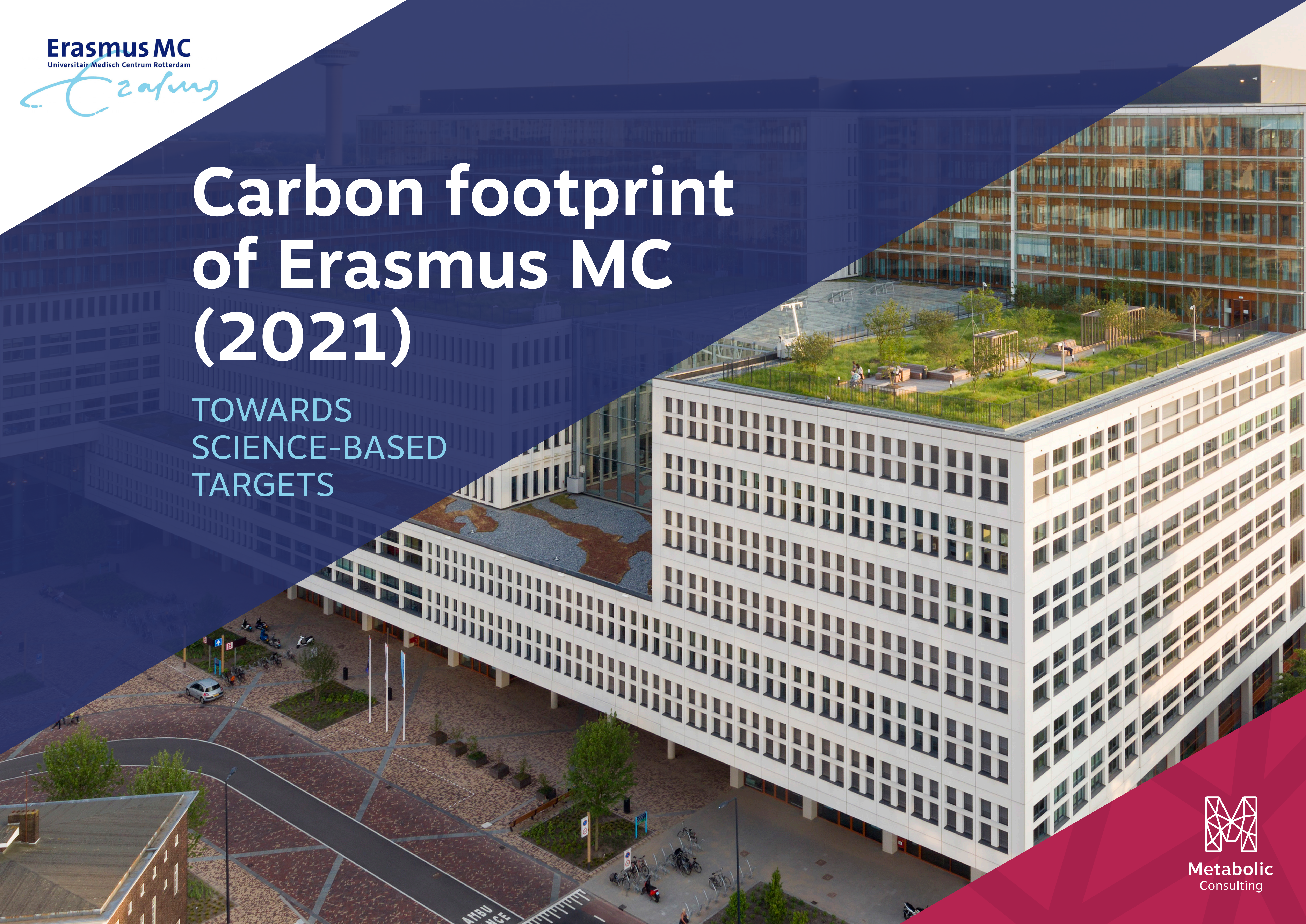
Erasmus MC
Universitair Medisch Centrum Rotterdam



Carbon footprint of Erasmus MC (2021)

TOWARDS SCIENCE-BASED TARGETS

Metabolic
Consulting

Index

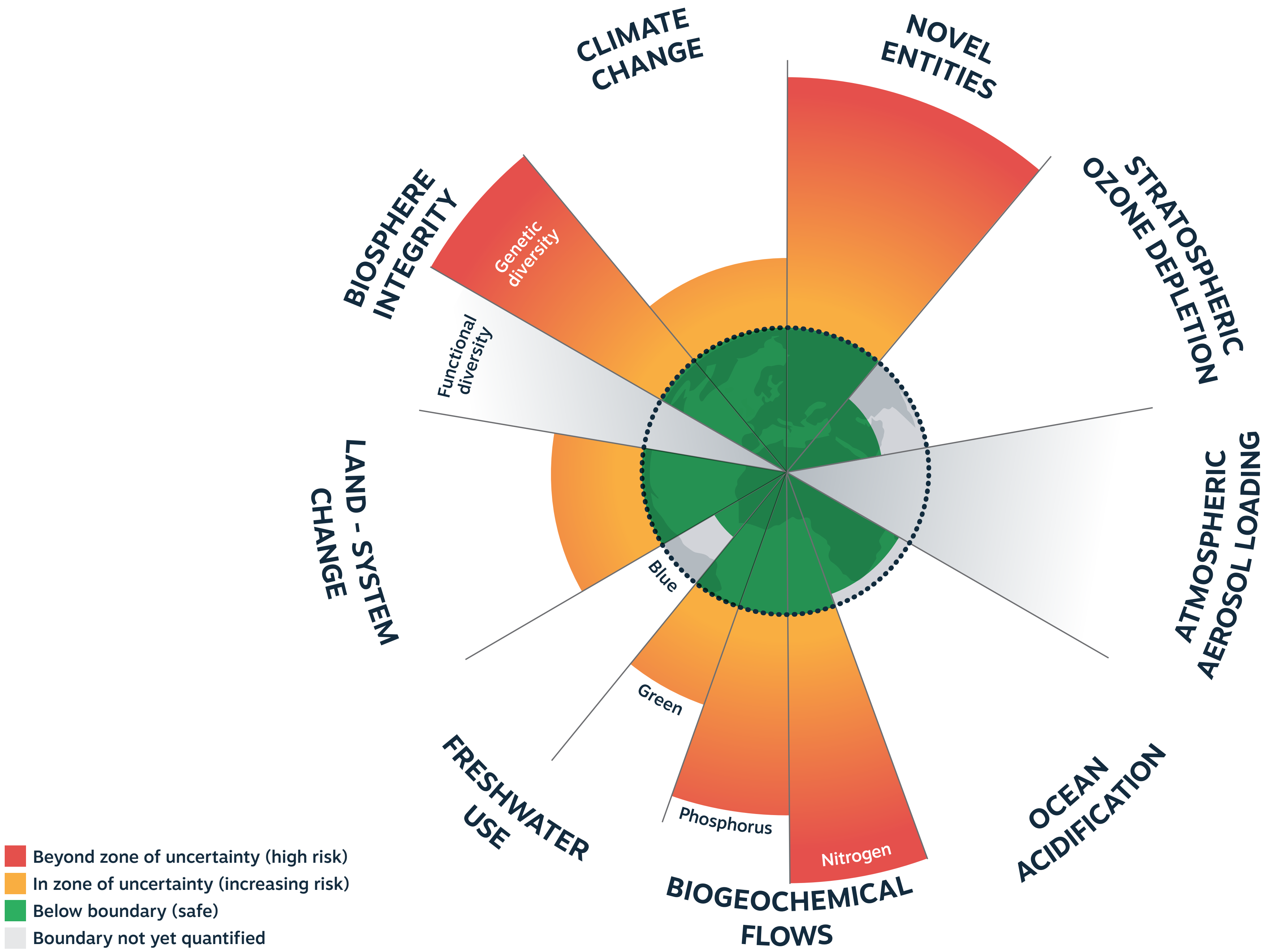
01 Introduction and objectives

Planetary boundaries and human health in context

The amount of greenhouse gases (GHGs) emitted from human activities is increasing. In the past 30 years, GHGs have increased by more than 50% ([World Meteorological Organization, 2022](#)). The consequences of climate change directly affect our planet. We are already experiencing changing weather conditions, which affect agricultural and food production. Changing weather conditions, coupled with rising sea levels, increase the risk of flooding. These are just a few examples of some of the many ways the impacts of climate change are already felt around the world.

Scientists introduced the concept of planetary boundaries in 2009. This framework shows that multiple important systems are currently in a critical condition due to human activities (see Figure 1). Next to causing climate change, humans impact the planet by excessive nutrient deposition, land-use change and deforestation, water consumption and chemical pollution among others. These environmental impact categories result in massive biodiversity loss, and disrupt the natural balance of the earth's ecosystem.

It is not surprising that human health is impacted as well. Prerequisites for a healthy life include the availability of clean air and drinking water and food which is nutritious and safe to eat. Next to GHG emissions, there is a plethora of substances brought into the world of which the consequences to human health are estimated to be severe (KNAW, 2023). To make sure that we stay within all planetary boundaries, we need to act now.



Source: *Updated Planetary Boundaries, Stockholm Resilience Centre, based on analysis in Wang-Erlandsson et al., 2022, Persson et al 2022 and Steffen et al 2015.*

Figure 1 *Overview of planetary boundaries (Bron: Updated Planetary Boundaries, Stockholm Resilience Centre, based on analysis in Wang-Erlandsson et al.,2022; Persson et al.,2022; Steffen et al., 2015.*

Erasmus MC's pursuit of sustainable healthcare

HEALTHCARE SERVICES CAUSE SERIOUS CLIMATE IMPACT

The healthcare sector contributes about 7 percent to the total GHG emissions in the Netherlands (Steenmeijer et al., 2022). Healthcare services contribute to climate change through emissions from the production, use and disposal of products that they depend on and from energy use.

Providing healthcare is a material intensive practice, due to the wide variety of products these services require. With a shortage of medical staff and infection prevention at heart, the share of single-use products has increased significantly over the past decades. In addition to these disposables, medicines, consumables and sterilized durable tools, advanced medical equipment complete the arsenal of products that the sector relies on. All these products cause environmental impacts along their life cycle, from raw material extraction and manufacturing to use and final disposal.

This report has focused on the impact of hospital care on climate change. Even though this specific lens is applied, we should always keep in mind how environmental impact is an intricate web of cause and effect within and between different impact areas. Other environmental impact areas of the planetary boundaries framework should also be kept in mind in the sustainability discourse.

ERASMUS MC AND THE GREEN DEAL 3.0 FOR SUSTAINABLE HEALTHCARE

The Erasmus Medical Center (Erasmus MC) is one of the largest university medical centers in Europe. In November 2022, Erasmus MC signed the Green Deal 3.0, together with many healthcare representatives. The Green Deal 3.0 is an agreement with the Dutch national government, multiple sector organizations, knowledge institutions, health insurance companies and banks to accelerate sustainable healthcare.

The Green Deal is aimed at realizing a minimal impact of the healthcare sector on the climate and the environment by 2050. To achieve this, five goals have been established (Green Deal, 2022):

1. Promote health among patients, clients and employees
2. Raise awareness and understanding of the impact of healthcare on climate and vice versa
3. Reduce CO_2 emissions by 55% by 2030 and to be climate neutral by 2050
4. Reduce the consumption of primary raw materials by 50% by 2030 and maximize circularity in healthcare by 2050
5. Reduce environmental harm caused by (use of) medication

A FRONT RUNNER IN SUSTAINABILITY

Erasmus MC has the ambition to take the lead in sustainable healthcare and establish wider collaborations. Some of Erasmus MC's aspirations to take forward the sustainability transition include, but are not limited to:

1. the publication of their environmental impact assessments
2. linking environmental sustainability to value-based healthcare
3. working towards the establishment of a national healthcare (impact) database

ERASMUS MC CONTINUES TO WORK ON SUSTAINABILITY

This project is a continuation of the work on sustainability that Erasmus MC has started previously. In 2020, Metabolic carried out an assessment of circularity for the intensive care unit (Browne-Wilkinson et al., 2021). In 2021, Erasmus MC collaborated with Royal HaskoningDHV to calculate their 2021 GHG emissions within scope 1 and scope 2. This year, Erasmus MC commissioned Metabolic to complete their 2021 GHG inventory by calculating its scope 3 emissions and support them in setting Science-Based Targets (SBTs).

Erasmus' pursuit of sustainable healthcare

SCIENCE-BASED TARGETS

The Science Based Targets initiative (SBTi) is a partnership between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF) with the aim to mobilize the private sector to take the lead on climate action. With this purpose in mind, they provide a range of resources to support organizations in setting science-based targets (SBTs) for GHG emissions reduction, aligned with defined SBTi criteria. "Science-based" refers to targets being in line with the reductions that are needed to meet the Paris Agreement global warming goal, according to the latest climate science (Science Based Targets, 2021).

SBTi target setting and reporting is Erasmus MC's next step towards climate action. Erasmus MC will be the first hospital in the Netherlands that commits to setting SBTs.

For some sectors, the SBTi has developed specific methodologies, frameworks and requirements for setting targets. Sector-specific guidance has not (yet) been published for the healthcare sector, meaning that the SBTi's core methodologies and resources should be used by organizations in this sector.

To enable SBT-setting and monitor progress on reaching SBTs, annual disclosure of GHG emissions is required. When submitting targets for the first time, the SBTi recommends that organizations use the most recent year for which data is available as the base year. For Erasmus MC, this is the year 2021, which has been selected as the base year for SBTi reporting. This report covers Erasmus MC's 2021 GHG inventory results.

