



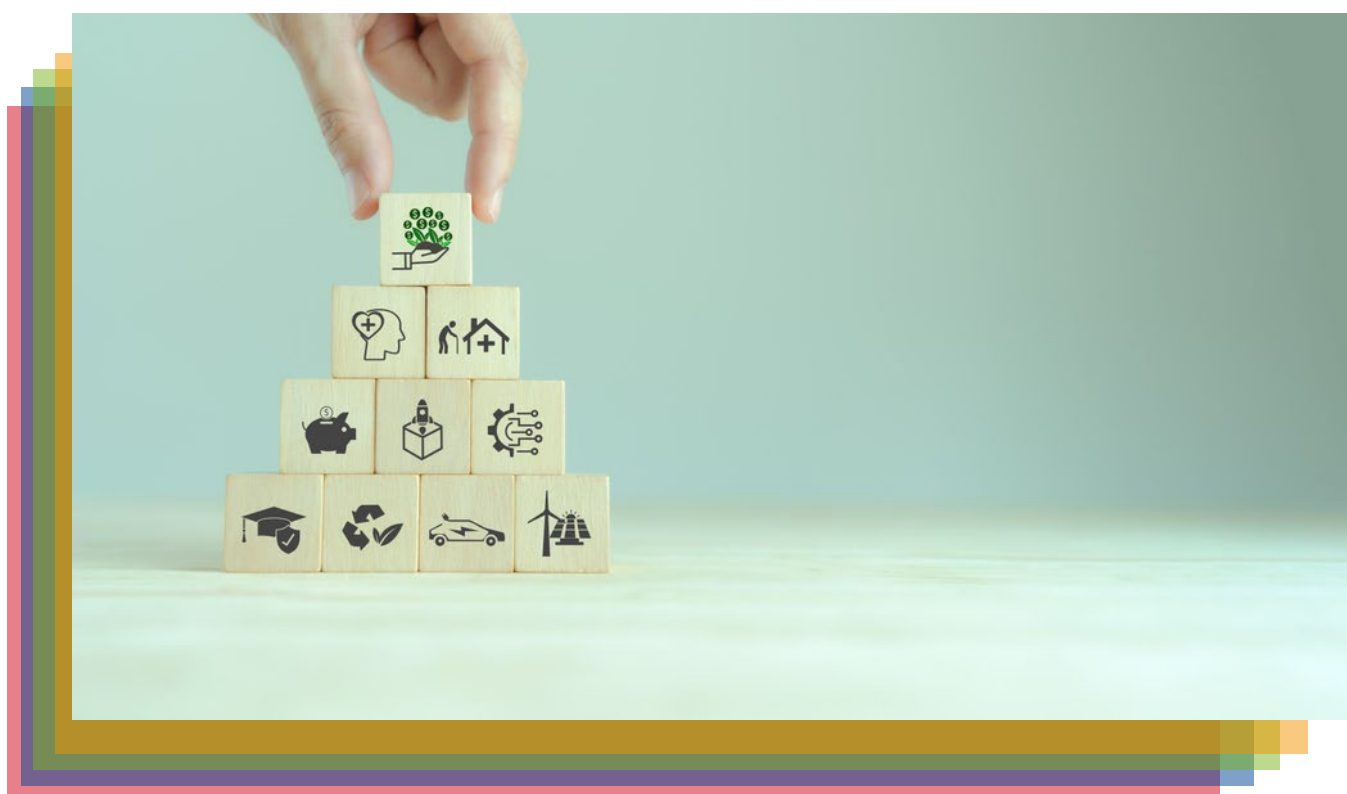
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HEALTH SYSTEM PERFORMANCE ASSESSMENT (HSPA): A FIRST STEP IN THE ASSESSMENT OF ENVIRONMENTAL SUSTAINABILITY



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All experts consulted within this report were selected because of their involvement in the topic. Therefore, by definition, each of them might have a certain degree of conflict of interest to the main topic of this report.

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- The external experts were consulted about a (preliminary) version of the scientific report. Their comments were discussed during meetings. They did not co-author the scientific report and did not necessarily agree with its content.
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LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
CH ₄	Methane
CO ₂	Carbon Dioxide
COP26	26 th Conference of the parties of the United Nations Framework Convention on Climate Change
COPD	Chronic obstructive pulmonary disease
COVID	Coronavirus disease
CT	Computed tomography
DALY	Disability-adjusted life year
DDD	Defined daily dose
DPI	Dry powder inhaler
Eq	Equivalent (e.g. CO ₂ eq)
EU	European Union
GHG	Greenhouse gas
HFA	Hydrofluoroalkane
HFC	Hydrofluorocarbon
HPV	Human papillomavirus
HSPA	Health System Performance Assessment
HTA	Health technology assessment
HVAC	Heating, ventilation, and air conditioning
ICS	Inhaled corticosteroid
LABA	Long-acting β 2-agonist
LCA	Life cycle assessment
MDI	Metered-dose inhaler
MeSH	Medical Subject Headings
MRI	Magnetic resonance imaging
N ₂ O	Nitrous oxide
NACE	Statistical classification of economic activities in the European Community
NEHAP	National Environment-Health Action Plan
NF ₃	Natrium trifluoride
NMVO	Non-methane volatile organic compounds
O ₃	Ozone
OECD	Organisation for Economic Co-operation and Development
PFC	Perfluorocarbons



PM	Particulate matter
pMDI	Pressurised metered-dose inhaler
SABA	Short-acting β 2-agonist
SF ₆	Sulphur hexafluoride
SMI	Soft mist inhaler
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation



■ SCIENTIFIC REPORT

1 CONTEXT AND OBJECTIVES

KEY POINTS TABLE

- The aim of this report is to assess the environmental sustainability of the health system using a selection of relevant quantitative indicators
- The environmental sustainability is a new subdimension of the Belgian HSPA framework and is defined as the system's capacity to "minimize negative impacts on the environment and leverage opportunities to restore and improve it to the benefit of the health and well-being of current and future generations"¹
- The impact of the environment on health and the resilience of the health system to climate changes are out-of-scope
- Some indicators from other dimensions and domains of the Belgian HSPA framework (e.g. those related to low value, inappropriate care) may also influence environmental sustainability. These will be highlighted in this report but are not part of the selection process

1.1 Towards sustainable low carbon health systems

In 2021, the United Nations Framework Convention on Climate Change (UNFCCC) 26th Conference of the Parties (COP26) highlighted the crucial role of health systems in achieving the Paris Agreement's goals to limit global temperature rise through adaptation and emission reductions. The COP26 Health Programme incorporates commitments to develop sustainable low-carbon health systems (see Textbox 1).²

Belgium formally committed to the COP26 Health Programme and to develop a climate resilient and low carbon, sustainable health system by 2050. The World Health Organisation (WHO) defines sustainable, low carbon health systems as "*those capable of implementing transformative strategies towards reducing greenhouse gas (GHG) emissions in their operations, reducing short- and long-term negative impacts on the local and global environment.*"³

Textbox 1 – COP26 Health Programme's commitments related to sustainable low carbon health systems

- Commitment "*to deliver a baseline assessment of greenhouse gas emissions of the health system (including supply chains)*"²;
- Commitment "*to develop an action plan or roadmap by a set date to develop a sustainable low-carbon health system (including supply chains) that also considers human exposure to air pollution and the role the health sector can play in reducing exposure to air pollution through its activities and actions*"²;
- Commitment "*to set a target date by which to achieve health system net-zero emissions (ideally by 2050)*"²

The commitments to develop a climate-resilient and low-carbon, sustainable health system were addressed by the Belgian National Environment-Health Action Plan (NEHAP). NEHAP emerged from the 1994 WHO European Region Environment-Health Ministerial Conference in Helsinki, which highlighted the reciprocal interaction between environment and health and encouraged Member

States to develop their own NEHAP. In Belgium, a cooperation agreement forming the legislative basis of the NEHAP was approved on 10 December 2003, establishing a framework for collaboration between the Federal State and the Federated entities regarding policies related to environment and health. Since 2003, two plans have been implemented. The third edition, NEHAP3, was launched on the 23rd of January 2024 and will be implemented between 2024 and 2029. NEHAP3 focuses on two main objectives: (1) resilience, adaptation and climate change mitigation and (2) reducing the harmful effects of chemicals on human health and the environment. This plan deepens the actions undertaken by the previous plans while incorporating new areas of action that respond to current and pressing societal challenges. These two objectives are pursued through eight separate action sheets, with factsheet 2 focusing on ensuring a just transition to sustainable and low-carbon health systems.⁴

Within this factsheet 2, a partnership with Health Care Without Harm Europe and Arup has been done to assess the [greenhouse gas emissions](#) (GHG) in the Belgian health system⁵ and to define a Belgium Healthcare Decarbonisation [Roadmap](#).⁶

A description of other actions linked to the NEHAP can be found on the website [Health & Environment](#).

1.2 Terminology

The Belgian report on the GHG emissions in the Belgian health system described in the previous section included a glossary. Interested readers can find in Table 1 definitions for a selected number of terms in this glossary,⁵ supplemented by some terms selected from the glossary provided by the European Environmental Agency⁷ and WHO.¹

Table 1 – Terminology

Terminology	Definition
Direct (scope 1) and indirect (scope 2 and 3) emissions	Scope 1 emissions are direct emissions associated with on-site fuel combustion (e.g. in boilers, heating systems, combined heat and power, backup power generation etc.) in healthcare facilities, emissions from the operation of fleet vehicles and other on-site emissions (from refrigerants, anaesthetics or on-site waste treatment). Scope 2 emissions are indirect emissions associated with the generation of purchased electricity, heat or steam. Scope 3 emissions are indirect emissions from upstream (e.g. material extraction, production of pharmaceuticals) and downstream (e.g. waste and sanitation) organisational activities.⁵
Environmental sustainability	Environmental sustainability is defined as the system's capacity to "minimize negative impacts on the environment and leverage opportunities to restore and improve it to the benefit of the health and well-being of current and future generations" ¹
Greenhouse effect	The warming of the Earth's atmosphere caused by gases such as carbon dioxide that trap heat. These gases absorb radiation emitted by the Earth, reducing the amount of energy that escapes back into space. ⁷
Greenhouse gas (GHG)	GHG refers to atmospheric components that contribute to the greenhouse effect, namely carbon dioxide (CO ₂), nitrous oxide (N ₂ O), methane (CH ₄), and fluorinated gases (i.e. hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF ₆) and sodium trifluoride (NF ₃)), expressed in CO ₂ equivalents. ^{5, 7}
GHG footprint	GHG "Emissions footprint estimates are calculated based on the consumption of all goods and services by the health sector, including direct emissions (scope 1), indirect emissions from the purchase of electricity, heating, cooling and steam (scope 2), and indirect emissions associated with the supply chains of purchased goods and services (scope 3)" ⁵



1.3 Evaluating Environmental Sustainability in Health System Performance Assessment (HSPA) Reports

1.3.1 HSPA in Belgium

HSPA is a process aiming to assess the performance of the health system holistically, a 'health check' based on measurable indicators. HSPA is specifically mentioned in the Tallinn Charter⁸ signed by all countries from the European region of the World Health Organisation (WHO). This charter states that "health systems need to demonstrate good performance" and that member states must "promote transparency and be accountable for health system performance to achieve measurable results".⁸ Each HSPA is based on a country-specific conceptual framework. The strategic objectives of the Belgian HSPA are highlighted in Textbox 2.

Textbox 2 – Strategic objectives of the Belgian HSPA

- To inform the health authorities about the performance of the health system and to provide needed information for policy planning;
- To provide a transparent and accountable view of the health system performance, in accordance with the commitment made in the Tallinn Charter;
- To monitor the health system performance over time.

In Belgium, HSPA reports are published every 4-5 years, with the first one published in 2010⁹ and the last one in 2024.¹⁰

To make the process more dynamic and to prevent information overload that may overshadow the main messages, it was also decided since the 2019 report:

- To use the period prior to the publication of a new HSPA to analyse new domains/dimensions, to revise existing ones, or to deepen some of them in thematic reports. Four thematic reports have been published since the HSPA report of 2019.¹¹⁻¹⁴. This report is a fifth thematic report.
- To split the information into several reports (i.e. a health status report including health determinants, a performance report, and a report on medical practice variations) rather than to publish only one single and voluminous report, allowing more in-depth information in each separate report. Due to these subdivisions and to prevent confusion for the reader, a specific terminology is now used to either refer to the global population health framework or to the specific report on the performance of the health system (HSPA framework), which is a subpart thereof (see Textbox 3).
- To gather the key messages and results of each report in one single website, <http://healthybelgium.be/>, so that any citizen, being a policy maker, a public health researcher, a journalist, or anyone interested in the subject, can easily find key information and data to evaluate and better understand the Belgian health system.



Textbox 3 – Terminology: Performance (HSPA) framework versus global population health framework

In several countries, HSPA reports contain not only information on the performance of health services delivery, but also information on the health status of the population and on non-medical determinants of health. In Belgium, assessments are subdivided over multiple reports. To prevent confusion for the reader, the following terminology is used:

- **The global population health framework:** refers to the three tiers of assessment: the health status of the population, the non-medical determinants of health, and the performance of the health system and of health services delivery.
- **The Performance (or HSPA) framework:** refers to the third tier of the global assessment, i.e. the performance of the health system and of health services delivery along several dimensions and domains of care.

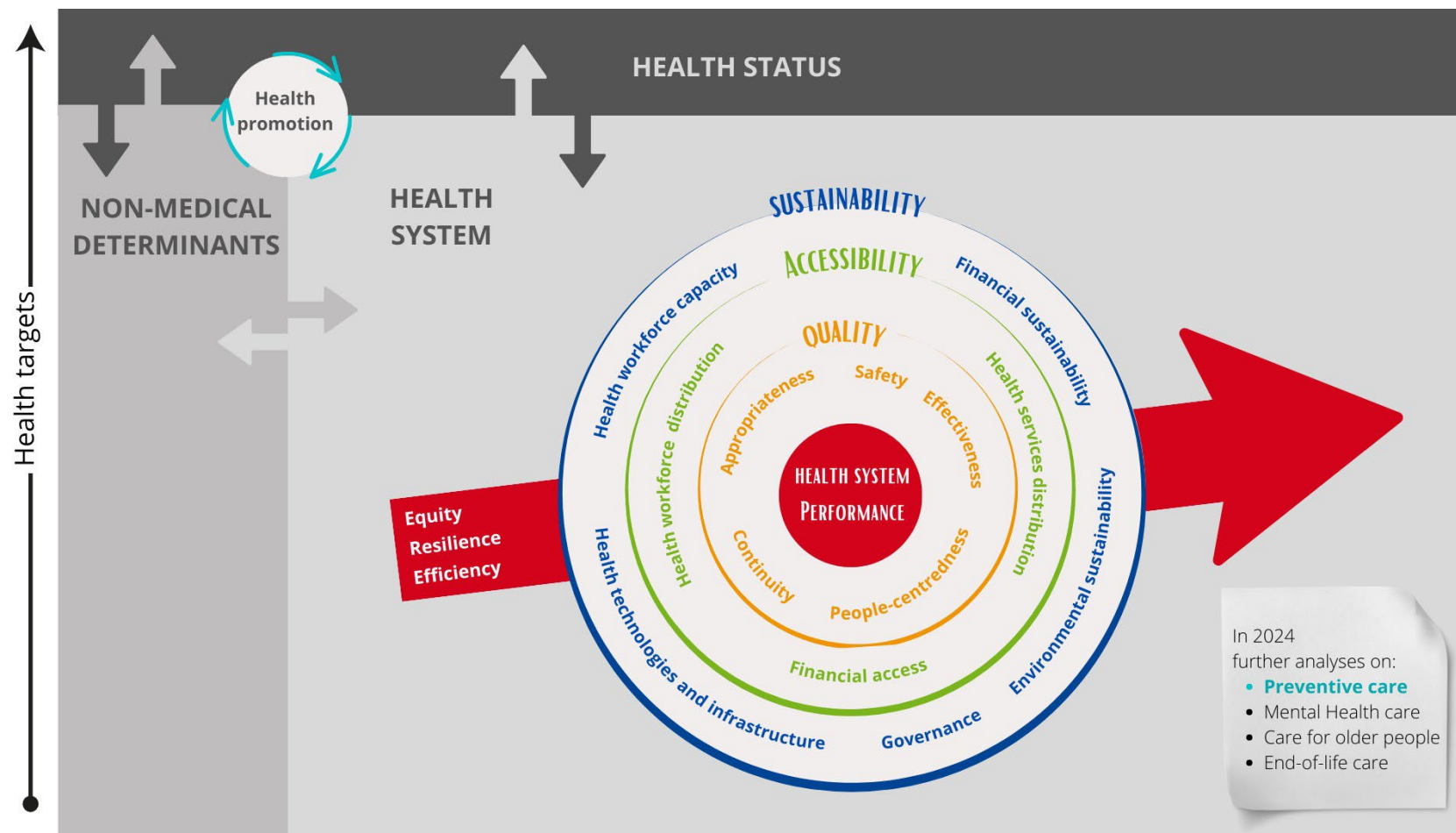
1.3.2 A new sub-dimension on environmental sustainability

In 2023, Belgium published a new version of its HSPA framework (see Figure 1).¹² In this revision, a new sub-dimension of sustainability was included: the environmental sustainability. However, due to timing and data availability constraints, the sub-dimension on environmental sustainability had not been developed and indicators are still lacking.

Therefore, this thematic HSPA report focuses on the environmental sustainability of the Belgian health system. In line with WHO, the environmental sustainability is defined as the system's capacity to "minimize negative impacts on the environment and leverage opportunities to restore and improve it to the benefit of the health and well-being of current and future generations".¹



Figure 1 – The Belgian global population health framework, including the new HSPA framework (in colour)



Source: KCE report 370¹²

1.3.3 A new sub-dimension in line with renewed international HSPA frameworks

The OECD's renewed HSPA Framework also integrated a new dimension of performance on environmental sustainability.¹⁵

Similarly, environmental sustainability is mentioned in different sections of the renewed global HSPA Framework of the European Observatory of Health systems policies and WHO.¹⁶

1.4 Study objective, research questions and scope

The study objective is to assess the environmental sustainability of the Belgian health system. This can be detailed into the following research questions:

- Which topics should be addressed to assess the environmental sustainability of the health system and what are the relevant indicators for each identified topic? This part aims to compile a long list of indicators classified by topic and to select the most relevant ones for each topic (see Chapters 2).
- What is the impact of the health system on the environment? The aim of this section is to assess the selected set of indicators, including international benchmarking where appropriate (Chapter 3) and highlight warning signals (see the synoptic tables and Chapter 4).

