MEASURE TO IMPROVE
THE CARBON FOOTPRINT OF LAERDAL MEDICAL, 2019

Document information

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Summary

Laerdal contacted us in 2019 for assistance in developing a carbon footprint measurement methodology. The first simplified report was prepared in 2019 based on data from 2018.

This report presents Laerdal's combined carbon footprint for the year 2019, that is the overall greenhouse gas emissions associated with Laerdal's overall purchases and activities. The footprint includes all emissions taking a life-cycle perspective, including direct on-site emissions, and all indirect emissions sustained upstream in the supply chain of the goods and services purchased by Laerdal. The analysis was performed based on Laerdal's detailed financial accounts combined with specific emission multiplier derived from an environmentally extended multiregional input-output model with global coverage.

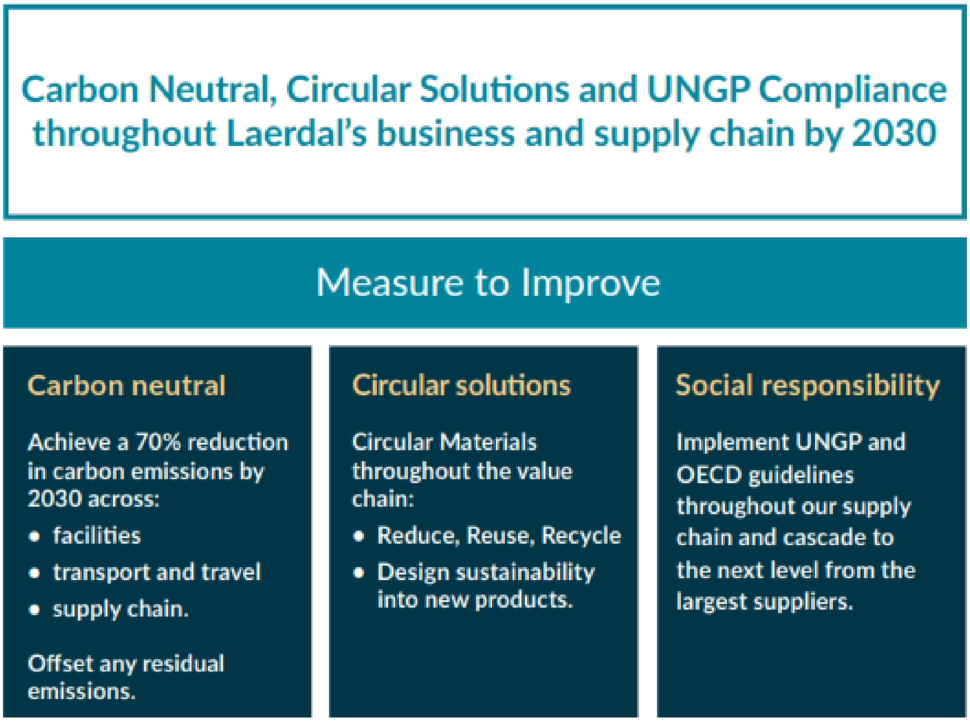
We estimate Laerdal's total carbon footprint to be 69 kilotonnes CO_2-equivalents (kt CO_2e), a little over half of which (36 kt CO_2e) were associated with Laerdal's operational activities, while the remaining 33 kt CO_2e were embodied in purchased raw materials, components, or finished products for redistribution. Just over half of the operations footprint, in turn, stemmed from logistics and travel activities (19 kt CO_2e), while the remainder was made up of a range of contributions such as onsite energy consumption, consultancy services, facility maintenance, tools, hardware, and office equipment.

Table of Contents

1. INTRODUCTION

1.1. Laerdal Medical motivation

Laerdal Medical are committed to cut greenhouse gas (GHG) emissions and are establishing a target of carbon neutrality by 2030. A key part in reducing both internal and external (value chain) GHG emissions is to develop a carbon footprint inventory.



Carbon Neutral, Circular Solutions and UNGP Compliance throughout Laerdal's business and supply chain by 2030

Measure to Improve

Carbon neutral

Achieve a 70% reduction in carbon emissions by 2030 across:

- facilities
- transport and travel
- supply chain.

Offset any residual emissions.

Circular solutions

Circular Materials throughout the value chain:

- Reduce, Reuse, Recycle
- Design sustainability into new products.

Social responsibility

Implement UNGP and OECD guidelines throughout our supply chain and cascade to the next level from the largest suppliers.

Figure 1. The Laerdal strategy for carbon neutrality.

A carbon footprint inventory is important, both to establish a starting point, but also identify important aspects in GHG mitigating strategies.

1.2. Growing concern about indirect emissions

Currently almost all emission inventories focus on direct emission from the studied organization, company, nation or industry of interest. In the last decade, however, there is a clear shift in trends to account for life cycle considerations of supply chain effects. These effects are often referred to as indirect effects. Using this perspective, more responsibility of emissions is pointed to the consumer of goods and services, and not only the traditional production-based perspective.

In the literature, however, we find early studies on indirect emissions, including work on input-output analysis and early process-based life cycle assessment (Leontief 1970b; Bullard, Clark et al. 1975; Bullard, Penner et al. 1978). These studies paved the ground for the later interest in indirect emissions and cause effect chains of energy demand. During the 1990's the concept further increased in popularity and the number of approaches and studies within the field exploded. One example is the concept of ecological footprint introduced in 1992 and may be considered as an early version of the carbon footprint.

International trade studies now demonstrate clearer and clearer the global nature of especially the climate issue, where it is shown how emissions embodied in international trade is significant, and that the existence of “pollution havens” may seriously affect initiatives on reducing emissions if these indirect effects are not accounted for. There are several international initiatives at the global scale, e.g. the work https://environmentalfootprints.org/.

For single products the life cycle perspective is included in so-called environmental product declarations of type III (ISO 2000) and other initiatives (British Standards 2008). The ISO standard builds upon the more general standards for life cycle assessment (ISO 2006a; ISO 2006b).

The last few years there has been an increasing focus on the same perspective for organizations and companies for instance the Greenhouse Gas Protocol (2009), which was used as background for the new standard for organizational carbon accounts ISO14064-1 (ISO 2006c). The GHG Protocol defined a framework of direct (scope 1) and indirect (scope 2: energy, scope 3: other goods and services) GHG emissions. However, scope 3 GHG emissions were termed as voluntary to report on.