Objectives

OBJECTIVES OF THE STUDY

The main objective of this study is to get a complete overview of Erasmus MC's organization-wide carbon footprint, in order to locate carbon footprint hotspots throughout the organization and prepare for effective reduction measures.

- To calculate Erasmus MC's scope 3 GHG emissions for the base year 2021, in accordance with the Greenhouse Gas Protocol (GHG Protocol).
- To calculate Erasmus MC's total scope 1, 2 and 3 GHG emissions, or "carbon footprint" in 2021 for SBTi reporting.
- To provide insights into carbon footprint hotspots within Erasmus MC's operations and opportunities for carbon footprint reduction, based on the 2021 GHG inventory.

02 Methods

Quantifying the carbon footprint of Erasmus MC according to the GHG protocol

CLASSIFICATION OF EMISSIONS INTO CATEGORIES

When preparing a GHG inventory in accordance with the GHG Protocol, emission sources are classified into 3 different reporting scopes and 23 categories (four each within scope 1 and 2 and fifteen within scope 3, Figure 2).

Scope 1

Scope 1 emissions are the direct GHG emissions from sources that are owned or controlled by the reporting entity. This includes e.g., the emissions that are released by burning natural gas for heating of buildings or burning of fuel in vehicles that are owned or controlled by the reporting entity.

Scope 2

Scope 2 emissions include the indirect GHG emissions from the generation of *purchased electricity*, steam, heating and/or cooling. For many companies and organizations, this is one of the largest GHG emissions sources.

Scope 3

Scope 3 emissions cover all of the remaining indirect GHG emissions that are caused by upstream and downstream activities of the reporting entity. This includes e.g., emissions from the extraction and production of purchased goods and fuels, employee and *business travel* and treatment of generated waste.

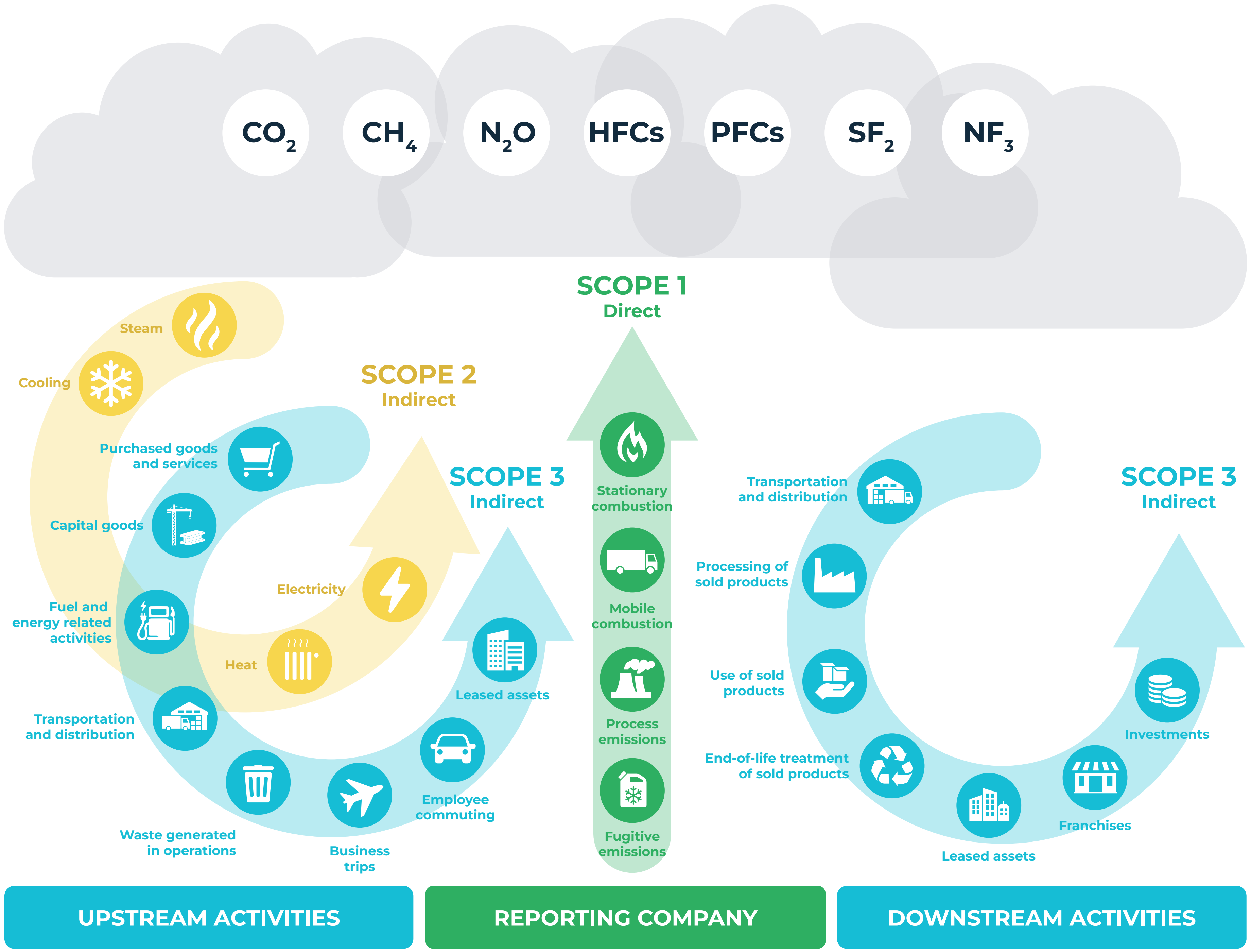


Figure 2 *Overview of Greenhouse Gas Protocol Categories. World Resources Institute, & World Business Council for Sustainable Development. (n.d.). Corporate standard: Greenhouse gas protocol. Corporate Standard | Greenhouse Gas Protocol. Retrieved January 5, 2023, from https://ghgprotocol.org/corporate-standard.*

WORKING WITH ORGANIZATIONAL ACTIVITY DATA IN THE CONTEXT OF THE STUDY OBJECTIVE

The study focuses on mapping the carbon footprint organization-wide, to be able to target organizational entities that have the most reduction potential. Such a high-level overview allows Erasmus MC to zoom in per organizational entity and develop tailored, effective emission reduction strategies.

Carbon footprint results of organizations highly depend on available data. To calculate Erasmus MC's organization-wide carbon footprint is an ambitious task, because Erasmus MC is a vast and complex organization. Erasmus MC entails a plethora of organizational entities, for which it is an ongoing challenge to streamline and optimize data management and availability.

To calculate a sound carbon footprint, data needs to be as complete and precise as possible for all organizational entities. Moreover, remaining gaps and imprecisions in available data requires transparent decision-making on data processing methods to make the data fit for use.

Grounded in the main goal of this study, the following text explains how calculation methods are deployed based on available data.

A suitable reference year according to SBTi

The carbon footprint of organizations is based on a chosen reference year. For setting Science-Based Targets, the appropriate year is the most recent year for which the organization's operational data is up to date and complete. In the case of Erasmus MC, the reference year is 2021.

THE APPROPRIATE CALCULATION METHOD FOR THE STUDY OBJECTIVE

Spend-based or LCIA-based method?

The carbon footprint of Erasmus MC is calculated based on two different methods. The first method translates data on physical quantities into GHG emissions. Erasmus MC's business operations are multiplied with emission factors from Ecoinvent 3.6 (using the ReCiPe2016 LCIA method, see Appendix 1) and the *CO2EmissieFactoren.nl* databases. The other method translates expenditure-based or "spend-based" data into GHG emissions. Following this method, Erasmus MC's business operations data are multiplied by emission factors from the EXIOBASE v.3.8 database. Emissions based on physical quantities are in fact a better representation of reality and are preferred to spend-based emissions.

In any case, the organization's data availability determines which methods can be applied, and both methods are appropriate according to the GHG Protocol. An overview of the differences between using spend-based methods or LCIA-based methods is elaborated in Textbox 1. Appendix 2 provides a full overview of the GHG Protocol categories that are covered in this report and the respective type of activity data input.

Refining spend-based emissions

The majority of Erasmus MC's carbon footprint relies on spend-based data (Figure 4). Erasmus MC provides healthcare services. Existing spend-based emission factors are not detailed for healthcare services. According to an RIVM study (Steenmeijer et al., 2022), 40% of the environmental impact in the healthcare sector is related to the use of chemical products, where medicines cover the majority of emissions. Therefore, to gain a more refined insight into emissions related to medicines at Erasmus MC, supplier-specific, spend-based emission factors were calculated for pharmaceutical companies that supply medicines to Erasmus MC, based on their reported total scope 1, 2 and 3 emissions and total revenue in 2021. The share of emissions calculated using this method is 24.6% of the total carbon footprint (Figure 4).

Discrepancy of methods

Because spend-based and LCIA-based methods are technically different, carbon footprint results are not comparable one-to-one. In this assessment the two methods are combined to give a complementary insight, and to be able to gain a full overview of emissions throughout the entire organization.

Spend-based method

Input data is based on expenditure

- ***Economic value of the purchased goods and services is multiplied by the relevant environmentally extended input-output (EEIO) emission factors***
- ***Indirect translation of expenditure into carbon footprint***
- ***Use of emission factors that are based on the average carbon footprint calculated for a specific sector, related to the average revenue in that sector.***
- ***The applied unit is kilogram (kg), tonne (t) or kilotonne (kt) CO_2-eq / €)***
- ***There is a limited amount of databases available. The most commonly used database is Exiobase.***
- ***There is a limited amount of emission factors available. Emission factors lack granularity for specific services.***

Benefit

Provides insight in organizations' carbon footprint and contribution to carbon footprint per organizational unit, when physical quantities are not available. Provides action perspective to organizations.

Drawbacks

Provides a high-level analysis that focuses on product- and service groups within a sector. Does not provide insight into the carbon footprint of specific products within a sector. Does not differentiate between products/services acquired from specific geographic regions or suppliers within a sector. Products/services acquired with high discounts can lead to underestimation of emissions.

LCIA-based method

Input data is based on physical quantities

- ***Physical quantities (materials and kilograms) of purchased goods and services are multiplied by relevant LCIA-emission factors***
- ***Direct translation of quantities into a carbon footprint***
- ***Many high-quality databases are available***
- ***The applied unit is kilogram (kg), tonne (t) or kilotonne (kt) CO_2-eq / amount of product or service***

Benefits

Gives good insight in product- and service-specific carbon footprint. Reveals environmental 'hotspots' and action perspective on the product- and service level.

Drawbacks

Often, data is not available coherently on the organizational level. When specific information is unavailable, reference products need to be identified to account for emissions.

Textbox 1 *Characteristics, benefits and drawbacks of spend-based and LCIA-based carbon footprint methods in the light of organizational footprinting.*

Activity data

As mentioned on the previous page, a hybrid approach was taken in calculating the total carbon footprint of ErasmusMC, based on the availability of data (see Figure 3). Activity data was based on multiple sources. In the following paragraphs, an explanation is provided per data source. Figure 3 and Figure 4 show how the hybrid calculation approach is related to the coverage of emissions in the total carbon footprint.

Expenditure data and provisions

Data on euros spent on all *purchased goods and services* for the reporting year 2021 was received in the form of two data files: expenditure data ("facturen") and provisions ("verstrekkingen"). This data was used as activity data input for calculating GHG Protocol scope 3 category 1 (*purchased goods and services*)*. Applied calculation methods for scope 3 category 1 are documented on the next page of this report.

* *The purchase of capital goods is included in category 3.1* purchased goods and services.

GHG calculations by Royal HaskoningDHV

Scope 1, scope 2 and (part of) scope 3 emissions for 2021 were calculated prior to this study by Royal HaskoningDHV, based on activity data on physical quantities. Metabolic has incorporated them into the 2021 GHG inventory without further validation of their results.

Sustainable childbirth and Intensive care projects

Detailed data on physical quantities of used products and materials were collected by Metabolic during visits to the Obstetric Clinic in 2022 and the Intensive Care department in 2021. This data was used to calculate the carbon footprint of product and material use in separate research projects (Browne-Wilkinson et al., 2021; Hesseling et al., 2023). This data served as an input for calculating part of the embedded carbon footprint in GHG Protocol scope 3 category 1, which is explained in more detail on Appendix 3 Applied calculation methods for scope 3 category 1. A full explanation of the applied calculation methods in the aforementioned projects can be found in the respective reports.