This report focuses on the impact of the health system on the environment, whereas the impact of the environment on health is out of scope and should rather be covered by the Belgian Health Status Report.¹⁷ The resilience of the health system to climate change is also beyond the scope of this report. This topic relates to the resilience dimension of the Belgian HSPA framework and could be examined in a future report.

It is also important to note that several other dimensions and domains of the Belgian HSPA framework impact the environmental sustainability of the health system. For example, reducing inappropriate care has a positive impact on environmental sustainability. While these linked dimensions and domains will not be part of the selection of indicators, their relevance and the main warning signals identified in the last transversal HSPA report of 2024 will still be discussed in a separate section.

Finally, in terms of environmental impact, the scope is larger than climate change only. Other impact categories such as acidification or resource use are also considered (see also section 2.4.4).

1.5 How do we perform HSPA evaluation?

In Belgian HSPA reports, the results of the selected indicators are summarised in synoptic tables (see Chapter 2.5.5). These tables show the most recent reliable results at national and regional levels, as well as the data sources and the unweighted averages for EU-14 and EU-27^a countries, where available.

^a EU-14 refers to the composition of the European Union between 1 January 1995 and 31 December 2003, before the new Member States joined the EU and excluding UK: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and Sweden. EU-27 refers to the 27 member states of the European Union after the United Kingdom's departure (Brexit) on first February 2020, representing the current composition of the EU: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden.



1.5.1 Evaluation based on level and trend

A pictogram (see Table 2) depicts the evaluation of the indicator, considering both the latest national results available and its evolution over time (from 2012 if available).

The national value is compared, in order of priority, to established targets (national if they exist, international otherwise), to results from EU-14 and EU-27 countries (benchmarking), and to standards of care (mainly for indicators derived from clinical guidelines). In the absence of targets, benchmarking or standards of care, the evaluation relies on a consensus among the authors of this report and experts having reviewed the indicator (expert opinion). However, if insufficient reference points were available for experts to assess the indicator's performance, no evaluation of the result was conducted. For these indicators, only the trend was assessed (e.g. the level of waste).

Trends were also analysed and classified as improving, deteriorating, stable, or not assessable due to insufficient or uncertain data. It should be noted that some indicators are context-dependent, and for these indicators the direction of change cannot be clearly interpreted as positive or negative (e.g. health expenditure in the full HSPA report). In such cases, only the direction of the observed trend is reported (increasing, decreasing, stable or not assessed).

1.5.2 Regional differences (Flanders, Wallonia and Brussels)

Regions are always compared to the region with the best results, and regions having results that are at least 20% worse (in terms of relative difference) are highlighted in bold (except for contextual indicators).

With respect to the regional comparisons, the specific context of Brussels has to be kept in mind: in particular, the Brussels region only consists of a single large urban area, while the other two regions consist of a mix of urban, suburban and rural areas.

Textbox 4 – How to interpret the results?

The reader has to keep the following in mind to avoid misinterpreting the results presented in this report:

- The aim of the HSPA report is to provide a comprehensive global assessment of the health system, rather than serving as a tool for monitoring the impact of specific programs. Indicators are chosen to illustrate a dimension or domain, not to analyse a topic in depth nor to assess a specific objective. Trends can be drawn from time series.
- Comparison with other (European) countries have to be made with caution, as there might be differences in methodology, data collection (survey vs. administrative data, sampling scheme, etc.), coding of information, etc.
- Results are influenced by several factors: it is not the aim of this report to identify these factors; many indicators are affected by factors outside the health system, e.g. determinants of health (social and economic environment, physical environment, individual characteristics and behaviours). When an indicator trend changes, it could be due to a new policy, but it could also be due to any other factor. Even if a correlation could be established, it would not be a proof of causality.

Textbox 5 – More data on our website

For each indicator described below, a technical sheet is available on the KCE website and in the supplement of the report (supplement on the technical sheets). The indicator ID (example: ENV-1) in the synoptic tables refers to the ID in the document. The technical sheet details the rationale for choosing the indicator, provides technical information on data sources and computation, gives all results (including subgroup analyses and benchmarking), limitations in interpretation, and

bibliographical references. Some technical sheets also present secondary indicators related to the main indicator which help to understand the context.

The report is also published on the healthybelgium.be website to reach a wider audience. This website gathers indicators from several reports (HSPA, the Health Status Report and medical practice variations) and includes graphics with downloadable data sets.

Table 2 – Pictograms for the evaluation of indicators

	Good results and improving
	Good results and trend not evaluated (no/not enough data or too uncertain)
	Good results and globally stable
	Good results but deteriorating
	Average results but improving
	Average results and trend not evaluated (no/not enough data or too uncertain)
	Average results and globally stable
	Average results but deteriorating
	Poor results but improving (warning signal)
	Poor results and trend not evaluated (warning signals) (no/not enough data or too uncertain)
	Poor results and globally stable (warning signal)
	Poor results and deteriorating (warning signal)
	Result not evaluated (not enough reference point to assess the performance) and trend improving
	Result not evaluated (not enough reference point to assess the performance) and trend not evaluated (no/not enough data or too uncertain)
	Result not evaluated (not enough reference point to assess the performance) and trend globally stable



⊖	Result not evaluated (not enough reference point to assess the performance) and trend deteriorating
C	Contextual indicator (i.e. indicators for which the direction of change cannot be clearly classified as positive or negative and whose implications are context-dependent): trend not evaluated (no/not enough data or too uncertain)
↗	Contextual indicator: upwards trend (no evaluation is given)
→	Contextual indicator: stable trend (no evaluation is given)
↘	Contextual indicator: downwards trend (no evaluation is given)

2 IDENTIFICATION OF TOPICS AND SELECTION OF INDICATORS

2.1 Introduction

HSPA projects aim to focus on the most relevant indicators in line with their framework. The initial step involved identifying the type of impact categories (not limited to climate change) and outcomes that should be investigated when assessing environmental sustainability as well as potential areas of interventions, with the aim of defining a long list of potential indicators classified by topics. This was done through:

- A review of indexed scientific literature (see section 2.2);
- A review of existing data (see section 2.3);
- An investigation of other relevant sources: policy plans, HSPA frameworks, and conceptual frameworks on environmental sustainability (see section 2.4).

Based on these sources, a long list of indicators was compiled, classified by topics (see section 2.5.1).

The second step, based on a collaboration with external experts, involved:

- Identifying potential missing indicators from the long list and selecting the most relevant indicators from the long list (see sections 2.5.2 and 2.5.3);
- Identify data gaps and need for future research (see section 2.5.4). As no new data collection is undertaken for Belgian HSPA reports, all data exploited in this report are extracted from existing data sources^b and data gaps highlight indicators or research areas that were considered relevant by the experts but for which no data are currently available or for which future research was needed.

It should also be noted that other HSPA dimensions and domains can also impact environmental sustainability. As defined in the scope (see section 1.4), indicators related to these other dimensions and domains were not selected but the link with environmental sustainability is highlighted in section 2.5.5.

^b The calculation of some indicators required the use of expertise from partners or subcontractors to process the available data.

2.2 Review of indexed scientific literature

2.2.1 Aim of the review and methodological warnings

The review of indexed scientific literature can be divided in two parts:

- **Environmental footprint:** Identification of studies assessing the environmental footprint of the health system or of a specific sector of the health system (e.g. hospital or primary care). This section aims to identify the type of impact categories and outcomes used to evaluate the environmental impact of the health system.
- **Interventions:** Identification of studies assessing interventions aimed at reducing the negative environmental impact of the health system. The objective of this section is to identify potential areas of interventions and their related outcome and process indicators.

It is important to note that the review of the literature performed in this chapter is not systematic and must be considered as explorative, as explained in Textbox 6.

Textbox 6 – A “scoping” rather than a “systematic” review of the literature

As environmental sustainability is a very broad concept, conducting a systematic review was not feasible within our resource constraints. Additionally, the rapidly evolving nature of this field means that a systematic review would quickly become outdated.

The followed approach should be considered as a scoping review of the literature, designed to identify relevant areas of interventions, impact categories and outcomes related to the environmental sustainability of the health system, with the objective of developing a long list of potential indicators classified by topic. Given the vast number of publications, a balance between comprehensiveness and feasibility was sought. This review is therefore a first exploratory step and should not be considered as exhaustive.

Moreover, given the high number of studies and the fact that no standardised quality assessment tools are available for studies assessing an environmental impact, the quality of the studies was not analysed. Methodological guidelines in this field are still under development and remain a work in progress.

Finally, only the environmental impact was considered. Other aspects, such as effectiveness, safety, cost-effectiveness, and budget impact, were not considered. These would have been essential, for example, if the aim of the study had been to determine an action plan.

In conclusion, this review is a first exploratory step to identify potential indicators. It should not be considered a systematic review of the literature, nor does it aim to determine an action plan. Moreover, as the research was not exhaustive, the interventions identified in this section are not necessarily comprehensive, and some alternative approaches may be missing. This was one of the main reasons for conducting expert consultation to identify potential indicators or interventions that may not have been captured in the initial search.

2.2.2 Search strategy

The search was performed in two steps.

STEP 1: A SEARCH STRATEGY LIMITED TO A REVIEW OF REVIEWS

Due to the large amounts of studies related to the research topic, the search strategy was – in a first step – limited to a review of reviews.

The following databases were searched in August 2024: Ovid (Medline) and Embase. A combination of MeSH and text word terms related to health system, environmental impact, and systematic reviews

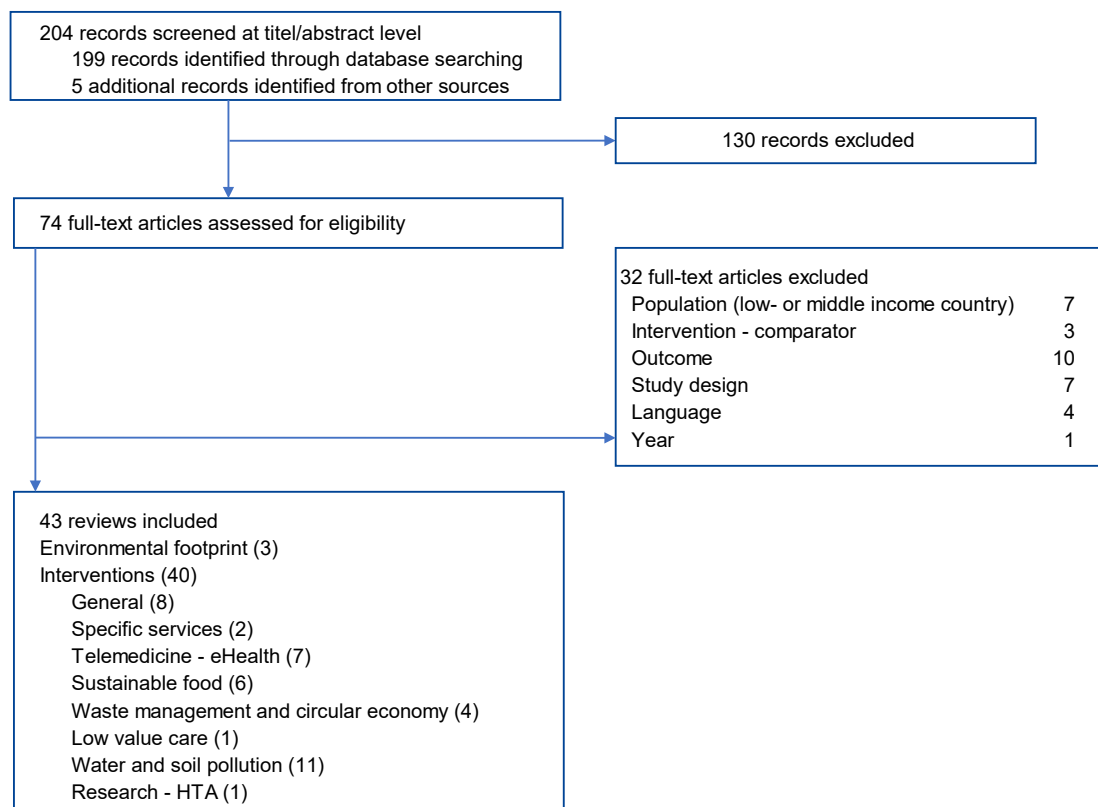


were combined (see Appendix 1.1.1). In addition, five reviews identified during the scoping phase of the project via hand searches and contacts with experts were added.

All retrieved references were assessed by two researchers using pre-defined selection criteria, in terms of population, intervention, comparator, outcome, study design, and publication year (see Table 3). The selection of relevant reviews was performed in a two-step procedure: initial assessment of the title, abstract, and keywords, followed by a full-text assessment of the selected references. Finally, three reviews on the environmental footprint and 40 reviews related to interventions were selected. Reviews of interventions were either general or related to a specific topic (see the flow chart in Figure 2).

Table 3 – Selection criteria used for the review of reviews

PICOS	Inclusion	Exclusion
Population	Population from high income countries → reviews including papers from high-income countries	Population from low- or middle countries → reviews only including papers from low- or middle-income countries
Intervention - comparator	Comparison of health care services or of interventions having an impact on the environment Assessment of the environmental footprint of the health system or of a specific healthcare sector (e.g. hospitals, primary care)	Interventions specific to the COVID-19 pandemic Assessment of a specific health service or of a single intervention without comparison (e.g. environmental impact of cataract surgery or of a dialysis unit)
Outcome	Quantitative impact on the environment	Qualitative outcomes (barriers and facilitators, perceptions, etc.) Other quantitative outcomes not related to the environmental impact (Effectiveness, cost-effectiveness, safety, etc.)
Study design	Reviews having described their method (at least a description of databases investigated)	Reviews that do not at least include a description of databases investigated, and other designs (e.g. opinion papers based on expert consensus)
Year	2015-2024	<2015
Languages	English, French, Dutch	Other

Figure 2 – Flow chart of the review of reviews

STEP 2: AN ANALYSIS OF PRIMARY STUDIES IDENTIFIED BY THE SELECTED REVIEWS

Several reviews included sources that did not satisfy our inclusion criteria (e.g., opinion papers or blog posts), making them unsuitable as a basis for our analysis. Instead, we examined the primary studies cited in those reviews, reapplied our selection criteria, and retained only the primary studies that met our inclusion criteria. Compared to Table 3, the following changes were made to the inclusion criteria:

- The years were extended to 2014-2024;
- The included study designs were limited to scientific studies (randomised controlled trials, cohort studies, case-control studies, cross-sectional studies) or mathematical models, while other designs such as case reports, opinion papers, blogs, and letters were excluded.

Because of the large number of studies, no snowball method was applied, implying for example that other narrative reviews not yet included in our selection, but referenced in the selected reviews were not added to the review.

All selected primary studies were subsequently classified by topic and analysed to identify potential indicators (see sections 2.2.3 to 2.2.5).



2.2.3 Synthesis of results and identification of indicators

One researcher read all selected studies, classified them by topic and constructed summary tables. For studies on the environmental footprint of the health system, the main element of the summary table was the type of impact categories and outcomes assessed. For studies on interventions, the main elements were the type of interventions and the environmental impact: positive (+), negative (-) or no (significant) impact (No). Other interesting elements were also added in the supplement (on literature) depending on the topic investigated.

Based on these results, one researcher identified potential outcome and process indicators. Requirements for the identification of indicators are described in Table 4. As the focus was on the environmental impact and as other evaluation criteria such as effectiveness and safety were not investigated (see also section 2.2.1), additional requirements were defined for process indicators related to a specific healthcare intervention.

Table 4 – Specific requirements for the selection of indicators

Type of indicator	Description	Requirements
Outcome indicators	Indicators related to a specific outcome reflecting the environmental impact of the health system (e.g. volume of food waste, in kg)	The indicator must not already be addressed by another dimension or domain of performance (as defined in the scope)
General process indicators	Indicators related to a widespread intervention already supported by Belgian authorities and not specific to the healthcare system (e.g. composting food waste)	The indicator must not already be addressed by another dimension or domain of performance (as defined in the scope)
Specific process indicators	Indicators related to a specific healthcare intervention aimed at reducing the negative impact of the health system on the environment (e.g. reducing the use of high-carbon pressurised metered-dose inhalers)	- The indicator must not already be addressed by another dimension or domain of performance - The indicator must be based on more than two positive studies and no negative studies - The indicator must be supported by existing guidelines (that have considered other aspects such as safety)

2.2.4 Results of studies on the environmental footprint of the health system or of a specific healthcare sector

Three reviews¹⁸⁻²⁰ assessing the environmental footprint of the health system were included. These reviews enabled the identification of 14 studies that met the inclusion criteria:^c 12 on the environmental footprint of the health system,²¹⁻³² one on the environmental footprint of hospitals,³³ and one on the environmental footprint of primary care.³⁴

Impact categories and outcomes identified in these studies are summarised in Table 5 (see also the Appendix 1.1.2 to obtain more details on the type of outcome per study).

^c As described in section 2.2.2, it is important to highlight that among the studies identified in these reviews, studies on the carbon footprint of a specific service (e.g. the operating room or a dialysis service) or of a specific intervention without comparison (e.g. cataract surgery) were excluded.

Providing detailed results from these studies was beyond the scope of this study and would have been highly time consuming (e.g. in the study of Lenzen et al.²⁵, calculations were done for 189 countries over 16 years). Therefore, only the main findings are summarised here. It is nevertheless important to highlight that summary data cited in this section must be used with caution as they are based on studies using different methods. Among the studies that met the inclusion criteria, the following results can be highlighted:^d

- GHG emissions from the healthcare sector, expressed as a percentage of total national GHG emission accounted for 4.78% on average, with values ranging from a minimum of 1.45% in Kuwait to a maximum of 9.80% in the United States (based on ten studies);^{22-30, 32}
- GHG emissions from the healthcare sector per capita accounted for 1.40 t CO₂ eq on average, with a minimum of 0.15 in Romania and a maximum of 67.99 in Greenland (based on six studies).^{23-25, 29, 31, 32}
- Hospitals accounted for the largest share of GHG emissions from the healthcare system, with an average of 32.17% (range: 23.94% - 44.52%; based on 7 studies)^{21-23, 26, 28, 29, 32}
- Scope 3 emissions accounted for 75% of GHG emissions from the healthcare system on average (range: 43%-87%; based on 37 countries from 2 studies).^{24, 30} Pharmaceuticals accounted for the largest share of scope 3 emissions, representing up to 41.2% in one study.³⁰
- In hospitals, the most important GHG emission sources were heating (26%), catering (17%), and building infrastructure (15%) (based on 1 study);³³
- In primary care, the most important GHG emission sources were staff and patient transport (45.7%) and heating (29.8%) (based on 1 study).³⁴

^d Only high income countries were considered and when multiple years were calculated, only the most recent year was included.