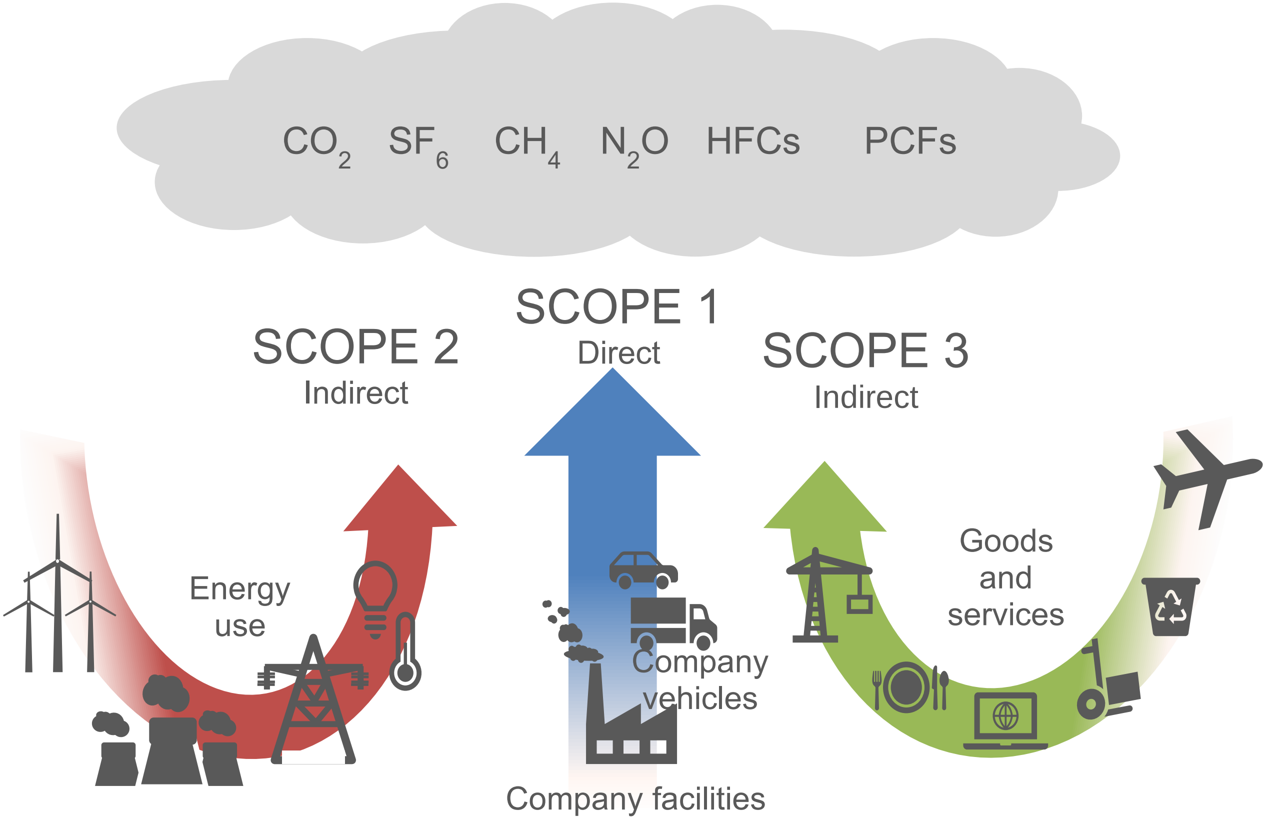


Figure 2. Schematic view of the three emission scopes regularly used in corporate carbon footprint accounts.

1.3. Introducing corporate carbon footprinting

Companies and organizations have developed GHG inventories for more than a decade. A vast majority of these focus on direct GHG emissions and energy use. This correspond to scope 1 and scope 2, respectively, in the framework first initiated by the Greenhouse Gas Protocol. A similar framework was also applied in the ISO 14064-01 development. In both guidelines, scope 3 GHG emissions classify as voluntarily to report on, and therefore often excluded. However, some companies - like Lærdal - aim to develop complete carbon footprints covering also scope 3 contributions.

There are two main strategies in including scope 3 emissions. One is to use physical data on selected products and activities (e.g. kg of materials or person-km travelled) to model contributions using life cycle assessment (LCA). Many companies are now applying this strategy in including e.g. air travels and waste generation as scope 3 contributions. The problem, however, is that this in most cases causes a significant (and unknown) portion of scope 3 not to be included. The other option is to use environmentally extended input-output (EEIO) modelling on the complete range of products and services purchased. Several studies show that even comprehensive LCA calculations often exclude significant parts of the upstream value chain emissions, as these emissions may be hidden far upstream in the supply chain.

In appendix 1 we illustrate the fraction of scope 3 emission for sectors in the Norwegian economy using the EEIO model Klimakost. It clearly illustrates the need for comprehensive scope 3 contributions in most sectors, in order to capture the complete carbon footprint. In the next chapter we illustrate in more detail the differences in LCA versus EEIO modelling, and the possible combination of both.

2. METHODOLOGY

2.1. Methodological frameworks for carbon footprint accounting

2.1.1. Life-cycle assessment

Life-cycle assessment (LCA) is the assessment of environmental impact throughout the lifecycle of product systems. The cornerstone to the life-cycle approach is the understanding that environmental impacts are not restricted to specific locations or single processes, but rather are consequences of the life-cycle design of products and services. The product life-cycle covers all processes from extraction of raw material, production, use, and final treatment or reuse (Baumann and Tillman 2004). The combination of a quantitative approach and a holistic perspective leads to trade-offs being clearly demonstrated in LCA results. It is a systems tool well suited for environmental decision making. Having been referred to by many names through its development (Baumann and Tillman 2004), LCA has, in the last four decades, evolved from the idea of cumulative resource requirements into a scientific field that includes emission inventory assessment methods (Heijungs and Suh 2002) and environmental cause-consequence modelling (Udo de Haes, Finnveden et al. 2002).

The standardized framework for LCA states four consecutive stages. The first stage of LCA consists of defining the aim and boundaries for the assessment, and the choice of methods for inventory and impact assessment. The goal and scope stage include defining the functional unit (FU). The functional unit is a quantitative measure of the functional requirement(s) that the product or service is designed to fulfil. It is the basis for comparison in LCA, used to evaluate the relative performance of alternative product systems. Life-cycle assessment may be applied for various purposes, such as product benchmarking, product declaration, process development and policy support. Study designs set important limitations on the applicability of the study to provide answers. An important issue in this respect is the functional unit. Other issues include the level of inventory completeness, temporal and spatial considerations, and impact and inventory assessment approaches.

The second stage consists of establishing an inventory that describes the environmental interventions that arise from the product system. Environmental interventions are inputs of resources from the environment to the product system (i.e., energy and material resources), and outputs to the environmental of adverse effect that the product system produces (i.e., emissions). The inventory is balanced to the functional unit.

Once the inventory of environmental interventions is established, the interventions are translated to environmental impact indicators in the third stage of LCA. The ultimate purpose of LCA is to provide indication of environmental impact potential. Quantitative scores are achieved by application of characterization factors that describe the relative potential of each intervention to adversely affect safeguard objects through defined impact mechanisms. An example is CO_2-equivalents which are used to aggregate the global warming potential of various emissions to air. Each substance is characterized by its potential relative to the global warming potential of CO_2.

The life-cycle impact assessment stage is divided into three consecutive steps. First, environmental interventions are separated according to their cause-and-effect chains, termed impact chains or impact categories in LCA. Interventions may be input-related; i.e., energy and material extracted from the environment, or they may be output-related; i.e., emissions made to the environment. Second, impact scores are aggregated for each impact category by multiplying inventory mass flows with their respective characterization factors and summarizing for each of the impact chains

The final stage of LCA is the interpretation of results. Vital in the interpretation stage is the consideration of uncertainty. Other aspects include the effect and validity of the selected impact assessment methods to fulfill the stated purpose of the study, and the potential bias introduced by inventory sources and approach. The re-visitation of methodological choices validates the outcome of LCA and increases the relevance of LCA for decision support.

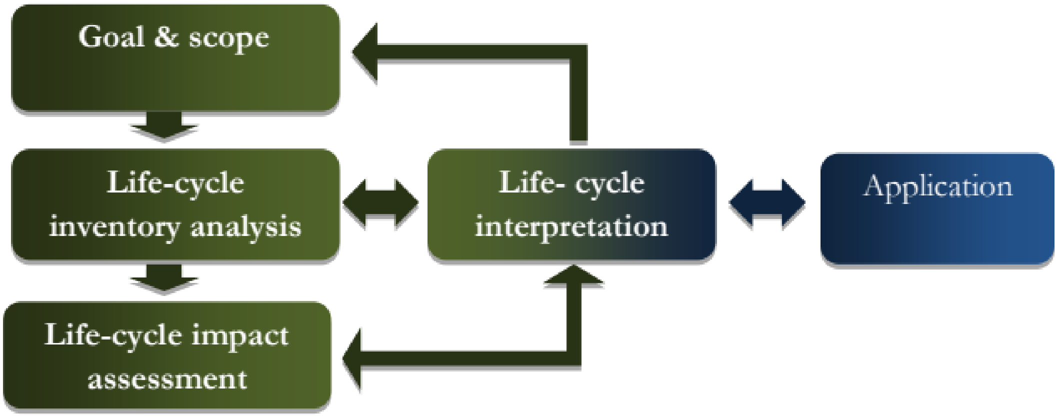


Figure 3. Outline of the stages and iterative approach of life cycle assessment (ISO (2006)).