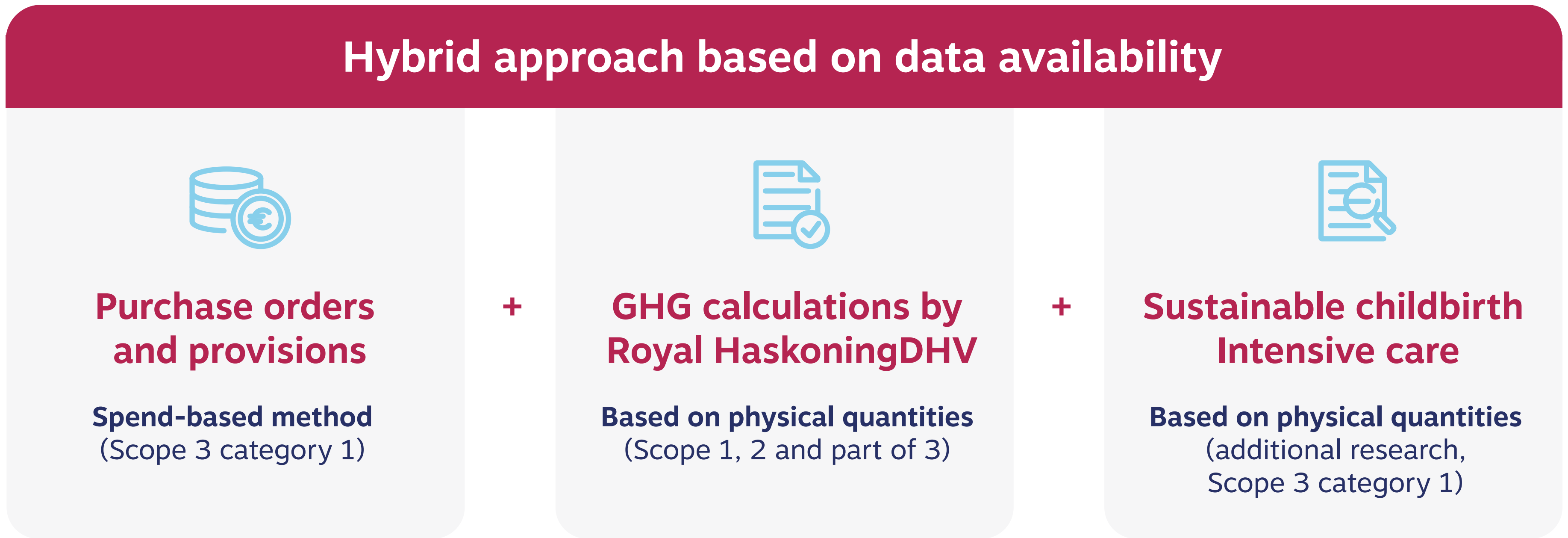


Figure 3 *Overview of the hybrid approach taken for calculating GHG emissions in scope 1, 2 and 3, using spend-based and LCIA-based methods, based on data availability.*

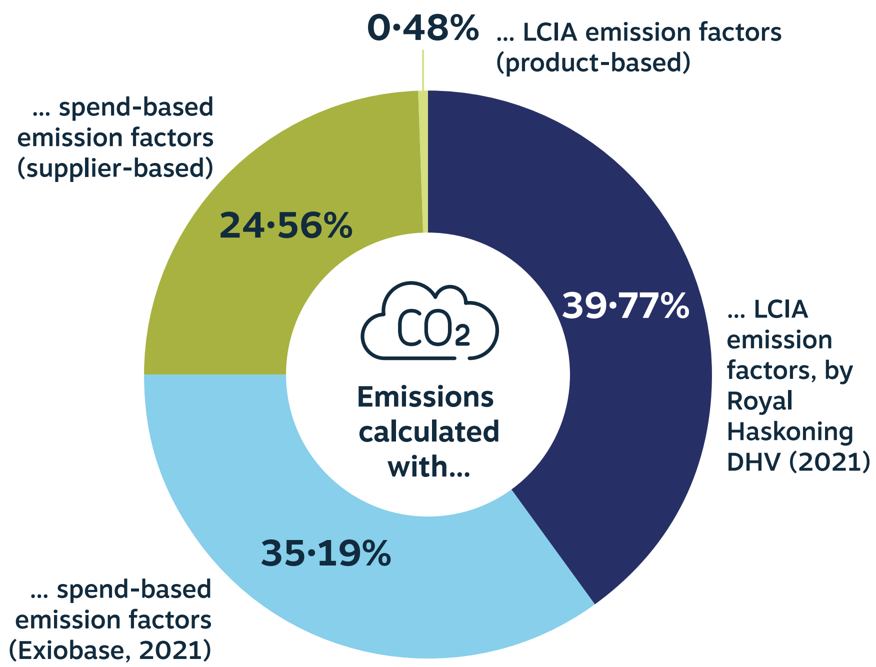


Figure 4 *Percentage of carbon footprint covered by spend-based and LCIA-based emission factors.*

Calculation methods for scope 3 category 1: purchased goods and services

COLLECTED ACTIVITY DATA

As mentioned on the previous page, for GHG Protocol scope 3 category 1, two types of activity data files were collected and used as calculation inputs, namely:

- Expenditure data ("facturen"): all expenditures on procured goods and services in 2021.
- Provisions ("verstrekkingen"): data on product supplies from stocks to different hospital departments in 2021 (goods inventory changes).

DATA PROCESSING

The expenditure data file provides euros spent on procured goods and services in 2021. It does not provide the quantities of the procured goods and services. Due to this data limitation, the spend-based method was applied for emission calculations.

Activity data from the Erasmus Circular IC (2020) and Sustainable Childbirth (2023) was used to account for emissions based on physical quantities. In order to match these with the expenditure data file, the GHG impact per product was translated into a spend-based impact (GHG emissions per euro spent).

To match every purchase entry in the data file to a relevant emission factor per euro spent, different matching layers were used to ensure that the matching was as specific as possible.

The aim of using these different layers was to obtain calculation results sufficiently precise to enable decision making based on the results with reasonable assurance that the GHG reporting is credible. The matching layers go from specific to less specific, using matching based on a product level where possible and then zooming out to e.g., matching based on product categories.

Furthermore, the provisions data file provides information on products that were supplied from stocks to different hospital departments in 2021. Within the expenditure data file, part of the data entries are labeled "Nog te ontvangen facturen", which refers to these provisions from stocks. The provisions data file was therefore used to match the "Nog te ontvangen facturen" data entries to the type of products that were actually provided.

Appendix 3 contains a detailed overview of the matching layers and respective calculation methods that were used in the GHG impact calculations for *purchased goods and services*.

In four steps: from activity data to carbon footprint

Identification of emission sources & data collection

As a first step, GHG emission sources were identified. Available activity data for the identified emission sources was collected from (1) internal hospital databases and (2) on-site research on quantities of used products and materials by Metabolic, during visits to Erasmus MC in 2022.

Data validation

All of the collected data was carefully checked and validated by both Erasmus MC and Metabolic. It was checked whether the collected data met the minimum activity data requirements to be used as input for impact calculations conform to the GHG Protocol. Where needed, additional data was requested or extrapolations were made to fill data gaps.

Data processing

The most appropriate calculation approaches were selected based on the available activity data. Consequently, the activity data was cleaned and matched to emission factors (EFs) from impact factor databases.

Impact calculation

GHG emissions were calculated and aggregated to cover the hospital's total emissions for 2021.

03 Results


XL
L
M
S
Kolmi
Bevat gebruikte FFP 1 en FFP 2 maskers en spatbrillen.
Bij wisselen van de zak dit op buitenkant van zak aangeven!

Total carbon footprint of Erasmus MC

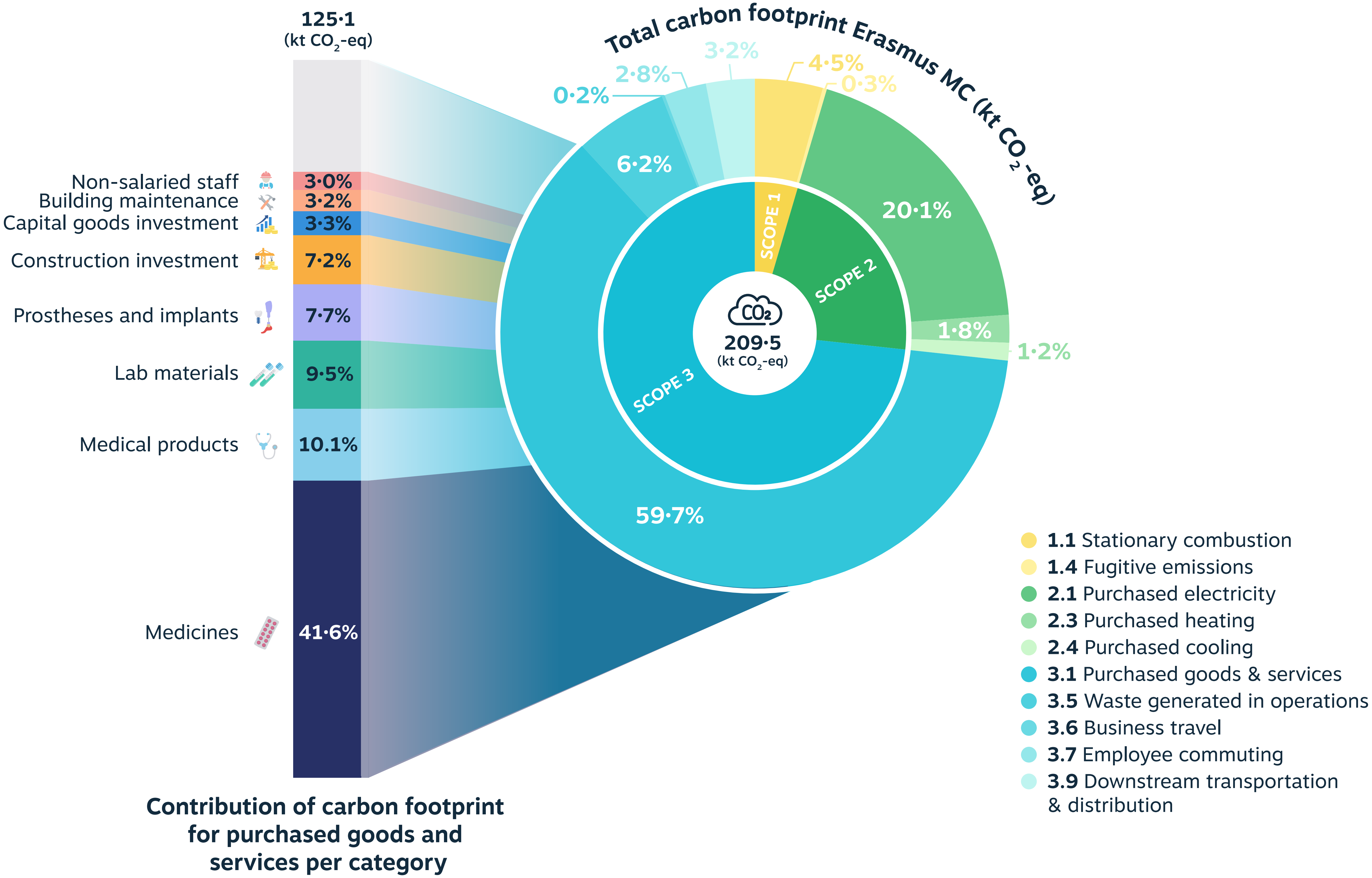


Figure 5 *2021 carbon footprint of Erasmus MC, classified into GHG Protocol scopes and categories.*

This chapter contains the results of the complete carbon footprint of Erasmus MC in 2021. As part of these results, GHG emission hotspots within Erasmus MC's operations are highlighted. Several sections of the carbon footprint are explored to deepen the understanding and interpretation of results. Figure 5 on the previous page shows the total carbon footprint, split into the different GHG Protocol categories that are applicable and that were included in this study. Not all of the GHG Protocol categories are relevant to Erasmus MC (Appendix 2).

The calculated carbon footprint for Erasmus MC in 2021 is 209.5 kilotonnes (kt) CO_2-eq. The largest contribution to the footprint is by indirect scope 3 emissions (72.1%), followed by indirect scope 2 emissions from the generation of acquired electricity, heating and cooling (23.1%) and direct scope 1 emissions (4.8%). This distribution of emissions across scopes, with scope 3 emissions accounting for over 70% of the total, is in line with the carbon footprint of the Dutch healthcare sector as a whole (Steenmeijer et al., 2022).

The top 3 categories with the largest carbon footprint for Erasmus MC are:

1. **Category 3.1 *Purchased goods and services* (59.7% of total, 125.1 kt CO_2-eq)**, which covers the indirect emissions related to all *purchased goods and services*. Within this category, emissions are largely driven by the purchase of medicines (further explored on page 24), medical products, prostheses and construction investments.
2. **Category 2.1 *Purchased electricity* (20.1% of total, 42.1 kt CO_2-eq),** which covers the indirect emissions from the generation of *purchased electricity*.
3. **Category 3.5 *Waste generated in operations** (6.2% of total, 12.9 kt CO_2-eq),** which covers the indirect emissions from processing of generated hospital waste.

On the following pages of this Results section, the GHG emissions from the largest contributing category *purchased goods and services* are further explored for organizational entities. Scope 1 and scope 2 emissions were calculated for the entire organization and cannot be disaggregated for separate organizational entities.

