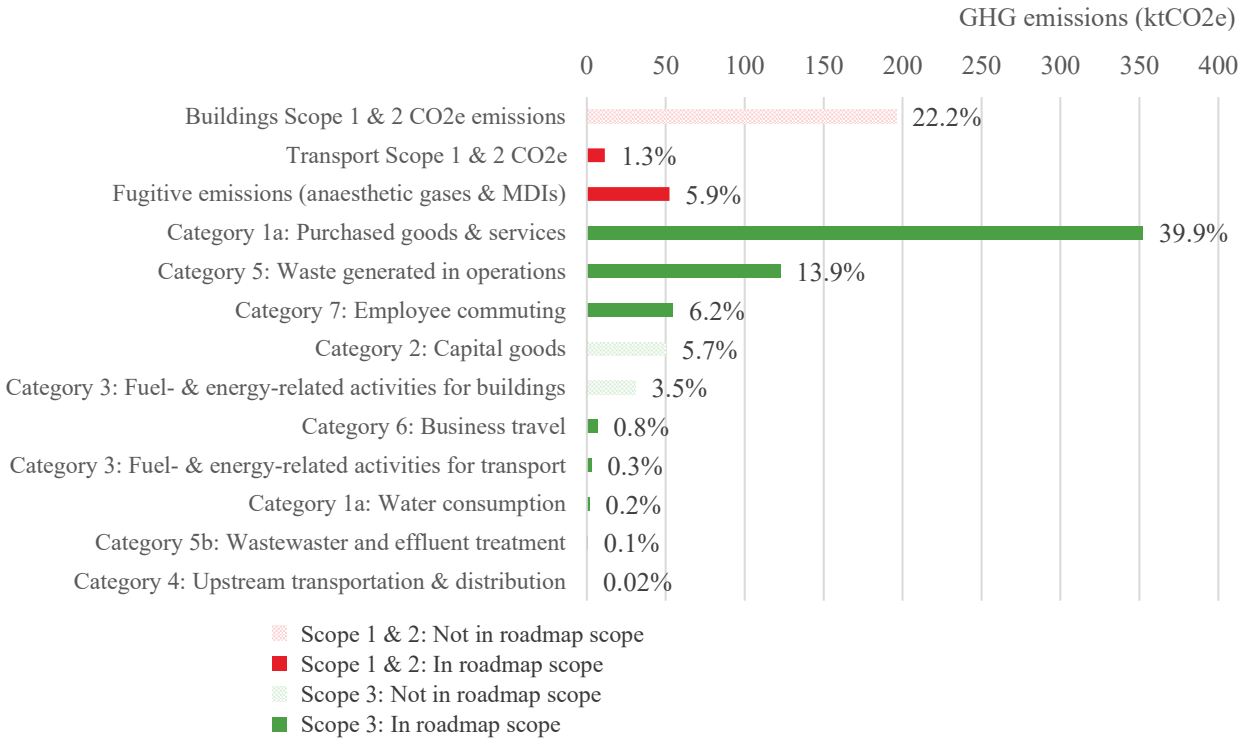


Figure 3: Revised baseline of the HSE in 2019 for use in this roadmap

2. Methodology

The approach taken to developing the evidence base underlying this roadmap is shown in Figure 4; beginning with calculating current emissions associated with the system (step 1), followed by analysing future emissions trends and emissions reduction actions (steps 2-4), the final step is to document the findings of this process in a decarbonisation roadmap. The methodology is aligned with Health Care Without Harm's (HCWH) Designing a Net Zero Roadmap for Healthcare: Technical Methodology and Guidance[7], which provides a framework tailored to national and regional health systems for constructing baselines, projections, and intervention scenarios.

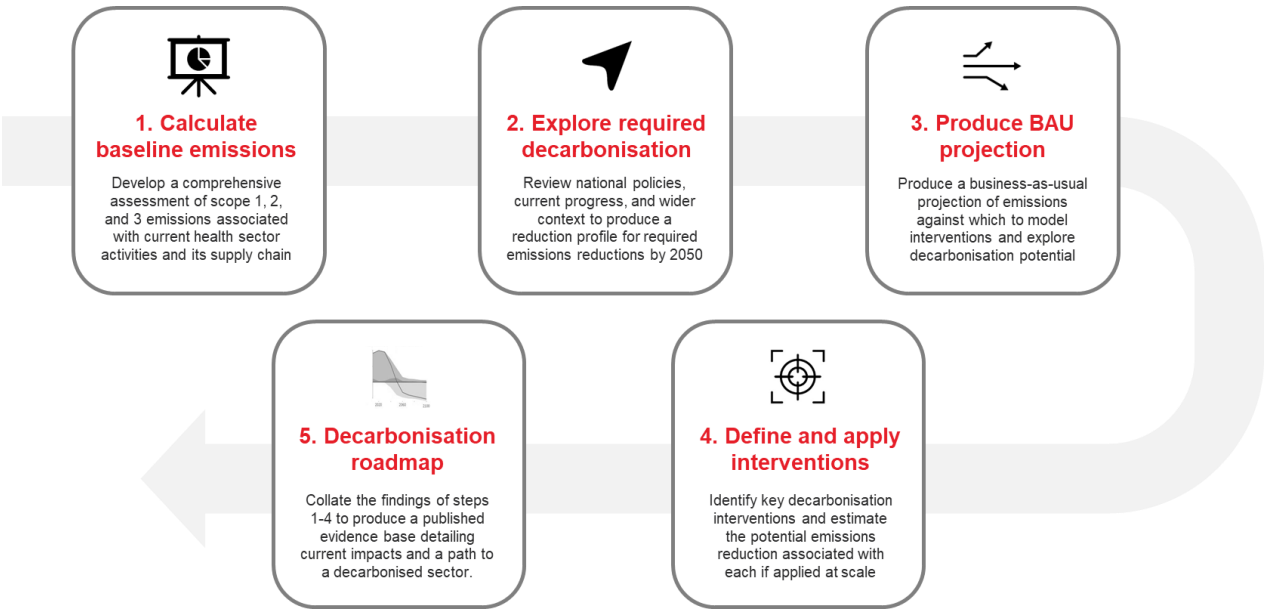


Figure 4: Key steps in the development of the decarbonisation roadmap

The following sections summarise the five stages of this approach, with further detail available in 0.

2.1 Calculate baseline emissions: HSE GHG emissions profile 2019

A robust baseline is critical for planning and evaluating effective decarbonisation. In order to effectively reduce emissions, it is important to first understand their causes and distribution. In this roadmap, the HSE's Revised Baseline serves as the foundational reference point. It underpins the entire modelling process: informing the reference target trajectory, enabling the development of a Business-as-Usual (BAU) projection, and serving as the emissions platform onto which decarbonisation interventions are applied to estimate mitigation potential.

The Full Baseline, and subsequent Revised Baseline, were developed in alignment with the HCWH Designing a Net Zero Roadmap for Healthcare: Technical Methodology and Guidance[7]. This guidance builds on the GHG Protocol Corporate Standard[8] and the Scope 3 Corporate Value Chain Standard[9], which define best practice for measuring and reporting full value chain emissions. This work has been detailed through reporting previously shared with HSE.

[7] 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

[8] World Business Council for Sustainable Development & World Resources Institute, (2004). The Greenhouse Gas Protocol: a corporate accounting and reporting standard (revised edition).

[9] 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.

2.1.1 Approach to calculating current emissions

The 2019 baseline was calculated using a hybrid approach that combines:

- **Bottom-up data:** Process driven activity-specific data (e.g., energy use, inhaler consumption, anaesthetic gases).
- **Top-down estimates:** Financial expenditure data linked to Environmentally Extended Input-Output (EEIO) emissions factors.

Where detailed data were available (e.g., for energy use in hospitals), these were prioritised for more accurate emissions estimates. For upstream Scope 3 emissions, such as procurement-related emissions, EEIO analysis was used to estimate embodied emissions from spend data using global input-output models (EXIOBASE). This combination allowed for a comprehensive and scalable estimate of both direct operational and value chain emissions across the health system.

2.1.2 Data sources used for the baseline calculations

The baseline draws on a combination of internal HSE datasets, national reporting systems, and internationally recognised emissions factors.

For Scope 1 and 2, energy consumption data submitted to SEAI formed the basis of emissions estimates. As SEAI's reporting only includes CO_2, additional GHGs (CH_4 and N_2O) were calculated. Emissions from anaesthetic gases were provided directly by the HSE, while MDI emissions were estimated from internal 2022 data, assumed to reflect 2019 activity.

For Scope 3, procurement-related emissions (e.g. purchased goods, capital goods, water, business travel, waste) were estimated using Environmentally Extended Input-Output (EEIO) expenditure-based emissions factors from EXIOBASE, applied to HSE's 2019 purchase ledger. Pharmaceuticals were treated separately using an emissions factor from the The UK Government Department for Environment, Food and Rural Affairs (DEFRA) due to EXIOBASE limitations. Commuting emissions were modelled using Central Statistics Office (CSO) data on commuting distances and modal share, combined with UK emissions factors. Waste emissions were estimated from tonnage data provided by HSE suppliers, using UK government factors for collection and transport. Upstream energy-related emissions (well-to-tank) were also accounted for using UK emissions factors.

This approach ensured a comprehensive footprint across all material emissions sources within the HSE's operations and supply chain. It is worth noting again here that the boundary of this emissions baseline excluded GHG emissions generated by the direct operations or the supply chain of Section 38 and 39 bodies. See 1.1 for more details on this exclusion.

2.2 Explore required decarbonisation: representing the necessary level of decarbonisation for the roadmap

To guide the modelling of the decarbonisation interventions, this roadmap defines a reference target trajectory, an indicative pathway that reflects the scale of decarbonisation required for the HSE to align with national climate legislation and international best practices in meeting its 2030 decarbonisation targets and its transition towards net zero by 2050. This roadmap does not introduce new binding emissions reduction commitments for the HSE but instead it provides a benchmark to support strategic planning and assess the ambition level needed across all emissions scopes. It is recommended that the formalisation of HSE-wide decarbonisation targets be pursued through a dedicated process beyond the scope of this roadmap.

The trajectory proposed draws on current HSE obligations, particularly those under the Climate Action and Low Carbon Development (Amendment) Act 2021 for energy-related emissions and complements them with reduction benchmarks for other emissions sources. These benchmarks are informed by international best practice, including the Science Based Targets initiative (SBTi), which provides frameworks for aligning organisational targets with the global carbon budgets from the Paris

Agreement. The milestones used to develop the trajectory are summarised in Table 2, with the absolute values being presented in 0, Table 7.

Table 2: Reference target trajectories used for the HSE decarbonisation roadmap

Emissions Boundary	Baseline Year	2030 Milestone	2050 Milestone
Scope 1 & 2 Transport-Related Carbon Dioxide Emissions (captured under the mandated target for energy-related emissions under the Climate Action and Low Carbon Development (Amendment) Act 2021)	2016-2018 Average	51% reduction	100% reduction
Scope 1 & 2 Transport-Related Methane and Nitrous Oxide Emissions	2018	51% reduction	100% reduction
Scope 3 Emissions (excl. Capital Goods)	2018	38% reduction	90% reduction
Combined	**2018**	**39% reduction**	**91% reduction**

Together, these reference points form a comprehensive reference target trajectory, consistent with current statutory obligations and scientifically aligned with the Paris Agreement's 1.5 °C pathway, while extending to capture emissions across the wider HSE value chain. Where data for 2018 was unavailable, values have been back-cast from 2019 to ensure continuity.