2.1.2. Input-Output modelling

Input-output analysis (IOA) was initially developed by Leontief (1936) as a method to study the interrelations between the sectors in an economy. In the beginning of the seventies, he formulated a framework to extend the analysis with environmental information (Leontief 1970). The basis of this analysis is to use information contained in national economic statistics, in combination with data on emissions from the various sectors in the economy, to calculate all the direct and indirect emissions occurring from a final demand placed upon the system.

The economic consequences of spending 1 NOK on, for example, gasoline, may be calculated and traced through all the interconnected sectors of the economy in an infinite, yet converging, series of demands between the sectors. Once the economic outputs required to support the production of this 1 NOK purchase of gasoline have been calculated, the resulting vector of economic activity in each sector may then be multiplied with emissions intensities for each sector to give the total (life cycle) emissions occurring in the production of 1 NOK worth of gasoline.

The strength of these environmentally extended input-output (EEIO) models for analyzing carbon footprints are quite clear:

- As they capture the complete economy/economies and all the related emissions, the carbon footprints become 100% complete. They include the entire value chain of production, including also all service inputs.
- EEIO models apply a fixed set of sectors in the economy, each with an emission intensity. Using financial data on final demand / purchases effectively provides an estimate of the carbon footprint, without time consuming gathering of other physical data.

Recent developments are numerous: on multi-regionality (e.g. Hertwich and Peters 2009), hybridization (e.g. Stromman and Solli 2008), sub-national levels (e.g. Larsen and Hertwich 2009), and on corporate carbon footprinting (e.g. Larsen et al. 2012).

Despite having a clear set of strengths, EEIO models also come with some inherent weaknesses:

- Using sector averages quickly provides a good overview on the carbon footprint. For detailed assessment on the product level, more detailed life cycle assessments need to be applied.
- Pricing and currency uncertainties. Also, potential time lag between production and financial accounting.

Given the strengths and weaknesses of EEIO modelling, we find it to be the best way forward, given the motivation of Laerdal Medical. However, we suggest applying LCA-data on the most important product inputs in order to calculate important inputs in more detail.

2.1.3. Hybrid life-cycle assessment

While process-based LCAs require relatively specific types of data, it has been criticized for leaving out significant portions of the emissions that occur in the system (Lenzen 2001). This issue is referred to as cut-off and is particularly true for processes far upstream and service-based activities. On the other hand, input-output analysis is ideal for including emissions from all types of activities without any cut-offs, since it is based on an aggregated model of all existing sectors of the economy. However, it lacks the detail provided by LCA. Because of this, several authors describe the use of LCA and IOA in a hybrid approach, trying to utilize the benefits of both approaches, thereby retaining the completeness associated with input-output analysis, as well as the specificity offered by process based LCA. Various variants of these approaches are described by several authors (Treloar, Love et al. 2000; Suh and Lenzen 2004 ; Michelsen, Solli et al. 2008; Stromman and Solli 2008).

In Norway, the Klimakost model exemplify a hybrid LCA model focusing on complete scope 3 contribution using financial data as a core element in deriving carbon footprints. An additional strength of the hybrid approach is illustrated in Figure 4: Using financial data will help companies identify large contributions of interest as potential candidates for a more comprehensive LCA assessments.

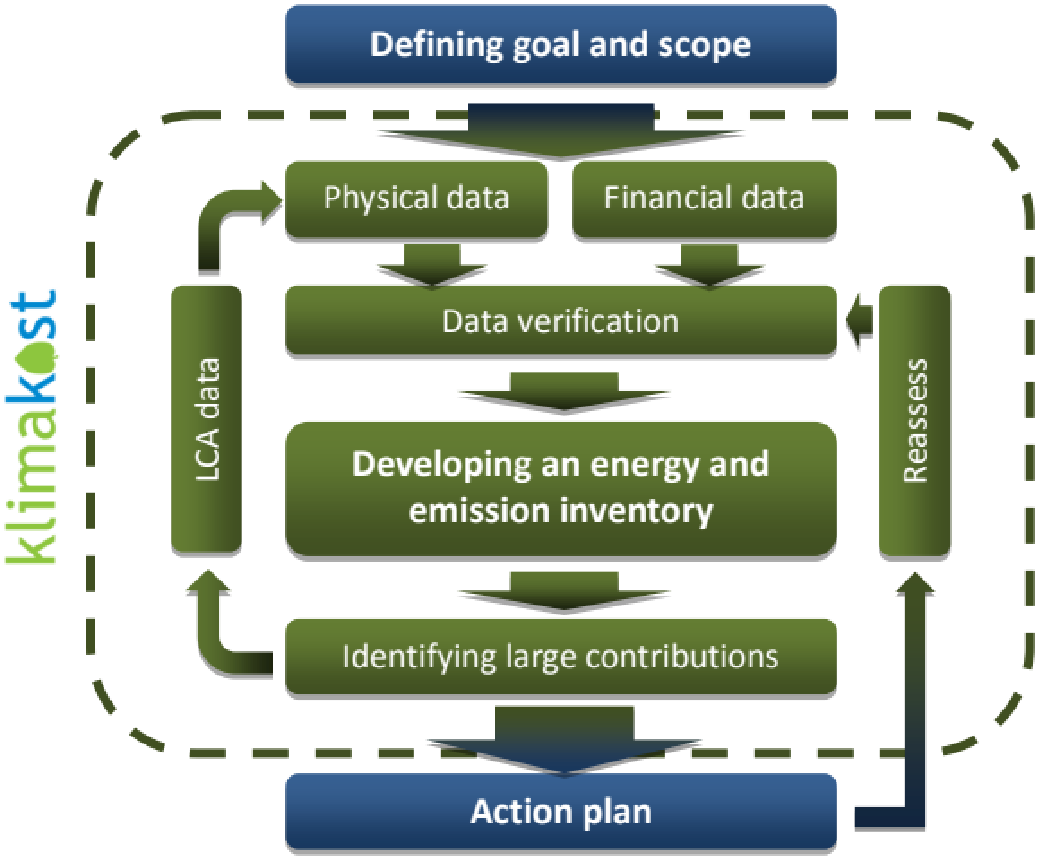


Figure 4. Schematic overview of the Klimakost hybrid-LCA model.

2.2. Data

In this section the datasets underlying the present carbon footprint assessment are presented.

2.2.1. EXIOBASE3

The development of the EXIOBASE framework and databases was the main goal of three multimillion-euro research projects funded by the European Commission, involving large international research consortiums. The projects EXIOPOL[1] (2007-2011), CREEA[2] (2011-2014), and DESIRE[3] (2012-2016) led to three increasingly detailed and advanced versions of EXIOBASE, all freely available at https://www.exiobase.eu/.

Version 3 of EXIOBASE, used in the present analysis, includes economic data for the global economy available as a time series spanning the years 1995-2015. The economy and the flows of traded goods and services within it is classified in a system of 200 products and 163 industries in 49 different geographical regions, including 44 individual countries and 5 aggregate "rest of"-regions for complete coverage of the global economy. Due to the EXIOBASE development projects and consortiums being European, the emphasis has been put on achieving high level of regional detail on Europe; hence the 44 individual countries explicitly modelled include 30 European countries. The environmental extensions include over 1000 emissions, material, and resource categories.