**To avoid confusion: 'waste generated in operations' is a GHG Protocol category, in which the term 'operations' refers to 'business operations' rather than 'patient operations'. Therefore, this category refers to waste generated in all, organization-wide, business operations.*

Contribution to carbon footprint of purchased goods and services on two organizational levels

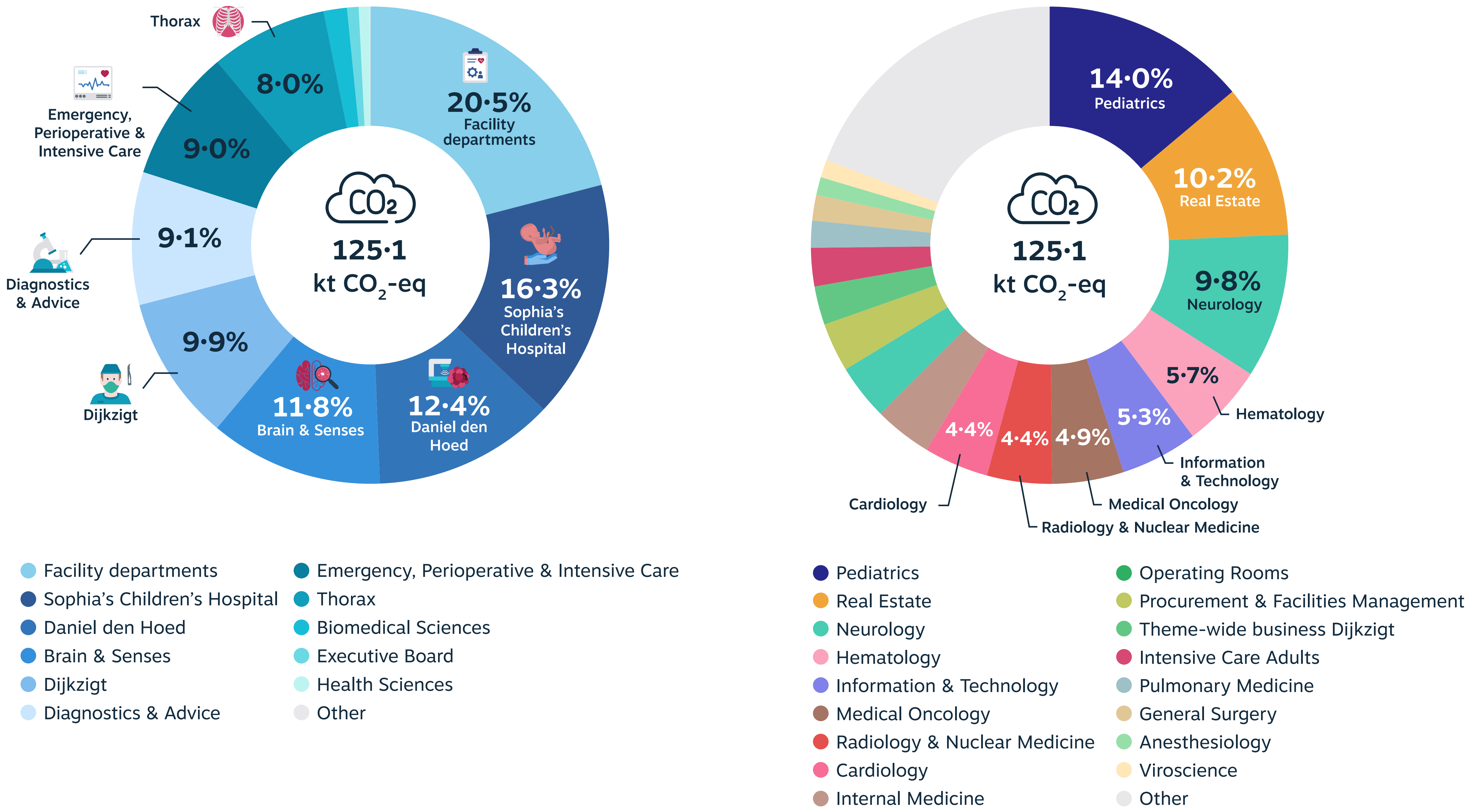


Figure 6 *Category 3.1 Goods and services GHG emissions, categorized into hospital themes (left) and hospital departments (right).*

Contribution to carbon footprint of purchased goods and services on two organizational levels

CONTRIBUTION OF HOSPITAL THEMES TO CARBON FOOTPRINT

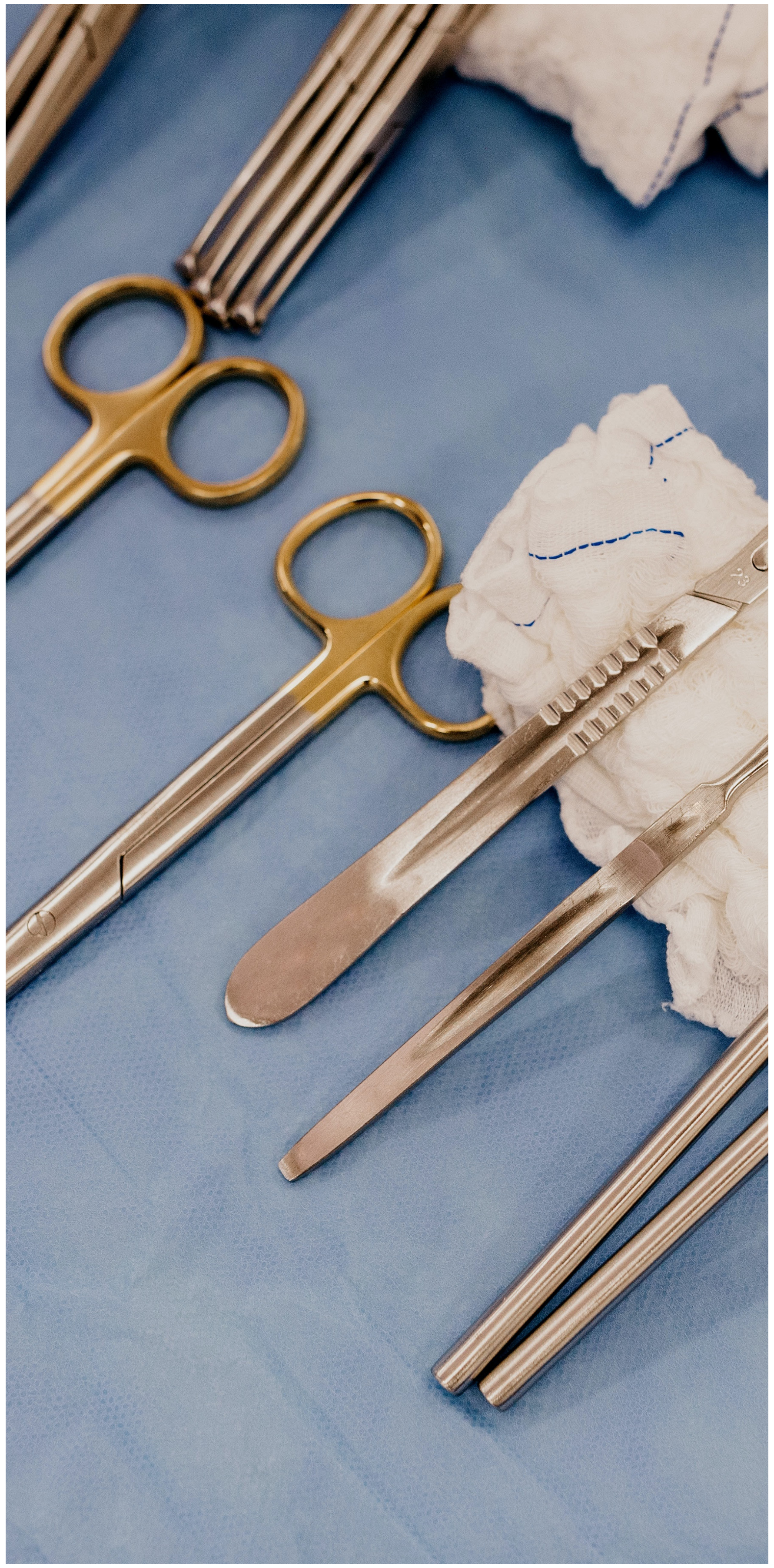
***Facility departments* is the hospital theme with the largest share of the total carbon footprint (20.4%).** *Facility departments* includes all the hospital departments that deliver supporting products or services, so that all doctors, nurses, researchers, trainers and teachers can perform their best in delivering healthcare services. All investments in construction projects, as well as a significant share of other goods and services procurement, fall under *Facility departments*.

The hospital themes that follow next are *Sophia's Children's Hospital* (16.3%), *Daniel den Hoed* (12.4%), *Brain & Senses* (11.8%) and *Dijkzigt* (9.9%). Hospital departments that fall under these themes deliver healthcare services that require intensive product use, including medicines and medical products.*

The contribution to the carbon footprint of the different departments and management committees within each hospital theme is explored on page 21. Furthermore, the contribution of different product and service categories within each hospital theme is explored on page 23.

CONTRIBUTION OF HOSPITAL DEPARTMENTS TO CARBON FOOTPRINT

The departments that contribute most to the GHG emissions from *purchased goods and services* are *Pediatrics* (14.0%), *Real Estate* (10.2%) and *Neurology* (9.8%).



** Medical products is a category that includes all disposable and durable tools, products and fast moving consumer goods, purchased in 2021 for providing healthcare services. Excluded from this category are medical machines (covered by Capital goods investment) and medicines.*

Contribution to purchased goods and services carbon footprint of departments and management committees within hospital themes

Figure 7 shows the relative contribution of the different departments and management committees to the GHG emissions from *purchased goods and services* within each hospital theme. Each white, rectangular area represents a department's relative contribution to the carbon footprint, within their related theme.

- Figure 7 shows that within the largest contributing theme *Servicebedrijf*, half of the GHG emissions are related to *Vastgoed*, under which all investments in construction take place.
- Overall, the biggest contribution to the carbon footprint is made by themes and departments providing healthcare services as a collective. Themes focused on healthcare services that stand out are *Thema Sophia, Thema Hersenen en Zintuigen, Thema Daniël den Hoed*, and *Thema Dijkzigt*. Departments that stand out are *Kindergeneeskunde, Neurologie, Hematologie, Interne Oncologie, Radiologie* & *Nucleaire Geneeskunde, Cardiologie*, and *Interne Geneeskunde*.
- Themes that contribute significantly less to the carbon footprint are T*hema Gezondheidswetenschappen* and *Thema Biomedische Wetenschappen*. Likewise, *Raad van Bestuur en overige programma's* does not contribute as much.
- Table 1 further explores the contribution of *purchased goods and services* per organizational entity.

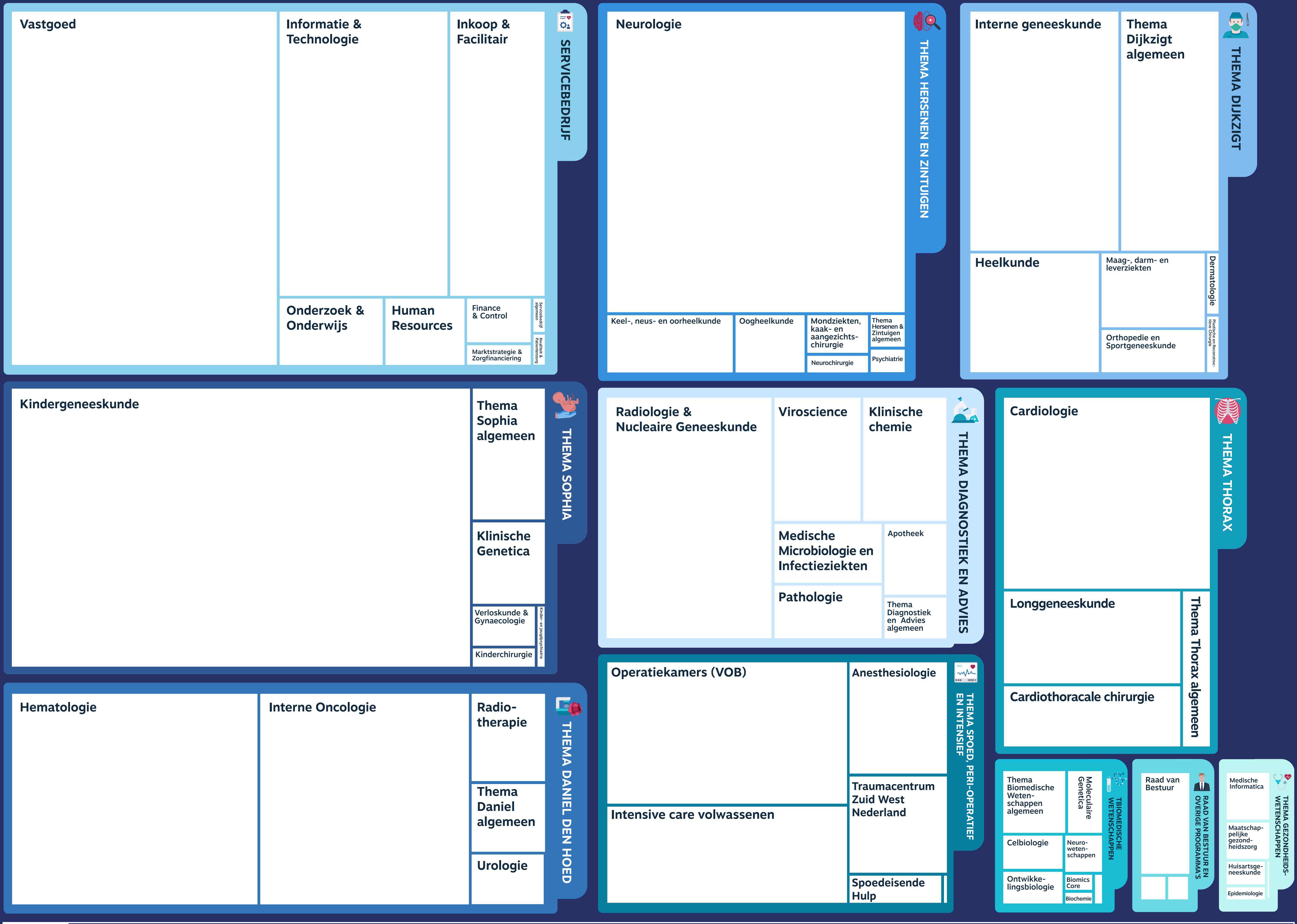


Figure 7 *Relative contribution of hospital themes to category 3.1 Purchased goods and services GHG emissions, further categorized into departments and management committees.*

Contribution to purchased goods and services carbon footprint of product and service categories within hospital themes

Figure 8 shows the contribution of the different product and service categories to the GHG emissions from *purchased goods and services* within each hospital theme. Each white, rectangular area represents the relative contribution of product and service categories to the carbon footprint, within their related theme.

