# Experimental consumption-based environmental pressures for Sweden using FIGARO

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# Summary

There is growing international interest in statistics on consumption-based greenhouse gas emissions. Harmonized global multiregional input-output (MRIO) datasets can make a key contribution to high-quality national data in this area. However, no such harmonized data currently exist.

Currently, Statistics Sweden uses data from the environmentally extended MRIO database EXIOBASE for producing statistics on greenhouse gas emissions from consumption. However, the data landscape within the field is constantly evolving. The FIGARO global MRIO dataset produced by Eurostat represents a notable development within the field.

There exist to date few examples of FIGARO's application for producing statistics on greenhouse gas emissions from consumption. This report fills this gap by applying the FIGARO MRIO data in the model Statistics Sweden uses to produce Sweden's official statistics on greenhouse gas emissions from consumption.

The objectives of the report are the following:

- Compare and analyse the data and methods used to compile FIGARO tables with EXIOBASE and other databases.
- Develop relevant environmental extensions to be applied to FIGARO tables for environmentally extended input-output analysis.
- Develop a new version of Statistics Sweden's environmentally extended input-output model using the FIGARO tables as input data.
- Use the version of Statistics Sweden's environmentally extended input-output model to produce experimental time series for Sweden's consumption-based environmental pressures.
- Evaluate and analyse the experimental time series developed above in light of the results for the current model.

When it comes to the quality of FIGARO and EXIOBASE, both databases have strengths and weaknesses. EXIOBASE has the advantages of presenting data at a higher level of detail (163 industries and 49 countries) compared to FIGARO (64 industries and 46 countries). Furthermore, EXIOBASE presents vectors for 1113 stressors, including all greenhouse gases, while FIGARO currently only presents a $CO_2$ vector. Instead, FIGARO has the advantage of using real supply, use and

IO tables up to 2020 (in the 2023 edition) for updating the MRIO tables while the last year for real data for intermediate use matrices in EXIOBASE is 2011. Furthermore, FIGARO is updated on an annual basis with secure financing from Eurostat while the updates of the EXIOBASE tables are more irregular and needs to secure new financing for each update.

Using the FIGARO tables to produce national statistics on greenhouse gas emissions from consumption has come with some challenges:

- As FIGARO tables only comes with a $CO_2$ vector, environmental vectors from EXIOBASE have been used for other environmental pressures together with FIGARO economic IO tables. As the product/industry classification and the geographical coverage differs between the databases, several different aggregation and disaggregation matrices have been developed to match the data.
- Statistics Sweden's internal national accounting data are classified according to 91 product groups. Therefore, FIGARO data was disaggregated to match the Swedish national statistics.

The preliminary results indicate that FIGARO has the potential to be included as a statistical tool in the future production of national statistics on environmental pressures from Swedish consumption. In general, the analysis shows that $CO_2$ emissions are in average 8.5 percent higher when using the FIGARO MRIO tables, even though the difference at a more disaggregated level is more pronounced. Before Statistics Sweden fully adopt the FIGARO MRIO framework into the regular production system, more analysis is needed to understand the effects of the disaggregation and aggregation issues. Further analysis is also needed to understand the consequences of integrating the full FIGARO environmental data when more environmental vectors are available.

# Introduction

Since 2019 Statistics Sweden has been publishing official statistics on consumption based environmental pressures for Sweden. The statistics are published yearly every autumn with a two-year time lag. The statistics are produced using a method developed in the research project PRINCE – Policy Relevant Indicators for National Consumption and Environment that ran from 2015 to 2018. This method is based on environmentally extended input-output (EEIO) analysis (for details on the methodology, see for example (Brown et al., 2021, 2022; Palm et al., 2019)). A key strength of the method is that it makes it possible in a manageable framework to include real data about economic exchanges and environmental pressures across the globe (rather than relying on simplifying assumptions) that contribute to the environmental pressures embodied in the products that the Swedish economy imports.

To calculate the environmental pressures due to Swedish consumption (from imports as well as domestic production) an environmentally extended multi regional input-output (EE MRIO) model is applied. Here, trade data and input-output (IO) tables for Sweden produced in-house at Statistics Sweden are combined with data from the EE MRIO database EXIOBASE.

The data landscape in the field is constantly evolving. A recent significant development is Eurostat's publication and yearly updates of the FIGARO tables. The FIGARO tables provide amongst other things a time series of multi-regional input-output (MRIO) tables with global coverage and disaggregated for EU member states and major EU trading partners. Considering these factors, the objective of this report is to evaluate the potential for the FIGARO tables to be used as input data to produce country-level statistics on environmental pressures from consumption.

In Sweden the IO methods currently used to produce official statistics on consumption-based environmental pressures may increase greatly in policy significance if the suggestion to supplement territorial goals for greenhouse gas emissions with consumption-based goals becomes law. However, there is a notable need for increased harmonization in input data and methods in the use of IO methods for statistics production. Methodological and data selection for pressures arising due to imported products is a particularly significant issue here. The FIGARO tables represent a notable step forward in this area because they have been compiled and published by Eurostat from high quality data sources, and Eurostat has expressed an institutional commitment to update the time series regularly with high quality data and methods.