2.3 Produce business-as-usual (BAU) projection: projecting future emissions in the absence of decarbonisation interventions

2.3.1 Developing a business-as-usual projection

To project forward the HSE's GHG emissions in the absence of further climate mitigation measures, a BAU projection was developed. This projection provides a benchmark against which future decarbonisation actions can be assessed and is constructed using the revised baseline as its foundation. It combines projections for healthcare demand growth with anticipated decarbonisation trends in key sectors of the wider economy.

Growth in demand for healthcare services was modelled using public expenditure forecasts on health expenditure for Ireland through to 2070[10]. These projections, expressed as a percentage of national GDP, were paired with GDP forecasts from the International Monetary Fund to estimate how total healthcare provision is likely to evolve through to 2050[11]. The resulting projection, based on constant prices, indicates a 150% increase in healthcare activity by 2050 relative to 2019.

To account for changes in emissions intensity linked to broader economic decarbonisation, the BAU projection also integrates sectoral pathways from the Transition Pathway Initiative's (TPI) Sectoral Decarbonisation Pathways (v4.0). These pathways, based on International Energy Agency data, provide expected emissions intensity trends for key industries such as electricity generation, transport, non-metallic minerals (e.g. cement), and metals. Where EXIOBASE industry sectors corresponded directly to TPI categories, the sectoral pathways were applied directly. For all other goods and services, emissions factor trajectories were generated indirectly through the inter-industry relationships encoded in EXIOBASE's environmentally extended input–output (EEIO) tables. In this way, reductions in carbon intensity in upstream production (e.g. electricity, fuels, or chemicals) cascade through supply chains, lowering the embodied emissions of downstream categories such as pharmaceuticals, medical devices, or catering.

This approach ensured that every EXIOBASE product category reflected an evolving emissions intensity trajectory from 2020 to 2050, with TPI sectoral pathways serving as the drivers of upstream

[10] European Union. "2024 ageing report - Publications Office of the EU" (2024).
[11] International Monetary Fund "World Economic Outlook database: April 2024." (2024). For years for which a forecasted GDP value was not available, values were linearly extrapolated from the provided data.

decarbonisation consistently propagated across the healthcare supply chain via the EEIO framework. Together, these inputs yield a BAU projection that reflects both projected increases in healthcare activity and wider systemic decarbonisation. This projection will serve as a key reference point in the roadmap to evaluate the scale and impact of HSE's planned emissions reduction interventions.

2.4 Define and apply interventions: identifying mitigation options and developing scenarios where they are applied

To explore the HSE's potential to reduce greenhouse gas (GHG) emissions across its operations and supply chain, a suite of decarbonisation interventions were developed and modelled against the business-as-usual (BAU) emissions projection. These interventions are designed to represent realistic but ambitious mitigation actions that could be taken by the health service in the coming years.

The interventions were identified based on HSE's existing decarbonisation ambitions, as articulated through its Climate Action Strategy and supporting frameworks, and refined through expert input, evidence from comparable health systems, and best practice in healthcare decarbonisation. They span both operational and value chain emissions sources and reflect opportunities for both behavioural and technological change. Interventions consider the impact on GHG emissions where these interventions are applied at scale, and by implication assume that enabling actions and infrastructure is developed alongside. For example, a transition to electric vehicles included in the model assumes that associated charging infrastructure can be established in parallel to the fleet transition.

2.4.1 Framing interventions

The decarbonisation interventions modelled in this roadmap are structured around the Priority Areas of Focus set out in the HSE's Climate Action Strategy 2023–2050. These strategic pillars guide the organisation's climate action efforts and provide a framework for identifying emissions reduction opportunities across its operations and value chain.

Of the six Priority Areas established in the Climate Action Strategy, four are directly relevant to emissions mitigation and included within the scope of this roadmap. The remaining two, *Adaptation and Resilience* and *Sustainable Buildings and Green Environment*, fall outside the scope of this analysis; with the latter being covered by the Infrastructure Decarbonisation Roadmap as explained in Section 1.3.

The four Priority Areas of Focus included in the scope of this roadmap are:

- **Transport and Mobility**: These are treated as two distinct areas in this roadmap to reflect the HSE's decision to develop and implement separate strategic frameworks following the Climate Action Strategy. The Transport area focuses on the electrification and optimisation of HSE's operational fleet, while Mobility addresses emissions from staff commuting and business travel, promoting modal shift, public transport, and active travel.
- **Water and Waste Management**: This area targets reductions in both the volume of waste generated and the emissions associated with its treatment, with a particular focus on high-impact clinical waste streams. It also encompasses water conservation measures and improved monitoring of water use to reduce consumption and associated emissions
- **Greener Models of Healthcare**: Encompassing a range of clinical and operational practices, this area includes interventions such as the shift to low-carbon inhalers and anaesthetic gases, optimising pharmaceutical use, and extending the lifespan of equipment.
- **Sustainable Procurement**: This area focuses on addressing emissions embedded in the health system's supply chain. Interventions include engaging suppliers to disclose emissions data, shifting purchasing decisions toward lower-carbon products and services, and applying sustainability criteria in procurement processes.

By aligning with these four Priority Areas of Focus, the interventions in this roadmap build upon existing HSE strategies while providing a robust modelling framework to assess and plan for comprehensive emissions reduction across the organisation's operations and value chain. Following this framework, the full list of interventions considered is provided in Table 3, including a description of the actions and the 'Priority Area of Focus' under which each intervention is applied. Importantly, while these interventions are primarily designed to target decarbonisation, many also bring significant co-benefits, from improving health outcomes (e.g., through reduced air pollution or increased physical activity) to enhancing care delivery efficiency and reducing costs.

Table 3: Decarbonisation interventions applied to emissions baseline and BAU trajectory

HSE CAS Priority Area of Focus	Intervention category	Description
Transport	Electrification of fleet vehicles	Involves transitioning the health sector's fleet to fully electric vehicles. This includes ambulances, and other vehicles owned and operated by health care providers.
Greener models of healthcare	Optimised use of pharmaceuticals	Implementing strategies to reduce the over-prescription and unnecessary use of pharmaceuticals within the health care system, in manner than reduces overmedicalisation without altering patient care pathways or health outcomes.
	Extending the lifespan of medical and other IT equipment	Extending the lifespan of electrical products to reduce consumption of new equipment. More proactive maintenance schemes, as well as prioritising suppliers offering longer warranties and servicing can contribute to longer service lives for products.
	Shift to low carbon inhalers	Transitioning from traditional propellant inhalers to low carbon inhalers. This can take the form of dry powder products and soft-mist inhalers in the near term, and in the longer term include the non-GHG based propellant systems currently under development.
	Shift to low carbon anaesthetic gas equivalents	Transitioning to lower carbon anaesthetic practices by eliminating desflurane, optimising the use of Total Intravenous Anaesthesia (TIVA), minimising fresh gas flows, and continue to implement nitrous oxide mitigation plans.
	Reduce plate waste and optimise food purchasing	Implementing food demand planning strategies to minimise over-purchasing, thereby reducing food waste at the point of consumption and improving overall catering efficiency.
Mobility	Encourage lower-carbon employee commuting	Promoting a modal shift in employee commuting by expanding infrastructure and incentives for active travel and making urban hospitals active transport hubs; improving access to public transport; supporting carpooling and shared travel; and encouraging the adoption of electric vehicles for residual car use.
	Reducing total mileage of business travel and shifting to less emissions intensive modes of transportation	Centralising and managing business travel to reduce unnecessary trips, promote digital communication, and prioritise lower-emission transport options, supported by policy thresholds, behavioural incentives, and leadership engagement.
Water and waste management	Reduce the volume of waste generated and the emissions intensity of the treatment methods	Minimising waste through improved procurement planning, prioritisation of reusable medical and support products, vendor take-back programmes, and adoption of low-emission waste treatment technologies, particularly for risk waste.
Sustainable procurement	Reduce the carbon intensity of food in catering by reducing meat intake and transition to a plant-based diet.	Reducing the emissions intensity of meals served in healthcare settings by reducing meat intake in meals and shifting more plant-based and low-emission options, while maintaining the necessary nutritional standards for patients and staff.

HSE CAS Priority Area of Focus	Intervention category	Description
	Prioritising low carbon pharmaceuticals suppliers	Prioritising low carbon suppliers involves requesting Environmental Product Declarations (EPDs) or sustainability data during the procurement process for pharmaceuticals, aiming to aid selection of lower carbon alternatives. Complemented by engaging suppliers on broader environmental performance, including efforts to reduce single-use items, prioritise reusable or refillable formats where clinically appropriate, and adopt more sustainable packaging materials.
	Prioritising low carbon medical equipment suppliers	Engaging with key suppliers of medical equipment to ensure that carbon associated with products is a key consideration in procurement. Through requesting Environmental Product Declarations and other information when selecting products and suppliers, procurement teams can select suppliers with lower emission products.
	Supplier decarbonisation standards	Mandate that suppliers have validated Science Based Target aligned decarbonisation strategies consistent with achieving net zero by 2050. If suppliers adopt and deliver against these targets, decarbonisation progress can be driven across the full health care value chain.

2.4.2 Applying interventions in the roadmap

To model each intervention and its impact on emissions, two key parameters were defined:

1. The **intervention threshold**: the scale of emissions reduction that can be achieved through the application of actions attributable to the intervention.
2. The **intervention adoption rate**: the timeline over which the intervention is to be implemented. These rates have been modelled using an end-year where the intervention is fully applied, with an S-curve to represent the rate at which progress is made between the start- and end-years.

Data on intervention potential decarbonisation thresholds and feasible adoption rates were grounded in an evidence base of mitigation activities and associated magnitudes of changes in activity or emissions activity that was determined to be applicable to the sector based on Irish sources, research, and understanding of opportunities and limitations within the sector. For each intervention, the approach to assigning thresholds and adoption rates is detailed in 0, Table 8.

Table 4 provides a list of decarbonisation interventions that were applied to the emissions baseline and BAU projected emissions considering global decarbonisation trajectories. When modelling how these interventions result in future emissions reductions, each intervention has been applied in a cumulative manner, beginning with the interventions that the HSE have the greatest control over actioning, moving sequentially down to those which rely the most on external engagement.