Table 5 – Type of impact categories and outcomes identified in studies on the environmental footprint of the health system

<i>Pressure</i>	<i>Impact categories (unit of measure for the outcome)</i>	<i>Steenmeijer et al. (2022)³⁰</i>	<i>Malik et al. (2021)²⁷</i>	<i>Lenzen et. (2020)²⁵</i>	<i>Eckelman et al. (2020)²¹ and Eckelman et al. (2018)²³</i>	<i>Eckelman et al. (2016)²²</i>	<i>Keller et al. (2021)³³</i>	<i>Nicolet et al. (2022)³⁴; Tennison et al. (2021)³¹; Nansai et al. (2020)²⁸; Weisz et al. (2020)³²; Karlner et al. (2019)²⁴; Pichler et al. (2019)²⁹; Wu (2019)³⁵; Malik et al. (2018)²⁶; SDU (2016)³⁶;</i>
Air emissions	GHG emissions (CO ₂ eq)	x	x	x	x	x	x	x
	Particulate matter (PM _{2.5} or PM ₁₀)			x		x	x	
	Acidification (NO _x , SO ₂ eq or mol H ⁺ eq)			x		x	x	
	Photochemical ozone formation (O ₃ or NMVOC eq)					x	x	
	Ozone depletion (CFC-11 eq)					x	x	
Water and soil pollution	Reactive nitrogen in water (N)			x				
	Ecotoxicity, Freshwater					x	x	
	Eutrophication - Freshwater, Marine, Terrestrial (P or N eq)					x	x	
Resources depletion	Water use	x	x	x			x	
	Land use	x					x	
	Resource use, fossil fuels						x	
	Resource use, minerals and metals	x					x	
Waste generation	Multiple impact	x	x					
Mixed pressures, health related impact (out-of-scope)	Malaria risk			x				
	Loss of DALYs				x			
	Cancer and non-cancer toxicity (in million people)					x	x	
	Ionising radiations (in kBq U-235 eq)						x	

For impact categories other than GHG emissions, the healthcare sector's share of the national footprint was reported in the following studies^e:

- For particulate matter: 2.8%^f (PM₁₀) in Lenzen et al. 2020²⁵ and 8.9% (PM_{2.5}) in Eckelman et al. 2016²²;
- For acidification: 3.4% (NO_x) and 3.6%^c (SO₂) in Lenzen et al. 2020²⁵ and 11.7% (SO₂ eq) in Eckelman et al. 2016²²;
- For ozone depletion: 1.6% (CFC-11 eq) in Eckelman et al. 2016²²;
- For photochemical ozone formation: 10.0% (O₃) in Eckelman et al. 2016²²;
- For eutrophication - Freshwater, Marine, Terrestrial: 1.5% (nitrogen eq) in Eckelman et al. 2016²²;
- For water use: 4% in Malik et al. (2021)²⁷ and 7.5% (mainly for pharmaceuticals and chemical products, followed by food and food services) in Steenmeijer et al. (2022)³⁰;
- For land use: 7.2% (mainly for pharmaceuticals and chemical products, followed by food and food services) in Steenmeijer et al. (2022)³⁰;
- For resource use, minerals and metals: 13.0% (mainly from pharmaceuticals and chemical products) in Steenmeijer et al. (2022)³⁰;
- For waste: 4.2% (mainly from pharmaceuticals and chemical products, followed by food and food services) in Steenmeijer et al. (2022)³⁰ and 8% in Malik et al. (2021)²⁷

2.2.5 Results of studies on interventions aimed at reducing the impact of the health system on the environment

Studies on interventions aimed at reducing the impact of the health system on the environment have been classified by topic by one researcher.

2.2.5.1 Building and energy use

In total, 11 reviews included studies related to building and energy use.^{20, 37-46}

From these reviews, 10 primary studies satisfied the inclusion criteria (see Appendix 1.1.3 for details on the flow chart).⁴⁷⁻⁵⁶

As shown in Table 6, several interventions aimed at reducing energy use were reported. While some common principles can be highlighted to reduce the annual energy consumption (e.g. turning off devices that consume energy during out-of-hours period), the interventions assessed were too diverse to select a specific intervention as indicator.

Concerning building and energy use, only one general outcome indicator was therefore proposed (see Textbox 7).

^e It is important to note that in some studies, the outcomes were not reported in percentage of the national footprint or were only presented in a figure without details allowing to obtain the percentage. These are therefore not summarised in this section.

^f Global estimate based on 189 countries rather than national estimate.



Table 6 – Studies on building and energy use

<i>Interventions</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Turning off devices</i>		
Switching MRI unit to off mode or power-save mode for 12 hours overnight	1 ⁵⁶	+
CT scanner powered down during overnight and Sunday	1 ⁴⁸	+
Turning off workstations during out-of-hours periods	1 ⁵⁰	+
Switching off idle sterilisers	1 ⁵⁴	+
Strategy 1: Switching off idle sterilisers Strategy 2: Switching off one steriliser at 10 am and a second steriliser at midnight	1 ⁵³	+
Turning off ancillary electrical equipment, lighting, desktop and workstation during out-of-hours periods	1 ⁴⁹	+
Education, audit and feedback to turn off devices when not in use	1 ⁵²	+
<i>Sustainable health records</i>		
Promoting sustainable practices for health records development	1 ⁵¹	+
<i>Sustainable buildings and materials</i>		
Promoting more efficient energy class A buildings compared to class C and D buildings	1 ⁵⁵	+
Promoting heating, ventilation and air conditioning (HVAC) duct types with a favourable environmental impact	1 ⁴⁷	+

+ = positive impact. See Appendix 1.1.3 for more details

Textbox 7 – Indicators on buildings and energy use

Outcome indicator:

Annual energy consumption

2.2.5.2 Transport and mobility

Concerning transport and mobility, three key areas emerge from the literature: the use of teleconsultations, the proximity of the supply, and the implementation of a "green" healthcare fleet. It should be noted that the topic related to virtual conferences also emerged but was considered in the section "research" (see section 2.2.5.10).

TELECONSULTATIONS

In total, 11 reviews included studies related to the use of teleconsultations⁹ to avoid patients' travel.^{20, 37, 39, 41, 42, 45, 46, 57-60} From these 11 reviews, 32 primary studies satisfied our inclusion criteria (see Appendix 1.1.4 for details on the flowchart).⁶¹⁻⁹²

Most of these studies (n=29) assessed the carbon impact of avoiding journeys due to teleconsultations, without considering the impact of teleconsultation materials.^{61-63, 65, 67-70, 72, 74-92} Only four studies included the impact of teleconsultation materials.^{64, 66, 71, 73} It should also be noted that, after our review, a Belgian report on this topic was published.⁹³ We therefore decided to include this study in the analysis retrospectively.

Important variation was observed across the studies (see the ranges highlighted in Table 28). As expected, greater carbon savings were associated with longer distances avoided and more polluting vehicles used.

Most studies identified in the review of the literature relied on assumptions about inputs that favoured the environmental impact of teleconsultations, such as assuming high travel distances avoided (with 258 km avoided on average and a range between 5.89 km and 1387 km avoided per teleconsultation according to the studies). Only one study conducted a sensitivity analysis to test the robustness of such assumptions. This study concluded that, depending on the assumptions regarding the environmental impact of teleconsultation-related materials and the average CO₂ emissions per km, a minimum travel distance between 3.6 km and 32 km was required for teleconsultations to be environmentally neutral.⁷³

In the Belgian report, more realistic assumptions were applied regarding the distance avoided (between 5.89 and 14.50 km). Based on the number of teleconsultations in 2023 and assuming that only 27% of these teleconsultations replaced face-to-face consultations, the report estimated that between 2000 and 5000 tonnes of CO₂ eq per year could be avoided.⁹³

However, in Belgium, the reimbursement of phone teleconsultations is currently suspended due to a substantial increase in the number of contacts following their introduction, which placed pressure on the healthcare budget. The development raised concerns about potential unnecessary teleconsultations and their possible negative environmental consequences. However, none of the studies evaluated the potential negative environmental impact associated with unnecessary teleconsultations (e.g. unnecessary use of phone, software, energy, etc.). Hence, while reducing patient travel has a positive environmental effect, the overall environmental impact of teleconsultations remains uncertain, particularly given the relatively short travel distances in Belgium and the limited substitution of in-person consultations.

As reimbursement of phone teleconsultations is currently suspended in Belgium – resulting in the absence of ongoing data collection – and given the potential conflicts between environmental sustainability, financial sustainability and appropriateness of care, proposing an indicator related to teleconsultations was considered premature.

⁹ Some studies referred to telemonitoring but as the focus is the distance avoided in all studies, we simplified this section by using the terminology “teleconsultation” for all studies.

**Table 7 – Studies on teleconsultations**

<i>Interventions (elements considered for the impact)</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Teleconsultations (studies only based on avoided distance)</i>	29 ^{61-63, 65, 67-70, 72, 74-92}	+
<i>Teleconsultations (studies that also consider the impact of teleconsultation material used)</i>	5 ^{64, 66, 71, 73, 93}	+
<i>Teleconsultations (studies that also consider the negative impact of unnecessary teleconsultations)</i>	0	?

+ = positive impact. ? = impact unknown. See Appendix 1.1.4 for more details

PROXIMITY OF HEALTHCARE SUPPLY

Three reviews^{20, 37, 39} were retained and allowed to identify one primary study related to the proximity of healthcare supply to reduce patient travel (see Appendix 1.1.5 for details on the flowchart).⁹⁴

This study assessed the positive impact of selecting the closest site for dental care (mainly based on travel saved).^{h94}

However, in Belgium, patients are free to consult the provider of their choice and choosing the closest provider cannot be imposed in the current system. Moreover, the geographical accessibility is covered by another dimension of performance, i.e. accessibility - distribution of health services. Consequently, no indicators were added to the long list of indicators for this topic. It should be noted, however, that in the dimension on accessibility, there is an indicator on the population living within 20 km of the nearest hospital.

Table 8 – Studies on the proximity of the supply

<i>Interventions</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Selecting the closest site for medical visits</i>	1 ⁹⁴	+

+ = positive impact. See Appendix 1.1.5 for more details

A GREEN HEALTHCARE FLEET

Two reviews^{37, 39} were retained and allowed to identify one primary study related to the implementation of a green healthcare fleet (see the Appendix 1.1.6 for details on the flowchart).⁹⁵

This study assessed the carbon impact of switching the German healthcare fleet from fuel to diesel vehicle (7% of annual greenhouse gas emissions saved) or electric vehicle (between 26 and 30% of annual greenhouse gas emissions saved, see also Table 9).⁹⁵

Because some fiscal incentives are provided in Belgium to promote the use of green vehicles, a process indicator related to this widely implemented intervention, already supported by Belgian authorities and not specific to the healthcare system, can be proposed.

Table 9 – Studies on the proximity of the supply

<i>Intervention</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Switching the healthcare fleet from fuel to diesel vehicle and to electric vehicle</i>	1 ⁹⁵	+

+ = positive impact. See Appendix 1.1.6 for more details

^h This study also assessed the impact of closing sites with low utilisation rates but as this is rather covered by another dimension of performance, i.e. the efficiency of care, such a topic was not kept.

Textbox 8 – Indicators on transport and mobility

General process indicator:

- The share of green vehicles in the healthcare fleet

2.2.5.3 High carbon footprint medical products

In the literature, two kinds of medical products were especially targeted: inhalers and anaesthetic gases. It should be noted that topics on an inappropriate use of pharmaceuticals and on pharmaceutical waste also emerged but are considered in the sections on low-value care and waste management, respectively.

HIGH CARBON FOOTPRINT INHALERS

Three reviews^{20, 39, 96} included studies focusing on reducing the use of inhalers with a high carbon footprint, of which five primary studies met our inclusion criteria (see Appendix 1.1.7 for details on the flowchart).⁹⁷⁻¹⁰¹

Pressurised metered-dose inhalers (pMDIs) have a high carbon footprint impact and reducing their use is promoted (see Table 10). The reduction of carbon emissions depends on the current usage patterns and of the capacity to replace these with dry powder inhalers (DPIs) and soft mist inhalers (SMIs). It is also important to note that a new generation of pMDIs (using hydrofluoroalkane (HFA)-152a) with a low global warming potential is being developed, also offering a more sustainable alternative to traditional pMDIs (HFA-134a and HFA-227 propellants). In Table 10, two interventions are also related to low value care (SABA inhalers, see section 2.2.5.7) and waste management (recycling, see section 2.2.5.5).

Table 10 – Studies on medical products: high carbon footprint inhalers

Intervention	Nb of studies	Impact
<i>Substituting pressurised metered-dose inhalers (pMDI) with dry powder inhalers or soft mist inhalers</i>	5 ⁹⁷⁻¹⁰¹	+
<i>Substituting current pressurised metered-dose inhalers pMDI with new pMDI using hydrofluoroalkane (HFA)-152a</i>	2 ^{97, 99}	+
<i>Minimising SABA inhalers</i> ⁹⁹	1 ⁹⁹	+
<i>Recycling all inhalers</i> ⁹⁹	1 ⁹⁹	+

+ = positive impact. SABA: Short-Acting Beta-2 Agonist. see Appendix 1.1.7 for more details.

As substituting pMDI is a healthcare specific intervention, additional requirements were applied to be included in the long list of indicators: more than two positive studies and no negative studies. In addition, the intervention should be supported by guidelines. As five positives studies were identified and the Belgian centre for pharmacotherapeutic information (BCFI-CBIP) recommends choosing an inhaler based on patient needs and characteristics and then, wherever possible, selecting one with a low climate impact, the topic was retained for the long list of indicators.¹⁰² Nevertheless, as the BCFI-CBIP highlighted that inhalation powders are not always appropriate for older people or young children, the main indicator should focus on the adult population.



Textbox 9 – Indicators on medical products: high carbon footprint inhalers

Specific process indicators:

- The share pMDI inhalers on all inhalers, in adults
- The share of low impact inhaler (DPI and SMI) on all inhalers, in adults

HIGH CARBON FOOTPRINT ANAESTHETIC GASES

Eight reviews^{20, 37, 39, 40, 43, 44, 96, 103} included studies on the reduction of the use of high carbon footprint anaesthetic gases, of which 13 primary studies met our inclusion criteria (see Appendix 1.1.8 for details on the flowchart).¹⁰⁴⁻¹¹⁶

As shown in Table 11, there is an agreement on the necessity to reduce desflurane use and to reduce the flow of fresh gases. The use of vapor-capturing technology was also discussed. Furthermore, there is an agreement on the preferred use of propofol compared to all anaesthetic gases. In addition, Belgian guidelines have been published, with the recommendation to stop using desflurane, to reduce the use of nitrous oxide and to avoid central piped N₂O delivery systems.¹¹⁷ Specific process indicators were therefore added to the long list (see Textbox 10).

Table 11 – Studies on medical products: high carbon footprint anaesthetic gases

Intervention	Nb of studies	Impact
<i>Reducing desflurane use</i>	10 ^{104, 106, 107, 108, 110, 111, 113, 114-116}	+
<i>Promoting the use of propofol instead of anaesthetic gases (desflurane, sevoflurane, isoflurane or nitrous oxide)</i>	3 ^{106, 108, 110}	+
<i>Reducing the flow of fresh gases (or promoting low-flow anaesthesia)</i>	4 ^{105, 108, 109, 116}	+
<i>Using vapor-capturing technology</i>	1 ¹¹⁰	+

+ = positive impact. See Appendix 1.1.8 for more details.

Textbox 10 – Indicators on medical products: High carbon footprint anaesthetic gases

Specific process indicators:

- Annual volume of desflurane
- Annual volume of gas (desflurane, sevoflurane and isoflurane) (per type of gas as sub-indicator)
- Annual volume of propofol (an alternative to anaesthetic gases)
- Percentage of hospitals using vapor capturing technology
- Percentage of hospital using systems to reduce the flow

2.2.5.4 Sustainable food

A total of 8 reviews included studies on sustainable food,^{20, 37, 118-123} of which 19 primary studies¹²⁴⁻¹⁴² met our inclusion criteria (see Appendix 1.1.9 for details on the flowchart).

Several areas of interventions emerged from the review:

- Reducing (plate) waste by improving appearance, improving taste, allowing choice, or allowing size reduction;
- Improving the disposal;
- Promoting sustainable diet, i.e. diet favorising optimal human health while ensuring that food production stays within planetary environmental limits (such as plant-based diet).¹⁴³

The proposed interventions were nevertheless either based on one single study or on several studies showing mixed results. It was therefore considered premature to propose specific process indicators. It should nevertheless be noted that composting and segregated waste collection are general measures promoted and/or mandated by Federated authorities. Only general outcomes and process indicators were therefore proposed (see Textbox 11).

Table 12 – Studies on sustainable food

Intervention	Number of studies	Impact
<i>Interventions to reduce waste</i>		
<i>Improving appearance</i>	1 ¹²⁹	No
<i>Improving taste – quality</i>	1 ¹³⁸	+
<i>Allowing choices (e.g. menu, room service, bedsize ordering system)</i>	3 ^{125, 128, 137}	No
	4 ^{130-132, 135}	+
<i>Allowing size reduction</i>	1 ¹³⁶	+
<i>Mix of strategies</i>	4 ^{124, 127, 133, 140}	+
<i>Other interventions</i>		
<i>Improving disposal</i>	1 ¹⁴¹	+
<i>Promoting sustainable diet (e.g. vegetarian meals)</i>	3 ^{126, 134, 142}	+
	1 ^{139*}	-
<i>Promoting local purchase of food</i>	0 respecting our inclusion criteria but topic included in the reviews.	/

+ = positive impact; - = negative impact; No = no (significant) impact or mixed results (e.g. positive in the best case scenario and negative in the worst case scenario). *negative impact on plate waste. See Appendix 1.1.9 for more details.

Textbox 11 – Indicators on sustainable food

Outcome indicator:

- Annual volume of food waste

General process indicator:

- Share of food waste composted



2.2.5.5 Waste management and circular economy

This section on waste management and circular economy was divided in three parts: the reduction of single-use medical devices, the disposal of unused pharmaceuticals, and other waste management interventions (recycling, decontaminating, repairing and educating).