- The hospital theme associated with the highest GHG emissions from *purchased goods and services* is *Servicebedrijf*. This graph shows that within *Servicebedrijf*, the GHG emissions embedded in building construction investments (*Investeringen bouw*) and building maintenance work (*Onderhoudswerk gebouw*) constitute a large share of these emissions.
- The hospital themes that follow in terms of their contribution to the *purchased goods and services* carbon footprint are T*hema Sofia, Thema Daniel den Hoed, Thema Hersenen en Zintuigen* and *Thema Dijkzigt*. The graph highlights that within these themes, the procurement of medicines is largely driving the GHG emissions.
- Besides medicines, product and service groups with significant embedded GHG emissions across the different hospital themes are medical products (*Medische producten*), lab materials (*Lab materiaal*) and prostheses and implants (*Prothesen en implantaten*).

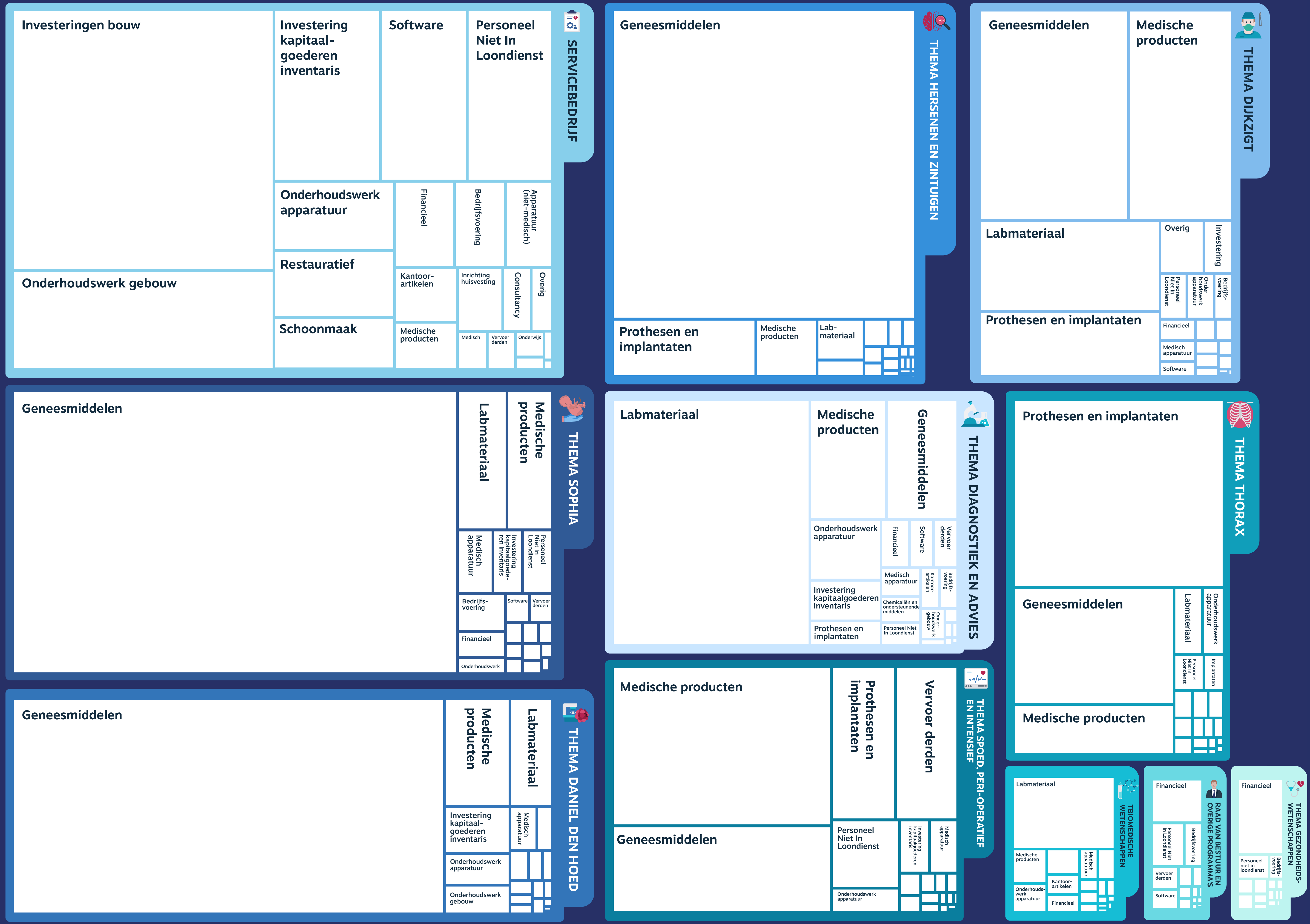


Figure 8 *Relative contribution of hospital themes to category 3.1 Purchased goods and services GHG emissions, further categorized into product and service categories.*

Contribution of medicines to purchased goods and services carbon footprint, per department

As seen from Figure 9, the embedded GHG emissions in purchased medicines constitute a large share of Erasmus MC's carbon footprint. Figure 9 shows how these emissions from purchased medicines relate to the different hospital departments. ***Kindergeneeskunde*** is the department with the largest medicine GHG emissions share (16.5 kt CO_2-eq). Further, ***Neurologie***, ***Hematologie***, ***Interne Oncologie***, ***Interne geneeskunde***, ***Longgeneeskunde*** and ***Intensive Care Volwassenen*** are departments that all contribute significantly (by at least more than a kilotonne of CO_2-eq) to the GHG emissions from purchased medicines.

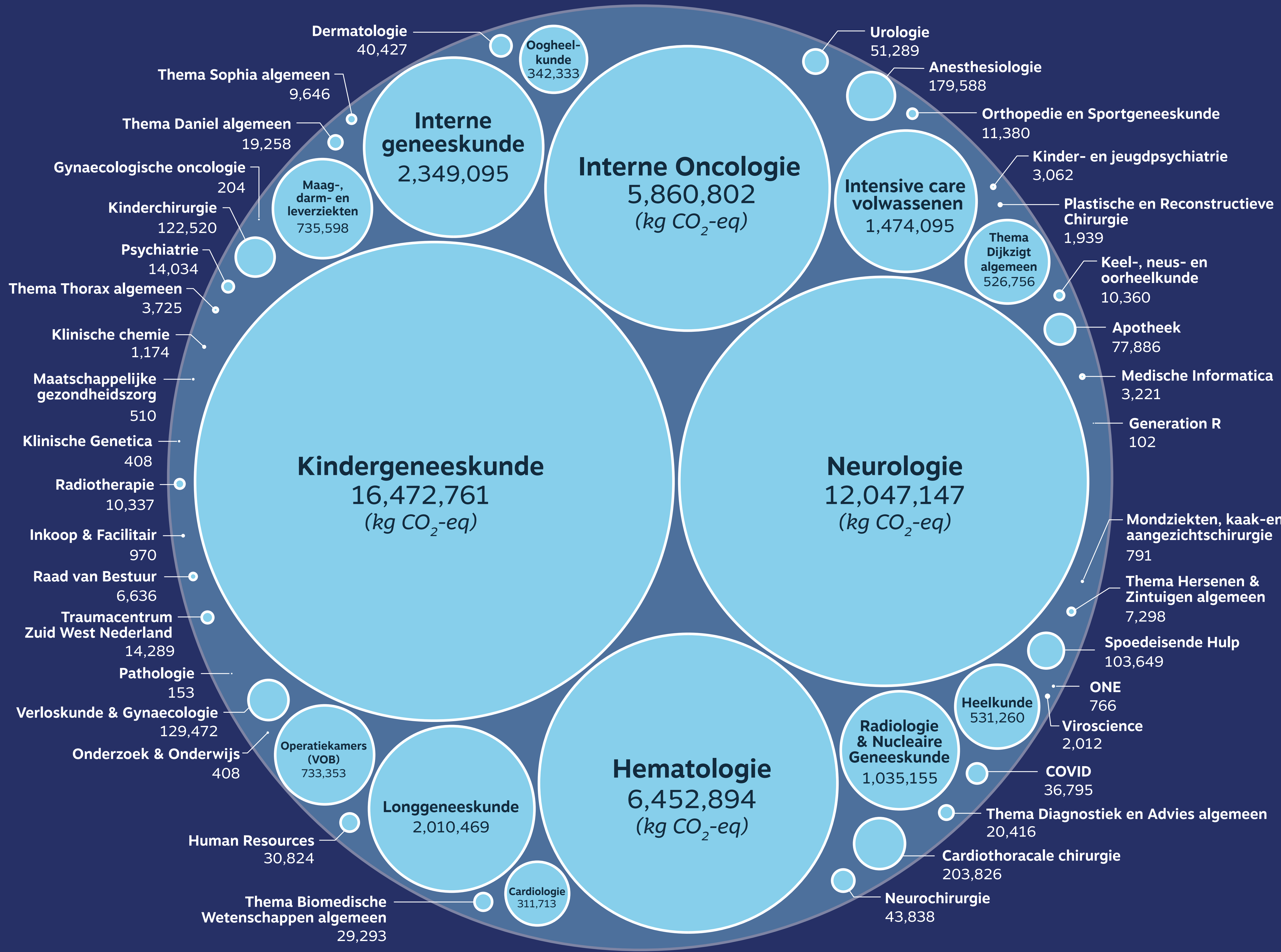


Figure 9 *GHG emissions embedded in purchased medicines (kg CO_2-eq), categorized into hospital departments.*

Contribution to carbon footprint of procured goods and services per business unit

Table 1 *Contribution of purchased goods and services to carbon footprint per organizational entity.*

Afdeling, directie of programma	Klimaatvoetafdruk [ton CO_2-eq]	Bijdrage afdeling, directie of programma aan totale voetafdruk	Bijdrage afdeling, directie of programma aan bedrijfsonderdeel
SERVICEBEDRIJF			
Programma Integrale Bouw	12,784.5	10.22%	49.96%
Informatie & Technologie	6,571.1	5.25%	25.68%
Inkoop & Facilitair	3,750.2	3.00%	14.65%
Onderzoek & Onderwijs	980.9	0.78%	3.83%
Human Resources	763.2	0.61%	2.98%
Finance & Control	403.9	0.32%	1.58%
Marktstrategie & Zorgfinanciering	198.4	0.16%	0.78%
Servicebedrijf algemeen	71.5	0.06%	0.28%
Kwaliteit & Patientenzorg	66.9	0.05%	0.26%

Afdeling, directie of programma	Klimaatvoetafdruk [ton CO_2-eq]	Bijdrage afdeling, directie of programma aan totale voetafdruk	Bijdrage afdeling, directie of programma aan bedrijfsonderdeel
THEMA SOPHIA			
Kindergeneeskunde	17,475.3	13.96%	85.91%
Thema Sophia algemeen	1,361.2	1.09%	6.69%
Klinische Genetica	857.1	0.68%	4.21%
Verloskunde & Gynaecologie	365.0	0.29%	1.79%
Kinderchirurgie	194.1	0.16%	0.95%
Kinder- en jeugdpsychiatrie	87.9	0.07%	0.43%
THEMA DANIEL DEN HOED			
Hematologie	7,176.6	5.73%	46.38%
Interne Oncologie	6,099.1	4.87%	39.41%
Radiotherapie	924.0	0.74%	5.97%
Thema Daniel algemeen	726.1	0.58%	4.69%
Urologie	534.7	0.43%	3.46%
Gynaecologische oncologie	14.4	0.01%	0.09%
THEMA HERSENEN EN ZINTUIGEN			
Neurologie	12,312.0	9.84%	83.32%
Keel-, neus- en oorheelkunde	1,050.4	0.84%	7.11%
Oogheelkunde	589.7	0.47%	3.99%
Mondziekten, kaak- en aangezichtschirurgie	349.9	0.28%	2.37%
Neurochirurgie	174.3	0.14%	1.18%
Psychiatrie	132.4	0.11%	0.90%
Thema Hersenen & Zintuigen algemeen	167.5	0.13%	1.13%
Psychiatrie	132.3	0.11%	0.90%

Afdeling, directie of programma	Klimaatvoetafdruk [ton CO_2-eq]	Bijdrage afdeling, directie of programma aan totale voetafdruk	Bijdrage afdeling, directie of programma aan bedrijfsonderdeel
THEMA DIJKZIGT			
Interne geneeskunde	4,949.3	3.95%	39.92%
Thema Dijkzigt algemeen	3,301.6	2.64%	26.63%
Heelkunde	2,174.1	1.74%	17.53%
Maag-, darm- en leverziekten	1,094.7	0.87%	8.83%
Orthopedie en Sportgeneeskunde	657.5	0.53%	5.30%
Dermatologie	114.8	0.09%	0.93%
Plastische en Reconstructieve Chirurgie	107.0	0.09%	0.86%
Reumatologie	34.6	0.03%	0.47%
Revalidatiegeneeskunde	13.7	0.01%	0.19%
THEMA DIAGNOSTIEK EN ADVIES			
Radiologie & Nucleaire Geneeskunde	5,550.2	4.44%	48.99%
Viroscience	1,518.9	1.21%	13.41%
Klinische chemie	1,458.0	1.17%	12.87%
Medische Microbiologie en Infectieziekten	920.6	0.74%	8.13%
Pathologie	834.8	0.67%	7.37%
Apotheek	652.7	0.52%	5.76%
Thema Diagnostiek en Advies algemeen	393.4	0.31%	3.47%
THEMA SPOED, PERI-OPERATIEF EN INTENSIEF			
Operatiekamers (VOB)	4,719.6	3.77%	41.79%
Intensive care volwassenen	3,277.0	2.62%	29.02%
Anesthesiologie	1,534.0	1.23%	13.58%
Traumacentrum Zuid West Nederland	1,359.5	1.09%	12.04%
Spoedeisende Hulp	383.0	0.31%	3.39%
Thema Spoed, peri-operatief en intensief algemeen	19.8	0.02%	0.18%