Table 4: Thresholds, timelines, and associated assumptions relating to the decarbonisation interventions

HSE CAS Priority Area of Focus	Intervention category	Intervention threshold	Intervention timeline
Transport	Electrification of fleet vehicles	Transition to a fleet, including ambulances, to **100%** Zero Emission Vehicles (ZEVs).	Fully applied by 2035
	Optimised use of pharmaceuticals	Reducing quantity of pharmaceuticals purchased by **20%**.	Fully applied by 2050

HSE CAS Priority Area of Focus	Intervention category	Intervention threshold	Intervention timeline
Greener models of healthcare	Extending the lifespan of medical and other IT equipment	All medical and IT equipment kept for a **25%** extended lifespan.	Fully applied by 2050
	Shift to low carbon inhalers	Transition to lower carbon inhalers reducing emissions intensity of inhalers by **90%**.	Fully applied by 2040
	Shift to low carbon anaesthetic gas equivalents	A **50%** decrease in emissions from anaesthetic gases.	Fully applied by 2030
	Reduce plate waste and optimise food purchasing	Reduce excess purchase of food by **21.5%**.	Fully applied by 2050
Mobility	Encourage lower-carbon employee commuting	A **43%** decrease in emissions from employee commuting by 2030 and an **86%** decrease by 2050.	Half applied by 2030, fully applied by 2050
	Reducing total mileage of business travel and shifting to less emissions intensive modes of transportation	Reduction in business travel emissions **50%** by **2030**, whilst all business travel will be **zero emission by 2040**.	Half applied by 2030, fully applied by 2040
Water and waste management	Reduce the volume of waste generated and the emissions intensity of the treatment methods	Reduction in total waste by **50%**.	Fully applied by 2040
Sustainable procurement	Reduce the carbon intensity of food in catering	**38%** decrease in emissions from food by **2030**, with a **76%** reduction by **2050**.	Half applied by 2030, fully applied by 2050
	Prioritising low carbon pharmaceuticals suppliers	Transition to greener procurement of pharmaceuticals, reducing the emissions intensity of pharmaceuticals by **10%**.	Fully applied by 2030
	Prioritising low carbon medical equipment suppliers	Prioritisation of lower carbon suppliers reducing the emissions intensity of medical equipment by **10%**.	Fully applied by 2030
	Supplier decarbonisation standards	Transition to sustainable suppliers could reduce emissions for purchased goods and services by **76.5%**.	Fully applied by 2050

2.5 Assumptions and limitations

In developing the analysis presented in this roadmap, there are a number of assumptions and limitations associated with this work, summarised in the paragraphs below. A full discussion of these is presented in the technical annex.

2.5.1 Baseline

The baseline emissions assessment relies on several key assumptions due to data gaps and methodological constraints. The analysis primarily used expenditure-based estimates using EEIO models like EXIOBASE, which apply average emissions intensities across product categories and lack supplier-specific accuracy. Additionally, data completeness varies across categories due to

missing or extrapolated activity data, with F-gases excluded entirely. Pharmaceutical emissions were estimated using UK DEFRA proxies, assuming similarity with Irish conditions. MDI inhaler emissions were based on incomplete 2022 data used as a proxy for 2019, likely underrepresenting actual figures. Freight emissions could not be separately identified from purchased goods and services. The emissions intensity of waste treatment may be overstated due to conservative assumptions about treatment methods, while it is believed that available data may not capture all waste streams. Commuting emissions were modeled using national averages, which may not reflect actual staff distribution. These limitations introduce uncertainty and variability across the emissions profile, highlighting areas for future data improvement.

It is also important to note that this study covers only HSE's directly managed facilities and the associated supply chain. Emissions from Section 38 and 39 organisations, which together deliver a significant share of healthcare services in Ireland, including many of the largest tertiary academic teaching hospitals, were not included. This exclusion reflects both data availability (particularly for Scope 3 categories) and the need for direct engagement with those organisations to ensure accurate estimation. As a result, the 2019 Revised Baseline presented here should be understood as the footprint of the HSE itself, not the totality of HSE-funded organisations. The full emissions of the Irish health sector are therefore likely to be significantly higher than those reported in this study. See 1.1 for more details on this exclusion.

2.5.2 Required decarbonisation trajectory and the BAU projection

The required decarbonisation trajectory and the BAU projection are shaped by several assumptions that limit their ability to reflect dynamic or disruptive changes in the healthcare system. Firstly, the Business-as-Usual (BAU) projection is built on a static 2019 model of the economy, assuming no structural shifts in supply chains, technology, or clinical practices beyond those already embedded in sectoral emissions factors. Secondly, the projection incorporates emissions intensity trends from the Transition Pathway Initiative (TPI), which reflects expected decarbonisation under current policy pledges but does not guarantee implementation. Thirdly, sectoral emissions growth is projected in line with anticipated increases in healthcare expenditure as a share of GDP, assuming emissions scale proportionally with spending and not accounting for changes in service models or population health needs. Finally, the BAU projection does not incorporate future shifts in disease burden or climate-related cost impacts, such as increased insurance or infrastructure stress from extreme weather, which could significantly alter future emissions profiles. In the creation of the the reference target trajectory, to ensure consistency across emissions scopes, some 2018 data was backcasted from 2019 estimates, introducing minor distortions in trajectory curves.

2.5.3 Interventions modelled

While the roadmap models interventions related to operations, procurement, and mobility, where emissions drivers are measurable and emissions factors are available, it **was not possible to model more systemic decarbonisation opportunities** with certainty. These more complex changes can be expected to lead to many knock-on and rebound effects, and emissions reductions are likely to come from a large number of smaller improvements and efficiencies. These include interventions such as redesigning care pathways to reduce clinical throughput, scaling reusable and modular medical equipment models, reducing reliance on high-intensity treatments through prevention-led healthcare, or embedding circular principles into logistics and service delivery. While these changes may offer significant long-term emissions reduction potential, accurately modelling impacts at a system wide level is a highly complex exercise reliant on more granular data that is currently available. Future strategic work should explore how these types of interventions, particularly circular care models, prevention-based approaches, and digital care redesign, could contribute to HSE's broader decarbonisation goals. Identifying best practice case-studies and piloting approaches can help to demonstrate potential that cannot easily be explored through modelling.

It is acknowledged that some capital works, such as equipment replacement, infrastructure upgrades, EV charging infrastructure, or energy system overhauls, may be necessary enablers for certain

decarbonisation interventions modelled within this roadmap. As such, **while capital goods emissions are excluded from the emissions scope and modelling, it is recognised that there may be some overlap with other infrastructure programmes**. Additionally, embodied emissions from such new infrastructure and capital investments are not factored into this modelling. This represents a limitation of the current analysis and underscores the importance of integrated planning across decarbonisation efforts. Future alignment with emerging government targets for embodied carbon will help ensure that mitigation efforts across both domains are fully accounted for.

3. HSE's decarbonisation roadmap

This section summarises the key findings from HSE's decarbonisation roadmap. It begins by outlining the 2019 GHG emissions baseline, which establishes a comprehensive picture of emissions across the HSE's operations and value chain. It then sets out the trends of emissions under a BAU projection and introduces a reference target trajectory aligned with Ireland's national climate policy and international net-zero frameworks. These analyses serve as the foundation for the decarbonisation roadmap, which quantifies the impact of targeted emissions reduction interventions. These interventions are grouped according to the HSE's Priority Areas of Focus, as defined in its Climate Action Strategy 2023–2050, and represent the central focus of this roadmap. When the impact of these interventions are considered together, this represents the decarbonisation roadmap scenario.

3.1 The HSE's GHG emissions baseline

The following section presents the results of the emissions baseline developed for the 2019 reporting year, summarised through key tables and figures. Table 5 provides 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 $ktCO_2e$. 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. Faded values represent GHG emission categories not included within the roadmap scope.

Across the full baseline scope, scope 1 and 2 emissions represented just under 30% GHG emissions in 2019. Scope 3 emissions accounted for approximately 70% of the HSE's total annual GHG emissions. 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.

Table 5: The 2019 Baseline GHG emissions of the HSE. Note: emissions excluded from the scope of this roadmap are greyed, leaving the revised baseline values used within the roadmap.

	Emissions $ktCO_2e$	Share of total emissions, %
Scope 1 & 2 emissions	259.7	29.5%
Transport Scope 1 & 2 CO_2e	11.5	1.3%
Buildings Scope 1 & 2 CO_2e emissions	196.0	22.2%
Fugitive 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 for transport	33.6	0.3%
Category 3: Fuel- & energy-related activities for buildings	2.8	3.5%
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 (Full Baseline scope)	**881.9**	**100.0%**
Total emissions (Revised Basline scope)	**605.0**	**68.6%**

Since emissions from Purchased Goods and Services (excluding water) comprised a significant share of the overall inventory, Figure 5 offers a more detailed breakdown of the highest-emitting categories, showing the percentage share of the Full Baseline emissions relating to each Purchased Goods and Services subcategory. Pharmaceuticals and medical equipment and instruments were the largest contributors, jointly representing 26% of the Full Baseline GHG emissions across all scopes in 2019.

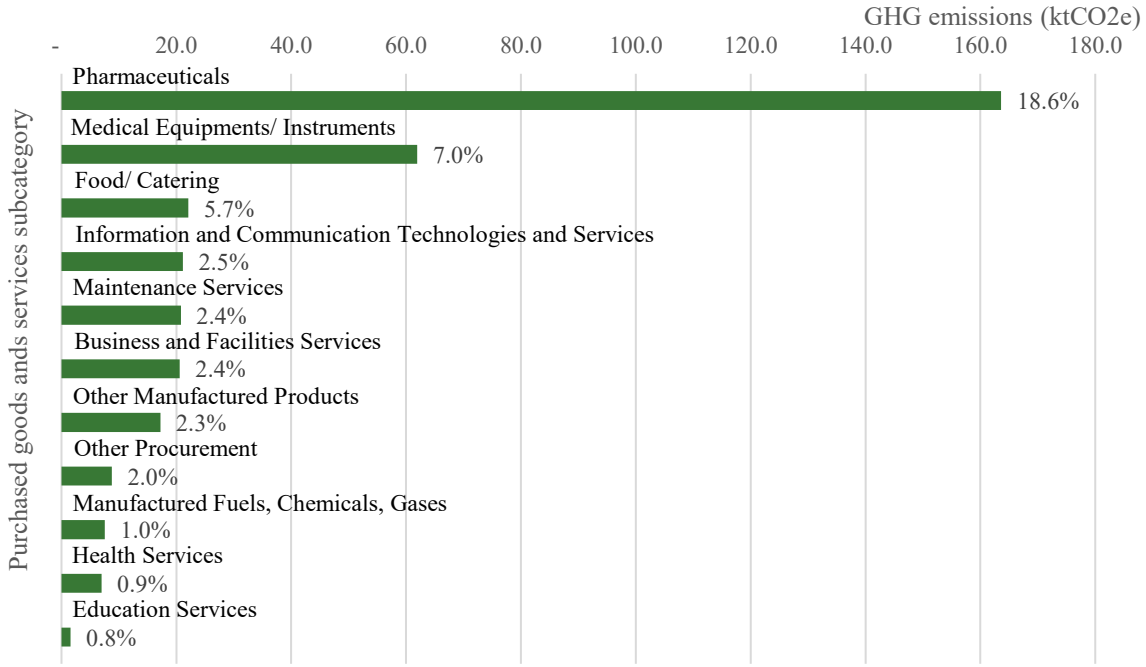


Figure 5: Percentage of Full Baseline emissions associated with subcategories of Purchased Goods and Services (i.e., Scope 3 Category 1a)

3.2 The scale of required decarbonisation and the business-as-usual emissions of the HSE

The Business as Usual (BAU) emissions projection illustrates the potential growth in the HSE's emissions in the absence of additional mitigation measures. The projection shows an 89.8% increase in emissions by 2050, reflecting both expected growth in healthcare activity and broader economic decarbonisation trends. For comparison, the indicative target trajectory, shown by the dotted black line in Figure 6, represents the scale of emissions reduction required to align with Ireland's national climate targets and international best practice.