SINGLE-USE VERSUS REUSABLE MEDICAL DEVICES

Seven reviews^{20, 37, 39, 40, 43, 44, 144} included studies comparing single-use and reusable medical devices, of which 33 primary studies^{54, 144-175} met our inclusion criteria (see Appendix 1.1.10 for details).

Table 13 – Studies on single-use versus reusable medical devices

Intervention	Nb of studies	Impact
<i>Using reusable instead of single-use medical devices:</i>		
<i>Flexible endoscope</i>	4 ^{148, 151, 157, 159}	+
	4 ^{145, 149, 155, 168}	–
<i>Anaesthetic equipment, Laryngoscope blades and handles</i>	1 ¹⁷⁶	No
	1 ¹⁶⁶	+
<i>Laparoscopic or endoscopic trocar systems</i>	2 ^{147, 163}	+
	1 ¹⁷¹	–
<i>Other laparoscopic material</i>	2 ^{158, 163}	+
<i>Specula</i>	3 ^{150, 164, 167}	+
	1 ¹⁴⁴	No
<i>Textiles (Gowns)</i>	4 ^{146, 173-175}	+
<i>Blue wraps – surgical packaging</i>	3 ^{152, 156, 170}	+
<i>Sharp containers</i>	2 ^{154, 161}	+
<i>Several medical devices (arthroscopic shavers, compression sleeve, endoscopic trocars, ligatures, pulse oximeters, scissor tips, ultrasonic (harmonic) scalpels)</i>	1 ¹⁷¹	No
<i>Dental burs</i>	1 ¹⁷²	No
<i>Incontinence Underpads</i>	1 ¹⁵³	+
<i>Blood pressure cuffs</i>	1 ¹⁶⁵	+
<i>Bedpans</i>	1 ¹⁶⁹	–
<i>Laryngeal mask airways</i>	1 ¹⁶⁰	+
<i>Surgical stapling systems</i>	1 ¹⁶²	+

+ = positive impact; - = negative impact; No = no (significant) impact or mixed results (e.g. positive in the best case scenario and negative in the worst case scenario). See Appendix 1.1.10 for more details.

As shown in Table 13 important variations were found. According to the analysis of these studies, the environmental impact depends on multiple factors:

- The material of the single-use and of the reusable device (e.g. plastic, metal, etc.)
- The lifespan of the reusable devices (number of reuses)
- The energy source mix of the country (renewable energy, coal, gas, etc.). Results were for example better in Europe and USA than in Australia (which remains heavily reliant on fossil fuels)
- The cleaning, disinfection, or sterilisation process required
- The disposal procedure (landfill, incineration, etc.)

The strongest consensus was observed for reusable gowns and surgical packaging (blue wraps), with four and three positive studies respectively.

It should also be noted that there are HGR-CSS recommendations on good clinical practice for the management of textile in healthcare institutions, including reusable surgical textile.¹⁷⁷

Two specific process indicators were therefore included in the long list of indicators (see Textbox 12).

Textbox 12 – Indicators on waste management and circular economy: single versus reusable medical devices

Specific process indicators:

- The share of hospitals using reusable surgical gowns
- The share of hospitals using reusable surgical packaging

DISPOSAL OF UNUSED PHARMACEUTICALS

Two reviews^{178, 179} included studies on the disposal of unused pharmaceuticals but none of these studies met our inclusion criteria (mainly because the reviews focused on the behaviour of people) (see Appendix 1.1.11 for details on the flowchart).

However, as returning drugs in pharmacy is a general measure supported by Belgian authorities, one general process indicator was included in the long list of indicators (see Textbox 13).

Textbox 13 – Indicators on waste management and circular economy: disposal of unused pharmaceuticals

General process indicator:

- Annual volume of unused pharmaceuticals returned to the pharmacy

OTHER WASTE MANAGEMENT INTERVENTIONS

Eleven reviews^{20, 37, 39, 40, 43, 44, 46, 144, 180-182} included studies on other waste management interventions, of which six primary studies¹⁸³⁻¹⁸⁸ met our inclusion criteria (see Appendix 1.1.12 for details on the flowchart).

**Table 14 – Studies on other waste management interventions**

<i>Intervention</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Repairing surgical scissors</i>	1 ¹⁸⁵	+
<i>Using aluminium containers or tray wraps instead of individually wrapped instruments (if more than 11 instruments)</i>	1 ¹⁸⁶	+
<i>Using autoclaves with integrated shredding or sodium hypochlorite-based technology instead of vacuum autoclaves, batch wise microwaves, continuous microwave, frictional heat, treatment and incineration technologies or chemical treatment with sodium hypochlorite-based technology.</i>	1 ¹⁸⁸	+
<i>High-temperature incineration of waste</i>	1 ¹⁸⁶	-
<i>Recycling or low temperature incineration with energy from waste instead of high temperature incineration</i>	1 ¹⁸⁴	+
<i>Education on waste management, promoting recycling and relocation of landfill and medical waste bins</i>	2 ^{183, 187}	+

+ = positive impact; - = negative impact. see Appendix 1.1.12 for more details

In general, recycling of waste and segregated waste collection is a general measure (not specific to the health care system) supported and/or mandated by Federated authorities. Moreover, based on Table 14, it seems high-temperature incineration should be avoided and recycling promoted (see Table 14). However, guidelines on medical waste required incinerations in some circumstances for safety reasons (for hazardous medical waste).¹⁸⁹

General process and outcome indicators were therefore proposed in the long list of indicators (see Textbox 14) and the analysis on waste disposal should take into account the type of waste (non-medical, hazardous medical waste, etc.).

Textbox 14 – indicators on other waste management interventions

Outcome indicator:

- Annual volume of waste

General process indicator:

- Share of diverse waste disposals (recycled waste, waste going to the landfill, waste with high temperature incineration)

2.2.5.6 Water and soil pollution

A total of 15 reviews^{20, 38, 40, 180, 190-200} included studies on water and soil pollution by medical products, ecotoxicity of medical products or drug removal techniques in waste waters. These studies were outside of our field of expertise and were therefore not analysed here. Only the topic was kept. This topic was further examined when investigating existing data, in collaboration with experts in this field.

2.2.5.7 Low value care

Seven reviews^{20, 37, 39, 44, 96, 103, 180} included studies on low value care, of which eleven primary studies²⁰¹⁻²¹¹ met our inclusion criteria (see Appendix 1.1.13 for details on the flowchart).

Avoiding unnecessary or inappropriate care has a clear positive impact on the environment. However, this topic is already incorporated in another sub-dimension in the HSPA framework “quality – appropriateness” and unwarranted clinical variation. As defined in section 1.4, this topic is therefore

considered out-of-scope. Nevertheless, for reference, the topics investigated in the selected studies are summarised in Table 15.

Table 15 – Studies on low value care

<i>Interventions</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Avoiding unnecessary blood - pathology testing</i>	5 ^{202, 208-211}	+
<i>Avoiding ineffective diabetes care</i>	2 ^{203, 205}	+
<i>Avoiding inappropriate use of short-acting b2- agonist (SABA)</i>	1 ²⁰¹	+
<i>Avoiding unnecessary flupentixol decanoate injections</i>	1 ²⁰⁷	+
<i>Avoiding unnecessary biopsy</i>	1 ²⁰⁶	+
<i>Avoiding unwarranted clinical variation in the use of MRI and CT</i>	1 ²⁰⁴	+

+ = positive impact. See Appendix 1.1.13 for more details

2.2.5.8 Other studies comparing health interventions

Six reviews^{20, 37-39, 96, 180} were retained that included studies comparing health interventions not classified in other sections, of which 14 studies²¹²⁻²²⁵ met our inclusion criteria (see Appendix 1.1.14 for details on the flowchart).

Among these studies, three showed that MRI has a worse environmental impact than CT, but CT induces higher radiation exposure for patients. As the use of MRI and CT is already examined in another sub-dimension of the HSPA framework, i.e. “quality - appropriateness of care”, this topic is considered out-of-scope.

Two other studies were related to pathology testing, which was also considered to be part of the sub-dimension appropriateness of care.

Other potential interventions were only based on one study and were therefore not kept.

Table 16 – Studies on comparison of specific health interventions

<i>Interventions</i>	<i>Nb of studies</i>	<i>Impact</i>
<i>Using MRI instead of other medical imaging techniques (CT, ultrasound, etc.)</i>	3 ²²³	–
<i>Promoting pathology testing with the lower environmental impact</i>	2 ^{221, 222}	+
<i>Promoting day care surgery instead of inpatient surgery</i>	1 ²²⁴	+
<i>Robotically-assisted laparoscopy instead of laparoscopy and laparotomy</i>	1 ²²⁵	–
<i>Single-dose targeted intraoperative radiotherapy (TARGIT) instead of external beam whole breast radiotherapy (EBRT)</i>	1 ²¹²	+
<i>Biopsy with 1 instead of 3 specimen jar</i>	1 ²¹⁴	+
<i>Applying fluoride varnish (FV) during an existing appointment or in school instead of at a separate appointment</i>	1 ²¹⁸	+
<i>Stretchable instead of rigid electronics cardiac monitoring devices</i>	1 ²¹⁷	+



Packaging options for contrast media delivery: polymer bottle instead of glass bottle	¹²¹³	+
6-month adjuvant trastuzumab and once every 4-week trastuzumab dosing compared to other dosing schedules	¹²¹⁶	+
Social support-based interventions instead of traditional mental health treatments	¹²²⁰	No

+ = positive impact; - = negative impact; No = no (significant) impact or mixed results (e.g. positive in the best case scenario and negative in the worst case scenario). See Appendix 1.1.14 for more details.

2.2.5.9 Assessment of multiple interventions or plans

Seven reviews^{20, 39, 40, 43, 46, 120, 182} included studies on the assessment of multiple interventions or plan, of which 9 studies²²⁶⁻²³⁴ met our inclusion criteria (see Appendix 1.1.15 for details on the flowchart).

As it is not possible to isolate the impact of a specific intervention from these studies, only the topics covered were analysed. Among the topics identified, two were not previously included in our review:

- Disease prevention. However, this topic is already addressed under another domain of the HSPA framework, i.e. “preventive care” and is therefore out-of-scope;
- Reduction of adverse events. However, this topic is already addressed under another sub-dimension of the HSPA framework, i.e. “quality - safety” and is therefore out-of-scope.

2.2.5.10 Research

Three reviews^{39, 42, 235} included studies on the evaluation of the environmental impact in HTA but no studies respected our inclusion criteria (rather methodological studies or opinion papers).

Two reviews^{38, 180} also included studies on virtual conferences compared to in-person conferences but, again, no studies respected our inclusion criteria (see Appendix 1.1.16 for details on the flowchart).

As KCE is currently participating in an international working group to include the environmental impact in HTA, such general topic was still included in the long list of indicators.

General process indicator:

- Share of HTA assessing the environmental impact

2.3 Review of existing data

2.3.1 Aim of the review

In addition to the review of indexed peer-reviewed scientific literature, a complementary review was conducted to identify existing data sources and indicators that could support evidence-informed monitoring of the environmental sustainability of the healthcare sector. The objective was to map what is already measurable using routinely available datasets at international, national and regional level, to document key methodological characteristics (scope, units, disaggregation potential, time coverage and update frequency), and to identify gaps where further indicator development would require additional data collection or modelling.

2.3.2 Method

The review combined structured desk screening by two researchers with targeted expert consultation. This mixed approach was used because relevant data for assessing environmental sustainability in healthcare are dispersed across multiple institutions and information systems, including healthcare

activity and expenditure statistics, environmental monitoring and reporting systems, and environmental-economic accounting frameworks. While many datasets do not explicitly label indicators as “healthcare-related”, sector-level breakdowns are often possible and allow the contribution of healthcare activities to environmental pressures to be quantified.

First, major international databases and initiatives were screened for environment- and health-relevant statistics, including Eurostat²³⁶, the European Environment Agency (datahub, indicators and greenhouse gas inventories)²³⁷⁻²⁴¹, OECD²⁴², WHO^{3, 243, 244}, Our World in Data²⁴⁵, and the DAPHNE project²⁴⁶. This screening focused on environmental-economic accounts and inventories, as well as indicators of environmental pressures (e.g. greenhouse gas emissions and other air pollutants, chemical pollution, radiation, energy use, water use and pollution, land use, material use, and waste generation), where the healthcare sector or specific components (e.g. hospitals, pharmaceuticals) could be separately identified.

Second, Belgian federal and regional sources were reviewed to identify datasets with greater sectoral detail. This included structured screening of institutional websites, reports and databases, complemented, where possible, by email exchanges and online meetings with data owners or experts to validate interpretation and document limitations, clarify sector coverage and decomposition (e.g. delineation of the healthcare sector and its subsectors), discuss data access modalities, and identify additional relevant sources. The full list of screened sources and contacted stakeholders is reported in Appendix 1.2, and includes key actors such as the FPS Public Health, the Federal Planning Bureau, Statistics Belgium, regional environmental, energy, water and waste authorities, and research organisations such as VITO.

2.3.3 Results

All potential indicators identified through the review were consolidated into an indicator database to support transparency and to inform subsequent prioritisation. After removing duplicates, 93 indicators were retained (Appendix 1.3).

For each indicator, the database documented: (1) a short description and calculation logic, (2) unit(s), (3) frequency of data collection, (4) latest available year, (5) data source, (6) geographical level (international/national/regional), (7) EU-wide availability (yes/no), (8) potential disaggregation (e.g. by provider type, care setting, region, spending category, pollutant/material type), and (9) additional remarks on scope, comparability, access modalities and known limitations. This database provided an operational overview of available measurement options and supported the selection of indicators for monitoring and reporting.

2.4 Investigation of other relevant sources

2.4.1 Aim of the section

The aim of this review was to ensure the completeness of potential topics identified in the previous sections by investigating three additional sources:

- National action plans in a selection of countries;
- Other HSPA frameworks;
- Conceptual frameworks related to environmental sustainability.

2.4.2 National action plans

National action plans from a selection of European countries with more advanced healthcare sustainability strategies (France, Ireland, the Netherlands and England) were reviewed by two researchers to assess whether additional environmental sustainability topics emerged compared with



those identified in the literature review and data review. Sources consulted for the selected countries can be found in Appendix 1.2.

The reviewed plans primarily focused on decarbonisation of the health system and presented roadmaps of priority actions, including the transition away from fossil fuels (energy efficiency, low-carbon transport and heating), reduction of waste and material use (e.g. reusable alternatives where safe), changes in clinical and organisational practices (e.g. prevention and healthy lifestyle, reduction of inappropriate or avoidable care, digitalisation, anaesthetic gas use and prescribing practices), and strengthening sustainability across supply chains (e.g. sustainable procurement, food, and pharmaceuticals).

No fundamentally new topics were identified compared with those derived from the scientific literature and the data review. However, these action plans supported the policy relevance of the topics already included. They also highlighted growing recognition of the need for improved monitoring and reporting, but at the same time included few (proposals of) measurable indicators. Hence, the translation of strategic actions into operational indicators, measurable targets and data collection remains limited and is still evolving in most countries.

2.4.3 HSPA frameworks

To identify potential topics and indicators from existing HSPA frameworks in other countries, the following sources were investigated:

- The international inventory of HSPA indicators,²⁴⁷⁻²⁵⁰ supplemented with the literature review of performed in our previous thematic HSPA report on chronic patients.¹⁴
- The German²⁵¹ and Irish²⁵² HSPA frameworks, published after the updated inventory cited above;

No indicators addressing the environmental impacts of the health system were identified. Only indicators related to the impact of the environment on health, which fall outside the scope of this, were identified.

In a second step, additional information was requested through the EU expert group on HSPA²⁵³ and the Health Systems and Policy Monitor Network²⁵⁴, but no further relevant indicators were identified.

No indicators or topics were therefore identified from this review.

2.4.4 Conceptual frameworks

To ensure completeness of our scope in terms of relevant environmental pressures and the coherence of the selected topics and indicators, we examined existing conceptual frameworks for environmental sustainability that were identified in the review of the literature, data and national action plans. The aim of this exercise was to aid the selection of final indicators (see section 2.5.3) by making a link to the conceptual frameworks and ensuring a consistent global perspective, relevance and coherence.

Based on the previous steps, two key conceptual frameworks were identified: life-cycle assessment (LCA) and the Planetary Boundaries framework. LCA provides a standardised methodological approachⁱ to quantify potential environmental impacts along the full life cycle of products and services, including both direct and upstream burdens. It covers multiple impact categories (e.g. climate change, land use and resource use), which makes it particularly relevant for healthcare, where many impacts occur in supply chains. The EU Environmental Footprint (EF) method builds on LCA by providing a

ⁱ Regarding standardised LCA approaches, the first international standard defining how to conduct product-level life cycle assessments (LCAs) for pharmaceutical products has been published by the British Standards Institution (BSI), i.e. the PAS 2090:2025. The standard provides a credible, consistent and science-based framework for measuring and comparing environmental performance across medicines and health technologies.²⁵⁵

harmonised impact-assessment framework that supports consistent measurement across multiple environmental categories and can be applied at higher levels of aggregation, such as sectors or economies (e.g. healthcare consumption).²⁵⁶⁻²⁵⁸

In parallel, the Planetary Boundaries framework provides a complementary, system-level perspective. It defines a “safe operating space” by identifying nine critical Earth-system processes and assessing the degree to which human pressures increase the risk of destabilising those systems.^{259, 260} This framework is useful for interpreting environmental pressures (e.g. climate change, land-system change, resource use) in terms of global risk and ecological limits.

A link between both frameworks can be established by mapping LCA/Environmental Footprint impact categories to planetary boundary dimensions, as proposed by Sala et al. 2020²⁵⁷ and Sanyé Mengual et al. 2023²⁶¹ (see Table 17).

Table 17 – Link between LCA impact categories and planetary boundaries

LCA mid-point impact categories	Planetary boundaries									Resource use
	Biosphere - biodiversity Integrity	Climate Change	Novel entities	Stratospheric Ozone Depletion	Atmospheric Aerosol Loading	Ocean Acidification	Biogeochemical Flows	Freshwater Change	Land-System Change	
Climate change	■	■				■				
Particulate Matter					■					
Photochemical Ozone Formation	■		■							
Ozone Depletion				■						
Acidification	■						■			
Eutrophication	■						■			
Ecotoxicity	■		■							
Human Toxicity			■							
Ionizing Radiation			■							
Land Use	■								■	
Water Use	■							■		
Resource use (fossil fuels, minerals, and metals)		■								■

Source: Adapted from Sala et al. 2020²⁵⁷ and Sanyé Mengual et al. 2023²⁶¹. Blue square = direct impact, dark square = indirect impact

During the review of the indexed literature, a scoping review that aimed to identify environmental impact factors for sustainable healthcare was also identified. In this review, impact factors were classified according to three types of direct pressures:²⁶²

- Waste generation (mass, volume and emission);
- Pollutant emission (in air and water); and
- Resource use (water and energy)

This review also makes the link with the environmental impacts cited by the WHO framework for building climate-resilient and environmentally sustainable health care facilities (i.e. water, sanitation, wastes, air pollution, chemicals, radiation, and GHG).²⁶³ They concluded that they identified factors



for each type of WHO impact categories except for sanitation and radiation (chemicals was only indirectly taken into account via water pollution (pharmaceutical residues in water)).