2.2.2. Laerdal economic data

The analysis of Laerdal Medical's carbon footprint is based on economic accounts for 2019. For the purpose of the analysis, the accounts were structured in three parts:

- Components – purchased raw materials / components as production inputs
- Finished products from external suppliers (ESFP) – purchases of finished products from external suppliers
- Operations – purchases related to the day-to-day operation of Laerdal's facilities

The components dataset consists of 357 purchases classified as 83 different types of purchased components through a three-tiered hierarchical classification scheme. In addition to the specific type of product, each purchase specifies the site country, supplier country, and the purchase sum in NOK.

The ESFP dataset includes 1,373 individual purchases, each classified as one of 13 unique product types. As with the components dataset, each purchase record is accompanied by information about the site country, the supplier country, as well as the total purchase sum in NOK.

Finally, the operations dataset comprises of 10,856 purchases or outlays. These outlays are classified using a six-digit account system standard to economic accounts. In total, 159 unique accounts had outlays associated with them. The accounts included in this dataset are the 6x/7x series, i.e. account codes starting with 6 or 7. These are the accounts relating to operational expenses. The only exception is the inclusion of account no. 470250 ("Freight and duty actual").

In summary, the combined datasets analyzed contains over 12,500 records organized as around 250 different types of products/services purchased.

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[1] https://cordis.europa.eu/project/id/37033 and http://www.feem-project.net/exiopol/

[2] https://cordis.europa.eu/project/id/265134 and http://www.creea.eu/

[3] https://cordis.europa.eu/project/id/308552 and https://www.exiobase.eu/

2.3. Analytical procedure

2.3.1. Matching product classification systems

A core part of the analysis consisted of matching the 250 types of purchases from Laerdal to the 200 sectors included in EXIOBASE. Since the two classification systems are rather different, the matching was not straightforward. Although the two schemes may appear on first glance to be comparable in terms of level of detail, the Laerdal data is in fact significantly more detailed, since it covers only the specific products/services relevant to Laerdal Medical, whereas the EXIOBASE classification is designed to cover the entire global economy. As such, some of the detail in the original dataset is lost in the analysis.

Following the products matching, the site and supply countries were matched to the regions in EXIOBASE. For the most part, the regional level of detail in EXIOBASE was high enough to cover the regional detail in the datasets from Laerdal. Countries that are not specifically modelled in EXIOBASE are instead included in five aggregate "rest of" regions; for instance, Malaysia is part of the "Rest of the World, Asia and the Pacific" aggregate region in EXIOBASE.

2.3.2. Harmonizing datasets

Following the matching of the Laerdal datasets to the EXIOBASE classification scheme, a further couple of steps were necessary to reconcile the two systems. First, whereas the most recent year for which an EXIOBASE database was available was 2015, whereas the Laerdal data and the carbon footprint assessment is based on 2019 numbers. A set of consumer price indexes by country and year was retrieved from the World Bank's statistical database and used to convert the Laerdal data to 2015 prices. The reliance of cross-sectoral average indexes introduces some uncertainty.

Second, EXIOBASE tallies interindustrial transactions valued in so-called basic prices, which exclude direct product taxes and allocates trade and transport margins to specific margin sectors of the economy. The Laerdal data was adjusted accordingly, relying on sector- and region-specific statistics on average tax and margin rates extracted from the macroeconomic statistical data underlying the EXIOBASE tables. For the purpose of this conversion, Laerdal Medical was assumed to belong to Division 29 in NACE[4] Rev. 1.1 (Manufacture of machinery and equipment not elsewhere classified).

Finally, while the Laerdal data is given in NOK, EXIOBASE transactional data is given in million EUR. The Laerdal data was therefore converted to euros using the 2015 average exchange rate of 9.85 NOK/EUR[5].

2.3.3. Estimating emission multipliers

The desired outcome of the exercise of harmonizing the Laerdal accounting datasets to the EXIOBASE database is a set of so-called emission multipliers, sometimes referred to as emission intensities, one for each specific type of purchase classified in the Laerdal data (a combination of a product and a region of supply). A multiplier consists of the final analysis estimate of the total CO_2e emissions, both direct and indirect through the supply chain, arising from the final purchase of the specific product from the specified region, expressed in kg CO_2e/NOK. After arriving at a final set of estimated multipliers, the carbon footprint of each purchase is simply evaluated as the product of the purchase (in NOK) and the multiplier.

To estimate the multipliers, a Matlab script was prepared, taking the following main steps:

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[4] The *Statistical Classification of Economic Activities in the European Community* (NACE) is the industry standard classification system used by the European Union. The sector classification used in EXIOBASE is built on NACE Rev. 1.1.

[5] https://www.norges-bank.no/tema/Statistikk/Valutakurser/?tab=currency&id=EUR (yearly average, 2015)

1. Load EXIOBASE3, Laerdal data, and previously established conversion matrices between the two classification systems
2. Apply the conversion matrices to translate the Laerdal purchases data to final demand matrices in MRIO/EXIOBASE format
3. Adjust the purchase data according to year, valuation, currency
4. Calculate carbon footprint using the EXIOBASE database with EE-MRIOA methodology
5. Calculate multiplier per product as the calculated carbon footprint divided by the purchased amount

More detailed breakdowns of the footprint and its drivers were obtained through advanced contribution analyses following standard EE-MRIOA principles.

3. RESULTS

The combined carbon footprint of Laerdal was estimated to be 69 kt CO_2e (Table 1). This footprint represents the overall emissions either directly emitted from Laerdal's offices and production sites or embodied in the products purchased by Laerdal through emissions incurred in the supply chain of those products. *Products* here refer to all purchases made by Laerdal, including both raw materials and finished products for processing and/or resale, energy, consumables, services, and so forth.

The analysis of Laerdal Medical's carbon footprint is based on economic accounts. For the purpose of the analysis, the accounts were structured in three parts:

- Components – purchased raw materials / components as production inputs
- Finished products from external suppliers (ESFP) – purchases of finished products from external suppliers
- Operations – purchases related to the day-to-day operation of Laerdal's offices and facilities

Table 1. Laerdal's overall carbon footprint, 2019

	CARBON FOOTPRINT (T CO2E)	
COMPONENTS	24 769	36 %
ESFP	8 434	12 %
OPERATIONS	35 989	52 %
LAERDAL OVERALL	**69 192**	**100 %**

Overall, the operational activities of Laerdal contributed 52 % of the carbon footprint, while emissions embodied in purchased components and finished products represented 36 % and 12 %, respectively. Although this roughly aligns with the magnitude of each account in economic terms, the components purchases were deemed on average to be more carbon intensive in terms of emissions per NOK purchased than the ESFP purchases and operational activities.

The activities of Laerdal's sites and offices in the United States, China, and Norway represented the bulk of the overall carbon footprint – 54 kt CO_2e combined (Figure 5, left). When instead assessing the geographical location of the actual emissions embodied in the footprint, the analysis showed the same three regions at the top of the list, although Norway's contribution was significantly smaller (Figure 5, right). In general, the latter perspective shows emissions allocated more spread out across regions, as indicated by the size of the "Other" columns in the two charts. This underlines the globalized nature of industrial supply chains of today. Notably, several of the regions with the highest emissions were regions with no direct Laerdal activities, such as Russia and "Rest of Middle East".