Figure 6: Comparison of projected BAU emissions and the target reduction trajectory

The difference between the BAU projection and the reference target trajectories illustrates the scale and pace of decarbonisation required for HSE to transition towards net zero.

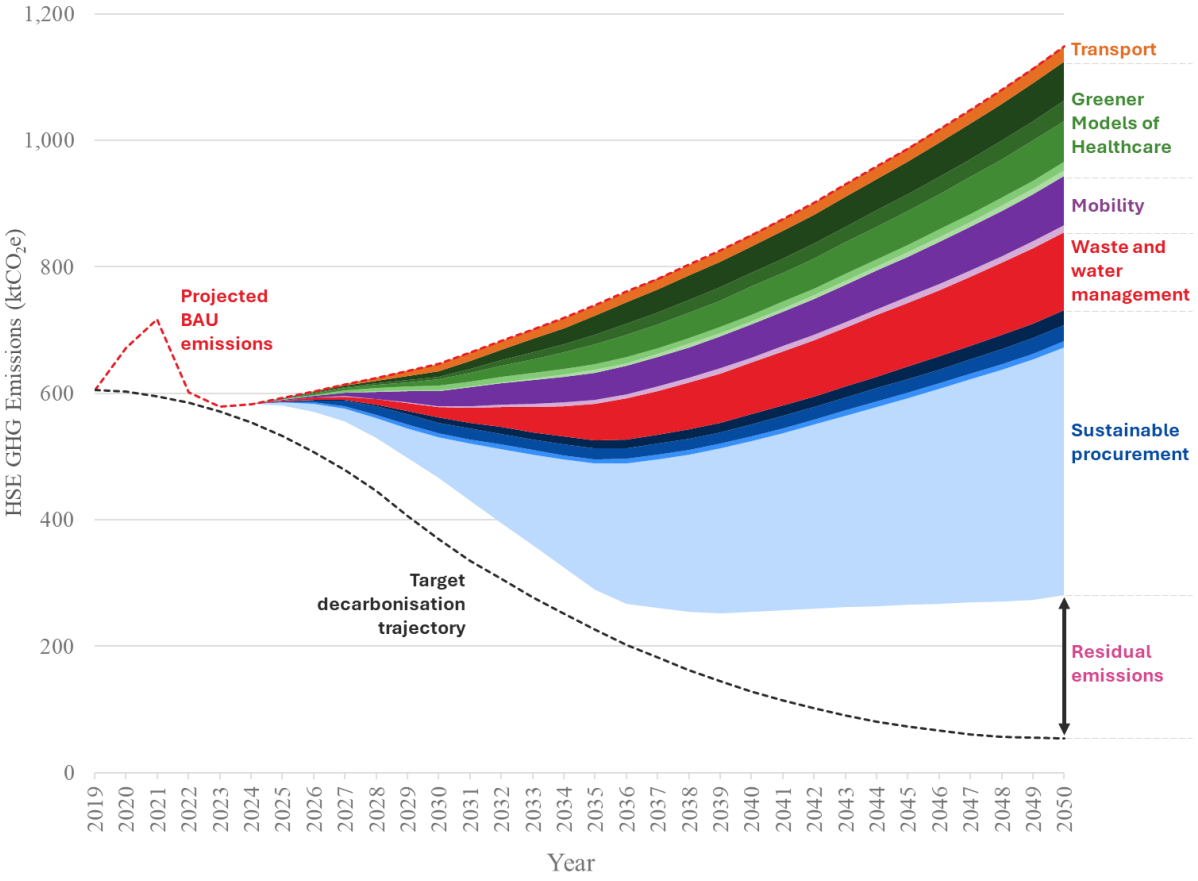
3.3 The decarbonisation roadmap scenario

Though analysing the scale of emissions reduction potential for key decarbonisation interventions across the health system, a decarbonisation roadmap scenario has been developed which, with all the interventions taken together, provides a roadmap towards the HSE being a net-zero aligned organisation.

3.3.1 Decarbonisation roadmap scenario outputs

In 2019, emissions within the scope of this roadmap for the HSE were estimated at 605 $ktCO_2e$. In the absence of further mitigation measures, emissions are projected to grow significantly, reaching an annual total of 1,148 $ktCO_2e$ by 2050 under the BAU projection. This projected increase reflects both anticipated growth in healthcare activity and broader trends in economic decarbonisation, as outlined earlier in the roadmap. The initial increase in emissions between 2019 and 2022 reflects heightened healthcare activity during the COVID-19 pandemic, with elevated levels of service demand and associated resource use captured in the underlying public health expenditure projections used to model the BAU projection.

However, when the full suite of modelled decarbonisation interventions is applied, emissions are reduced to an annual total of approximately 280 $ktCO_2e$ by 2050. This represents a 76% reduction compared to the BAU projection and a 54% reduction compared to the Revised 2019 Baseline. The interventions are applied cumulatively and aligned with the HSE's Climate Action Strategy Priority Areas of Focus. Figure 7 presents the projected emissions trajectory from 2019 to 2050, showing the impact of each individual intervention layered over time. Among these, the 'Supplier decarbonisation standards' intervention delivers the largest contribution to emissions reductions, delivering a 34% reduction in annual emissions in 2050 relative to the BAU projection GHG emissions.



Intervention Name	Roadmap Colour
Electrification of inter-site vehicles	
Optimised use of pharmaceuticals	
Extending the lifespan of medical & IT equipment	
Shift to less GHG emissions intensive inhalers	
Shift to less GHG emissions intensive anaesthetic gas equivalents	
Reduce the carbon intensity of food in catering	
Reduce plate waste and optimise food purchasing	
Encourage lower-carbon employee commuting	
Reduce the distance covered in business travel cumulatively and the emissions intensity of the transportation modes	
Reduce the volume of waste generated and the emissions intensity of the treatment methods	
Prioritising low carbon pharmaceutical suppliers	
Prioritising low carbon medical equipment suppliers	
Supplier decarbonisation standards	

Figure 7: The HSE decarbonisation roadmap. The GHG emissions reductions ($ktCO_2e$) of individual decarbonisation interventions over time are illustrated by individual wedges, colour coded by their respective Priority Area of Focus.

The waterfall chart in Figure 8 breaks down the emissions reduction by intervention grouping, categorised under the CAS Priority Areas, in 2050. The most significant emissions savings are delivered through actions in Sustainable Procurement (−451 $ktCO_2e$) and Greener Models of Healthcare (−181 $ktCO_2e$), followed by Water and Waste Management (−124 $ktCO_2e$), Mobility (−89 $ktCO_2e$), and Transport (−24 $ktCO_2e$).

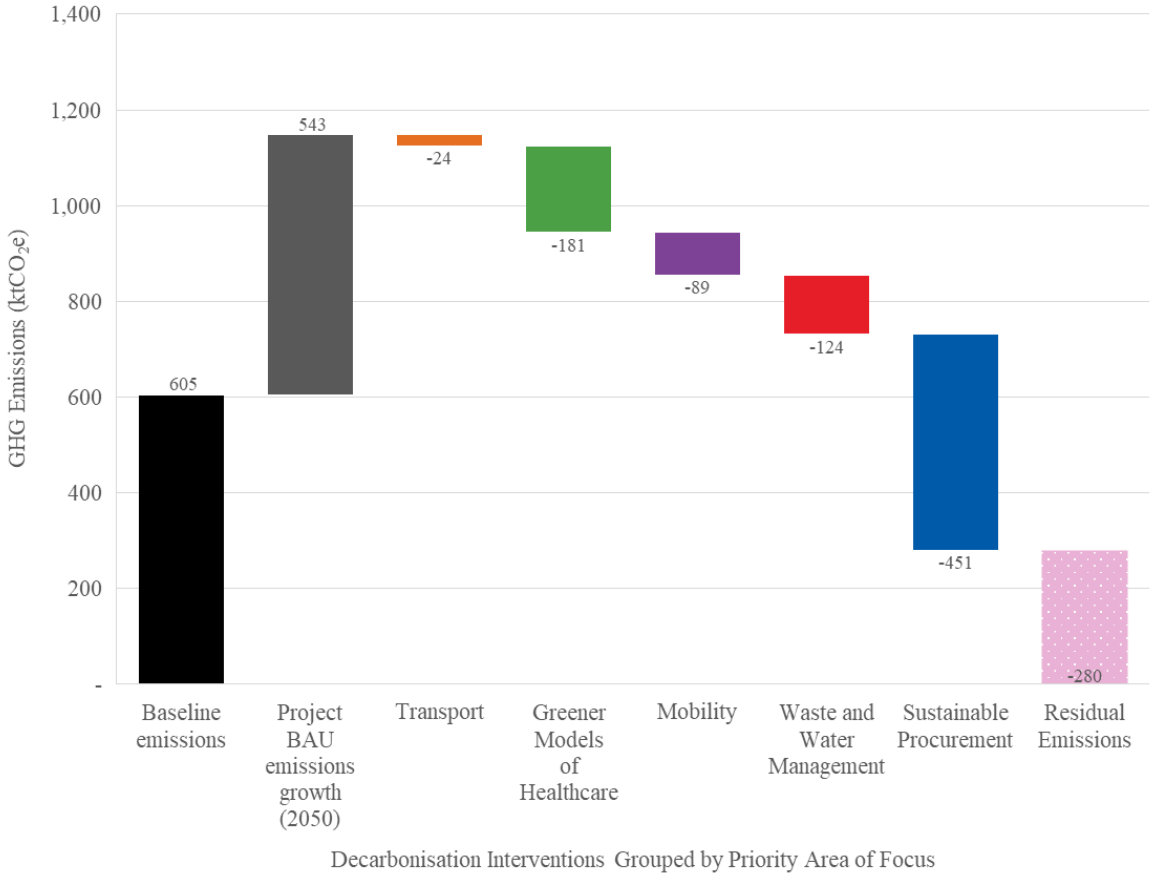


Figure 8: Decarbonisation waterfall chart, illustrating the emissions reductions from each group of interventions by 2050, relative to the Revised Baseline and BAU projection emissions.

Cumulatively over the course of the roadmap, the total emissions reductions resulting from the different interventions are listed in Table 6 below. The results highlight the outsized role of supplier decarbonisation standards, which account for more than 5,400 $ktCO_2e$ of avoided emissions between 2019 and 2050, by far the single most impactful measure. Other major contributions come from waste and water management interventions (1,650 $ktCO_2e$), lower-carbon commuting (1,140 $ktCO_2e$), and the adoption of low-GHG inhalers (888 $ktCO_2e$). While smaller in scale, actions such as extending the lifespan of equipment (434 $ktCO_2e$) and prioritising low-carbon pharmaceutical suppliers (455 $ktCO_2e$) also represent meaningful opportunities for sustained reductions.