Afdeling, directie of programma	Klimaatvoetafdruk [ton CO_2-eq]	Bijdrage afdeling, directie of programma aan totale voetafdruk	Bijdrage afdeling, directie of programma aan bedrijfsonderdeel
THEMA THORAX			
Cardiologie	5,520.1	4.41%	55.29%
Longgeneeskunde	2,302.7	1.84%	23.06%
Cardiothoracale chirurgie	1,516.9	1.21%	15.19%
Thema Thorax algemeen	644.4	0.51%	6.45%
THEMA BIOMEDISCHE WETENSCHAPPEN			
Thema Biomedische Wetenschappen algemeen	605.7	0.48%	30.49%
Moleculaire Genetica	347.5	0.28%	17.50%
Celbiologie	322.8	0.26%	16.25%
Ontwikkelingsbiologie	306.5	0.24%	15.43%
Neurowetenschappen	220.4	0.18%	11.10%
Biomics Core	83.5	0.07%	4.20%
Biochemie	56.0	0.04%	2.82%
Genetische Identificatie	43.8	0.04%	2.21%
RAAD VAN BESTUUR EN OVERIGE PROGRAMMA'S			
Raad van Bestuur	982.2	0.78%	91.48%
COVID	88.1	0.07%	8.21%
Miscellaneous*	3.3	0.00%	0.31%

Afdeling, directie of programma	Klimaatvoetafdruk [ton CO_2-eq]	Bijdrage afdeling, directie of programma aan totale voetafdruk	Bijdrage afdeling, directie of programma aan bedrijfsonderdeel
THEMA GEZONDHEIDSWETENSCHAPPEN			
Medische Informatica	341.8	0.27%	38.07%
Maatschappelijke gezondheidszorg	274.7	0.22%	30.59%
Huisartsgeneeskunde	168.7	0.13%	18.79%
Epidemiologie	90.4	0.07%	10.06%
Generation R	21.6	0.02%	2.40%
Nihes	0.0	0.00%	0.00%
Thema Gezondheidswetenschappen algemeen	0.7	0.00%	0.07%

04 Conclusions and recommendations

Conclusions

Conclusions focus on the carbon footprint of Erasmus MC as well as on the applied methodology.

KEY RESULTS INTO PERSPECTIVE

The carbon footprint of Erasmus MC

The calculated carbon footprint for Erasmus MC in 2021 is 209.5 kilotonnes (kt) CO_2-eq. The largest contribution to the footprint is by indirect scope 3 emissions (72.1%), followed by indirect scope 2 emissions from the generation of acquired electricity, heating and cooling (23.1%) and direct scope 1 emissions (4.8%).

The reporting category *purchased goods and services contributed* the largest share, 125.1 kt CO_2-eq (59.7%), to the carbon footprint. More granular insights were provided in this report for the *purchased goods and services* category, in which the indirect impacts were split according to the parts of the organization (themes, hospital departments and ledger accounts) under which the impacts occurred. Within this GHG category, the most impactful product categories are medicines (41.6%), medical products (10.1%) and lab materials (9.5%). *The Pediatrics (*"Kindergeneeskunde"*)* department, due to high medicine use in the delivery of healthcare services, is therefore the top contributing hospital department (14.0%), followed by the *Real Estate* ("Vastgoed") department (10.2%), which is responsible for investments in construction projects. Following in magnitude of GHG impact are other hospital departments with extensive use of medicines, medical products and lab materials in the delivery of healthcare services. These include the departments of *Neurology* ("Neurologie") (9.8%), *Hematology* ("Hematologie") (5.7%), *Medical Oncology* ("Interne Oncologie") (4.9%), *Radiology & Nuclear Medicine* ("Radiologie & Nucleaire Geneeskunde") (4.4%), *Cardiology* ("Cardiologie") (4.4%) and *Internal Medicine* ("Interne Geneeskunde") (4.0%).

***Purchased electricity* also has a significant share of 42.1 kt CO_2-eq (20.1%) within Erasmus MC's carbon footprint.** Steenmeijer et al. (2022) likewise reported a significant contribution (of 10.5%) by *purchased electricity* to the total carbon footprint of the Dutch healthcare sector. At this moment we do not have data available to provide further insights into Erasmus MC's electricity use. Electrical energy consumption in hospitals typically comes from building climate control (HVAC systems), the use of refrigerators and freezers (e.g., for storage of medicines and specimen samples), cooking, lighting and the use of computers and other office/ medical equipment (Bawaneh et al., 2019). Some important sources of electricity use for Erasmus MC specifically include the use for CT and MRI scanners, air humidification, space cooling, buildings and installations, lighting and other equipment.

Waste generated in operations contributes 12.9 kt CO_2-eq (6.2%) to the carbon footprint. This includes the treatment of generated waste and hazardous waste, as well as the cleaning of textiles. The largest share of emissions within this category come from the treatment of special industrial waste (72.1%) and specific hospital waste (SZA) (17.6%).

Remaining GHG categories had an individual share of less than 5 percent (e.g., *employee commuting*, 2.8% and *business travel*, 0.2%) in the calculated 2021 carbon footprint.

INPUT DATA QUALITY AND METHODOLOGY

Spend-based results offer valid high-level insights with room for improvement

The conducted spend-based analysis does provide a good first approximation of Erasmus MC's scope 3 carbon footprint and is a useful starting point in identifying emission hotspots within Erasmus MC's operations. The GHG inventory results for *purchased goods and services* and *capital goods* are based on the spend-based calculation method, and use EXIOBASE spend-based emission factors, which have a lower level of granularity than the available emission factors in product-level databases like Ecoinvent. This means that carbon footprint differences between products, services, suppliers and geographies are disregarded. The results should be interpreted while keeping in mind that this is a first high-level scope 3 assessment, and that the use of more granular (spend-based or product-level) emission factors, when coming from reliable sources, would increase the accuracy of the calculated emissions.

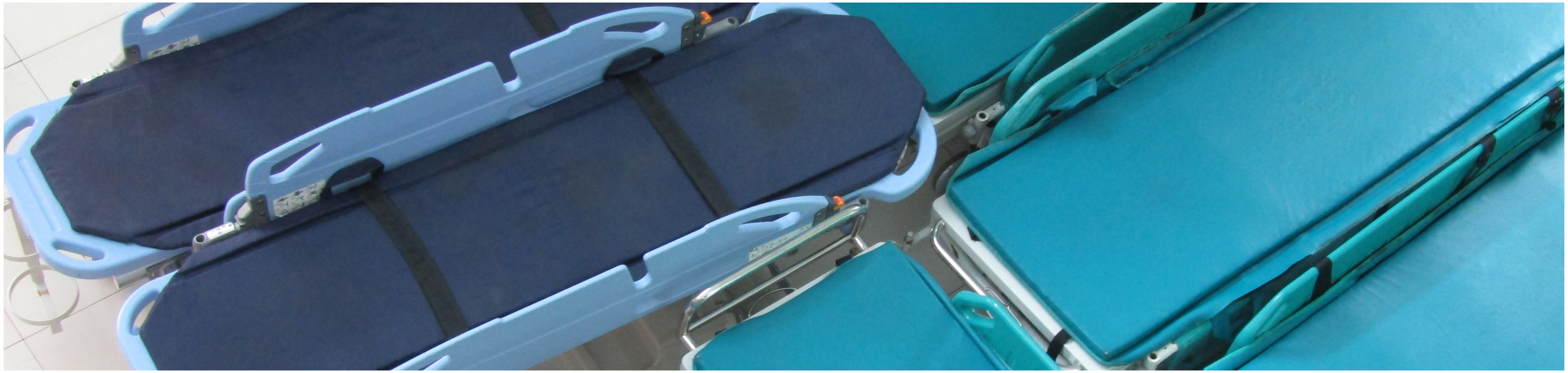
Spend-based emissions depend on critical accounting

Another critical note concerning the spend-based method is that expenditures on discounted goods/services and fluctuating prices could lead to inaccurate emission estimates, or give an incorrect impression of changes in the GHG inventory between different accounting years when discounts are offered in one year, but not in another year. When suppliers offer discounts, the spend-based method carbon footprint would account for a decrease in accounted emissions, despite the fact that no change in actual emissions takes place.

Relevance of spend-based emissions factor matching also depends on granularity of input activity data

Furthermore, procured goods and services were largely matched to EXIOBASE emission factors based on the ledger account descriptions. This matching was done to our best ability. However, some ledger account descriptions are very high-level and/or non-descriptive. The more specific the description of available input activity data, the more accurate this data can be matched to relevant emission factors.

In light of the discussed accuracy of the spend-based method results, the Recommendations section in this report contains guidance on how to move towards a more accurate assessment of Erasmus MC's scope 3 emissions.



Recommendations

OPPORTUNITIES FOR REDUCING EMISSIONS

Take an integral approach to implementation of emission reduction measures
Erasmus MC encompasses multiple organizational entities that either provide healthcare services or services to facilitate healthcare provision directly or indirectly. Although the majority of absolute reduction potential lies at departments that provide healthcare, and substantial parts of absolute reduction potential lies at *facility departments*, both have an equal role to play. Responsibility should be taken by all, to feel that everyone is making an effort in accomplishing a difficult task. This inspires motivation much more than pointing out who is responsible for the majority of impact. In line with this, increased awareness throughout the organization paves the way for a change of behavior. Next to grander scale reduction measures, increased awareness can be induced by alternative reduction measures, that although modestly effective on the whole, are visible and show integral implementation throughout the organization.

Recommendations focus on hotspots mentioned in the conclusion, as well as on the applied methodology and future data collection

MEDICINES

Reducing the impact of purchased medicines at Erasmus MC requires an exploration of multiple pathways. Contributing to 24.9% of Erasmus MC's total carbon footprint and to 41.6% of the *purchased goods and services* footprint, there lies a huge emission reduction potential regarding medicine use.*

The manufacturing of drugs and medicines leaves a large carbon footprint along the different stages of its supply chain, notably in the raw material sourcing for active pharmaceutical ingredients (APIs), the chemical synthesis of these materials and solvents and manufacturing of finished pharmaceutical products (Jimenez, 2022). The provisioning of medicines is crucial for Erasmus MC in delivering healthcare services and has an indirect (scope 3) GHG impact, which makes it challenging to cut the emissions embedded in medicine purchases.

However, despite the fact that API production directly influences the carbon footprint of medicines, there are various approaches that can be pursued to decrease the overall medicine consumption and subsequently minimize the impact of purchased medicines at the hospital.

Erasmus MC could seek opportunities for reducing the amount of needed (and procured) medicines. The Green Deal 3.0 presents the idea of transitioning towards a society that prioritizes healthy lifestyles and a sustainable care and living environment. This shift represents a long-term systemic change initiative that requires sustained efforts. Erasmus MC, in the long run, can investigate the possibilities of implementing preventive healthcare measures to reduce emissions associated with procured medicines. Additionally, in the near future, Erasmus MC can explore potential opportunities to decrease emissions through the proper handling and disposal of medicines, while considering relevant legislation and medical protocols.

A value-based approach could be taken in the procurement of medicines, which considers the embedded environmental impacts or reported carbon footprint of pharmaceutical companies. To realize short-term emission cuts, Erasmus MC could explore opportunities for the sourcing of medicines from pharmaceutical companies that are more dedicated to sustainable production and sourcing to reach environmental targets.

Erasmus MC could join forces with other hospitals to lobby for more sustainable practices in the pharmaceutical industry as well as other suppliers to the healthcare sector. Many pharmaceutical companies have already committed to making changes and there are opportunities for cutting carbon emissions at all stages of the pharmaceutical supply chain (Jimenez, 2022). Increased ask and pressure from the healthcare sector could potentially add a push to the sustainability transition within the pharmaceutical industry.

**When deploying a spend-based calculation method for assessing the carbon footprint of medicines, results are influenced by pricing as well. The carbon footprint of expensive medicines may be overestimated compared to the carbon footprint of cheaper medicines or the carbon footprint of cheap medicines may be underestimated. Nevertheless, given the size of the organization, most extremes will be averaged out.*

PURCHASED GOODS AND SERVICES

The reduction of impact of procured goods and services throughout the organization requires a tailored approach. Any service provided by Erasmus MC entails different needs. Procurement policy should be adapted to meet the absolute need per service. For the procurement of new healthcare specific and non-specific products it is important to consider whether these meet absolute needs, or whether procurement of new products can be avoided.

The level of product complexity and application helps to determine what other options exist. To give a few examples, for medical machines one might prefer state-of-the-art devices that live up to the newest healthcare standards. One might consider whether a new product is essential or whether this can be achieved by a service contract with the supplier taking ownership of the product. For IT equipment one might consider whether these can be repaired or bought second-hand instead of purchased new. For other facility services, reduction measures might impact people's awareness rather than Erasmus MC as an entire organization, such as avoiding the procurement of meat and dairy food supplies and cut flowers.

Use disaggregated results to generate insight on department level. In general, results depict a high-level insight on scope 1, 2 and 3 emissions. Scope 3.1 results were shown in a more disaggregated way. The relative contribution of departments, as well as the relative contribution of product categories by departments might be a viable starting point for investigating what are key areas of attention per department. These insights can be shared and reflected with other hospitals, to discern commonalities and formulate effective interventions.