2.5 Expert meeting and selection of indicators

2.5.1 *Compilation of a long list of indicators, classified by topics*

One researcher screened all indicators identified in previous sections, removed duplicates, grouped indicators by topic and discussed the results with the research team. The following topics were identified:

- Overall indicators (18 indicators);
- Building and energy management (27 indicators);
- Transport and mobility (10 indicators);
- Medical products (13 indicators);
- Sustainable food (8 indicators);
- Waste management (20 indicators);
- Water management (9 indicators).

A total of 105 indicators were included in the long list (see Appendix 1.3). As information for experts, an excel sheet with the long list of indicators was prepared, divided by topic, and including an explanation of all indicators and details on the unit, frequency of data collection, latest year of data available, data source, geographical level, EU data available, disaggregation possible, and any other information on data and method.

2.5.2 *Experts consultation*

An expert meeting was organised to identify the most relevant indicators for the Belgian context, taking into account data availability. Given the objective of the exercise, primarily Belgian experts were invited. Representatives from the following institutions participated in the final selection:

- From the Federal State: Federal Public Service Health, Food Chain Safety and Environment (FPS Public Health), the National Institute For Health and Disability Insurance (RIZIV – INAMI), the Federal Planning Bureau;
- From Federated entities: Departement zorg, Vivalis;
- From universities: UZ Gent, KU Leuven, UAntwerpen;
- From other Belgian institutions: The Shifters Belgium, the Scientific Society of General Medicine (*“Société Scientifique de Médecine Générale”* (SSMG));
- From international or foreign research institutions: Healthcare without Harm^j, *“Institut de recherche et documentation en économie de la santé”* (IRDES, France)).

Experts from the following institutions were also invited but were unable or refused to participate: AVIQ, Sciensano, ULB, UCL, KU Leuven, Arup, Lancet Commission on Sustainable Healthcare, Greener NHS.

^j Healthcare without Harm filled in the survey after the expert meeting. Their contribution was therefore not included in the results discussed during the expert meeting but was taken into account by the research team afterwards.

An online survey was prepared and with the help of the Excel sheet described in the previous section, experts were invited to:

- Step 1: Select indicators they would include for each topic (no minimum or maximum). Experts were not obliged to do the exercise for all topics but only for those for which they considered they had sufficient competencies. They were also authorised to propose new indicators for each topic and to make any additional comments;
- Step 2: Classify per order of preference a minimum of 1 indicator and a maximum of 5 indicators for each topic for which indicators were selected in the step 1 (including those they proposed). From this ranking, the first indicator (considered as the most relevant) got 5 points, the second 4 points, etc. This allowed us to calculate an average score for each indicator per topic;
- Step 3: Select at the end of the process no more than 15 indicators among those they had selected for each topic in step 2 (without the new proposed) and classify them per order of preference. From this ranking, the first indicator got 15 points, the second 14 points, etc. This allowed us to calculate an average total score for each indicator.

To prepare the meeting, one researcher sorted the indicators in each topic based on their average score, highlighted the new proposed indicators or comments, and provided additional information on the score and ranking obtained, the number of experts who had selected the indicator, the number of experts who had selected the indicator in the top 5, and details on data availability (e.g. if international comparison was possible). These results were presented and discussed during the expert meeting. At the beginning of the meeting, some general remarks highlighted by experts in the survey were presented (see Textbox 15). Discussions were then done per topic.

Textbox 15 – General remarks done by experts

- **Intensity-based indicators, expressing the emissions or energy use in terms of expenditure:** According to some experts, expenditure-based intensity metrics could be misleading, because if expenditures grow faster than the environmental harm, that would give a misleading idea that the trend is improving which is not necessarily the case. It was therefore decided to rather select absolute indicators but to also present results per capita to allow for international comparison when possible.
- **Missing topics:** Some experts highlighted the need to have more indicators on circular economy and natural resource use.
- **Scopes:** Some experts suggested to be cautious when using indicators based on upstream and downstream activities because of the limited influence of the healthcare sector on these activities, while other considered these indicators as important, especially for medical products as they represent an important share of the carbon footprint. It was therefore decided that both scope 1 and all scopes indicators should be included.
- **Data availability and limitations:** For a large number of indicators, data were only available for Flanders. If such kind of indicator is selected, this should be mentioned in the limitation and collecting these data in other regions should be recommended. The use of the NACE sector code to identify the health sector was also criticised as this is not ideal. This should also be mentioned in the limitations when used.
- **Other HSPA dimensions:** A final remarks concerned the fact that no indicators on the efficiency of care or on avoidable low value care were included in the long list of indicator. For this remark, the scope of the report was recalled (see section 1.4. explaining that other dimensions of the Belgian HSPA framework were out-of-scope).



2.5.3 *Final selection*

Based on the expert meeting discussion, a final selection of topics and indicators was done by the research team (see Table 18).

To aid the selection of final indicators and ensure broad coverage in terms of relevant environmental pressures and selected topics and indicators, a link was made between the selected indicators and the conceptual frameworks (see section 2.4.4 and Table 17).

Concerning the mid-point impact categories, eutrophication was only indirectly assessed via the indicator ENV-6 on acidifying gas and indicator ENV-13 on annual food waste. However, according to section 2.2.4, the impact of the health system on eutrophication was less important than other impact categories. Ionising radiation was also not covered by a specific indicator while in Belgium, 44% of annual ionising radiation exposure in 2021 originated from medical applications.²⁹² This aspect is nevertheless indirectly covered by another dimension of the HSPA framework, i.e. the appropriate use of medical imaging (see section 3.9). Concerning the planetary boundaries, all concepts were covered but sometimes only indirectly (see Table 18).

Table 18 – Final selection of topics and indicators

Topics	Indicators	Main LCA impact categories	Planetary boundaries
Overall environmental footprint of the health system			
• GHG emissions	ENV-1 GHG footprint of the health system (Annual direct and indirect emissions (scope 1, 2 and 3) in the healthcare sector)	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
• Resource use	ENV-2 Material footprint of the healthcare system (direct and indirect use)	Resource use (fossil, minerals and metals)	Resource use and climate change (indirect)
• Land use	ENV-3 Land use footprint of the healthcare system (direct and indirect use)	Land use	Land system-change, biodiversity (indirect)
Air emissions			
• GHG emissions	ENV-4 Direct GHG emissions (scope 1) in the healthcare sector (on-site fuel combustion, fleet vehicles) - production perspective	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
• Air pollutants	ENV-5 Particulate matter emissions (PM _{2.5}) in the healthcare sector (direct emissions)	Particulate matter	Atmospheric aerosol loading
	ENV-6 Emissions of acidifying gas in the healthcare sector (direct emissions)	Acidification and eutrophication (indirect)	Biogeothermal flows, biodiversity (indirect)
	ENV-7 Ozone precursor emissions in the healthcare sector (direct emissions)	Photochemical ozone formation	Novel entities, biodiversity (indirect)
Building and energy			
• GHG emissions	Link with Indicator ENV-1 (sub-indicators on fossil fuel, electricity and steam, construction and maintenance services)	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
• Energy consumptions	ENV-8 Fossil energy consumption in the healthcare sector	Climate change and resource use (fossil)	Climate change, resource use, biodiversity (indirect), ocean acidification (indirect)
	ENV-9 Percentage of healthcare facilities conducting energy audit/scan since 2018	Climate change and resource use (fossil)	Climate change, resource use, biodiversity (indirect), ocean acidification (indirect)
Transport and mobility			

Topics	Indicators	Main LCA impact categories	Planetary boundaries
• GHG emissions	Link with Indicator ENV-1 (sub-indicators on transport and mobility) and indicator ENV-2	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
High carbon footprint medical products			
• GHG emissions	Link with Indicator ENV-1 (sub-indicators on medical products)	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
• High carbon footprint pharmaceuticals	ENV-10 Proportion of low-carbon footprint inhalers prescribing for both reliever (SABA) inhalers and preventer (ICS-LABA) inhalers	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
	ENV-11 GHG impact of anaesthetic gases (sevoflurane, desflurane, isoflurane)	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
	ENV-12 Direct emissions of nitrous oxide (N ₂ O) in the healthcare sector	Climate change and ozone depletion	Climate change, stratospheric ozone depletion, biodiversity (indirect), ocean acidification (indirect)
Sustainable food			
• GHG emissions	Link with Indicator ENV-1 (sub-indicators on food)	Climate change	Climate change, biodiversity (indirect), ocean acidification (indirect)
• Food waste	ENV-13 Annual food waste in hospitals and residential care	Climate change, land use, and eutrophication (indirect)	Climate change, land system-change, biodiversity (indirect), ocean acidification (indirect)
Waste management and circular economy			
• Waste management	ENV-14 Annual primary waste in the healthcare sector	Climate change and resource use (fossil, minerals and metals)	Climate change, resource use, biodiversity (indirect), ocean acidification (indirect)
• Circular economy	ENV-15 Percentage of hospitals with a designated person or team responsible for implementing a strategy on waste recycling, waste reduction, or circular economy	Climate change and resource use (fossil, minerals and metals)	Climate change, resource use, biodiversity (indirect), ocean acidification (indirect)
Water use			
• Water consumption	ENV-16 Annual water consumption in healthcare sector	Water use	Freshwater use, biodiversity (indirect)
Ecotoxicity			
• Water pollution	ENV-17 Hazard potential of pharmaceutical consumption in surface water	Ecotoxicity and human toxicity	Novel entities, biodiversity (indirect)

Among the selected indicators, two were added by experts, i.e. indicators on material footprint of the health system (ENV-2) and on land use foot print of the health system (ENV-3).

The following indicators were also discussed during the expert meeting but finally not kept:

- In building and energy use:
 - The “percentage of healthcare and social care facilities with on-site renewable energy production”: While all experts agreed on the importance of using renewable energy, it was concluded that the responsibility for renewable energy implementation should not fall solely on healthcare facilities (i.e. not especially “on-site”). Instead, this should be addressed at a broader level to increase the overall share of renewable energy in Belgium.
 - The “percentage of healthcare and social care facilities meeting energy label E or better”: the insulation of healthcare buildings was considered as important by experts. The current energy label nevertheless was related to the use of local renewable energy and not to the insulation of the building. This indicator was thus not kept and rather identified in the data gaps (see section 2.5.4).
- In transport and mobility:
 - The “percentage of healthcare sector employees that commute by bike, foot, or public transport”: indicators on transport and mobility were considered as less important by experts as already covered by the indicators on annual direct emissions (scope 1) in healthcare sector (on-site fuel combustion, fleet vehicles, ENV-4) and particulate matter emissions (ENV-5). Some experts highlighted the interest of selecting an actionable indicator such as the percentage of healthcare sector employees that commute by bike, foot, or public transport. Nevertheless, as the impact of this is minimal, the indicator was finally not kept.
- In high carbon footprint medical products:
 - The “percentage of hospitals with guidelines for sustainable procurement of pharmaceutical products”: as pharmaceuticals have an important impact on GHG emissions, all experts agreed that measures should be done in this sector. Nevertheless, as no guidelines have currently been defined at the national level, this indicator was considered as premature and was rather identified in the data gaps and need for future research (see section 2.5.4).
 - The “percentage of hospitals using vapor-capturing technology”: one expert proposed to link this indicator with the indicator on the volume of high carbon footprint anaesthetic gases. Nevertheless, after having contacted experts and having looked at the literature, it seems that more research is needed on this topic.^{264, 265} This indicator was therefore rather added in the data gaps and need for future research (see section 2.5.4).
- In sustainable food:
 - The “percentage of annual meals in hospitals being from vegetal origin”: a lot of experts proposed to add this kind of indicator in the list but as no data was available, it was rather added in the data gaps (see section 2.5.4).
- In waste management:
 - The “annual volume of household pharmaceutical waste returned to pharmacies”: while all experts agreed that an indicator on pharmaceutical waste was important, they also agreed that data on annual volume of household pharmaceutical waste returned to pharmacies is less appropriate because the interpretation was difficult (returning pharmaceuticals in pharmacy is positive but a high volume of waste is negative). They recognised another method to measure pharmaceuticals waste was needed (see section 2.5.4).



- In water management:
 - The “percentage of hospitals implementing drug removal techniques in wastewater”: for this indicator, it was also concluded that this should not fall solely on healthcare facilities and that the treatment of wastewater should rather be addressed by municipalities.

2.5.4 Data gaps and need for future research

During the expert meeting, the topics highlighted in Textbox 16 were also identified as essential. However, either no data was available or future research was needed.

Textbox 16 – Data gaps and need for future research

Building and energy management:

- Insulation of hospitals: In Flanders, the EPC-NR includes both an energy label and an energy score. The energy label mainly reflects the share of renewable energy, while the energy score expresses energy consumption per m²; insulation influences this score but is also affected by other factors such as technical installations and building size/use. To better monitor the insulation status of buildings, a complementary indicator specifically capturing insulation performance could be developed and routinely collected.

High carbon footprint medical products:

- Sustainable procurement of pharmaceuticals: guidelines on the sustainable procurement of pharmaceuticals are needed. Then, data on the share of hospitals applying these guidelines could be collected.
- Vapor-capturing methods: methods to capture and reuse anaesthetic gases have been developed but more research on this topic is needed^{264, 265} before envisaging to select this kind of indicator.

Sustainable food:

- Food from vegetal origin: in hospitals and other healthcare institutions, methods to identify the share of meals being from vegetal origin could be developed (an expert for example suggested to conduct a two-weeks survey), and then data could be collected.

Waste management and circular economy:

- Pharmaceutical waste: While in hospitals and nursing homes, pharmaceuticals are delivered by unit, this is not the case in community pharmacists and the packaging is not always adapted to the recommended treatment, generating unnecessary waste. Methods to measure this waste could be developed (no data currently available). A reflection on potential policy measures to reduce pharmaceutical waste (such as extending the delivery per unit) could also be done.
- Single-use versus reusable medical devices: the literature showed that a lot of factors influence the choice between single-use or reusable medical devices and the safety impact was not assessed in this report. It was therefore decided to first assess pilot projects on this topic before proposing indicators.²⁶⁶ It should also be noted that based on FINHOSTA data in hospitals, an increase in expenditures for single-use textile per capita was observed between 2012 and 2024, even after correction for inflation.
- Circular economy and the volume of medical consumables purchased by hospitals: this indicator was proposed after the expert meeting and is also an indirect way of measuring the circular economy. As experts considered that more indicators on circular economy are needed, a reflection on methods to develop this kind of data in Belgium could be done.

eHealth:

- During the validation meeting, the impact of digital health data storage was also identified as an important area that would require more attention.

2.5.5 *Links with other HSPA dimensions and domains*

During the review of the scientific literature, existing data sources and national action plans, several indicators were identified that relate to other dimensions and domains of the HSPA framework. In particular, these indicators were linked to the following topics:

- Reducing avoidable care, related to the dimension “quality – effectiveness of care”
- Reducing inappropriate care or overuse of care, related to the dimension “quality – appropriateness of care”
- Reducing adverse events, related to the dimension “quality – safety of care”
- Reducing exposure to ionising radiation, related to the dimension “quality – appropriateness of care”
- Supporting rational prescribing and deprescribing of pharmaceuticals, related to the dimension “quality – appropriateness of care” and “quality – continuity of care”
- Improving geographical accessibility, related to the dimension “accessibility – health services distribution”
- Improving the efficiency of care (e.g. promoting day care), related to the dimension “efficiency” and “quality – effectiveness”
- Preventing diseases, related to the domain “preventive care”
- Promoting healthy lifestyles, related to the health status report

For these dimensions and domains, the present report will not develop new indicators, but will only highlight warning signals already identified in the previous HSPA report.

3 ASSESSMENT OF THE ENVIRONMENTAL SUSTAINABILITY OF THE HEALTH SYSTEM

3.1 Introduction

This section summarises the main results for each indicator selected in the previous chapter. More detailed analyses can be found in the technical sheets provided in the supplement to the report. The evaluation score (pictogram, see Table 2) for each indicator as well as the data sources are provided in the synoptic tables in the discussion (see chapter 4).

3.2 Overall environmental footprint of the health system

Healthcare is a major economic sector that delivers essential social value and represents a sizeable share of final demand. Moreover, demand for healthcare is expected to continue increasing due to population ageing, expanding medical treatment options and rising expectations regarding access and quality of care.^{10, 267, 268} As a result, and as shown in the literature, healthcare consumption exerts substantial pressure on the environment through energy use, infrastructure, food provision, medical products and a wide range of goods and services supplied along global value chains.^{20, 24, 25, 30, 256, 269-271}



This section provides an overview of the environmental impact of the health system through three broad and partly interrelated footprints. Greenhouse gas emissions drive global warming and climate change, with consequences for climate-related hazards, ecosystems and human health and societal functioning.^{3, 272} Land-system change and primary material extraction are key environmental pressures that drive biodiversity loss, soil degradation and ecosystem disruption, through land occupation and transformation, depletion of natural resources and associated water stress and pollution.^{258, 259, 270, 273, 274} Together, climate change, land-system change and material extraction place increasing stress on ecological systems and reduce the resilience of the natural environment on which population health and wellbeing ultimately depend.²⁵⁷⁻²⁵⁹

Because healthcare relies heavily on purchased goods and services, a large share of its environmental impacts occurs indirectly through upstream supply chains rather than at the point of care delivery.^{269, 275, 276} The three footprint indicators are therefore estimated using environmentally extended input–output (EE-IO/MRIO) methods, which link healthcare expenditures to greenhouse gas emissions, land use and material extraction embodied in domestic and international production networks.²⁷¹ This top-down, multi-category approach allows consistent quantification of environmental pressures, identification of supply-chain hotspots, and assessment of mitigation strategies while reducing the risk of burden shifting across impact categories.