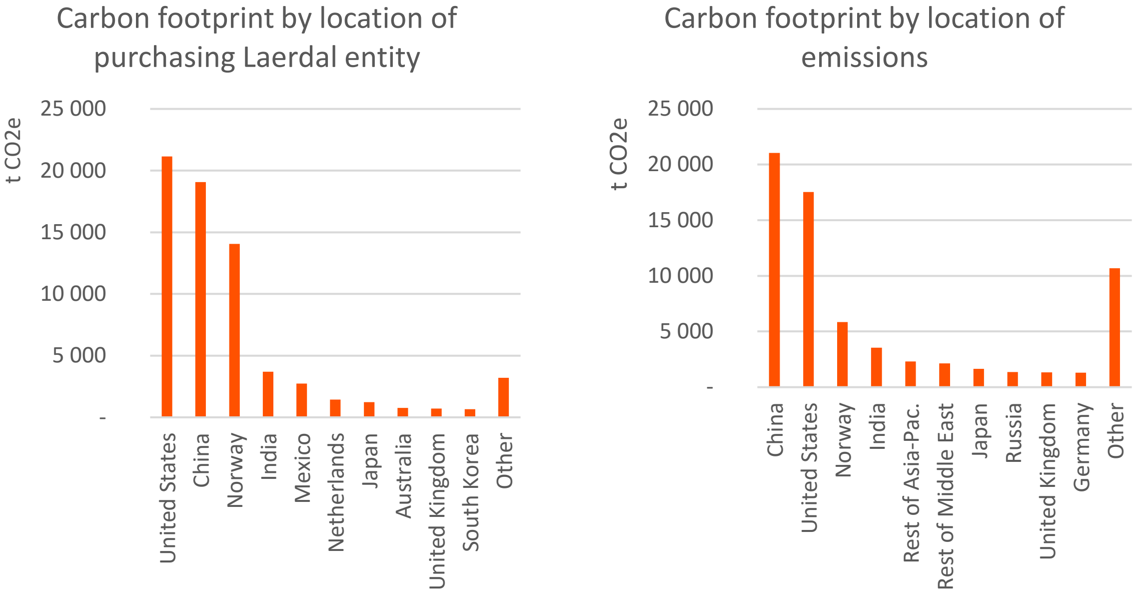

Figure 5. Laerdal's carbon footprint broken down regionally, by where consumption took place (left) and where emissions occurred (right).

In the following, the carbon footprint associated with each of the three datasets is presented and broken down in more detail.

3.1. Components

The purchases of components and raw materials by Laerdal facilities in Norway, the United States, China, and Mexico, carried a total of 25 kt CO_2e of embodied emissions. The largest footprint was associated with purchases made by the sites in China, as shown in Figure 6.

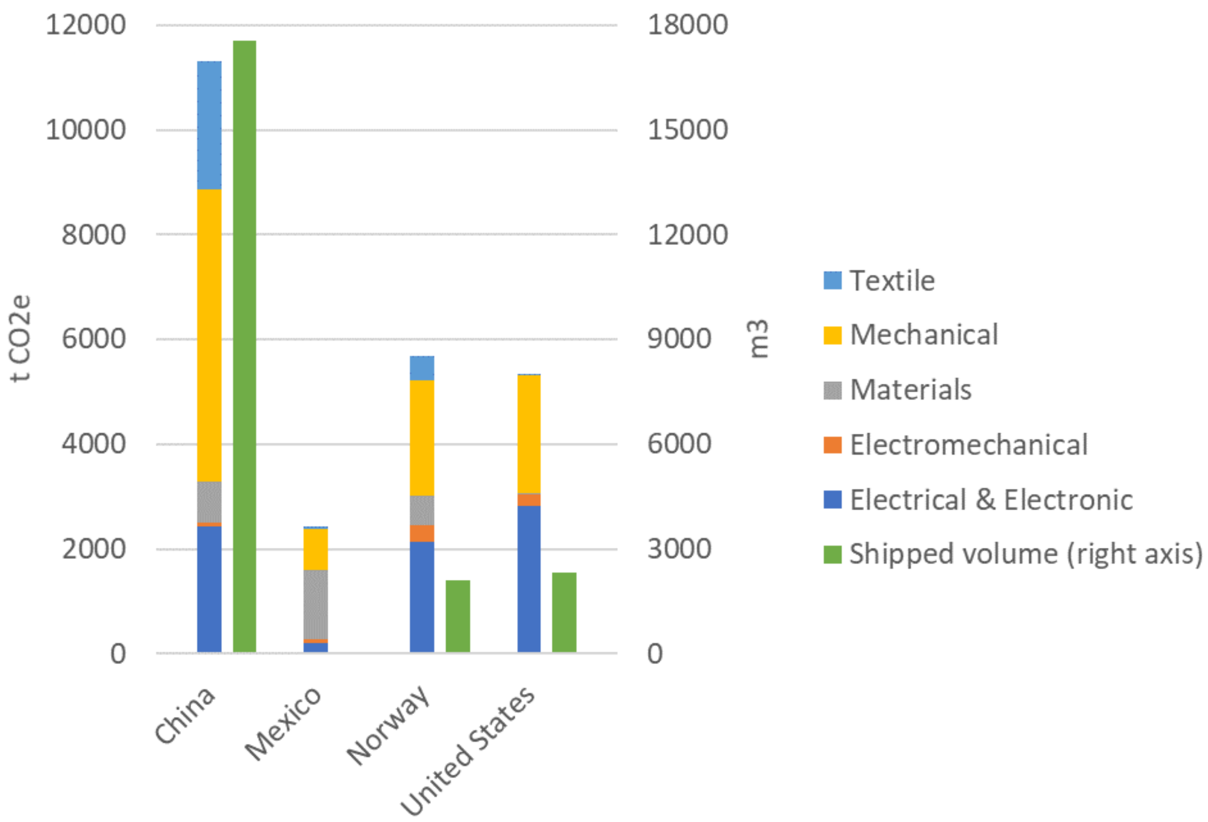

Figure 6. The carbon footprint of purchased components, by location of Laerdal site and main category of components purchased. The total volume shipped from each site is shown as a second, green column for comparison, with values in (m3) referring to the right axis.

At the most aggregate level, the components dataset was classified in five main categories: Electrical & electronic, electromechanical, materials, mechanicals, and textile. Purchases of components in the mechanical and electrical & electronic categories carried the highest total footprint, at 44% and 31% of the total, respectively. This pattern was distinctly different for the site in Mexico, where purchases in the materials category dominated with 54% of the total footprint. Textile purchases had mostly small footprints, apart from in China where textile purchases contributed 22% to the total footprint.

In Figure 7, the footprint of the top-level categories is expanded to higher levels of product detail. This reveals that the "mechanical" category, with the overall highest footprint, is dominated by single item purchases, which in turn for a large part consists of emissions associated with purchases of anatomical parts as well as machine or structural parts. The most important product types when it comes to emissions from purchases in the "electrical & electronic" category were products classed as PCBA, IT, and cables.