Inspire decisions on procurement of products of any complexity based on supplier-specific life cycle assessment data. When new products are essential, it is important to assess which variants exist with a lower carbon footprint. The majority of the carbon footprint (and other environmental impacts) is mainly determined by amount, type and manufacturing of materials within these products, and the associated life expectancy. When products involve a high level of complexity, such as prostheses, longer life cycles generally decrease the carbon footprint. When products involve a low level of complexity, such as disposable medical products, life expectancy is intrinsically short and therefore an informed decision based on supplier-specific life cycle assessment data is even more important. In addition, life cycle assessment research can aid decision-making on replacing disposable materials by durable materials.

Gain insight into how and which medical products and lab materials are used to reveal where reduction opportunities are. The use of medical products and lab materials is evident throughout all healthcare departments at Erasmus MC. Provision of healthcare to people in need is a priority. The use of medical products and lab materials is instrumental. Approaches to how medical products and lab materials are used varies among individuals and departments. Investigate how protocols, routines and ad-hoc decision-making affect daily practice throughout departments or healthcare trajectories.

ELECTRICITY AND WASTE

Explore opportunities to reduce electricity consumption. An effective way to achieve impact reduction is to reduce actual electricity consumption. To identify where it is feasible to reduce electricity consumption, it is recommended to collect more granular data that allows for insights into e.g., energy use per hospital department or the most energy-intensive hospital equipment. The more specific data collection is, the better emission reduction opportunities can be identified. Based on the available electricity consumption data, which provides only the total 2021 electricity consumption for Erasmus MC, the following possibilities for electricity-related emission reductions can be investigated:

- Reduce electricity consumption from a use-case point of view
- When new equipment needs to be purchased, purchase equipment with better energy labels
- Investigate improvements in energy labels for current equipment

Explore opportunities for on-site renewable electricity generation and moving to renewable energy contracts. Another way to reduce the carbon footprint is to change the source of electricity from fossil-based to renewable.
Ideally, explore the possibility of on-site renewable energy generation, e.g. from the installation of rooftop solar panels.
Alternatively, explore the possibility of entering a renewable energy contract.

Explore opportunities to reduce waste. Reducing waste essentially leads to multiple benefits. If less materials and medicines are disposed of, less materials and medicines need to be purchased. Inherently, this leads to reduction of the carbon footprint (and other emissions) for waste treatment, as well as for producing these materials.

There are multiple ways to reduce waste. Reducing waste requires a tailored approach, which depends on the type of products turning into waste, and related user behavior, protocols, and purchase arrangements.

- Waste generated by consumption of disposable products is partly driven by the fact that these disposable products are inherently meant for one-time use. Explore if and how disposable products can be replaced by durable products, considering their functionality for providing healthcare services, and in respect of relevant life cycle assessments.
- Moreover, consumption of disposable products is related to the way they are deployed by medical practitioners (users). Explore opportunities for changing user behavior, tailored to the specific medical context the products are used.

A full elaboration on opportunities for waste reduction can be found in Browne-Wilkinson et al. (2021).

JOIN FORCES WITH OTHER HOSPITALS

Establish partnerships. It is Erasmus MC's ambition to establish partnerships with other hospitals in their pursuit of delivering sustainable healthcare. This ambition is also in line with the Green Deal 3.0, which steers towards a collaborative approach in accelerating sustainable healthcare.

We recommend establishing these partnerships to:

- Facilitate knowledge sharing on emission hotspots within the healthcare sector.
- Facilitate knowledge sharing on sustainable healthcare practices and results of pilot interventions aimed at increased sustainability.
- Collectively set up a program for preventative healthcare and the promotion of healthy lifestyles and living environments.
- Collectively shape guidelines for delivering value-based healthcare, which considers the environmental impact of healthcare services.
- Collectively improve the available environmental impact data. E.g., by commissioning LCA-consultancies to perform medical product/service LCA's, prioritizing those products and services that appear to be high in impact and/or that are used/ carried out most often.

DATA COLLECTION

Improve collection of activity data to support carbon footprint reporting in the future. The carbon footprint analysis provided insight into currently available and missing activity data in light of the required data inputs for calculation of all GHG Protocol scope 1, 2 and 3 categories relevant to Erasmus MC (see Table A1: GHG Protocol categories, in **Appendix 2. Overview of relevant GHG categories).**

The carbon footprint of the organization relies heavily on available data about specific products and services (scope 3). The more data is available about relevant products and services (including e.g., production location, material composition, brand, type, etc.), the better this data can be used to either match products and services to existing emission factors (from available LCAs and LCA or EEIO databases), or create new emission factors based on reference flows of products (key products) for calculating the carbon footprint.

In the light of 1) matching procured products to available emission factors and 2) creating new emission factors, information on the material composition and mass of products is essential. When economic procurement data is used to assess environmental impact of specific products, another variable (price per product) is introduced, which creates a higher uncertainty of the result, as this variable can vary greatly between different markets, product types, sizes, etc.

Keeping this in mind, the following data points should be considered to add and to be completed for all procured goods and services within the current expenditure data:

- **Product category**
- **Product type**
- **Product sale unit (e.g. 100 per box)**
- **Product mass (kg/unit)**
- **Product price (€/unit)**

Ideally, the carbon footprint of procured goods of organizations is based on LCAs or physical data, rather than EEIO or spend-based data. However, as the healthcare sector consumes many sector specific products with specialized materials and production processes, not many relevant LCAs exist. Therefore, to increase the specificity of the carbon footprint , it is crucial to conduct more in depth LCAs of specific products relevant to the healthcare sector. The recommendation is to combine forces with other health care institutions, and to request LCA data in procurement processes of products that are both expected to have a high environmental impact and are representative for a larger product group In order to start monitoring the carbon footprint over a longer period of time, tools like a dashboard could be used to create more insights. The footprint assessment could be carried out monthly or yearly and progress to meeting set goals can be measured.

LOOKING FORWARD: FOLLOW-UP CARBON FOOTPRINTS AFTER THE 2021 BASE YEAR

Looking forward, Erasmus MC will need to assess and report their organization-wide carbon footprint on an annual basis. The annual disclosure of GHG emissions is required as part of SBT-setting and -monitoring, and will continue to guide Erasmus MC in their emission reduction efforts.

Considering the challenges surrounding the availability and collection of organization-wide activity data, the spend-based calculation method could remain the key method for calculating the scope 3 carbon emissions in the short term. However, using industry-average, spend-based emission factors means that year-to-year changes in carbon emissions from switching to the procurement of substitute goods and services (with a different material composition, from different suppliers and/or different geographical locations) cannot be monitored. Only changes from absolute reductions or increases in expenditure on goods and services will result in monitored emissions changes. Therefore, on a longer term, it would be best to refine and replace organization-wide data by providing updated carbon footprints for smaller organizational entities.

So, next to updating the annual organization-wide carbon footprints, it is recommended to carry out carbon footprints with a higher level of granularity for smaller parts of the organization. Erasmus MC, and the broader healthcare sector, will gain more perspective for action from these more granular insights. For this purpose, it is crucial to keep improving both the organizational activity data collection and the available environmental impact data, starting with the organizational operations that make up the largest share of the footprint and that are crucial in providing hospital care.

Lastly, for annual reporting purposes, it is useful to report the organization-wide carbon footprint in context, especially when year-to-year changes need to be monitored. E.g., it could be that the total emissions (for selected GHG categories) increase from year to year, due to a higher number of delivered healthcare services, with a monitored decrease in the emissions per delivered healthcare service. Insightful metrics are, for example, the (department-/healthcare service-specific) carbon footprint per FTE, per patient-hour or per euro revenue. The reporting of such metrics is recommended in all published carbon footprints, because it provides context and additional insights for action perspective.

THE NEXT STEPS TOWARDS SCIENCE-BASED TARGET-SETTING

Erasmus MC aims to set Science-Based Targets (SBTs) using the base year 2021. SBTs reflect an organization's level of ambition towards reduction of emissions. When setting SBTs, Erasmus MC needs to commit to a certain level of ambition. The level of ambition determines the amount of emissions Erasmus MC is committing to reduce.

The first step is to explore whether a so-called "net-zero" goal (90% of emissions reduced in or before 2050) or a so-called "SBTi" goal (short-term reduction of emissions 5-10 years ahead) is feasible and desirable. Short-term goals focus on either a "well-below 2 degrees" goal or a "maximum 1.5 degrees" goal. Naturally, a "maximum 1.5 degrees" goal is more ambitious than a "well-below 2 degrees" goal.

To understand how this level of ambition is related to a targeted reduction per scope, Erasmus needs to evaluate which, according to SBTi, reduction targets exist per scope category, and how these reduction targets can be achieved.

For Erasmus MC, the majority of emissions is related to scope 2 and 3 emissions. Scope 3 emissions cover more than 40% of the total emissions, so according to the SBTi, a scope 3 target must be set. SBTi provides the option to set targets for scope 1 and 2 (taken together) and scope 3 separately, or a combined target for all scopes.

To underpin decisions on the level of ambition, Erasmus MC could compose a list of high-level intervention strategies and evaluate their reduction potential with regards to the scope. Scope 1 emissions, which come predominantly from stationary combustion, constitute 4.5% of the total carbon footprint. It is advised to look into feasible reduction options, however, there is less significant reduction potential than within other scopes. Most reduction for a combined Scope 1 and 2 target should be accomplished for Scope 2, considering that *purchased electricity* contributes by 20.1% to the total carbon footprint. For setting a Scope 2 target, at least 80% of *purchased electricity* should be generated by renewable sources - or other interventions should be deployed to achieve an 80% reduction. Erasmus MC needs to explore how this can be achieved in practice.

To set a well thought-through scope 3 target is essential. scope 3 covers 72% of all emissions at Erasmus MC. According to SBTi, a short term "SBTi" goal should cover at least 2/3 of those emissions (which is 48% of the total emissions). Concrete intervention strategies that lead to an estimation of the amount of reduced emissions have not been calculated and formulated within this study. Therefore, to set a combined reduction target that encompasses all categories for scope 3 is most feasible.

To anticipate on reaching the total combined reduction target, a list could be created of feasible interventions for each scope 3 category, including interventions per organizational entity and assessed product groups to evaluate their total carbon emissions reduction potential. It could be wise to focus on reciprocal reduction measures - which means that Erasmus MC could explore which interventions can be mutually beneficial. For example, if less products need to be purchased because less is wasted, this feeds into lower emissions for category 3.5 *waste generated in operations*, as well as for category 3.1 *purchased goods and services*.

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05 Appendix

1. Life cycle analysis and system boundaries

Life cycle assessment (LCA) is a method for calculating the environmental impact throughout the life cycle of products, materials and fuels (in short ‘products’). Guidelines on life cycle assessment are captured by the ISO14040/ISO14044 standards.

A product life cycle exists of life cycle stages. For each life cycle stage, inputs and outputs are identified that are relevant for the total environmental impact. For each lifecycle stage, materials and energy enter the system (inputs), and this results in outputs such as co-products, waste and emissions.

A full LCA provides insight into various environmental impact categories. Climate change (Global Warming Potential) is often considered, but land use, water use, ecotoxicity, eutrophication and acidification are other important impact categories. A carbon footprint focuses on the impact of greenhouse gas emissions. Various impact assessment methods have been developed. The ReCiPe2016 method by Huijbrechts et al. (2016) is method commonly used.

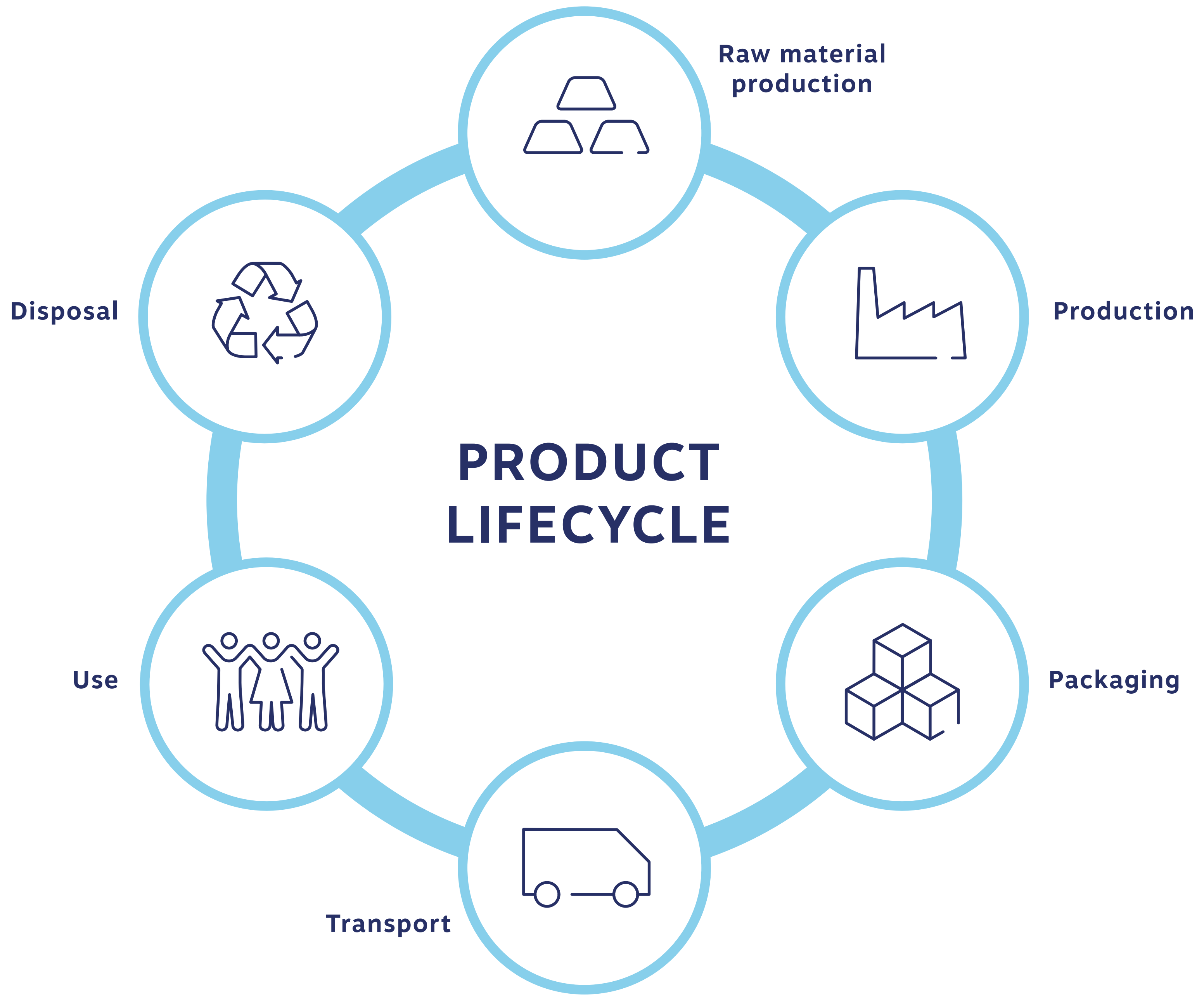

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Figure 10 *Schematic visualization of a product life cycle.*

System boundaries define which life cycle stages are included. When all life cycle stages are included, this is called a 'cradle-to-grave' analysis. A cradle-to-grave analysis gives a complete picture of the environmental impact caused throughout the product life cycle. Raw material extraction, manufacturing, distribution, use and end-of-life are included.