However, this top-down approach also has limitations. It relies on monetary expenditure flows and sector-average environmental intensities, and typically lacks detailed bottom-up data on healthcare-specific practices and emission sources. As a result, estimates remain relatively coarse and depend on the sectoral resolution of the underlying database, the mapping of healthcare expenditure categories, and modelling assumptions. Footprint estimates can therefore differ across EE-IO/MRIO frameworks and datasets. In this report, all three footprint indicators are based on the VITO model, while for the GHG footprint additional estimates are available from the OECD and NEHAP (also including some bottom-up data) models (see supplement on technical sheets for details).

3.2.1 GHG emissions footprint

ENV-1 DIRECT AND INDIRECT GHG EMISSIONS (SCOPE 1, 2 AND 3) IN THE HEALTHCARE SECTOR

Assessing direct and indirect GHG emissions in the healthcare sector is complex, and results vary depending on the model and assumptions applied. While these estimates should be interpreted with caution, understanding the magnitude and trends of these emissions remains essential to achieve a climate-resilient, low-carbon, and sustainable health system by 2050.

To estimate these emissions, this report used data from three different models: NEHAP⁵, VITO, and OECD²⁶⁹ (see the technical sheet for details).

Estimated direct and indirect GHG emissions in the healthcare sector in 2022 ranged between 7 321 and 9 901 kt CO₂ eq, depending on the model. On a per capita basis, this corresponded to 629–851 kg CO₂ eq.

When accounting for the increase in population, a small decline in the GHG emissions per capita was observed, with the lowest value observed in 2022 (629 kg CO₂ eq per capita) and the highest value in 2015 (711 kg CO₂ eq per capita). The share of the health system in the Belgian GHG footprint remained relatively stable over time, fluctuating within a range of 4.9% and 5.5% but a temporary increase to 5.8% was observed during the COVID-19 pandemic (based on the VITO model, no evolution available for other models).

Scope 3 emissions dominated, accounting for 86.4% of total healthcare-related GHG emissions in 2022, while Scope 1 direct emissions represented 10.9%. Medical products (pharmaceuticals, medical equipment, and instruments – scope 3) were the largest contributors at 44.3%. Among healthcare providers, hospitals accounted for 55.4% of emissions (based on the NEHAP model).

Compared to other countries, direct and indirect GHG emissions per capita in Belgium (731 kg CO₂ eq per capita in 2018) were above EU averages (with 560 and 452 kg CO₂ eq for the EU-14 and EU-27, respectively – based on the OECD model). Belgium ranked the second highest country in the EU in 2018, just after Germany. Expressed as a share of total GHG emissions for all sectors, results were also higher in Belgium (5.5%) than the EU-averages (4.9% for the EU-14 and 4.3% for the EU-27) and Belgium was the fourth highest country in 2018 (after Germany, Denmark and Portugal).

3.2.2 *Material footprint*

ENV-2 MATERIAL ENVIRONMENTAL FOOTPRINT OF THE HEALTHCARE SECTOR

The material footprint captures the extraction of biomass, fossil energy carriers, metal ores and non-metallic minerals (domestically and abroad, directly and indirectly) required to meet healthcare demand. Health systems account for substantial shares of material extraction, including biomass for medical textiles, paper and food provision; fossil resources for plastics and synthetic polymers, energy use and transport; metal ores for infrastructure, medical equipment and batteries; and non-metallic minerals for construction and renovation, medical devices and pharmaceutical ingredients.^{270, 271} Reducing material use aligns with circular economy strategies that aim to maintain material value, reduce new extraction and improve supply resilience. In healthcare, this requires rethinking product design, procurement and use in line with the hierarchy of R-strategies (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover), while safeguarding patient safety, quality of care, performance and cost-effectiveness.^{277, 278}

The material footprint of the Belgian healthcare sector amounted to around 1 000 kg per capita. It declined modestly over time, from 1 084 kg per capita in 2012 to 1 042 kg per capita in 2022, despite growth in healthcare output. Substantial variability was observed over the period, with a decline between 2012 and 2016 followed by an increase linked to higher investment activity under favourable macroeconomic conditions, such as low interest rates. The footprint peaked in 2021 due to COVID-related surges in healthcare activity and investment, followed by a partial decline that did not return to the 2016 minimum. Outside the pandemic period, changes in the healthcare material footprint broadly tracked developments in the wider economy. Overall, the health system accounted for approximately 5.6% to 6.7% of the Belgian material footprint, with a temporary increase in 2020-2021 reflecting a sharper rise in healthcare-related material use compared with other sectors during the pandemic (e.g. protective and sterile materials, vaccines, transport services, etc.).

In terms of composition, non-metallic minerals dominated the footprint, accounting for more than half of total material use. Biomass, largely related to food provision and catering, and fossil energy carriers, particularly associated with energy use, transport and pharmaceuticals, each represented around one fifth of the footprint. Metal ores contributed a smaller but stable share, reflecting their role in equipment, machinery and infrastructure.

The results showed that material use in healthcare was driven less by direct medical products than by enabling goods and services, such as infrastructure, logistics, energy and food provision. Investments were relatively more material-intensive than current spending, as their share of total material use exceeded their share of healthcare expenditure. Among healthcare providers, hospitals and outpatient care both accounted for about 30% of the footprint in 2022. Moreover, material extraction largely occurred outside Belgium: In 2022, only 22% of the material footprint was domestic, 23% originates in other EU countries, and more than half was generated outside the EU, highlighting a strong dependence on international supply chains. From a sectoral perspective, around three quarters of material extraction originated in mining, and approximately one fifth was attributable to agriculture and forestry.

Internationally comparable results for the material footprint were only available for 2015²⁷⁰ and were considered insufficiently recent to support conclusions; they are reported in the supplement on technical sheets for completeness.



3.2.3 Land use footprint

ENV-3 LAND USE ENVIRONMENTAL FOOTPRINT OF THE HEALTHCARE SECTOR

The land use footprint was used as a proxy for land-system change and captures the land required (domestically and abroad, directly and indirectly) to satisfy healthcare demand. Results were reported both in physical surface area (see synoptic table) and weighted by soil quality, with both metrics showing similar trends over time. Land is a finite and scarce resource that serves multiple competing societal functions. Deforestation and conversion of natural ecosystems into cropland, pasture, forest plantations or built infrastructure alters soil properties.^{258, 273, 274} Recent assessments of planetary boundaries indicate that land-system change has exceeded the safe operating space, increasing risks to ecosystem stability and resilience.²⁵⁹ The health system impacts land use through direct land occupation (e.g. hospitals and care facilities), but most land use occurs upstream through food provision and biomass-based inputs such as textiles, paper and packaging.^{257, 258} Reducing land pressures therefore links to circular strategies and shifts towards more plant-based food provision.^{279, 280}

Between 2012 and 2022, the land use footprint of the health system declined modestly from 0.54 to 0.48 m² per capita (from 6 007 to 5 587 km²). While fluctuations occurred between 2012 and 2018, with peaks in 2015 and 2018, a gradual decline was observed thereafter. No COVID-related peak was visible, reflecting the structurally biomass-driven nature of this indicator (e.g. food provision, paper, etc.), which is less sensitive than the material footprint to the surge in activity caused by the pandemic.

The healthcare sector represented a stable share of Belgium's land use footprint, accounting for approximately 4.9-5.8% of total land use in surface terms. When weighted by soil quality, this share was slightly lower (4.2-4.9%), suggesting that healthcare-related land use was, on average, associated with somewhat lower soil-quality impacts than land use in the wider economy.

The results show that land use impacts were mainly driven by enabling goods and services rather than direct medical products. Food and catering and goods each accounted for around 20–25% of land use, while pharmaceuticals, transport and trade services, and infrastructure-related activities each contributed around 10%. Consistent with the recurring demand for food and other biomass-based goods, current spending dominated land use (85-90% of the footprint), while investment-related land use declined strongly over time. Among healthcare providers, hospital and long-term care accounted for more than 40%, while outpatient care represented more than 30% of total healthcare-related land use. Finally, around 98% of land occupation originated in agriculture and forestry, and roughly two thirds of land use occurred outside the EU, with only 7% taking place in Belgium. This underscores the strong dependence of healthcare delivery on international biomass production and upstream land-system impacts.^{25, 275, 276}

Internationally comparable results for the land use footprint were only available for 2015²⁷⁰ and were considered insufficiently recent to support conclusions; they are reported in the supplement on technical sheets for completeness.

3.3 Air emissions

This section provides an overview of four indicators related to direct air emissions released by the health system and impacting the environment: direct GHG emissions, particulate matter emissions (PM_{2.5}), emissions of acidifying gas and ozone precursor emissions. These indicators are calculated by the National Planning Bureau and published in the Eurostat Air Emission Accounts.

It is important to note, however, that significant methodological limitations have been identified for these indicators. These are described in detail for the first indicator (ENV-4, Textbox 17) but also apply to the other indicators (ENV-5, ENV-6, ENV-7), as well as to ENV-8 in the next section (energy consumption) and ENV-1 in the previous section, as direct emissions are part of the overall environmental footprint assessment.

3.3.1 GHG emissions

ENV-4 DIRECT GHG EMISSIONS (SCOPE 1) IN HEALTHCARE SECTOR (ON-SITE FUEL COMBUSTION, FLEET VEHICLES) - PRODUCTION PERSPECTIVE

Direct GHG emissions (Scope 1) in the healthcare sector include emissions from on-site combustion of fossil fuels (e.g. fuel used in hospital boilers) and from the operation of the healthcare fleet. The healthcare sector was identified using the statistical classification of economic activities in the European Community (NACE Rev. 2), specifically code Q86, which covers human health activities (excluding residential care).

Annual direct GHG emissions in the healthcare sector in Belgium increased from 760 311.5 t CO₂ eq in 2012 to 1 296 864.2 t CO₂ eq in 2023 (+70.6%). However, it is important to note that Belgium changed its methodology to better estimate emissions from road transports (with retroactive adjustments) and based on the previous methodology, direct GHG emissions were lower and more stable (585 202 t CO₂ eq in 2012 and 586 578 t CO₂ eq in 2022, +0.2%) (See also Textbox 17).

While CO₂ was the dominant greenhouse gas (96.9% in 2023), it is currently challenging to determine which CO₂ source had the greatest impact. Nitrous oxide (N₂O) also played a role in the healthcare sector but the impact was smaller (2.8% of GHG emissions in 2023) and emissions from this gas decreased between 2012 and 2023 (-50%). Other gases (methane (CH₄) and fluorinated gases) accounted for less than 0.3%.

At the regional level, Wallonia reported higher per capita emissions in 2022 (153.5 kg CO₂ eq per capita), compared to Flanders (80.5 kg CO₂ eq per capita) and Brussels (76.2 kg CO₂ eq per capita). In this case, methodological factors were not the main explanation as the methodology was more aligned between regions since 2021. A more in-depth analysis of these disparities is therefore required to identify their underlying causes.

At the European level, direct GHG emissions per capita were generally lower and more stable in other countries. In 2023, Belgium recorded 110.1 kg CO₂ eq per capita, representing a 60.8% increase compared to 2012, whereas the EU-27 average stood at 37.0 kg CO₂ eq per capita, with a slight decrease of 1.8% over the same period. Notably, Belgium reported the highest level of direct GHG emissions from the healthcare sector among all EU member states in 2023. However, it is also important to note that the new methodology introduced in Belgium to better estimate emissions from road transport strongly influenced this result. Under the previous methodology, Belgium's emissions were consistently higher than the EU average but remained closer and more stable (50.2 kg CO₂ eq per capita in Belgium in 2022, compared to 33.3 and 35.0 kg CO₂ eq per capita in the EU-27 and EU-14, respectively).

Textbox 17 – Direct emissions in the healthcare sectors: Methodological factors behind cross-country and regional differences

Differences with other EU countries and within the country as well as jumps observed in data (in 2015 and 2021) can partly be explained by methodological factors:

- Regarding the assessment of non-vehicle fuel emissions, Wallonia introduced a new and more accurate methodology in 2021 without retroactive adjustments. This can partly explain the high increase observed in Wallonia in 2021. While estimation methods for energy consumption varied across regions between 2012 and 2020, methodologies are more aligned since 2021, with all regions now using distribution network data as the common data source.
- Regarding emissions from road transport, allocation keys among NACE sectors vary:
 - In Belgium, the allocation key is based on excise duties for Eurostat data released in 2025 (with retroactive adjustments), whereas previous estimates (e.g. data released in 2024) relied on vehicle registrations. Excise duties are considered more reliable; however, this new



approach was not applied in most countries and appears to have an important impact for Q86 emissions. GHG emissions in the healthcare sector in Eurostat version released in 2024 are quite stable in Belgium across the years while an important increase is observed in Belgium based on Eurostat data released in 2025.

- In addition, excise duties in Belgium are estimated on a five-year basis (2010, 2015, 2020) using a “structural survey” of the National Bank of Belgium while intermediate years are based on less detailed surveys and extrapolations. The year 2014 is therefore based on an extrapolation of 2010 data and a jump in excise data is observed in 2015, which can also partly explain the 2015 jump in GHG emissions.
- A study performed by Eurostat has showed important variations between countries regarding the share of CO₂ emissions from road transport by NACE activity, with coefficients of variance greater than 40% for each of the NACE activities, suggesting that the comparability across countries is most likely not given.²⁸¹

These methodological factors have an impact on the following indicators: ENV-4, ENV-5, ENV-6, ENV-7, ENV-8, but also to a lower extent ENV-1, as direct emissions are part of the overall GHG environmental footprint assessment.

3.3.2 Air pollutants

ENV-5 PARTICULATE MATTER EMISSIONS (PM_{2.5}; PM₁₀) IN THE HEALTHCARE SECTOR

PM_{2.5} are dangerous small particles that can cause severe illness such as heart and respiratory diseases and cancers (5 million deaths per year over the world).

The health sector was responsible for only 0.5% of total Belgian PM_{2.5} emissions in 2023. However, expressed in tonnes, a 18.3% increase in PM_{2.5} emissions from the healthcare sector was observed over the 2012-2023 period (with 94.3 tonnes in 2023). By considering the increase in the population, the increase was slightly reduced (+11.5%, with 8 g per capita in 2023) but remained far from decreasing. Such results should nevertheless be used with caution as they are influenced by methodological factors (see Textbox 17).

Higher PM_{2.5} emissions were observed in Wallonia (12.9 g, compared to 4.6 and 4.5 g per capita in Flanders and Brussels, respectively) and in this case, methodological factors are not the main explanation, other factors such as the higher distances may also have influenced the results. More in-depth analysis is therefore needed.

Other European countries achieved better outcomes than Belgium, with PM_{2.5} emissions per capita increasing by 11.5% in Belgium over the 2012–2023 period, compared with decreases of 25% in EU-14 countries and 44% in EU-27 countries. However, cross-country comparisons should be interpreted with caution, as methodological differences may partly explain these disparities. In particular, the introduction of a new method in Belgium to allocate road transport emissions to the health sector had a substantial impact on the results (see Textbox 17). Under the previous methodology, the trend in Belgium was more stable.

ENV-6 EMISSIONS OF ACIDIFYING GASES IN THE HEALTHCARE SECTOR

Emissions of acidifying gases, measured using the ACID index, include sulphur dioxide (SO₂), nitrogen oxides (NO_x), and ammonia (NH₃), expressed in SO₂ equivalents. These gases can potentially damage plant growth, animals, and the quality of soil and groundwater.

In Belgium, emissions of acidifying gases from the healthcare sector remained stable over time, amounting to 109.3 g SO₂ eq per capita in 2012 and 110.9 g SO₂ eq per capita in 2023 (+1.4%).

As with the two previous indicators, regional differences were also observed, with higher emissions in Wallonia (184.3 g SO₂ eq per capita in 2022 compared to 72.6 g and 62.6 g per capita in Flanders and Brussels, respectively). This again would require more in-depth analysis to understand the underlying causes.

At the European level, acidifying gas emissions in Belgium (110.9 g SO₂ eq per capita in 2023) were approximately three times higher than those of the EU-27 (34.4 g per capita) and EU-14 averages (34.2 g per capita). While Belgium showed a relatively stable trend over time, European averages displayed a decreasing trend between 2012 and 2023 (–37.6% for the EU-14 and –36.4% for the EU-27). Moreover, the share of the healthcare sector in total acidifying gas emissions across all NACE activities increased in Belgium (+8%) but declined at the European level (–35% for both the EU-14 and EU-27 averages). However, cross-country comparisons should be interpreted with caution due to methodological differences (see Textbox 17).

ENV-7 OZONE PRECURSOR EMISSIONS IN THE HEALTHCARE SECTOR

Ozone (O₃) in the lower layer of the atmosphere (troposphere) can generate smog, which is harmful to health, especially for people with respiratory disorders. Ozone precursors, measured using the TOFP index, include non-methane volatile organic compounds (NMVOC), nitrogen oxides (NO_x), carbon monoxide (CO), and methane (CH₄), with NO_x as the most significant source of emissions from the healthcare system (78% in 2023).

Even if the healthcare sector (Q86 in NACE – human health activities, excluding residential care) account for only a small proportion of ozone precursor emissions in Belgium, representing only 1% of total emissions from all NACE activities in 2023, this share almost doubled since 2012 (0.55% in 2012).

Regional differences can also be highlighted. Wallonia's emissions per capita were twice as high as those of Flanders or Brussels in 2022 (350.5 g compared to 155.6 g and 123.6 g of NMVOC eq per capita in Wallonia, Flanders and Brussels, respectively). Again, more in-depth analysis is required to determine the underlying cause of these differences.

Belgium's per capita emissions in 2023 (224.3 g of NMVOC eq per capita) were more than twice as high as those of the EU-14 and EU-27 averages (100.9 and 95.2 g of NMVOC eq per capita). Moreover, they increased by 13.4% between 2012 and 2023, whereas both EU averages declined markedly over the same period (EU-14: –30.4%; EU-27: –31.0%). However, methodological factors may explain these differences (see Textbox 17). International comparisons must therefore be used with caution.

3.4 Building and energy management

Two indicators related to building and energy management were selected (ENV-8 and ENV-9). Moreover, based on the NEHAP model (see ENV-1), the share of GHG emissions attributable to buildings and energy management within the health system's overall GHG footprint can be estimated.

3.4.1 GHG emissions

Based on the NEHAP report,⁵ emissions related to building and energy use accounted for 14.95% of direct and indirect GHG emissions in the healthcare sector, with on-site fuel use representing the most important part (8.14%, see the technical sheet ENV-1 for details).