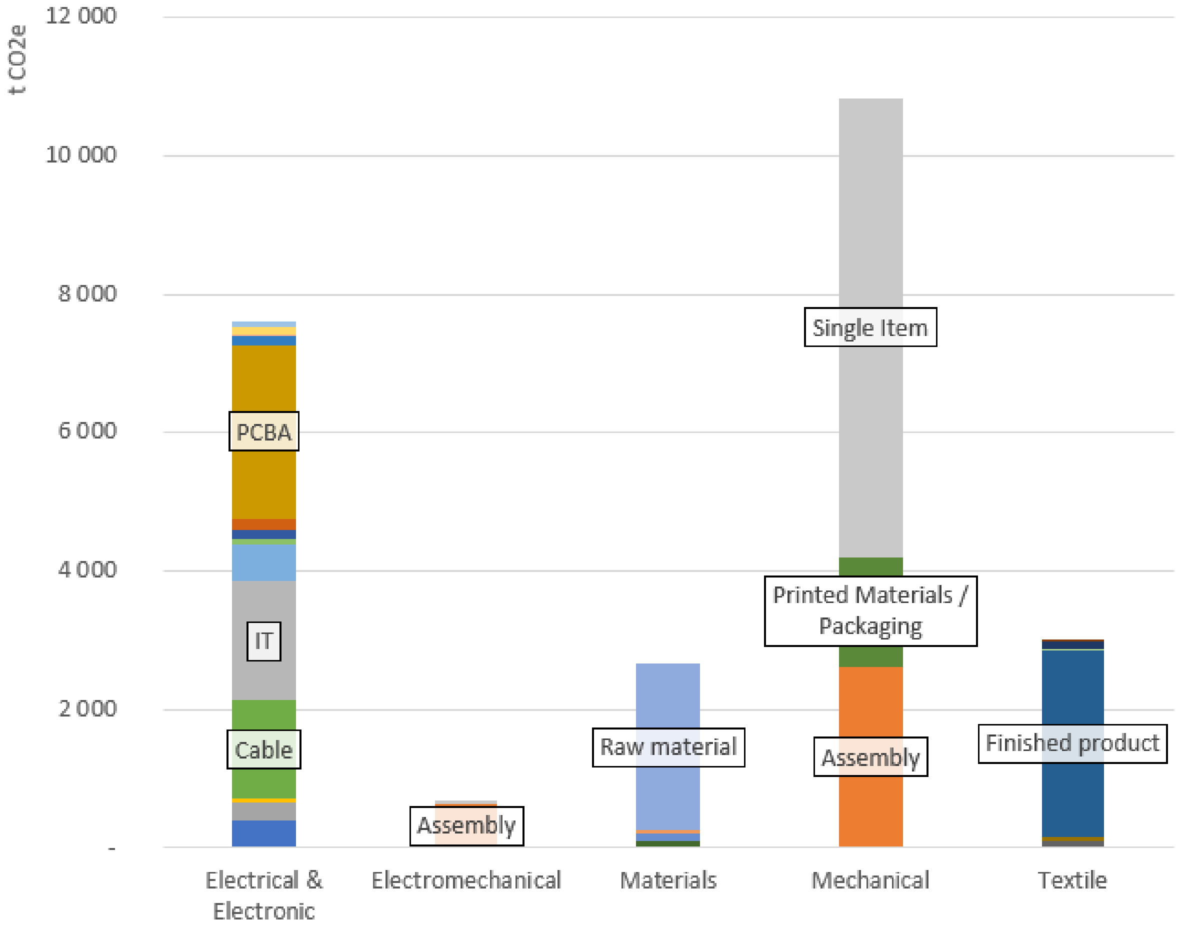

Figure 7. Carbon footprint of purchased components. The five main categories and the contribution of product groups within each. The largest product contributions are specifically labelled.

The purchase of textile products carried a combined footprint of 3.0 kt CO_2e, most of which where emissions embodied in various finished products – especially bags, suitcases, and jackets.

3.2. Finished products from external suppliers

The finished products purchased from external suppliers were estimated to carry a combined carbon footprint of 8.4 kt CO_2e. These purchases were made by sites in 13 different countries across the world (Figure 8). By far the highest footprint from ESFP purchases was associated with Laerdal sites in the United States (3.6 kt CO_2e), with sites in the Netherlands, Norway, and China also carrying significant, but smaller footprints.

The ESFP purchases dataset categorized purchases in four classes at the most aggregated level: Electrical & electronic, electromechanical, mechanical, and services – the latter of which making only a negligible contribution. Purchases in the electromechanical category contributed the most (50%) to the overall footprint, whereas electromechanical and electrical & electronic products contributed 39% and 11%, respectively.

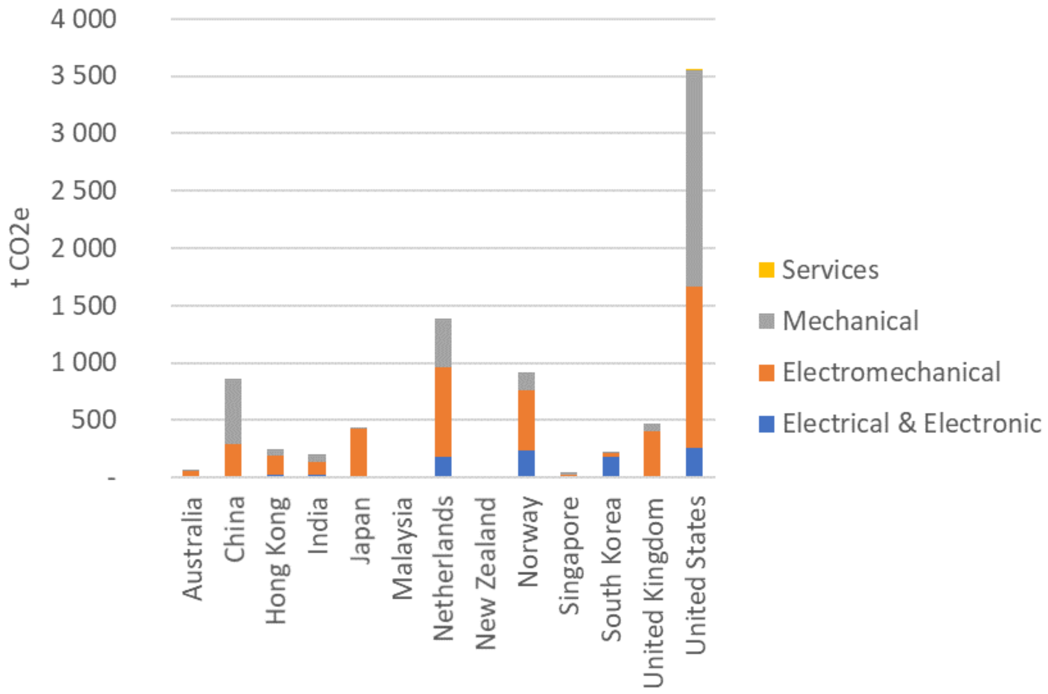

Figure 8. Carbon footprint of purchased finished products, by Laerdal site country and by main product category.

3.3. Operations

The overall operational activities of Laerdal Medical, such as operation of the various facilities, travel activities, and consumption of computers and other equipment, was estimated to have a total carbon footprint of 36 kt CO_2e, or just over half the total carbon footprint estimated for Laerdal as a whole in this assessment. The operational purchases dataset is the most extensive and detailed of the three, listing well over ten thousand purchases made by 32 different Laerdal entities worldwide. Of those entities, the highest operations carbon footprints were sustained by Laerdal Medical Corporation (United States) at 10 kt CO_2e, and Laerdal Medical A/S (Norway) at 7.2 kt CO_2e. Other significant contributions were associated with Laerdal sites in China (Suzhou and Hangzhou), India, and Japan.

In Laerdal's economic accounts, which form the basis for the present analysis, the operational activities are classified as a range of specific, six-digit accounts in the 6- and 7-series (that is, accounts starting with 6 or 7). Figure 9 shows the carbon footprint of Laerdal's operations broken down both by Laerdal entities grouped by regions, and by category of operational expenses. For the sake of displaying these results, the accounts in the 6- and 7-series were aggregated to a set of groups of operation expenses, with Figure 9 explicitly showing the contributions of the 8 groups with the highest combined carbon footprint contributions. This grouping shows that the operational carbon footprint of the various Laerdal entities generally consists of a combination of many smaller contributions. Some groups stand out for some of the Laerdal entities, such as "Travel" for entities in the Americas. The Travel group is, together with the group "Inbound freight and duty", the group with the highest footprint for Laerdal overall. The latter contributes especially to the footprint of entities in the Asia Pacific region.

