

# Note on the implementation of emission multipliers from EXIOBASE in Laerdal's emission accounting tool

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## 1. Environmentally extended input-output analysis

Whereas traditional emission accounting involved quantifying and addressing only those emissions emanating directly from one's own facilities, several countries, companies and organizations are now looking to widen the scope to also include *indirect* emissions. These include all the emissions occurring upstream in the supply chain in the process of producing, transforming, and transporting all the products we consume.

However, since most consumed products today have extensive and complex process chains, often involving activities and components from many different parts of the world, analyzing a product to enumerate all the emissions *embodied* in it by the time it reaches the point of final consumption, can be a very challenging and labor-intensive task.

To allow simultaneous such analyses for a wide range of different products, necessary for calculating the combined indirect emissions associated with a company's total purchases over a certain year, environmentally extended input-output analysis (EE-IOA) is the preferred methodological framework. These rely on corresponding input-output models, which model a given country's entire economy. To allow further analyses including international trade links, multiregional input-output (MRIO) models, preferably with global coverage, are very useful.

Input-output tables are routinely produced for most countries' economies by national statistics agencies on an annual basis. Statistics Norway (SSB) also creates such tables annually for Norway, with sector classifications in accord with the EU standard (SSB, 2020).

## 2. EXIOBASE

Due to the highly time-, data- and labor-intensive process of creating a global MRIO model, it is only over the past decade or two that these have become commonplace. Still, however, there are only a handful such models available, all with certain drawbacks and shortcomings. One such shortcoming applicable to all MRIO models is that to allow a model of an entire economy, individual firms and businesses must be grouped into a predefined set of aggregate sectors such that much detail is lost.

The MRIO model chosen for Laerdal's carbon footprint accounting scheme, EXIOBASE<sup>1</sup>, was constructed and further developed under a series of EU-funded research projects by a consortium of European universities and research institutions. It was designed specifically with carbon footprint analyses in mind, emphasizing detail on sectors especially relevant for such analyses.

The third and latest version of EXIOBASE models the global economy as 49 individual countries and aggregate regions with a regional focus on Europe and its main trading partners (Stadler, et al., 2021). Each region's economy is modeled as a set of 163 economic sectors and 200 different product categories.

## 3. On assigning CO<sub>2</sub> multipliers to accounts in the financial report

When using input-output analysis as the methodological basis for calculating corporate carbon footprints, the basic principle is to use the company's financial statements to quantify every purchase made and estimate the associated emissions from those purchases by assigning each purchase an estimated average emission multiplier expressed in kgCO<sub>2</sub>e/EUR or similar.

For the analyst calculating the carbon footprint then, a central task becomes to go through each individual account in the company's statement of operations to determine whether the account should be assigned a CO<sub>2</sub>e multiplier value at all, and if so, what multiplier value to choose.

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<sup>1</sup> [www.exiobase.eu](http://www.exiobase.eu)

The former question - whether an account should be assigned a multiplier value at all - can sometimes be a bit challenging to answer. Fundamentally in carbon footprinting, a guiding principle is that the purchase of any product<sup>2</sup> is associated with some level of emissions, no matter for instance how immaterial some services may appear. As an example, consider that we schedule a short phone meeting with a law firm to get some legal advice on a particular matter. In a carbon footprint account, this would be considered a purchase of legal services and would be assigned a certain amount of emissions. The rationale is that the law firm's various operations in turn lead to various emissions, although they are mostly occurring upstream of their operations: The firm would need offices to be built and maintained, energy to power and heat or cool those offices, computers and office machinery for their employees, air travels for their employees to attend courses, etc. All those emissions are required for the law firm to be able to deliver their output, which is legal advice to their clients.

Nevertheless, in a company's statement of operations there are typically several accounts that should not be assigned multiplier values. Some types of accounts generally excluded include:

- Accounts that are purely financial constructs with no real-world counterpart
- Internal purchases. Consider a company that consists of entity A and entity B, and that entity A makes a purchase from entity B. The emissions embodied in the product or service would already be accounted for when entity B made the purchase externally. If entity B only made a purchase of intermediate goods that were then processed into something else before resale to entity A, any emissions arising from this process would already be accounted for under the company's scope 1- or 2-emissions. Thus, including internal purchases would lead to internal double-counting of emissions.
- Salary expenses. We consider that the emissions associated with having employees are already accounted for with the overhead costs per employee. They include desks, chairs, computers, a workspace, etc. Salary goes to fund the employee's time outside of work, and the associated emissions are considered outside the scope.
- Income accounts. Under, e.g. the Greenhouse gas protocol, companies have the option to include downstream scope 3 emissions, i.e. emissions associated with the

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<sup>2</sup> We define *products* to be either goods or services.

distribution and use of their products. However, it is generally not standard practice to do so, and we have thus far not opted to include these emissions here.

In summary, an emission multiplier should generally be assigned whenever the account represents an external purchase of a good or service. Typically, the exercise of determining which accounts to include involves some common sense and subjective judgment, and is best performed by those with intimate knowledge about what is actually behind each account code/name in the financial reports.

## 4. Modifications for Laerdal accounts

To implement EXIOBASE results into Laerdal's carbon footprint accounting scheme, precalculated carbon footprint *multipliers* were downloaded directly from the EXIOBASE online repository<sup>3</sup>. In carbon footprint terminology, multipliers are footprint intensities, or estimates of the total embodied emissions per Euro's worth of a given product. These multipliers are expressed in kg of CO<sub>2</sub>-equivalents per Euro (or other monetary unit), and can be directly multiplied by a purchased amount to estimate total embodied emissions. The multipliers used here have been calculated using the full EXIOBASE model and includes all upstream contributions from all sectors and regions of the model.

With multipliers precalculated and included in the published EXIOBASE data package, the main step necessary involves matching Laerdal's purchase accounts and locations to EXIOBASE's product and region classification. The EXIOBASE classification system is based on the NACE classification<sup>4</sup>.

One further necessary adjustment of significance to the multipliers is a change of *valuation*. Transactions in IO models are usually valued in what is known as *basic prices*, which exclude direct product taxes as well as trade and transport margins. Since this is different from the prices actually paid by the final consumer, the carbon footprint multipliers had to be adjusted. To this end, we used valuation data to calculate average tax and margin ratios per sector and region, which were then used to adjust multipliers. We

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<sup>3</sup> <https://zenodo.org/record/4588235>

<sup>4</sup>

[https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=DSP\\_GEN\\_DESC\\_VIEW\\_NOHDR&StrNom=NACE\\_REV2&StrLanguageCode=EN](https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=DSP_GEN_DESC_VIEW_NOHDR&StrNom=NACE_REV2&StrLanguageCode=EN)

implemented a harmonization steps in which aberrant values were identified and replaced with global median values.

## References

SSB. (2020). Retrieved from Supply and Use and Input-Output tables:

<https://www.ssb.no/en/nasjonalregnskap-og-konjunkturer/tables/supply-and-use-and-input-output>

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