Table 6: Cumulative GHG emissions reductions for interventions from 2019-2050

HSE CAS Priority Area of Action	Decarbonisation Intervention	Cumulative Emission Reductions 2019-2050 ($ktCO_2e$)	Percentage of Cumulative Roadmap Emission Reductions
Transport	Electrification of inter-site vehicles	400	3%
Greener Models of Healthcare	Optimised use of pharmaceuticals	850	7%
	Extending the lifespan of medical and IT equipment	434	4%
	Shift to low GHG intensity inhalers	888	7%

HSE CAS Priority Area of Action	Decarbonisation Intervention	Cumulative Emission Reductions 2019-2050 ($ktCO_2e$)	Percentage of Cumulative Roadmap Emission Reductions
	Shift to low GHG intensity anaesthetic gas equivalents	236	2%
	Reduce plate waste and optimise food purchasing	116	1%
Mobility	Encourage lower-carbon employee commuting	1,140	9%
	Reduce the distance covered in business travel cumulatively and the emissions intensity of the transportation modes	166	1%
Water and Waste Management	Reduce the volume of waste generated and the emissions intensity of the treatment methods	1,650	13%
Sustainable Procurement	Reduce the carbon intensity of food in catering	348	3%
	Prioritising low carbon pharmaceutical suppliers	455	4%
	Prioritising low carbon medical equipment suppliers	177	1%
	Supplier decarbonisation standards mandating Net Zero commitments and demonstrated progress.	5,487	44%

4. Analysis: Interventions by Priority Area

This section provides analysis and discussion of the results from the roadmap modelling; including implications of the findings across each of the five HSE Climate Action Strategy priority areas of focus addressed within this roadmap. These include:

- Transport
- Greener Models of Healthcare
- Mobility
- Waste and Water Management
- Sustainable Procurement

While the roadmap's modelling does not offer an exhaustive list of all actions the HSE could undertake, it identifies key, high-impact interventions that are ambitious yet feasible. These have been selected and applied through engagement with HSE stakeholders, and their inclusion does not preclude further or more ambitious action being considered in the future. As such, the analysis below is intended to support implementation planning by highlighting where key opportunities lie. To ensure alignment with existing workstreams, commentary under each section also references the relevant Strategic Frameworks being developed under the Climate Action Strategy, where available at the time of publication.

4.1 Priority area of focus 1: Transport

Modelling shows that electrification of the HSE's inter-site vehicle fleet could result in a complete abatement of road transport emissions within the scope of this roadmap by 2050. The intervention delivers a modest cumulative emissions reduction of 400 $ktCO_2e$, due to the relatively small contribution of transport emissions within the baseline (2%). Nevertheless, this represents a clear and actionable route to decarbonisation. Achieving the full benefits of this measure depends on several enabling factors, including continued grid decarbonisation, adequate grid capacity, widespread EV charging infrastructure, and expanded use of on-site renewable electricity to reduce reliance on the national grid. As these emissions fall under to energy-related GHG emissions, this intervention also directly aligns with the HSE's mandated targets for public sector organisations under the Climate Action and Low Carbon Development (Amendment) Act 2021. As noted previously, this area is also reliant on the availability of related infrastructure such as charging facilities.

This aligns directly with the HSE's Strategic Framework on Transport[12], which outlines the objective of transitioning to a zero-emissions fleet and identifies electrification of vehicles as a critical action. Continued coordination with the Transport Working Group is recommended to ensure the roadmap's implementation dovetails with ongoing delivery planning.

4.2 Priority areas of focus 2: Greener models of healthcare

This priority area provides the second largest potential for emissions reductions within the roadmap, with the five interventions delivering a total reduction of 2,408 $ktCO_2e$ by 2050. This represents a fifth of total cumulative emissions reductions across the roadmap. These five interventions all fall within the seven principles for sustainable healthcare as laid out in the Greener Models of Healthcare Delivery Framework[13] of the HSE. This includes a focus on preventative models of care; operational resource use efficiency; the implementation of low carbon alternatives; lean care pathways with integrated care closer to home; a patient empowered approach to health management; leadership and a climate-informed workforce; and an adaptation and resilience focus.

[12] HSE. (2025). HSE Transport Framework.
[13] HSE. (2025). HSE Greener Healthcare Framework. [Not currently available online]

Interventions include reduced use of high-impact metered dose inhalers (MDIs), reducing the use of high-impact anaesthetic gases by switching to lower-impact agents and alternative techniques and nitrous oxide mitigation plans, extending the lifespan of medical and IT equipment, and minimising plate waste. In many cases, these actions offer co-benefits such as reduced procurement costs and improved patient outcomes. However, implementation depends on enabling practice change across a diverse set of professional actors. As such, change management and engagement with clinicians, procurement teams, and facilities management will be essential.

This category of intervention builds progressively through the 2020s and 2030s, driven by relatively diffuse but cumulatively impactful action across healthcare delivery. GHG reductions from the reduced use of high-impact MDIs and anaesthetic gases, including through nitrous oxide mitigation plans, ramp up steadily, while lower-carbon prescribing and reduced overuse of medical goods gain importance in later decades. The HSE has developed a dedicated Strategic Framework on Greener Models of Healthcare Delivery[13]. Alignment with its direction will be critical. For example, engagement with clinicians and sector bodies should be structured to build literacy around environmental metrics, helping embed low-carbon practices across prescribing and clinical decision-making.

4.3 Priority area of focus 3: Mobility

Interventions targeting staff and business travel emissions contribute a cumulative reduction of 1,306 $ktCO_2e$ in emissions reductions by 2050, representing 11% of all roadmap reductions. These measures include encouraging active and low-carbon commuting and reducing the distance and emissions intensity of business travel. These actions depend heavily on travel policies, digital transformation (e.g., telehealth or virtual meetings), and availability of public transport infrastructure. This modelling has not considered the environmental impacts of patient and visitor travel, which can be expected to have large emissions impact which HSE would be in a position to influence and reduce. These emissions were outside the scope of this assessment, but it should be noted that some other health systems track and report these emissions alongside staff and business travel.

A key limitation in this area is the lack of disaggregated data on commuting patterns. Current modelling estimates the rural-urban distribution of employees using top-down proxies, introducing uncertainty around baseline commuting emissions. Improved data, potentially gathered through staff surveys, be essential to refine future modelling and intervention planning. The Strategic Framework on Mobility acknowledges this and includes a commitment to improving this evidence base.

In terms of modelling assumptions, a conservative approach was taken, commuting emissions reductions through modal shift (to active, public, or shared transport) were applied only to urban-based staff, while in rural areas, only an EV transition was assumed. This reflects the practical limitations of modal shift in rural settings. However, with the right support, such as rural shared mobility schemes, park-and-ride infrastructure, or investment in community transport, there may be additional emissions savings available in rural regions. Broader public policy will be a key enabler here. This also highlights the limited degree of agency the HSE has to fully decarbonise mobility-related emissions and underscores the need for coordinated action across government. For employees living in urban areas, the assumed modal shifts associated with the intervention to encourage lower-carbon employee commuting are provided in Table 8. It is worth noting that of the remaining private car share after this mode shift, 50% are assumed to be electric vehicles (EVs). This assumes that the electrification of the employee fleet extends beyond what is sought after with the national target set out in the Climate Action Plan 2021 for approximately 945,000– million EVs on Irish roads by 2030, which would amount to roughly 25–30% of all cars, assuming around 3.1 million vehicles in total vehicle stock[3]. However, if the national target of ~1 million EVs by 2030 is not achieved, then additional reductions in private car use will be required. In practice, this would mean further increases in active and public transport mode share to compensate.

The roadmap's recommendations are consistent with the actions laid out in the Strategic Framework on Mobility[14], which promotes teleworking, cycling schemes, and carpooling. A continued emphasis on equity in commuting solutions and behavioural change campaigns is recommended.

4.4 Priority area of focus 4: Waste and water management

This category contributes a cumulative reduction of 1,650 $ktCO_2e$ in the modelled roadmap through to 2050. However, it is important to emphasise that the waste emissions baseline has a high degree of uncertainty. The data provided by the HSE primarily classified waste by treatment method (incineration or "alternative treatment") without specifying what those alternative treatments entail. In the absence of clarity, incineration was assumed as a default, potentially overestimating emissions where less intensive treatments (such as autoclaving) are used. Furthermore, waste volume data is incomplete in some facilities, and food waste data was unavailable.

To address these limitations, a targeted programme to improve waste data reporting is needed. This could include standardised templates, classification of treatment methods, and training for facility managers and contractors. The roadmap includes a target for gradual reduction in waste generation over time, which is considered realistic given the multi-decade timeline and expected improvements in waste segregation, procurement, and material circularity. The emissions savings from this category increase significantly after 2030 as systems and reporting mature.

This aligns with the Strategic Framework on Waste[15], which emphasises the need for improved data collection and reporting tools. The framework's commitment to reducing healthcare-generated waste across the waste hierarchy supports the roadmap's long-term assumptions. The roadmap is also consistent with the Strategic Framework on Water Conservation[16], which targets reductions in potable water use and improved monitoring of consumption patterns.

4.5 Priority areas of focus 5: Sustainable procurement

Procurement-related interventions are responsible for the largest share of overall emissions reductions in the roadmap (i.e., the decarbonisation scenario) by Priority Area of Focus, totalling 6,467 $ktCO_2e$ by 2050. Despite their impact, these emissions are the most difficult for the HSE to abate directly. Supply chain emissions fall largely outside the organisation's operational control, and achieving reductions will require long-term supplier engagement, stronger reporting requirements, and alignment with external actors across Ireland and internationally. In particular, the success of the supplier decarbonisation standards intervention (the most impactful of all measures) depends on ambitious action from a large share of vendors across pharmaceutical and medical technology sectors.

Efforts to decarbonise procurement must be paired with comprehensive emissions tracking mechanisms, embedded environmental criteria in tendering processes, and greater capacity within procurement teams. This will require investment in training, new evaluation tools, and closer collaboration with clinical and commercial teams to evaluate trade-offs between cost, performance, and carbon impact. While procurement-based emissions reductions ramp up in the medium term (2026–2040), their strategic importance requires near-term attention to ensure foundational capabilities are in place.

The interventions modelled in this category are highly dependent on external supplier action, making them inherently uncertain. Nevertheless, they offer an outsized emissions reduction potential, over one-third of the total reductions modelled in the roadmap. As such, strong governance, transparency, and an active supplier engagement strategy will be necessary. Work will also be needed to improve supply chain data availability, set emissions-related procurement requirements, and ensure product and supplier sustainability information is consistently available at point of procurement. Due to the

[14] HSE. (2025). HSE Mobility Framework.
[15] HSE. (2025). HSE Sustainable Waste Framework.
[16] HSE. (2025). HSE Water Conservation Framework.

strong purchaser power in the health sector, HSE can influence supplier behaviour through clear policy and messaging. Additionally, alignment with other health services in Europe who are tackling the same challenge offers the potential to further reinforce the need to decarbonise to suppliers who will be having to balance supply chain standards across markets.