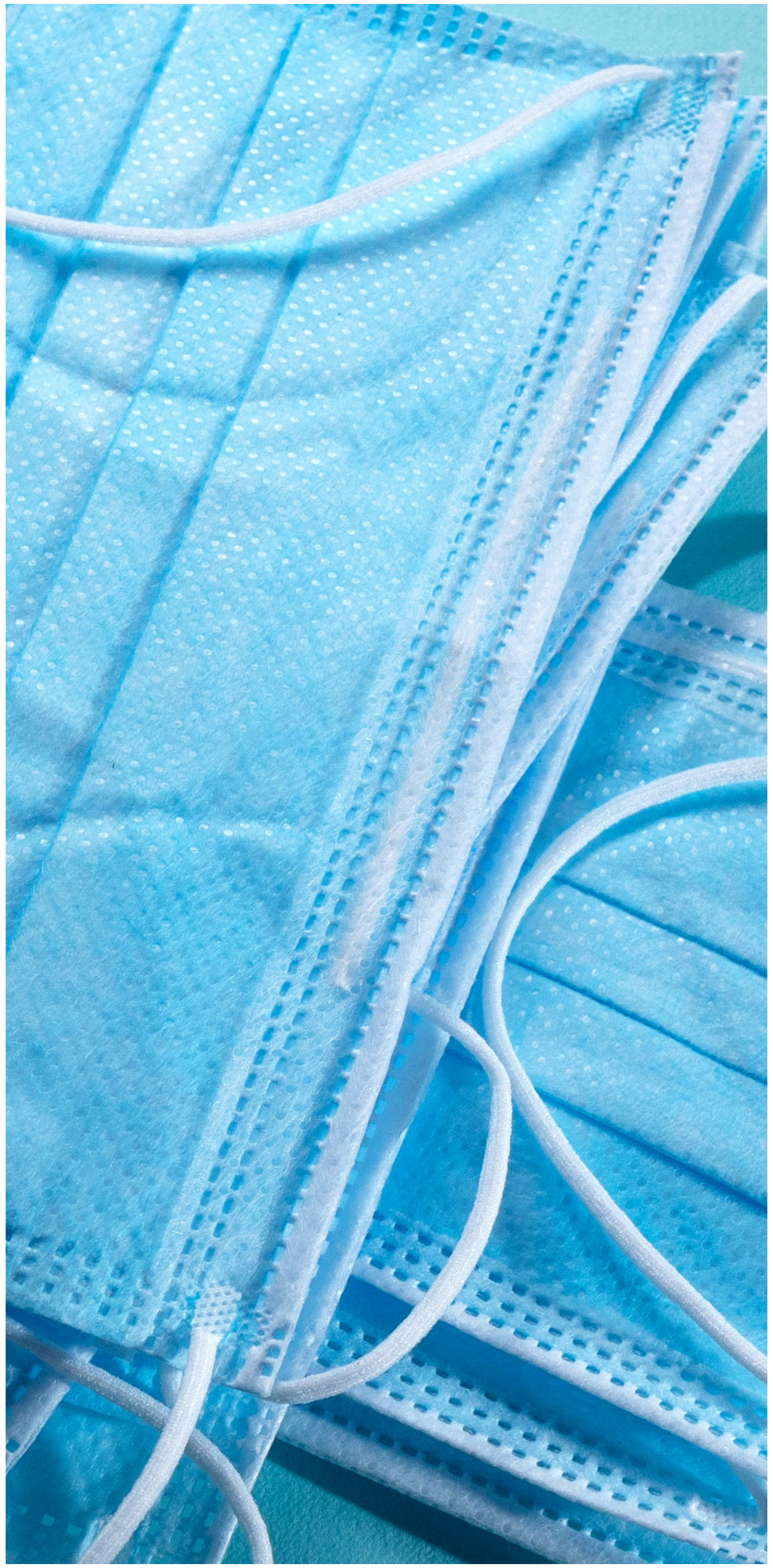
It is difficult to get this complete picture for the production, use, and disposal phase. Specific and detailed primary data from producers, users and processors is required to retrieve the complete picture. Most LCAs take into account the cradle-to-gate perspective, determining the impact from raw material extraction to a defined gate (farm-gate, factory-gate, etc.).

Producers generally only have, if available, info on production, whereas the users of those products would understand both the use phase and what happens to the material at the end of life (disposal). Moreover, for organizations that purchase and use a large number of products, it is often difficult to gather data on detailed level for all individual products. To perform LCAs for all products would be valuable but is time-consuming.

In order to quickly gain insight for these organizations, reference products are often used. This means that data from similar products or materials is used to represent the impact of the product in scope.

Metabolic has created reference products based on the inventory compiled with the obstetric care department and intensive care department within Erasmus MC. These reference products are created based on desk research into the materials used for the physical products at hand. The Ecoinvent 3.6 database is used for the translation of reference products into environmental impact.

Metabolic has defined the system boundaries cradle-to-factory-gate to ensure consistency for the results.



2. Overview of relevant GHG categories

Table A1 *GHG Protocol categories.*

Scope 3	Relevant for Erasmus MC?	Data availability for 2021	Included in 2021 GHG inventory?
1. Purchased goods and services	Yes	Euros spent on procured goods and services, derived from two types of activity data files: • Expenditure data (“facturen”): all expenditures on procured goods and services in 2021. • Provisions (“verstrekkingen”): data on product supplies from stocks to different hospital departments in 2021 (goods inventory changes).	Yes
2. Capital goods	Yes	Euros spent on procured *capital goods*, derived from two types of activity data files: • Expenditure data (“facturen”): all expenditures on procured goods and services in 2021. • Provisions (“verstrekkingen”): data on product supplies from stocks to different hospital departments in 2021 (goods inventory changes). Within these data files, entries under ledger account “Onderhanden werken inventaris” concern *capital goods* purchases.	Yes
3. Fuel- and energy-related activities (not included in scope 1 or scope 2)	Yes	-	Yes
4. Upstream transportation and distribution	Yes	No available activity data on supplier locations and/or shipping information.	Yes
5. Waste generated in operations	Yes	GHG emissions calculations by Royal HaskoningDHV covering the indirect emissions resulting from the treatment of *waste generated in operations*.	Yes
6. Business travel	Yes	GHG emissions calculations by Royal HaskoningDHV covering the indirect emissions resulting from business-related flights.	Yes
7. Employee commuting	Yes	GHG emissions calculations by Royal HaskoningDHV covering the indirect emissions resulting from *employee commuting*, which includes the commuting of both employees and students by private car and public transport.	Yes
8. Upstream leased assets	No	N/A	No

Scope 3	Relevant for Erasmus MC?	Data availability for 2021	Included in 2021 GHG inventory?
9. Downstream transportation and distribution	Yes[1]	GHG emissions calculations by Royal HaskoningDHV covering the indirect emissions resulting from clients (patients and visitors) traveling to and from Erasmus MC.	Yes
10. Processing of sold products	No	N/A	No
11. Use of sold products	No	N/A	No
12. End-of-life treatment of sold products	No	N/A	No
13. Downstream leased assets	No	N/A	No
14. Franchises	No	N/A	No
15. Investments	No	N/A	No

[1] *It is optional to include emissions from customer travel in this category. Emissions from client commuting were included in this GHG inventory, as they can be significant for hospitals.*

3. Calculation methods for scope 3 category 1: Purchased goods and services

Table A2 *Matching layers, corresponding methods and data coverage per layer.*

Matching layer	Method description	Emission factor boundaries	Method data coverage within category 3.1 (%)
1. Article number matching: matching of article numbers to corresponding key products[2], for which we have a calculated GHG impact per euro spent in Metabolic's impact assessment database.	All of the entries in the expenditure data file contain an article number. For all of the medical products for which we calculated a GHG impact in the Sustainable childbirth and Intensive care projects, we calculated an impact per euro. Furthermore, we compiled a list in which these created "key products" were linked to article numbers. These article numbers were then matched to every entry in the expenditure data file, which resulted in some article number matches.	Cradle-to-factory-gate, excluding product assembly and final transport emissions	0.01%
2. Ledger account - key product matching: matching of ledger account ("grootboekrekening") categories to corresponding key products, for which we have a calculated GHG impact per euro spent in Metabolic's impact assessment database.	All of the entries in the expenditure data file are connected to a ledger account ("grootboekrekening"). Some of these ledger accounts could be matched to specific key products in Metabolic's impact assessment database. E.g., the account called "Handschoenen" (EN: gloves) could be matched to a single key product for medical disposable gloves.	Cradle-to-factory-gate, excluding product assembly and final transport emissions	0.78%
3. Ledger account - EXIOBASE matching: matching of ledger account ("grootboekrekening") categories to corresponding EXIOBASE key products.	Ledger accounts that could not be matched to a specific key product, because they were more broadly defined, were matched to categories from the EXIOBASE v3.8[3] database.	Environmentally Extended Input-Output (EE I/O) emission factors	58.69%

[2] "Key products" is the term that we use to refer to all the products that are taken up in Metabolic's internal impact assessment database, and for which we have environmental life-cycle impact data (e.g., product emission factors).The term "product" in this context can refer either to a product system, service system or product-service system.
[3] EXIOBASE is a global, multi-regional, environmentally-extended input-output (EEIO) database.

Matching layer	Method description	Emission factor boundaries	Method data coverage within category 3.1 (%)
4. Ledger account “Apotheek HIX” - supplier matching: matching of supplier names for ledger account “Apotheek HIX” to corresponding key products, for which we have a calculated GHG impact per euro spent in Metabolic’s impact assessment database.	One of the ledger accounts in the expenditure data file is called “Apotheek HIX”, which covers the procurement of medicines. This category covers as much as ~40% of the total expenditures. Because of the large differences between the environmental impact of different types of medicine and the lack of an EEIO impact factor database which captures these impacts well, we used spend-based, supplier-based emission factors in the impact calculation for this ledger account. That is, we calculated a spend-based emission factor for the different supplying pharmaceutical companies, based on their CDP reporting (reported scope 1, 2 and 3 emissions divided by annual company revenue).	Unknown - the EFs were derived from the scope 1, 2 & 3 GHG emissions calculations performed and reported by medicine suppliers	40.52%
Ledger account “Nog te ontvangen facturen”	“Nog te ontvangen facturen”' is another ledger account connected to entries in the expenditure data, which could not be matched directly to a key product. This account concerns the product supplies from stocks to different hospital departments (NL: “verstrekkingen”). Therefore, they could not be matched based on the ledger account name (layer 2 and 3). Furthermore, these entries do not have an article number, so they could also not be matched based on this (layer 1). The separate dataset on provisions does contain a ledger account for these supplies from stocks (but no article numbers). Thus, the entries with ledger account “Nog te ontvangen facturen” could only be matched to a key product based on layer 2 and 3. Again, entries without a resulting match have a calculated impact based on extrapolation (layer 5).	See layer 2, 3 and 5	-
5. Extrapolation: extrapolation of the calculated GHG emissions for *purchased goods and services* to cover for data entries with no key product match after the four matching layers.	Extrapolation for missing matches is done based on the amount of missing expenditure per label. A coverage of expenditure is calculated for each label, and the calculated emissions are extrapolated using that coverage.	-	-

Colophon

This study was commissioned by Erasmus MC Rotterdam and conducted by Metabolic

Authors (Metabolic):
Simone Hesseling
Louise Wijk
Martin Tauber

Graphic Design (Metabolic):
Marta Sierra García
Twin de Rooy

Erasmus MC Rotterdam:
Hans-Peter Schilte
Nicole Hunfeld
Lex Burdorf

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Metabolic

+31 (0) 203690977
info@metabolic.nl
www.metabolic.nl

Klimopweg 150
1032HX Amsterdam
The Netherlands