3.4.2 *Energy consumptions*

ENV-8 FOSSIL ENERGY CONSUMPTION IN THE HEALTHCARE SECTOR

In the Belgian healthcare sector, fossil fuels are mainly used for transport and heating purposes. A total of 16 428 terajoules (TJ), corresponding to 1,4 gigajoules (GJ) per capita were consumed in the healthcare sector in Belgium during the year 2022. This represents 76% of healthcare's total energy consumption. When excluding transport, the healthcare sector represented 0.7% of Belgium's all-sector fossil fuel use. There was an upward trend of fossil fuel usage over time, even when adjusting for population size.

Wallonia had larger per capita usage of transport fuels and fuel oil than Brussels and Flanders. Belgium's fossil fuel consumption was above the EU-average, both with and without inclusion of transport fuels and the largest share of fossil fuel among total energy consumption in the healthcare sector.

ENV-9 PERCENTAGE OF HEALTHCARE FACILITIES CONDUCTING ENERGY AUDIT/SCAN SINCE 2018 (IN THE FLEMISH REGION)

An energy scan/audit was conducted in 52 out of 59 active general hospitals between 2018 and 2025. This cumulative share increased from 18.6% in 2018 to 88.1% in 2025. General and psychiatric hospitals were the most commonly audited and subsidised type of care facility (see the technical sheet for the results for other healthcare facilities). This was a positive finding given that the greatest potential of healthcare-related reduction of emissions was with hospitals, as they were responsible for approximately 55% of the emissions of the full healthcare sector.

The most commonly recommended measure was related to relighting or relamping. This category of interventions was also assigned the largest subsidy budget. The second most commonly recommended measure was the installation of photovoltaic panels, which was also the third most frequently subsidized intervention.

At present, no new VIPA subsidies are available for energy audits in the healthcare sector, as the current Flemish Government has not allocated funds for these climate objectives.

3.5 **Transport and mobility**

No indicators related to transport and mobility was selected. However, based on the NEHAP model (see ENV-1), the share of GHG emissions attributable to transport and mobility within the health system's overall GHG footprint can be estimated.

Moreover, it should be noted that concerning direct CO₂ emissions published in the Eurostat database, emissions from road transport are currently not reported separately for Belgium but this is foreseen for a next future (around end 2026).

3.5.1 *GHG emissions*

Based on the NEHAP report,⁵ emissions related to transport and mobility (vehicles fuel use - scope 1 and transport – scope 3) accounted for 3.65% of direct and indirect GHG emissions in the healthcare sector (see the technical sheet ENV-1 for details).

3.6 **High carbon footprint medical products**

Three indicators related to high carbon footprint medical products were selected (ENV-10, ENV-11, and ENV-12). Moreover, based on the NEHAP model (see ENV-1), the share of GHG emissions attributable to medical products within the health system's overall GHG footprint can be estimated.

3.6.1 GHG emissions

Based on the NEHAP report,⁵ emissions related to medical products (scope 3) accounted for 44.35% of direct and indirect GHG emissions in the healthcare sector, with pharmaceuticals – scope 3 representing the most important part (30.75%, see the technical sheet ENV-1 for details). Moreover, metered-dose inhalers accounted for 0.4%.

3.6.2 High carbon footprint pharmaceuticals

ENV-10 PRESCRIBING OF LOW-CARBON FOOTPRINT INHALERS FOR BOTH RELIEVER (SABA) INHALERS AND PREVENTER (ICS-LABA) INHALERS

Currently marketed metered-dose inhalers (MDIs) use propellant gases with a high global-warming potential. Other forms of inhalers, such as soft mist or dry powder inhalers (DPIs) have a much more lower impact and should be substituted whenever possible. This rapport therefore focus on the share of low carbon inhalers for both relieve (short-acting beta 2 agonists - SABA) and preventer (inhaled corticosteroid - ICS and long-acting beta 2 agonists - LABA) inhalers.

The proportion of low-carbon footprint inhaler for relieve purposes (SABA) decreased over the 2012-2023 period, reaching 45% in 2023. A decrease in the total use of SABA inhalers was also observed (- 50.7%). This may partly be explained by a change of treatment practice. As reliever inhalers' use becomes more targeted to more severe cases, the lack of effective low-carbon footprint alternatives for severe cases limits their uptake.

The proportion of low-carbon preventer inhalers (ICS-LABA) stayed high over the 2012-2023 period (77% in 2023), and the total prescribed decreased by 7.2%.

The proportion of low-carbon footprint inhalers differed according to the age category: for reliever inhalers, children (<12 years) had a higher proportion (67.7% in 2023 compared to 17.7% for adults (12-64years) and 36.9% for older people (>64years)). It was the opposite for preventer inhalers as children reached 56.3% while adults and older people stayed high, at 80.9% and 88.4%, respectively.

Regarding the regional comparison, similar proportions were observed for low-carbon footprint reliever inhalers in Flanders (42% in 2023) and Brussels (41%) while Wallonia had a higher rate (49%). For preventer inhalers, there were no disparities between regions and the proportions over the 2012-2023 period were stable (between 75% and 80%).

There were few corresponding data available from abroad, but from what has been gathered, Belgium was doing better. In England for example, the proportion of low-carbon inhalers was 9.7% for SABA inhalers and 53.7 for ICS-LABA inhalers in November 2025.

ENV-11 GHG IMPACT OF ANAESTHETIC GASES (SEVOFLURANE, DESFLURANE, ISOFLURANE)

Anaesthetic gases have a significant global warming impact, and their use should be minimised. When possible, intravenous anaesthesia should be preferred. If anaesthetic gases are yet required, those with a lower global warming potential (sevoflurane) should be selected, and the use of desflurane should be discontinued. Additionally, whenever feasible, low flow anaesthesia techniques should be employed.

In Belgium, the use of desflurane decreased over the 2015-2024 period, but not enough compared to other European countries. Sevoflurane was the most used gas and its consumption increased by 5.9% over the 2015-2024 period. A room for improvement therefore remains in Belgium.

As a consequence, GHG impact of anaesthetic gas was twice as high in Belgium in 2023 (1.8 kg CO₂ eq per capita) compared to the European average (0.9 kg CO₂ eq per capita, for 25 countries).



EU Regulation 2024/573 prohibits the use of desflurane as an inhalation anaesthetic from 1 January 2026, except in situations where its use is strictly necessary and no other anaesthetic gases can be used on medical grounds. Consequently, improvements are expected in the coming years.

ENV-12 DIRECT EMISSIONS OF NITROUS OXIDE IN THE HEALTHCARE SECTOR

Nitrous oxide (N₂O) is an anaesthetic and analgesic gas which has a greenhouse effect 120 times that of CO₂.

The healthcare sector contributed to less than 2% of N₂O emissions and its contribution decreased over time. Inpatient use was mostly for children (88.1% in 2023).

Medical N₂O use decreased from 254 to 94 tonnes over the 2013-2024 period (-63%) and the number of minutes of N₂O used per year increased by 31.1% from 2015 to 2023. This might be due to a switch from central distribution (high rate of leakage) to cylinders, following BeSARPP recommendations.¹¹⁷

Brussels had more emissions per capita than Flanders and Wallonia, but the difference was narrowing: in 2022, N₂O emissions were respectively 20.4, 16.7 and 16.3 g per capita. Belgian N₂O emissions per capita were comparable to EU-14 and EU-27.

3.7 Sustainable food

One indicator related to food waste was selected (ENV-13). Moreover, based on the NEHAP model, the share of GHG emissions attributable to medical products within the health system's overall GHG footprint can be estimated (see ENV-1) and based on the VITO model, the impact on land use can be estimated (see ENV-3).

3.7.1 GHG emissions

Based on the NEHAP report,⁵ emissions related to food and catering (scope 3) accounted for 7.83% of direct and indirect GHG emissions in the healthcare sector (see the technical sheet ENV-1 for details).

3.7.2 Impact on land use

Sustainable food provision is a key lever to reduce land-use pressures linked to healthcare delivery. In the land-use footprint results presented in section 3.2.3, food and catering consistently accounted for around 20-25% of healthcare-related land use, reflecting the land-intensive nature of agricultural production embedded in meals for patients, staff and visitors. Land-system change is driven largely by biomass demand and is a major driver of biodiversity loss, deforestation and ecosystem degradation.^{259, 273, 274, 282} More broadly, around half of the world's habitable land is used for agriculture, with a large share linked to livestock production through grazing land and feed crops (e.g. soy and cereals).^{280, 282} Evidence shows that dietary shifts towards more plant-based food provision can substantially reduce land requirements, as plant-based foods generally require far less land per unit of nutrition than animal-based products.^{279, 280} Sustainable food strategies can therefore reduce healthcare-related land use by reducing the agricultural land required for food provision, and can complement other measures such as reducing food waste (section 3.7.3).

3.7.3 Food waste

ENV-13 ANNUAL FOOD WASTE IN HOSPITALS AND RESIDENTIAL CARE (IN THE FLEMISH REGION)

In the healthcare sector (Flemish region only), 10.22 kilotonnes of food waste were registered in 2024 (5.3 kilotonnes in nursing homes and 3.2 kilotonnes in hospitals), though this is likely an underestimation because food waste may have been mixed with other waste streams.

Almost none of the potential food waste went directly to landfill, which is positive but the high share of “other” processing (77%) suggests that a significant portion was sent for secondary treatment, for which no detailed data were available. More data are therefore needed to determine if food waste was correctly processed.

3.8 Waste management and circular economy

Two indicators were selected on waste management and circular economy (ENV-14 and ENV-15). Data on ENV-15 are however not yet available.

ENV-14 ANNUAL PRIMARY WASTE IN THE HEALTHCARE SECTOR (IN THE FLEMISH REGION)

The healthcare sector in the Flemish region produced a total of 105 769 tonnes of waste in 2024, corresponding to 15.5 kg per capita. Estimation of the trends is currently not possible. Nursing homes produced the largest share of waste (42%), followed closely by hospitals (38%). However, in relative terms this corresponds to hospitals generating 4.64 kg/bed/day and nursing homes 1.08 kg/bed/day in the year 2022. Within hospitals, non-hazardous medical waste was the largest category of waste (40%), while in nursing homes, residual waste represented 63% of waste.

Most of the waste (64%) went to secondary processing, for which data were not available. Hazardous medical waste was primarily incinerated (97%), as recommended in the guidelines but non-hazardous medical waste were also mainly incinerated (97%), while there is also the option to recycle.

ENV-15 PERCENTAGE OF HOSPITALS WITH A DESIGNATED PERSON OR TEAM RESPONSIBLE FOR IMPLEMENTING A STRATEGY ON WASTE RECYCLING, WASTE REDUCTION, OR CIRCULAR ECONOMY

This indicator was considered as relevant by experts and was selected in the final list of indicators. However, data are not yet available. The indicator will be based on an annual hospital survey, which will include a specific question on the presence, in hospitals, of a designated person or team responsible for implementing a strategy on waste recycling, waste reduction, or circular economy.²⁸³ Results are expected to be available for the next overall HSPA report.

3.9 Water management

Two indicators were selected, one related to water use (ENV-16), the second related to water pollution (ENV-17).

3.9.1 Water use

ENV-16 ANNUAL WATER CONSUMPTION IN HEALTHCARE SECTOR (IN THE FLEMISH REGION)

In 2022, the Flemish healthcare sector consumed 6 972 182 m³ (0.68 m³ per capita), representing 1.40% of total water use in Flanders (excluding cooling water). Including cooling water, consumption rose to 7 698 854 m³ (0.75 m³ per capita), or 0.33% of total use. Water use type was mainly drinking water (71%), and trends over time showed no major shifts. Antwerp showed the highest per capita consumption.

The increase observed in water consumption in the healthcare sector was due to cooling water use in a single hospital for an environmental project. Excluding cooling water, water consumption slightly increased between 2012 and 2022, from 6 039 891 (0.59 per capita) in 2012 to 6 972 182 m³ (0.68 m³ per capita) in 2022.



3.9.2 Water pollution

One indicator related to water pollution was selected, i.e. the hazard potential of pharmaceutical consumption in surface water. Data for this indicator are expected by mid-2026. The report will be updated once these data will be available.

ENV-17 HAZARD POTENTIAL OF PHARMACEUTICAL CONSUMPTION IN SURFACE WATER

Pharmaceuticals deliver major health benefits, but they can also generate environmental risks. A substantial share of pharmaceuticals administered in outpatient and hospital care can enter wastewater through human excretion or washing, including widely used therapeutic classes such as antibiotics, hormones and anti-inflammatory drugs. Conventional urban wastewater treatment plants often have limited capacity to remove many pharmaceutical residues, which means that micropollutants may reach receiving surface waters.^{284, 285} This can contribute to adverse effects on aquatic organisms and ecosystem functioning, can create challenges for drinking-water production, and is increasingly linked to concerns about antimicrobial resistance, a major public-health challenge.^{286, 287}

Pharmaceutical pollution of surface water is expected to remain a growing issue, driven by increased consumption (linked to, among other factors, demographic ageing, increasing chronic disease and polypharmacy), and reduced dilution (linked to interacting environmental pressures such as climate change).²⁸⁴ EU environmental legislation provides an important regulatory framework for action, through the Water Framework Directive²⁸⁸ and its daughter directive, the Environmental Quality Standards Directive (EQSD).^{289, 290} Together, these directives establish a priority list of substances posing a direct threat to surface waters and a watch list of substances posing a potential threat, including several pharmaceuticals.^{288, 289, 291, 292k} In addition, the Urban Wastewater Treatment Directive²⁹³ introduces requirements for quaternary treatment to reduce micropollutants, including pharmaceuticals, with phased implementation between 2033 and 2045. It also applies the polluter-pays principle by requiring producers of products contributing to micropollutant emissions to cover at least 80% of the additional treatment costs.

Reducing pharmaceutical ecotoxicity requires a chain-wide approach, ranging from reducing consumption through rational prescribing and deprescribing, prevention strategies, and improved environmental awareness (e.g. reducing dispensed quantities and selecting pharmaceuticals with lower environmental impact where possible), to innovation in sustainable pharmaceutical design and production ("green chemistry"), and appropriate disposal and wastewater treatment solutions (including targeted measures in high-emission settings such as hospitals and long-term care facilities).

This indicator will estimate the hazard potential of pharmaceutical consumption in surface waters based on reimbursed pharmaceutical use in hospitals and outpatient care, using a risk-screening approach developed at GhEnToxLab (UGent). For each substance, consumption will be related to its Predicted No-Effect Concentration (PNEC), i.e. the concentration below which no harmful ecological effects are expected based on the sensitivity of the ecosystem to a specific substance. The indicator can be calculated with or without accounting for dilution in receiving waters and removal during wastewater treatment. The resulting risk quotient (RQ) provides a theoretical hazard signal: values above 1 indicate a potential concern for the substance, while values between 0.1 and 1 indicate a low risk when assessed as a single substance, but may still warrant attention due to potential mixture

^k The priority list includes several pharmaceuticals, such as oestrogenic hormones (estrone (E1), estradiol (E2), ethinyl estradiol (EE2)), antibiotics (azithromycin, clarithromycin, erythromycin), anti-inflammatory drugs (diclofenac, ibuprofen), anti-epileptic (carbamazepine), and anti-parasitic (permethrin). The watch lists includes several pharmaceuticals, such as antibiotics (sulfamethoxazole, trimethoprim, clindamycin, and ofloxacin); antifungals (clotrimazole, miconazole, and fluconazole); antidepressants (venlafaxine and desvenlafaxine); and diabetic drugs (metformin and guanylurea).



effects with other substances. The indicator aims to identify pharmaceuticals, locations and care settings where priority action may be required. Results are expected by mid-2026.

3.10 Link with other dimensions of the HSPA report

As mentioned in section 2.5.5, other dimensions and domains of the Belgian HSPA report also impact the environmental sustainability of the health system. While indicators from these other dimensions and domains were not updated, several warning signals reported in the latest Belgian HSPA report (2024) are still directly relevant to environmental sustainability. These warning signals are reported in Table 19 and discussed in section 4.4.



Table 19 – Warning signals identified in the last HSPA report having an impact on the financial sustainability

<i>Dimension / Domain</i>	<i>Indicator with a warning signal</i>	<i>Summary of results</i>
Quality Effectiveness	QE-10 COPD hospital admissions in adults (/100 000 population)	High hospital admission rates for COPD and diabetes can be interpreted as pointing to poor effectiveness of first-line care, as well as poor coordination or continuity of care. Belgium was below European average for patients living with diabetes or with COPD (for recent years), but this needs to be interpreted with caution, as differences between countries can be due to many other factors than to effectiveness of care, such as differences in prevalence of the disease, accessibility of care or methodology for measuring the indicator.
	QE-2 Diabetes hospital admissions in adults (/100 000 population)	
Quality - Safety	QS-1 Prevalence of healthcare-associated infections (% of patients hospitalised)	The prevalence of healthcare associated infections in hospitals was too high and not improving
	QS-9 Health workers thinking that staffing levels in hospitals are sufficient to handle the workload and work hours appropriate to provide the best care for patients (% of respondents, HSPSC)	Half of health workers in hospitals consider that staffing levels are insufficient to provide the best care for patients.
Quality - Continuity	QC-7 People with a reference pharmacist (% of people who should have a reference pharmacist)	The proportion of patients with a reference pharmacist among the targeted patients is too low (38.7% in 2021).
Quality Appropriateness	QA-1 Appropriate follow-up of diabetes (% of people 18+ living with diabetes and under insulin)	The percentage of people living with diabetes receiving a follow-up in line with the recommendations is too low, especially for those receiving glucose-lowering drugs other than insulin.
	QA-2 Appropriate follow-up of diabetes (% of people 18+ living with diabetes and receiving glucose-lowering drugs other than insulin)	
	QA-3 Use of antibiotics (total DDD/1000 pop/day)	The use of antibiotic remains high compared to the EU-14 and EU-27 averages and the choice of antibiotics prescribed in first intention still does not adequately align with recommendations. Although there has been some improvement, the use of quinolones, for example, remains disproportionately high.
	QA-4 Use of antibiotics at least once in the year (% of population)	
	QA-5 Use of antibiotics of second intention (% total DDD antibiotics)	
	QA-6 Spine imaging (X-ray, CT scan, MRI per 100 000 population)	Inappropriate use of medical imaging for low back pain is still important.