This category is supported by the HSE's Strategic Framework on Sustainable Procurement[17], which sets the strategic direction for embedding sustainability criteria across the supply chain. This roadmap complements that framework by providing a quantified evidence base of the potential emissions reductions from procurement interventions and by identifying the actions needed to achieve them. Additional coordination with the Office of Government Procurement and alignment with evolving EU directives will also be critical to ensure that sustainable procurement measures are implementable at scale and enforceable over time.

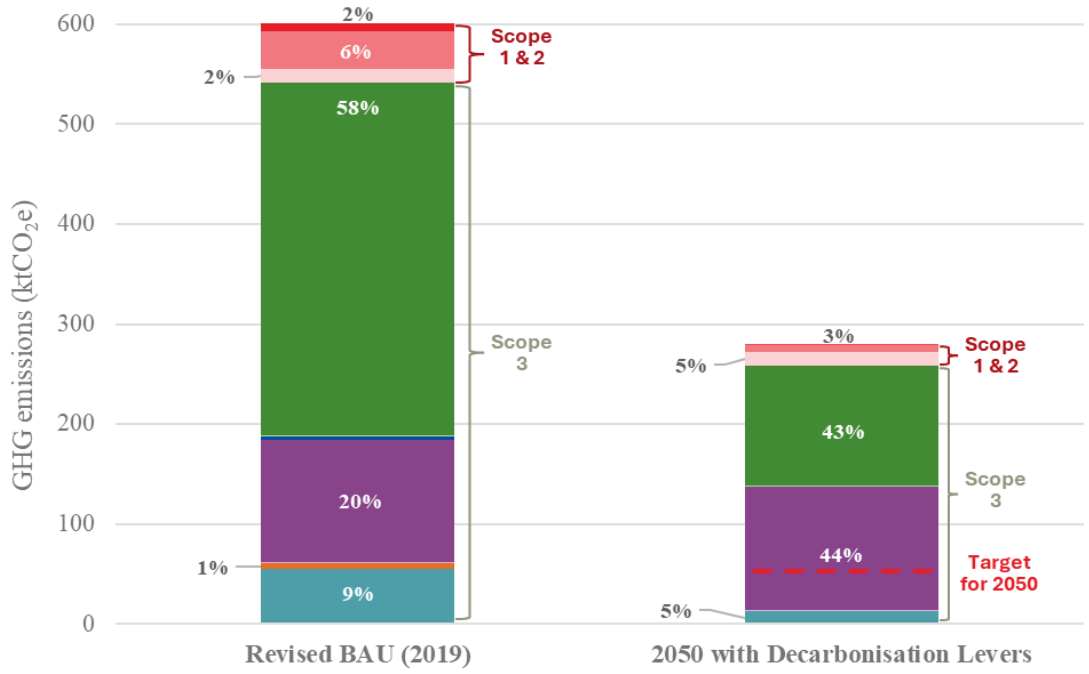
4.6 Residual emissions hotspots

While the interventions modelled in this study are predicted to offer decarbonisation at scale, they will not be enough on their own to deliver a net zero health system in Ireland. An emissions gap remains between the decarbonisation scenario, where all intervention are applied, and the reference target trajectory, with residual emissions of 280 $ktCO_2e$ predicted in 2050. Figure 9 illustrates the shifts in the composition of HSE's emissions profile from the revised baseline to 2050 with the application of decarbonisation levers.

In the revised baseline for 2019, Scope 3 emissions accounted for 89% of total GHG emissions, with the remainder made up of Scope 1 and 2 emissions (primarily from transport, anaesthetic gases, and MDIs). By 2050, after the implementation of roadmap interventions, the absolute contribution of Scope 1 and 2 emissions falls substantially. While Scope 3 emissions are reduced by over half in absolute terms, the still account for nearly 93% of remaining emissions in 2050. Notably, some categories such as Category 5a: Waste generated in operations appear to remain stable or even increase compared to 2019. This does not imply that waste-related interventions (e.g. reductions in volume or improvements in treatment methods) have had no effect; rather, their mitigative impact is largely offset by the projected growth in healthcare activity, meaning emissions remain at a similar order of magnitude by 2050. This is linked to the limitations in data availability for waste across HSE, and highlights both the importance of improved waste data and reporting, and the need for systemic reductions in waste generation alongside technical improvements.

[17] HSE. (2025). HSE Sustainable Procurement Framework. [Not currently available online]

This shift highlights the concentration of mitigation efforts in areas directly under HSE operational control, particularly transport and onsite energy-related emissions. It also makes clear the complexity of acting on some upstream supply chain emissions, which dominate the residual emissions profile. Understanding this distribution will be crucial for targeting future strategy development and implementation planning. The following section explores these hotspots in more depth.



GHG Emissions Category	Roadmap Colour
Transport	
Anaesthetic gases	
MDIs	
Category 1a: Purchased goods and services	
Category 1b: Water consumption	
Category 3: Fuel- & energy-related activities	
Category 4: Upstream transportation & distribution	
Category 5a: Waste generated in operations	
Category 5b: Water management	
Category 6: Business travel	
Category 7: Employee commuting	

Figure 9: Comparative 2019 Revised Baseline and 2050 decarbonisation scenario GHG emissions stacks. The decarbonisation scenario emissions stacks for 2050 follows the full implementation of modelled decarbonisation interventions.

4.7 Addressing residual emissions in 2050

The modelling presented in this roadmap indicates that, following full implementation of the interventions assessed, emissions across the HSE's operations and value chain can be reduced by 75% compared to the Business-as-Usual (BAU) projection. While this represents substantial progress, it also underscores the need for further action to fully meet the HSE's ambition to achieve net-zero emissions by 2050.

This roadmap has prioritised the modelling of decarbonisation measures that are both material in emissions impact and feasible for implementation across the HSE. Interventions have been aligned with the Priority Areas of Focus set out in the HSE Climate Action Strategy, reflecting areas where governance and operational frameworks are already in place or under development[5]. However, the

roadmap does not provide an exhaustive list of all potential decarbonisation and carbon removal actions.

Furthermore, limitations in the availability of implementation-ready data, evidence on emerging technologies, and methodological constraints on modelling complex system-wide transformations mean that a number of additional decarbonisation opportunities remain outside the current scope.

As such, the residual emissions estimated in this analysis do not necessarily represent the true limit of achievable reductions, and a broader range of actions will be required to fully close the gap to net zero through further GHG emission reductions and removals. These are outlined below.

- **Identify and pursue systemic decarbonisation opportunities:** While this roadmap has modelled interventions linked to operational, procurement, and mobility-related emissions, further reductions may be achieved by shifting to alternative models of care and circular economy practices and through demand reduction achieved through public health programmes. These include redesigning care pathways to reduce clinical throughput, scaling reusable and modular medical equipment models, reducing reliance on high-intensity treatments through prevention-led healthcare, and embedding circular principles into logistics and service delivery. Many of these changes could significantly reduce resource use and associated emissions but are not yet quantifiable at the organisational scale due to data gaps and implementation uncertainties. Future strategic work could explore how circular care models, prevention-based interventions, or digital care redesign could contribute to HSE's long-term decarbonisation goals.
- **Revisit and strengthen ambition of modelled interventions:** The decarbonisation thresholds and adoption timelines in this roadmap were co-developed between the HSE, HCWH and Arup, reflecting realistic yet ambitious assumptions based on current capacities and implementation environments. As individual climate action frameworks under the CAS are further operationalised, there is potential to update and strengthen ambition levels over time. Future revisions of this roadmap may benefit from updated implementation data, stakeholder feedback, and performance benchmarking, allowing for recalibration of targets to drive more aggressive decarbonisation outcomes within the same intervention areas.

  An ongoing measurement and reporting process should also target more granular and improved tracking of hotspots and emissions mechanisms that currently come with higher uncertainty, such as waste related emissions in this study. A better understanding of the scale and causes of such emissions can help in the identification of targeted interventions to reduce these emissions alongside existing efforts targeting other emissions sources across the organisation.
- **Offset residual emissions through durable carbon removal:** Even with ambitious implementation of all modelled interventions, a proportion of residual emissions will likely remain by 2050, especially in hard-to-abate categories of the healthcare supply chain. The HSE should therefore continue to prioritise further mitigation opportunities, including systemic changes, technology innovation, and policy support, to reduce the volume of emissions requiring offset. Offsets should not be viewed as a substitute for deeper decarbonisation, but as a complementary measure for what cannot feasibly be eliminated.

  To ensure credibility, any offset strategy must focus on **durable carbon dioxide removal (CDR)** solutions that physically remove CO_2 from the atmosphere and store it long term, in line with guidance such as the SBTi Corporate Net-Zero Standard and the Oxford Principles for Net Zero Aligned Offsetting. Options include direct air capture and storage, biomass carbon removal and storage (BiCRS), biochar, and enhanced rock weathering amongst others with permanence safeguards.

5. Conclusion

This roadmap builds on the HSE's existing climate action programme, complementing the Climate Action Strategy 2023–2050, the Infrastructure Decarbonisation Roadmap, and the suite of Strategic Climate Frameworks covering Transport, Mobility, Greener Models of Healthcare, Sustainable Procurement, Waste and Water Management, and Greener Space. Together, these strategies set out an organisation-wide approach to emissions reduction and position the HSE as a leader in Ireland's health sector decarbonisation effort.

Within this context, the roadmap provides a quantified scenario for the application of various decarbonisation interventions that would support the HSE in its journey towards net zero, identifying where the largest emissions savings can be achieved and the scale of ambition required. The analysis shows that the most significant reductions come through sustainable procurement and greener models of healthcare, alongside important contributions from mobility, waste and water management, and fleet electrification. It also highlights key dependencies: the need for stronger supply chain engagement, better data on waste and commuting, alignment with wider public transport and infrastructure investment, and continued clinical leadership to embed lower-carbon care practices.

Even with full implementation of the modelled interventions, residual emissions of 280 $ktCO_2e$ remain in 2050. Addressing these will require further action, including systemic changes to care pathways, circular economy approaches, and the eventual adoption of high-integrity carbon removals.

Taken together, this roadmap and the wider suite of HSE frameworks represent a decisive step forward. They demonstrate that the HSE is now significantly accelerating its decarbonisation programme, with a clear evidence base to guide priority actions. Beyond carbon savings, many of the interventions also bring health and system co-benefits, from improved air quality and increased physical activity to reduced waste and more efficient models of care. This dual impact underlines the opportunity for the HSE to meet its climate responsibilities while delivering a healthier, more sustainable service for patients and staff alike.