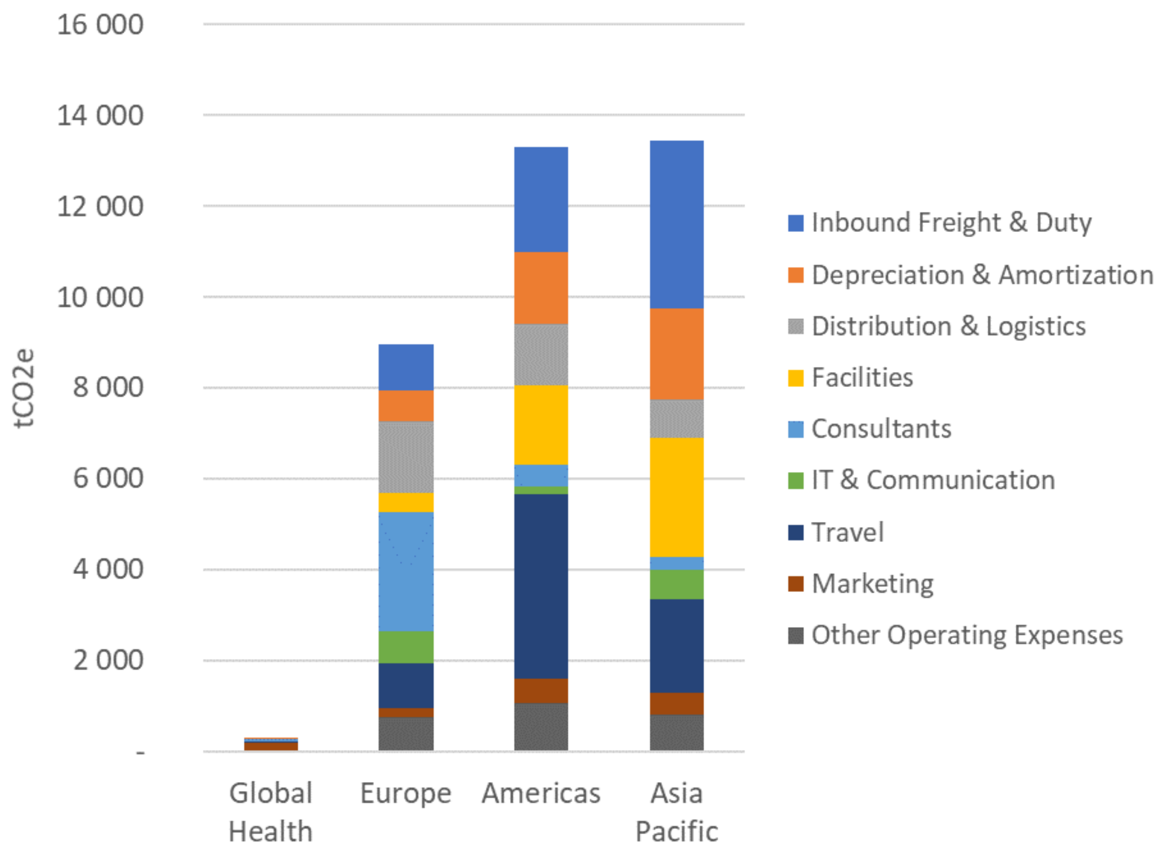

Figure 9. Operations carbon footprint of Laerdal, by Laerdal entity grouped by regions, and the contribution of various operating expenses.

Entities in Asia Pacific also have relatively high contributions in the “Facilities” group. These are expenses related to operation of the sites themselves, including items such as waste management, janitorial and cleaning services, facility maintenance, and – most importantly – direct energy consumption.

As suggested in the previous, logistics and travel activities are important contributors towards the overall operational carbon footprint of Laerdal, representing 11 and 8 kt CO_2e, respectively – just over half the total operation CF. The remaining 17 kt CO_2e associated with Laerdal operations comes from purchases such as energy and maintenance of the sites and offices, consultant services, computers and other hardware and office equipment. Travel-related emissions are especially important for entities in the Americas, as shown in Figure 10.

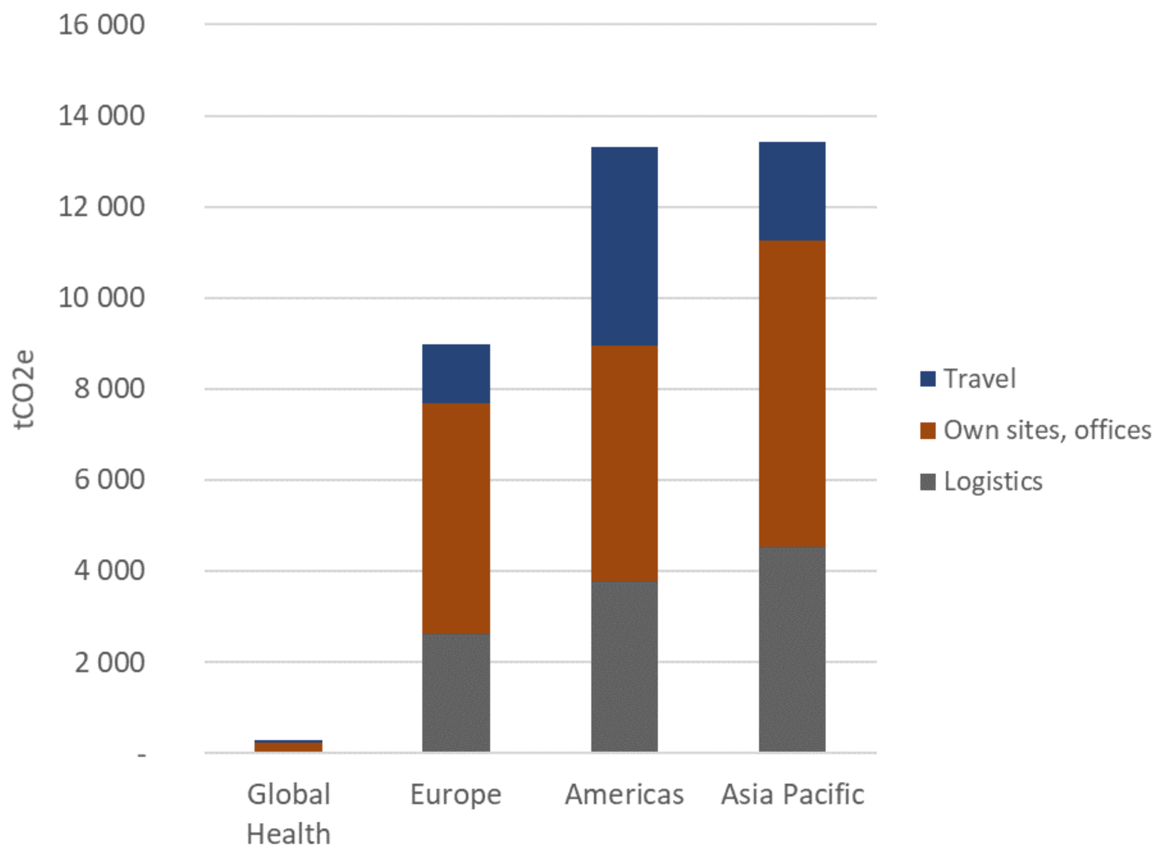

Figure 10. Operations carbon footprint by Laerdal entity, with expenses grouped to highlight travel and logistics activities specifically.

4. DISCUSSIONS

4.1. Way forward for Laerdal

This analysis of Laerdal's carbon footprint has indicated some key areas to focus on to reduce emissions. Firstly, as is the case for many companies with a high degree of international activities, a low-hanging fruit may be to address travel-related emissions. At the time of writing this report, a large share of the workforce across the economy is being forced to learn to work and collaborate efficiently remotely. There is significant potential here for businesses to learn which types of travel are in fact essential and which can just as well be replaced by virtual collaboration.