	MH-6 Use of antidepressants (total DDD/1000 pop./day)	The use of antidepressants (total DDD/1000 population/day) in Belgium remains above the EU average and continue to increase.
	OLD-10 Prescription of anticholinergic drugs >80 DDD in older people (% of population ≥ 65 years)	A high percentage (18.7% in 2021) of older people (65+ years old) are prescribed anticholinergic drugs, which are known to have side effects in this population (e.g. falls), but the situation has slightly improved recently.
	OLD-11 A Use of antipsychotics ≥1 DDD in homes for older people (% of residents ≥ 65 years)	Antipsychotics are prescribed to almost a third of people aged 65 years and over in residential care, but the situation is modestly improving.
	OLD-11 B Use of antidepressants ≥1 DDD in homes for older people (% of residents ≥ 65 years)	Almost half of the persons aged 75 years or over in residential care are prescribed antidepressants, the appropriateness of which may be questioned.
	Medical practice variations	Some unexplained variations of practice can still be observed (see the variations in medical practice on the website www.healthybelgium.be).
Accessibility	No warning signals concerning the share of the population living within 20 km of the nearest hospital	
Efficiency	No warning signals for indicators related to the share of one day surgical admissions or the length of stays for normal delivery	
Preventive care	P-2 Measles vaccination in adolescents (% , 2nd dose)	Measles and HPV vaccination in adolescents and influenza vaccination in the population aged 65 years and above are below the WHO targets.
	P-4 Influenza vaccination (% pop aged ≥65 years)	
	P-14 New HPV vaccination in girls (% , 2nd or 3rd doses following vaccines)	
	P-6 Breast cancer screening (% women aged 50-69 years)	The screening rate of breast cancer in the target group is relatively low and stagnates. Moreover, the screening rate of organised breast cancer is too low to be efficient. Screening rates of cervical and colorectal cancer is also insufficient.
	P-7 Breast cancer screening - organised programme (% women aged 50-69 years)	
	P-8 Cervical cancer screening (% women aged 20-69 years)	
	P-9 Colorectal cancer screening (% pop aged 50-74 years)	
	P-11 Regular contacts with dentist (% population aged ≥3 years)	Only half of the population has a regular contact with a dentist.



4 DISCUSSION AND CONCLUSIONS

Some strengths and positive developments are highlighted in this report. Some issues and warning signals should nevertheless also be considered. These elements are summarised in the following sections.

4.1 Strengths and weaknesses related to the environmental footprint of the health system

The Belgian health system exerts environmental pressures through greenhouse gas emissions, material extraction and land use, with a large share occurring upstream in supply chains rather than at the point of care delivery. Although modest improvements per capita can be observed concerning GHG and land use footprint, continued efforts are needed to further reduce environmental pressures. There is not yet a structural decoupling of healthcare delivery from environmental impacts.

A recent international comparison was only available for GHG emissions, showing that Belgium ranked second-highest in the EU-27, after Germany. This constitutes a warning signal and reinforces the relevance of decarbonisation efforts, but these results should be interpreted with caution, given the reliance on top-down modelling rather than bottom-up data and the age of international comparison data.

Achieving a climate-resilient, low-carbon and resource-efficient health system will require profound, systemic changes in procurement practices, product design, infrastructure, food provision and the adoption of circular economy principles. However, healthcare supply chains are multinational and highly complex, which considerably limits the ability of the health sector to act in isolation. Meaningful progress will therefore depend not only on sector-specific policies and initiatives, but also on broader transformations in the global economy, production systems and consumption patterns beyond healthcare.

Table 20 – Synoptic table: Overall environmental footprint of the health system

(ID) Indicator	Score	BE	Year	FL	WAL	BRU	Source	EU-14	EU-27
ENV-1 Direct and indirect GHG emissions in the healthcare sector, in kg CO ₂ eq per capita	+	851 629 731	2022 2022 2018	-	-	-	NEHAP VITO OECD	559.5	452.0
ENV-2 Material environmental footprint of the healthcare sector, in kg per capita	(ST)	1 042	2022	-	-	-	VITO	-	-
ENV-3 Land use environmental footprint of the healthcare sector, in m ² per capita	(+)	0.48	2022	-	-	-	VITO	-	-

Performance: Good (●), average (●) or poor (●) results, (○) performance not assessed; Trend: globally stable (ST), improving (+), deteriorating (-) or trend not evaluated (empty).

FL = Flanders, WAL = Wallonia, BRU = Brussels, NR = Comparison not reliable due to differences in methods.
! = Score to be used with caution because of methodological weaknesses

4.2 Strengths and weaknesses related to direct air emissions and energy consumption

Data quality related to direct air emissions and energy consumption was limited. This mainly reflects difficulties in allocating these data specifically to the healthcare system as well as methodological heterogeneity across countries (impacting all indicators) (see Textbox 17 in section 3.2.1 for details).

Nevertheless, while methodological differences in data reporting across countries may partly explain Belgium's relatively poor performance on these indicators, several substantive factors could also have contributed, such as the continued reliance on fossil fuels for heating and cooling, a relatively high density of hospitals per capita, and a carbon-intensive healthcare vehicle fleet. Furthermore, although no specific data on the thermal insulation of healthcare facilities were available, Belgium's hospital infrastructure is generally ageing, despite the existence of planned and ongoing renovation programmes. These hypotheses require confirmation through more in-depth analysis, and highlight the need for more bottom-up data on energy consumption in healthcare facilities and on fuel use by the healthcare fleet. The FPS Public Health is also taking steps to strengthen bottom-up evidence, notably through its annual hospital survey (STATHOSP), which aims to improve data availability on these issues (see below).

Regional comparisons showed a poor performance of Wallonia. Contributing factors could be longer distances travelled by the healthcare fleet and a higher share of fuel oil use. This also requires confirmation by more in-depth analysis of bottom-up data.

Finally, although trends were not included in the scoring due to methodological uncertainties (more specifically, the lack of clarity as to whether observed changes were stable or increasing), the expected downward trajectory has clearly not yet been achieved. Continued and sustained efforts therefore remain essential.

Table 21 – Synoptic table: Air emissions and energy consumption

(ID) Indicator	Score	BE	Year	FL	WAL	BRU	Source	EU-14	EU-27
ENV-4 Direct GHG emissions in the healthcare sector, in kg CO ₂ eq per capita	●!	110.1	2023				Eurostat	NR (40.9)	NR (37.0)
			2022	80.5	153.5	76.2	NPB		
ENV-5 Particulate matter emissions (PM _{2.5}) in the healthcare sector, in g per capita	●!	8.0	2023				Eurostat	NR (2.8)	NR (3.9)
			2022	4.6	12.9	4.5	NPB		
ENV-6 Emissions of acidifying gas in the healthcare sector, in g SO ₂ eq per capita	●!	110.9	2023				Eurostat	NR (34.2)	NR (34.4)
			2022	72.6	184.3	62.6	NPB		
ENV-7 Ozone precursor emissions in the healthcare sector, in g NMVOC eq per capita	●!	224.3	2023				Eurostat	NR (100.9)	NR (95.2)
			2022	155.6	350.5	123.6	NPB		
ENV-8 Energy consumption in the healthcare sector, in gigajoules (GJ) per capita	●!	1.4	2022	1.1	2.1	1.0	Eurostat	NR (0.6)	NR (0.5)
							NPB		

Performance: Good (●), average (●) or poor (●) results, (○) performance not assessed; Trend: globally stable (ST), improving (+), deteriorating (-) or trend not evaluated (empty). NPB = National planning bureau, FL = Flanders, WAL = Wallonia, BRU = Brussels, NR = Comparison not reliable due to differences in methods.

! = Score to be used with caution because of methodological weaknesses



4.3 Strengths and weaknesses related to specific area of interventions: energy management, high carbon footprint medical products, sustainable food, waste management and water management

Two warning signals related to high-carbon footprint medical products can be identified. The first concerned the use of anaesthetic gases. The GHG impact of anaesthetic gases was higher in Belgium than in other European countries, largely due to the continued use of desflurane (even if decreasing) and to insufficient reductions in the overall volume of anaesthetic gases compared with other countries. It is expected that the forthcoming European regulation will have a positive impact, with desflurane being restricted to very strict and well-justified clinical indications only. Further efforts are also needed to reduce the volume of sevoflurane used, for example by increasing the use of propofol where clinically appropriate or by implementing low-flow anaesthesia techniques and systems designed to reduce gas flow.

The second warning signal related to inhalers. The proportion of low-carbon reliever inhalers (SABA) remained low, mainly due to the lack of effective low-carbon alternatives for use in acute situations. This highlights the need for manufacturers to develop effective low-carbon options.

In contrast, the uptake of low-carbon preventer inhalers (ICS-LABA) was good and higher than that observed in England. It should also be noted that direct emissions of nitrous oxide (N₂O) in the healthcare sector were below the EU averages. However, more data on the share of hospitals having switch from central distribution (with high rate of leakage) to cylinders would be needed to determine if the performance of the Belgian health system concerning the use of N₂O is really good.

For bottom-up indicators linked to specific interventions implemented in Flanders, insufficient reference points were available to allow a robust assessment of the performance of the Belgian health system. This concerned indicators related to hospitals that had undergone an energy audit, annual (food) waste generation, and annual water consumption. Nevertheless, several general observations can be made.

First, an improvement was observed concerning the proportion of hospitals having conducted an energy audit, which increased from 18.6% in 2018 to 88.1% in 2025, seemingly accelerated by making them mandatory for organisations with large energy consumption (end of 2022). Second, waste management practices require further analysis. More complete data are needed concerning food waste and waste in general, including more details on their processing to be able to determine if they are being processed appropriately. Non-hazardous medical waste were predominantly incinerated (97%). Alternative options could be studied. Finally, annual water consumption in hospitals remained stable over the observed period. Measures to decrease water use could be studied to contribute to improved water availability in Belgium.

Table 22 – Synoptic table: Specific area of interventions

(ID) Indicator	Score	BE	Year	FL	WAL	BRU	Source	EU-14	EU-27
Energy management									
ENV-9 General hospitals that had an energy audit since 2018, in %	⊕	-	2025	88.1	-	-	VIPA	-	-
High carbon footprint medical products									
ENV-10a Prescribing of low-carbon reliever (SABA) inhalers as a proportion of all SABA inhaler prescribing, in %	⊖	44.6	2023 11/2025	42.1	49.0	41.4	IMA-AIM England ²⁹⁴	9.7 (England)	
ENV-10b Prescribing of low-carbon preventer (ICS-LABA) inhalers as a proportion of all preventer inhaler prescribing, in %	Ⓢ	77.4	2023 11/2025	76.3	79.5	74.9	IMA-AIM England ²⁹⁴	53.7 (England)	
ENV-11 GHG impact of anaesthetic gases, in kg CO ₂ eq per capita	⊕	1.8	2023	-	-	-	Talbot et al. ²⁹⁵		0.9
ENV-12 Direct emissions of nitrous oxide (N ₂ O) in the healthcare sector, in g per capita	⊕	11.6	2023	-	-	-	Eurostat	11.7	12.5
Sustainable food									
ENV-13 Annual food waste in hospitals and residential care, in kg per capita	○	-	2024	1.5 !	-	-	OVAM	-	-
Waste management									
ENV-14 Annual primary waste in the healthcare sector, in kg per capita	○	-	2024	15.5	-	-	OVAM	-	-
ENV-15 Hospitals with a designated person responsible for implementing a strategy on waste recycling, waste reduction, or circular economy	Data not yet available								
Water management									
ENV-16 Annual water consumption in the healthcare sector, in m ³	Ⓢ	-	2022	0.68	-	-	VITO	-	-
ENV-17 Hazard potential of pharmaceutical consumption in surface water	Data not yet available. Update foreseen by mid-2026.								

Performance: Good (●), average (●) or poor (●) results, (○) performance not assessed; Trend: globally stable (ST), improving (+), deteriorating (-) or trend not evaluated (empty). NPB = National planning bureau, FL = Flanders, WAL = Wallonia, BRU = Brussels, ! = Incomplete data



4.4 Strengths and weaknesses related to other dimensions or domains of the HSPA report

While indicators from other dimensions or domains were not part of the selection process, the potential impact of some of these indicators on environmental sustainability remains nonetheless substantial.

Among the indicators that positively impact the environmental sustainability, the observed shift to one-day surgical admissions, the short length of stay for normal delivery and the good geographical accessibility of hospitals (limiting patient travels) can be cited.

Moreover, it is important to note that from a sustainability perspective, whether environmental, financial, or in terms of workforce capacity, the most sustainable care is care that does not need to be delivered. In this area, several room for improvements can be highlighted.

First, strengthening disease prevention, promoting healthier lifestyles, ensuring healthier living, working and care environments can reduce avoidable healthcare utilisation. The HSPA report identified room for improvement in preventive care, while the Health Status Report, available on the healthybelgium.be website¹⁷, highlighted persistent challenges in population health behaviours and healthy lifestyles, as well as in the quality of living environments.

Second, the HSPA report indicated opportunities to improve the appropriateness and reduce low-value care delivery. Warning signals related to avoidable hospital admissions, inappropriate care (including overuse), and adverse events such as healthcare-associated infections. These may lead to avoidable resource use, emissions and waste. The report also pointed to medical practice variation as an indication of potential overuse and included several indicators suggesting potential overuse of pharmaceuticals and medical imaging.

This analysis therefore shows that potential co-benefits can be identified. For example, improving the appropriateness of care not only enhances the quality of patient care but may also positively influence both environmental and financial sustainability. Conversely, certain trade-offs may emerge. For example, while CT scans have a better environmental footprint than MRI, it induces higher radiation exposure for patients. Similarly, promoting low-carbon footprint pharmaceuticals could have financial implications if manufacturers use this argument to justify price increases. These considerations underscore the value of future analyses that examine the potential interactions and interdependencies across the different dimensions and domains of performance.

4.5 Limitations

The indicators presented in this report aimed to shed light on both the strengths and weaknesses of the health system regarding its environmental sustainability and identify warning signals for policy makers.

In some cases, policymakers may already be aware of these issues and have already initiated policy actions or commissioned additional analyses to identify the most appropriate responses. As noted in the introduction to the scientific report, Belgium has for example developed a roadmap to decarbonise the health system, and a dedicated working group is actively addressing this topic. Other initiatives are also performed at the regional level, such as the Green Deal in Flanders.

In other cases, the signal is new and calls for more in-depth analysis. In all cases, the comprehensive and structured presentation of indicators in the synoptic table in the previous section is intended to support the prioritisation of required actions and/or further studies. Nevertheless, readers should exercise caution when drawing conclusions based on HSPA reports (see also Textbox 18).

It should also be noted that some indicators already analysed in other dimensions and domains of the HSPA framework also impact the environmental sustainability. While these indicators were not updated in this report, the warning signals identified in the previous report were highlighted (see Table 19)

Textbox 18 – Be cautious when drawing conclusions based on HSPA reports

- Effects due to policy changes are very difficult to monitor only through figures, especially in HSPA reports whose scope is not to provide a detailed analysis on a specific issue. The HSPA should not be seen as a tool to evaluate policies, its aim is to give a broad view of the health system performance rather than an in-depth analysis of specific aspects of the health system or specific policies.
- Results presented in HSPA reports do not depend on a single factor, but have several causes, which can also come from outside the health system. The indicators presented in HSPA reports are intrinsically complex and are never the result of a single action but reflect the interaction of a full set of variables and parameters. Caution is therefore required when interpreting the results.
- The Belgian HSPA report must be seen as a tool that provides warning signals but these signals will then require further in-depth analysis.
- The frequency of data collection and the quality of these data also determine what can be learned from the indicators. Areas for improvement in the provision of relevant health and environmental data have been identified (see also below).
- The concept of performance is implicitly linked to the achievement of objectives. In the absence of quantifiable objectives for most indicators, this report describes the current situation and trends in Belgium, and compares these where possible with international benchmarks. However, the comparison between countries was often limited by the lack of uniform method and the difficulty to allocate total environmental data to the healthcare sector.

In addition, an important part of indicators presented in this report are global indicators. While useful to describe the overall magnitude of environmental pressures, they provide limited insight into the specific processes or settings driving these impacts, and therefore make it more difficult to identify the most appropriate policy responses. More actionable indicators, ideally based on rich bottom-up data, would be required but are currently not systematically available.

It is however important to note that within the statistical data collected annually in hospitals by the FPS Public Health (STATHOSP), new questions related to the environmental impact are planned, i.e. questions related to energy consumption (annual quantities of electricity, gas and fuel consumption), renewable energy, water consumption, investments in durable renovations of buildings, the presence of guidelines for the sustainable procurement of health products, the share of green vehicles, food consumption and the presence of a sustainable food programme, quantities of waste and the presence of a sustainable strategy to manage waste, and the consumption of anaesthetic gases and N₂O. The collection of such bottom-up data would help to better identifying where action is needed. The systematic collection of such bottom-up data would support a more precise identification of priority areas for action and monitoring of progress over time. At the same time, this initiative remains limited to hospitals and does not cover the wider health system. Other data gaps and need for future research were also identified in Textbox 16 in section 2.5.4.

For some indicators, data were only available for Flanders, while comparable information was not available for Wallonia and Brussels. Strengthening data collection in these regions – ideally using a standardised approach across Belgium – would improve completeness, comparability and the robustness of future monitoring.

Important methodological weaknesses were also identified for most indicators, limiting the ability to draw strong conclusions. Nevertheless, we consider it important to already publish these indicators and results, as they provide valuable initial insights into the environmental sustainability of the



healthcare sector, while explicitly acknowledging that further methodological improvements are required. This report should therefore be seen as a first step and the start of a promising and evolving monitoring process. Further progress will require continued efforts to improve data quality, transparency and comparability over time and across countries. In this context, international organisations such as Eurostat have an important role to play in supporting the further development and harmonisation of environmental indicators in the healthcare sector, including indicators related to air emissions and energy consumption.

Beyond this, it should be noted that the literature on potential interventions suffers from methodological weaknesses, complicating the identification of evidence-based actions whose effects can be considered statistically significant after accounting for uncertainty. Moreover, when multiple environmental impacts were assessed simultaneously, conflicting results sometimes emerge, making it difficult to draw firm conclusions. A broader approach that includes other aspects such as the safety and the cost-effectiveness would also be needed. While guidelines for studies assessing the environmental impact of interventions are emerging, continued efforts are required.

In the same vein, it is important to highlight that this report has focused primarily on environmental sustainability while adopting a more comprehensive perspective on the interconnections among the various dimensions and domains of performance would be beneficial in the future (see also section 4.4).

Finally, the ultimate goal of the health system is to improve the health of citizens living in Belgium, to which a healthy environment is an essential contributing factor. We hope that this report will serve as a valuable tool in achieving this fundamental objective. While this thematic report was a first step, the environmental sustainability will continue to be monitored via the full HSPA report through a selection of indicators.

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