To further build on this evidence base, this work has highlighted a number of recommended next steps for HSE to better track and manage emissions in future:

- Establish a forward programme of emissions measurement and management in alignment with the CAS and Frameworks. This should detail the approach for re-baselining and improving data collection, target setting, and repeating the roadmap process as new opportunities arise.
- Implement the recommendations from the Emissions Baseline report to improve granularity and reliability of emissions tracking. This will enable more targeted emissions mitigation measures.
- Set and formalise organisational decarbonisation targets, including near term reduction targets, which can be used to measure progress and catalyse action.
- Prioritise the high mitigation actions detailed in this roadmap, namely:
  - **Transport:** Pursue vehicle electrification in line with expanding charging infrastructure.
  - **Greener Models of Healthcare:** Prioritise less GHG-intensive inhalers and low-impact anaesthetic techniques including nitrous oxide mitigation. Target reusable equipment, extended equipment lifespans, and improved prescribing efficiency.
  - **Mobility:** Promote active travel and explore options to encourage EV uptake across the HSE workforce; assess strategies to reduce patient travel emissions, e.g., through eHealth solutions.
  - **Waste & Water Management:** Invest in standardised waste reporting and classification to target reductions more effectively. Develop waste reduction targets based off improved data.
  - **Sustainable Procurement:** Strengthen supplier engagement, embed sustainability criteria in tenders and contracts, and align with national/EU policy.

Annex A: Key Actions and Support Programmes (Capital & Estates SIO)

Action Area 1: **HSE Partnership Agreement with SEAI and Leadership Roles**

- Developed a partnership arrangement with the Sustainable Energy Authority of Ireland (SEAI) to support the delivery of shallow retrofit minor capital works, the pilot pathfinder programme (deep energy retrofit pilot programme) and local energy management teams through a shared capital contribution funding arrangement.

Action Area 2: Regional Energy Bureau, Energy Management Teams and Shallow Retrofit Programme

- Shallow energy retrofit minor capital (lighting, fabric and boiler upgrades, PV installation etc.) project support and funding mechanisms established in partnership with SEAI.
- The HSE Capital & Estates Energy Bureau restructured into 6 Regional Energy and Sustainable Infrastructure Bureaus, supported by the SIO, in line with the HSE's new Health Region structure, providing support to the HSE and Section 38/39 agencies Significant Energy Users (SEUs). They form part of a wider Health Region Green Committee structure which is being established as part of the HSEs Climate Action Strategy.
- The Energy Bureaus are resourced with dedicated Energy Officers who support SEUs through the establishment of Energy Management Teams to progress energy performance improvement and reductions through behavioural change programmes, along with development and delivery of a Shallow retrofit minor capital works.

Action Area 3: Energy Efficient Design (EED) and Net Carbon Zero Ready Design

- Requirement for an Energy Efficient Design (EED) approach, with formal detailed EED reviews is standard in the scope of services and engagement for all Capital Works Design Teams for new capital projects and major refurbishments since 2016 with updates in 2019 and 2021 which requires Designs to be Net Carbon Zero Ready.
- Design Team Technical Requirements and Scope of Services were revised in 2024 to further enhance and embed EED as part of the Design Process for Capital Projects.

Action Area 4: Deep Energy and Carbon Retrofit Programme

- A comprehensive renovation programme involving deep building fabric and energy systems retrofit across the HSE's portfolio of facilities will be required to achieve the targets set out in the Irish Government's Climate Action Plan. The HSE have progressed a Pilot Pathfinder programme at 10 representative healthcare sites in partnership with SEAI
- Based on the results of this pathfinder project an up-scaled report will be developed which will form the basis of a HSE Building Stock plan.

Action Area 5: Metering, Modelling, Reporting and Energy Management Systems

- The HSE have developed a Significant Energy User (SEU) database, which allows the HSE to target the largest users and direct limited resources to achieve the greatest benefit.
- Improvements to availability of energy data through the new EnMS (Energy Management System) and soft-ware identified as an extension of the National Estates Information System (NEIS).

- HSE has achieved certification to ISO 50001 Energy Management Standard as required under the Public Sector Climate Action Mandate
- Implemented improved energy data reporting to REOs with RHA Energy Reports for SEUs provided to each REO on a quarterly basis.

Undertaking a Meter Improvement Project which will improve real-time data availability on energy consumption for SEUs.

Annex B: Approach taken to develop the evidence base

This Annex provides additional detail on the technical approach behind the analysis presented in this roadmap. For more information on the approach taken to develop the HSE emissions baseline, please refer to the baseline report and annexes.

This annex is structured according to the following sections:

- **B.1 Modelling future trajectories.** This section describes the modelling approach and data sources used to develop the BAU scenario and reference target trajectory used in this analysis.
- **B.2 Framing interventions.** This section provides background to the development of the decarbonisation interventions explored and applied in the roadmap, detailing the approach and data sources used.
- **B.3 Assumptions and limitations.** This section sets out the assumptions and limitations associated with the modelling approach used in the development of this roadmap.
- **B.4 Recommendations to improve evidence base.** This section details recommendations around building upon this roadmap and evidence base in future years through future data collection and identification of decarbonisation opportunities.

B.1 Modelling future trajectories

The 2019 emissions inventory serves as the base year from which the business-as-usual (BAU) projection is modelled. The modelled impacts of emissions reductions actions can be assessed against this BAU projection.

B.1.1 Developing a BAU scenario

To forecast health care demand growth to 2050, health sector expenditure projections were used. While this considers the sector as a whole, it is assumed that HSE Ireland's provision of health services would grow in line with the wider sector through this timeframe. This projection was based on constant prices and therefore reflects the change in demand for health services and does not consider inflationary pressures and changes to cost or structure of delivery. This therefore makes it suitable for estimating growth in health care operations through this time period.

Annual rates of expenditure growth derived from the IMF, which are assumed to reflect demand for activities within the health sector, were applied to the base year emissions figures across each reporting category (e.g., scope 2, pharmaceuticals, food and catering, etc.) through 2050. This applies the growth uniformly across the sector and assumes the distribution of services in 2050 remains consistent with the current structure of the system. In developing the growth projections, the decision was made to use a single projection for health care growth. The sum of these results yields an emissions scenario reflecting only demand growth.

Global decarbonisation assumptions, sourced from the Transition Pathway Initiative's (TPI) "Sectoral Decarbonisation Pathways" (V4.0), focus on high-emitting sectors such as air travel, automotive, and electricity utilities, reflecting broader decarbonisation trends impacting health care's footprint. As more detailed data becomes available, the assumptions and data used in the BAU projection can be updated. National, international, and Paris pledges scenarios were selected (and prioritised in that order) to reflect current decarbonisation commitments. The most recent pathways were mapped to EXIOBASE emission factors, producing a dataset of 200 product factors annually through 2050 to represent changes in emissions intensity across key industries.

B.1.2 Absolute values for the reference target trajectories

Table 7 below lays out the absolute values relating to the reference target trajectory used within the roadmap, including for the subdivisions of emissions categories.

Table 7: Reference target trajectories used for the HSE decarbonisation roadmap in absolute values

Emissions Boundary	Baseline Year	2030 Milestone	2050 Milestone
Scope 1 & 2 Transport-Related Carbon Dioxide Emissions (captured under the mandated target for energy-related emissions under the Climate Action and Low Carbon Development (Amendment) Act 2021)	63.8	31.3	0.0
Scope 1 & 2 Transport-Related Methane and Nitrous Oxide Emissions	0.04	0.02	0.00
Scope 3 Emissions (excl. Capital Goods)	541.3	337.6	54.1
Combined	**605.1**	**368.9**	**54.1**

B.2 Framing interventions

A list of decarbonisation interventions was refined and applied to the emissions baseline and BAU projected emissions. The interventions list was grounded in an evidence base of mitigation activities and associated magnitudes of changes in activity or emissions activity that was determined to be applicable to the sector based on expert input, research, and understanding of opportunities and limitations within the sector. Where intervention rates were drawn from other sectors, such as residential, adjustments were made to conservatively reflect the health sector's specific needs and operational settings.

B.2.1 Framing interventions

When modelling how these interventions result in future emissions scenarios, each measure has been applied in a cumulative manner, where decarbonisation interventions modelled in this roadmap are structured around the Priority Areas of Focus set out in the HSE's Climate Action Strategy 2023–2050.

Of the six Priority Areas established in the Climate Action Strategy, four are directly relevant to emissions mitigation and included within the scope of this roadmap. The remaining two – *Adaptation and Resilience* and *Sustainable Buildings and Green Environment* – fall outside the scope of this analysis.

- **Adaptation and Resilience** addresses how the HSE can prepare for and respond to the health impacts of climate change, including extreme weather, disease outbreaks, and infrastructure vulnerabilities. While this is a critical area for long-term climate resilience, it does not relate directly to emissions mitigation and is therefore excluded from the decarbonisation roadmap.
- **Sustainable Buildings and Green Environment** targets estate-related emissions, including operational energy use and the embodied carbon of new capital projects. These emissions categories – comprising Scope 1 and 2 emissions from on-site fuel use and purchased electricity, as well as Scope 3 emissions from capital goods – are addressed in detail in the HSE's Infrastructure Decarbonisation Roadmap. That roadmap outlines a quantified trajectory for emissions reduction from building design, retrofit, and construction, and as such, these sources are not revisited here to avoid duplication and ensure alignment.

Table 8 outlines the full list of interventions, including the intervention rate, timeframe, and the relevant reporting category applied.

Table 8: Decarbonisation interventions applied to emissions baseline and BAU projection

HSE CAS Priority Areas	#	Intervention category	Description	Intervention rate (%)	Timeframe	Approach to deriving intervention threshold and timeline
Transport	1	Electrification of inter-site vehicles	Involves transitioning the health sector's fleet to fully electric vehicles. This includes ambulances, and other vehicles owned and operated by health care providers.	100	By 2035	This reflects the HSE commitment to only procure ZEVs (excl. ambulances) from 2022 and an assumed transition to a full fleet of ZEVs (excl. ambulances) by 2030 and a transition to full fleet of ZEVs (incl. ambulances) by 2035.
Greener models of healthcare	2	Optimised use of pharmaceuticals	Implementing strategies to reduce the over-prescription and unnecessary use of pharmaceuticals within the healthcare system.	20	By 2050	In their 2010 joint report, the York Health Economics consortium and the School of Pharmacy at University of London estimate that 30-50% of medicines are not used and therefore wasted, and this volume could be cost-effectively avoided[18]. We assume the HSE implements policies and prescriptions practices that lead to halving of this waste. It is not practical to reduce this waste more as there would be a risk of not having enough pharmaceuticals.
	3	Extending the lifespan of medical equipment	Extending the lifespan of electrical products to reduce consumption of new equipment. This could include establishing an exchange platform within the hospital (equipment lying idle in storage or under-used) and/or establishing a lifetime for medical equipment.	25	By 2050	Arup derived benchmark, assuming that all medical equipment can be kept for a 25% extended lifespan through improved maintenance processes and selection of more durable products.
	4	Shift to low carbon inhalers	Transitioning from traditional propellant inhalers to low carbon inhalers. This shift is being led by	90	By 2030	Ongoing work from manufacturers (GSK, AstraZeneca) to replace GHG propellant that would reduce carbon by 90%. Alongside, EU agreement in 2023 to phase out all consumption of

[18] NICE. (2010). Environmental impact report: Medicines optimisation.