Furthermore, for a manufacturing company such as Laerdal, transport related emissions are important not just in terms of business travel, but of shipping and logistics. The analysis pointed to significant emissions related to logistical activities, suggesting these as another focus area for emission reduction strategies.

Emissions embodied in materials and components required in the manufacturing process represent a third major contribution to the total footprint, suggesting the need to continue efforts in reducing material demands, and pursuing options for using recycled feedstock or alternative materials that are less emission intensive.

Onsite energy consumption represents a fourth significant source of embodied emissions. The analysis showed that electricity consumption dominated these emissions. To further reduce these emissions, an impactful strategy could be to continue work to establish onsite renewable electricity generation. As the emissions associated with electricity consumption is highly variable depending of the location of the site, these actions are especially important to consider in countries with a generally emission intensive electricity mix, such as China.

4.2. Final remarks

The use of EE-MRIOA to analyze the carbon footprint of a company, including both its own operations and the emissions embodied in its purchases of raw materials, components and finished products for processing and redistribution, is still a somewhat immature discipline. The various steps necessary to reconcile Laerdal's economic accounts with the EXIOBASE format all carry a certain degree of uncertainty. On the other hand, company-wide carbon footprint assessments are associated with significant uncertainty no matter which procedure is taken for the analysis. EE-MRIOA-based assessments with comprehensive databases such as EXIOBASE, which models the global economy as consisting of several thousand unique industries and products, comes with several important advantages. Through its mathematical framework based on a matrix structure, supply chains can be traced to their full extent, allowing an infinite number of tiers. As more experience and confidence is gained in the process of harmonizing business accounts to the MRIO structure, EE-MRIOA can provide a truly powerful tool for businesses to understand their carbon footprint. We believe the present analysis of Laerdal's carbon footprint is an important, pioneering step to this end.

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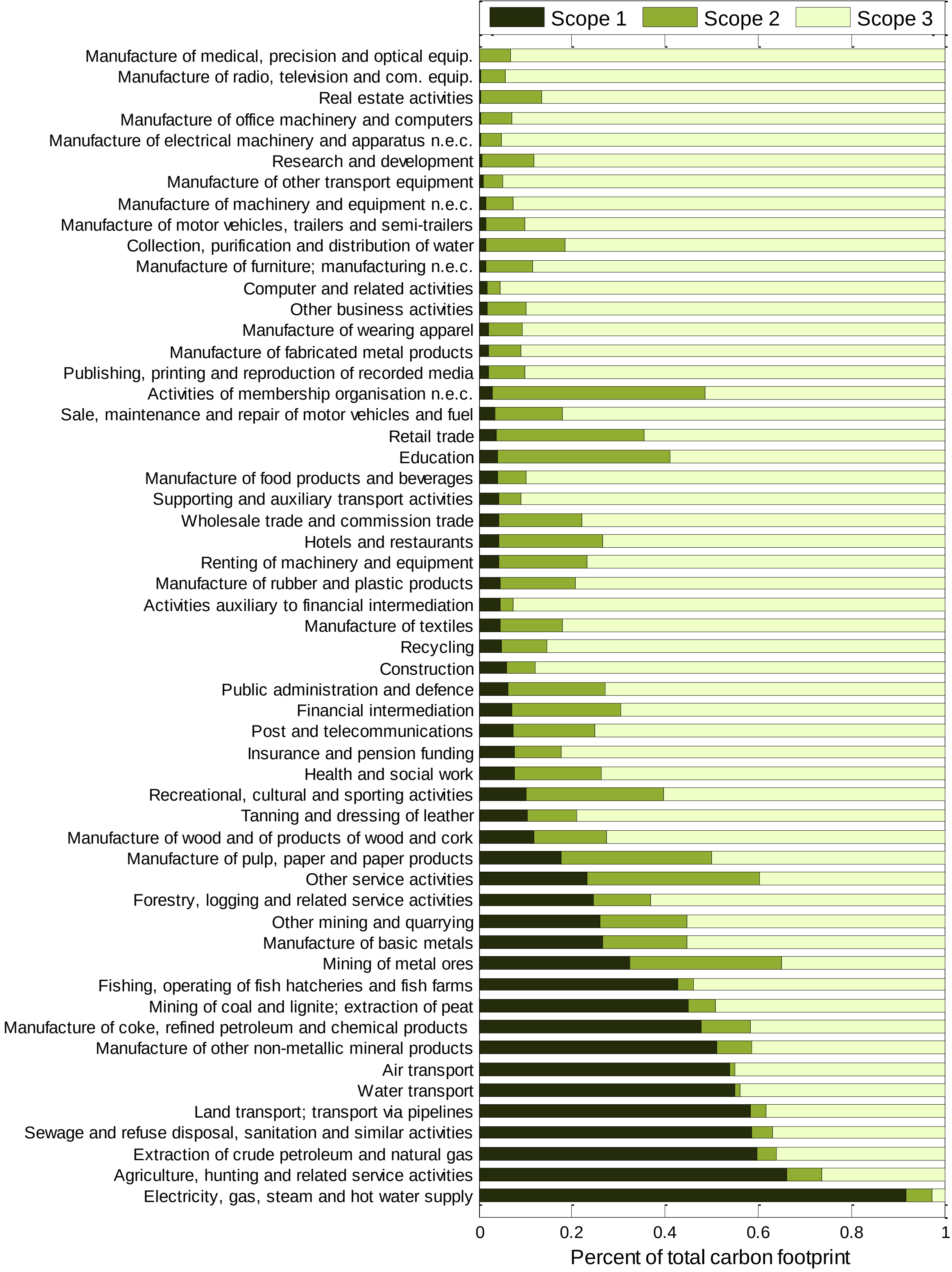
5. APPENDIX 1


Scope 1
Scope 2
Scope 3
Manufacture of medical, precision and optical equip.
Manufacture of radio, television and com. equip.
Real estate activities
Manufacture of office machinery and computers
Manufacture of electrical machinery and apparatus n.e.c.
Research and development
Manufacture of other transport equipment
Manufacture of machinery and equipment n.e.c.
Manufacture of motor vehicles, trailers and semi-trailers
Collection, purification and distribution of water
Manufacture of furniture; manufacturing n.e.c.
Computer and related activities
Other business activities
Manufacture of wearing apparel
Manufacture of fabricated metal products
Publishing, printing and reproduction of recorded media
Activities of membership organisation n.e.c.
Sale, maintenance and repair of motor vehicles and fuel
Retail trade
Education
Manufacture of food products and beverages
Supporting and auxiliary transport activities
Wholesale trade and commission trade
Hotels and restaurants
Renting of machinery and equipment
Manufacture of rubber and plastic products
Activities auxiliary to financial intermediation
Manufacture of textiles
Recycling
Construction
Public administration and defence
Financial intermediation
Post and telecommunications
Insurance and pension funding
Health and social work
Recreational, cultural and sporting activities
Tanning and dressing of leather
Manufacture of wood and of products of wood and cork
Manufacture of pulp, paper and paper products
Other service activities
Forestry, logging and related service activities
Other mining and quarrying
Manufacture of basic metals
Mining of metal ores
Fishing, operating of fish hatcheries and fish farms
Mining of coal and lignite; extraction of peat
Manufacture of coke, refined petroleum and chemical products
Manufacture of other non-metallic mineral products
Air transport
Water transport
Land transport; transport via pipelines
Sewage and refuse disposal, sanitation and similar activities
Extraction of crude petroleum and natural gas
Agriculture, hunting and related service activities
Electricity, gas, steam and hot water supply
0
0.2
0.4
0.6
0.8
1
Percent of total carbon footprint