HSE CAS Priority Areas	#	Intervention category	Description	Intervention rate (%)	Timeframe	Approach to deriving intervention threshold and timeline
			pharmaceutical manufacturers, including GSK and AstraZeneca.			Hydrofluorocarbons (HFCs) by 2050 has also hastened the pace of change.[19]
	5	Shift to low carbon anaesthetic gas equivalents	Transitioning to lower carbon anaesthetic practices by phasing out the use of desflurane, optimising the use of Total Intravenous Anaesthesia (TIVA), minimising fresh gas flows, and by identifying and mitigating nitrous oxide leaks, alongside capture and cracking where feasible.	50	By 2030	This follows the target in the HSE CAS to reduce the CO_2e emissions from inhalational anaesthetic agents by 50% by 2030.
	6	Reduce plate waste and optimise food purchasing	Implementing strategies to decrease over-purchasing and limit unnecessary stock acquisitions, optimising procurement processes. Buy better, direct demand on alternative products and suppliers. Focus on key items.	21.5	By 2050	HSE study suggesting that between 37-49% of food given to patients in Irish healthcare facilities is not eaten[20]. A halving of the average share of this waste to 21.5% is modelled. Some excess capacity is assumed to remain to ensure no shortages caused through reduced provision.
Mobility	7	Encourage lower-carbon employee commuting	Promoting a modal shift in employee commuting by expanding infrastructure and incentives for active travel, improving access to public transport, supporting carpooling and shared travel, and encouraging the adoption of electric vehicles for residual car use.	86	By 2030 and 2050	This has been calculated assuming that all urban commuting shifts to the mode share of commuting that resulted from the Mater Misericordiae University Hospital Mobility Management Plan by 2030, as reporting in the Mobility Framework[21]. This includes an increase in the following mode shares: - Rail: 2% to 9% - Bus: 12% to 25% - Cycling: 3% to 13% Beyond 2030, a continuation of this trajectory is assumed. Of the remaining private car share, 50%

[19] European Council. (2023). Fluorinated gases and ozone-depleting substances: Council and Parliament reach agreement.
[20] GreenHealthcare Ireland. (2020). Food waste.
[21] The HSE. (2025). HSE Mobility Framework.

HSE CAS Priority Areas	#	Intervention category	Description	Intervention rate (%)	Timeframe	Approach to deriving intervention threshold and timeline
						are assumed to be electric vehicles (EVs). This assumes that the electrification of the employee fleet extends beyond what is sought after with the national target set out in the Climate Action Plan 2021 for approximately 945,000– million EVs on Irish roads by 2030, which would amount to roughly 25–30% of all cars, assuming around 3.1 million vehicles in total vehicle stock[3]. However, if the national target of ~1 million EVs by 2030 is not achieved, then additional reductions in private car use will be required. In practice, this would mean further increases in active and public transport mode share to compensate.
	8	Reduce the distance covered in business travel cumulatively and the emissions intensity of the transportation modes	Centralising and managing business travel to reduce unnecessary trips, promote digital communication, and prioritise lower-emission transport options, supported by policy thresholds, behavioural incentives, and leadership engagement.	100	By 2040	In the absence of related targets from the HSE or the Irish Government, benchmarks have been applied from other Healthcare systems and providers (e.g., the NHS[22]).
Water and waste management	9	Reduce the volume of waste generated and the emissions intensity of the treatment methods	Minimising waste through improved procurement planning, prioritisation of reusable medical and support products, vendor take-back programmes, and adoption of low-emission waste treatment technologies, particularly for risk waste.	50	By 2050	Arup derived benchmark. Due to uncertainties in source data, this target was derived as a representative level of ambition. Further work is required to better understand emissions arising from waste management and measures that can be taken to mitigate these.

[22] NHS England. (2023). NHS net zero travel & transport roadmap.

HSE CAS Priority Areas	#	Intervention category	Description	Intervention rate (%)	Timeframe	Approach to deriving intervention threshold and timeline
Sustainable procurement	10	Reduce the carbon intensity of food in catering, by reducing meat intake and transition to a plant-based diet	Reducing the emissions intensity of meals served in healthcare settings by reducing meat intake and transitioning to more plant-based and low-emission options, while maintaining the necessary nutritional standards for patients and staff.	76	By 2030 and 2050	This follows the Coolfood Pledge goal of 38% per plate GHG reduction[23], this being an international, cross-sector effort to achieve a science-based collective target of reducing GHG emissions from food by 25% by 2030.
	11	Prioritising low carbon pharmaceutical suppliers	Prioritising low carbon suppliers involves requesting Environmental Product Declarations (EPDs) or sustainability data during the procurement process for pharmaceuticals, aiming to aid selection of lower carbon alternatives.	10	By 2030	Arup derived benchmark. Introduces a target to achieve a reduction of 10% emissions in pharmaceuticals procurement by seeking out suppliers that publish EPD data (by 2030 before wider trends in procurement).
	12	Prioritising low carbon medical equipment suppliers	Compact with suppliers of clinical consumables and medical devices focused on *e.g. reducing the emissions from product packaging.*	10	By 2030	Arup derived benchmark. Introduces a target to achieve an emissions reduction of 10% through making more informed decisions around procurement (e.g., asking for EPDs, choosing products with lower etc.).
	13	Supplier decarbonisation standards	Mandate that suppliers have validated Science Based Target aligned decarbonisation strategies consistent with achieving net zero by 2050. If suppliers adopt and deliver against these targets, decarbonisation progress can be driven across the full health care value chain.	76.5	By 2050	Arup derived benchmark. Assuming that 70% suppliers successfully achieve the 90% emissions reduction target included within the Science-Based Target initiative (SBTi) guidelines. Assumes that the remaining 30%, achieve half the required emissions reductions (45%).

[23] Healthcare Without Harm. (2024). Coolfood champions meet - & surpass – GHG plate reduction goals.

B.2.2 Electrification interventions

Separately, the rebound effects from increased electricity demand following the electrification of buildings and vehicles were accounted for in this model. To estimate the impact of this intervention for both buildings and vehicles, an S-curve multiplier was applied from 2019 to 2050 based on a threshold intervention rate to calculate the annual reductions in Scope 1 emissions, with the corresponding increase in Scope 2 electricity consumption emissions then estimated.

For vehicles, projected vehicle emissions ($ktCO_2e$) for 2019 to 2050 were converted from ICEs to electric vehicles using DEFRA factors. The S-curve multiplier for each year were then applied to calculate the annual electric vehicle consumption. The annual electric vehicle consumption was then multiplied by the decarbonised EV emissions factors to derive annual electric vehicle emissions ($ktCO_2e$). This ensures that increases in electricity consumption due to electrification of the fleet was represented in the decarbonisation scenario (i.e., the roadmap).

B.3 Assumptions and limitations

B.3.1 Developing a baseline

Assumptions and limitations associated with calculating the 2019 emissions baseline, and the revised baseline, are detailed in the Emissions Baseline Report previously issued to HSE.

B.3.2 Emissions scenarios and interventions

Table 9 highlights several assumptions to appropriately apply the decarbonisation interventions identified to the emissions baseline. These assumptions were made considering the nature and quality of the underlying source data leveraged to establish the emissions baseline.

Table 9: Main assumptions underpinning the scenario analysis and interventions

Assumption/ Limitation	Justification	Impact
Decarbonisation interventions are applied uniformly nationally.	Each of the decarbonisation interventions identified were applied on a national-level, though the implementation of each intervention may be more challenging in certain regions.	Low
Each decarbonisation intervention and its associated magnitude of impact are assumed to be additional to the "structural decarbonisation" effects applied in the development of the BAU projection.	It is assumed that the measures contained in the decarbonisation interventions are all additional to the wider economic trends embedded in the BAU projection. Efforts to avoid double counting emissions reduction measures have been made through the framing of interventions according to the different Priority Areas of Focus.	Low
Static structure of economy and supply chains	The BAU projection is based on a static model of the economy from 2019. No structural changes in supply chains, technology use, or clinical practices within the healthcare system are assumed beyond the trends captured in sectoral emissions factors. This limits the model's ability to reflect transformational or disruptive shifts in healthcare delivery or procurement.	Medium
Background economic decarbonisation	The BAU projection integrates emissions intensity trends from the Transition Pathway Initiative (TPI), which draws	Low

Assumption/ Limitation	Justification	Impact
	from IEA sectoral decarbonisation scenarios. These assumptions reflect likely decarbonisation trends under existing national and international pledges, but do not guarantee future policy implementation. They provide directional trends rather than firm commitments.	
Consistent growth	Growth in sectoral emissions in the BAU projection was projected using anticipated increases in health sector expenditure as a share of GDP, based on Irish public expenditure forecasts. This method assumes that emissions grow proportionally with expenditure and does not account for changes in service delivery models or demographic health demand patterns. It reflects quantity of care, not efficiency gains or systemic transformation.	Low
Backcasting of target trajectory baselines	In order to provide a consistent starting point across all emissions scopes, some emissions data for 2018 was backcasted using 2019 estimates (e.g., methane and nitrous oxide from transport). This introduces a minor distortion in trajectory curves but allows for a coherent cross-scope comparison against the baseline year and the existing decarbonisation targets established by the HSE.	Low
Rebound effects of enabling capital works (e.g. EV infrastructure) are not included	Some decarbonisation interventions, particularly those related to electrification of transport (e.g. EV rollout) and infrastructure upgrades, may require enabling capital works. While capital goods emissions are excluded from this roadmap to maintain alignment with the Infrastructure Decarbonisation Roadmap, the embodied emissions from such capital investments (e.g. EV charging infrastructure) could partially offset the savings from these interventions. These potential rebound effects are not captured in the current modelling.	Low
Future burden of disease	The model does not account for changing health demands (for example, changed distribution of infectious diseases) or changing the health cost base (from climate shocks e.g., higher insurance, more frequent extreme weather).	Medium

B.4 Recommendations to improve evidence base

The emissions baseline report and annexes list a number of specific recommendations relating to data collection and emissions calculation for year-by-year emissions tracking across the organisation. In addition to these recommendations, the following areas should be prioritised based on the findings of this roadmapping exercise:

- Improve data collected for key parts of baseline that have greater uncertainty, this is discussed in detail in the Emissions Baseline report, with the priority areas for improvement being:
  - **Waste** – Limitations in this data, and our understanding of the scale and cause of emissions, have limited the interventions which could be considered for this key emissions source.
  - **Employee commuting** – The absence of staff-level commuting data led to reliance on national averages and proxies for rural–urban splits, introducing uncertainty in both baseline estimates and future scenarios. Better survey data is required to understand commuting patterns by site and region. For example, St James's Hospital in Dublin has conducted multiple staff travel surveys stretching back over a decade, showing measurable improvements in mode shift towards lower-carbon commuting options such as public transport and active travel. Using such evidence can both improve the accuracy of baseline estimates and provide realistic benchmarks for achievable modal shift in other urban and rural hospitals
- Explore more systemic opportunities to reduce emissions, such as transitioning to more circular practices, adopting digital solutions such as telemedicine, and public health measures to reduce demand.
- Engage with other national health systems to share progress and findings as decarbonisation measures are implemented.
- Set and agree a formal organisational decarbonisation target trajectory between now and 2050 including near term targets against which progress can be measured.
- Repeat baselining approach in 3-5 years to assess progress, and allow for the exploration of more detailed opportunities which will be enabled by access to a more comprehensive baseline.