However there exists to date a lack of case studies by potential users demonstrating and evaluating the potential of FIGARO. It is this specific need that the identified general objective of this report speaks to. The objective addresses the challenge of developing and assess new data sources that are overall better suited to the needs of statistics production for consumption-based measures and therefore potentially bringing forward the harmonization of data and methods between organisations. More specifically, this report aims to:

- Assess and evaluate from an overall perspective of statistical quality the input data and production methods of FIGARO and EXIOBASE.
- Evaluate data sources and develop a method to produce environmental pressures vectors that can be used together with FIGARO as input for environmentally extended input output analysis.
- Implement FIGARO for the calculation of an experimental time series for Sweden's consumption-based environmental pressures.
- Assess and evaluate the experimental time series developed.

The outcomes of the above objectives will be directly informative for the ongoing development of Statistics Sweden's production methods. They are also highly relevant for any national statistics office interested in gaining an in-depth understanding and evaluation of the FIGARO tables.

# Statistical quality in FIGARO and EXIOBASE tables

Currently, Statistics Sweden uses data from the environmentally extended multiregional input-output (EE MRIO) database EXIOBASE to produce official statistics on greenhouse gas and other air emissions from a consumption perspective. As this report aims to investigate the possibilities of using FIGARO tables as input data for the official statistics, this chapter compares the statistical quality of the FIGARO tables with the currently used EXIOBASE tables.

The comparison includes both quantitative and qualitative aspects. Variations in input data, production methodologies and data processing steps are discussed considering the following:

- Geographical coverage and classification
- Industry/product classification
- Economic variables (major components of the input-output table i.e., matrices of intermediate use, production values, output, final demand, value added, international trade)
- Environmental vectors
- Reference year for real data

A comparison of FIGARO and EXIOBASE is most relevant in this report as EXIOBASE is the currently used database in the official statistics for Sweden and as FIGARO is the database of interest to test in practice in this project. However, these are not the only MRIO databases that exist. Moreover, to produce statistics on the environmental pressures from consumption, environmental vectors are needed as input data together with MRIO tables. Currently, FIGARO tables do not include environmental vectors (other than a $CO_2$ vector available upon request). Therefore, other potential databases and sources for producing statistics on consumption-based emissions are briefly described in the end of this chapter.

## FIGARO

FIGARO stands for Full International and Global Accounts for Research in input-Output analysis. It is a relatively new MRIO database that was developed by Eurostat in collaboration with the Joint Research Centre of the European Commission (Rémond-Tiedrez & Rueda-Cantuche, 2019). FIGARO aims to be the EU reference tool for policy makers in areas such as economic, social, and environmental consequences of globalisation.

FIGARO was first published in May 2021. Since then, several updates and improvements have been made, which are described, among others in European Commission (2021) and at the dedicated FIGARO webpage at Eurostat (2024c).

Since 2021, the FIGARO tables have been released annually as a statistical product by Eurostat. The tables will continue to be updated annually with emphasis being given to the 3 most recent years of the time series (Eurostat, 2024d). The database presents data with a time lag of 2 years. Thus, the latest update of FIGARO (2023 FIGARO edition) covers the whole time series of 2010 to 2021. The FIGARO tables can be downloaded from Eurostat (2024a) and are available in CSV flat or matrix format and in Excel format.

## Geographical coverage and classification

FIGARO covers the world economy as subdivided into 46 geographical areas, including 27 EU Member States, 18 other major national economies and one rest-of-the-world region (a full list of the geographical areas is presented in Appendix A).

## Industry and product classifications

The database contains supply, use, and input-output tables. The input-output tables are provided as either industry by industry tables or product by product, where 64 industries and 64 product groups are represented. Industries are classified according to the statistical classification of economic activities (NACE Rev. 2), and products according to the classification of products by activity (CPA version 2.1) (a full list of the included products and industries is presented in Appendix A). The FIGARO inter-country supply, use and input-output tables present transactions in nominal million euros, valued at basic prices (Eurostat, 2024d).

## Input data and methodology for monetary MRIO tables

According to Rémond-Tiedrez & Rueda-Cantuche (2019), input data to the FIGARO tables mainly consist of five building blocks:

- national accounts (as benchmark)
- national supply, use, and input-output tables
- international goods trade data
- international services trade data
- business statistics.

These building blocks are used to construct the three main data inputs needed for the process of constructing the EU inter country supply, use, and input output tables:

- A balanced bilateral trade database for goods and services.
- A full set of national supply and use tables, provided at both basic and purchasers' prices.

- A full set of national IO tables.

FIGARO release data with a time lag of 2 years. Therefore Eurostat needs to now-cast the national supply, use and IO tables to obtain estimates for year T-2 (T = year of FIGARO release) wherever real data is missing (Eurostat, 2024d). To do this, real data on macroeconomic aggregates (e.g., industry outputs, total imports, gross value added by industry, final use at purchasers' prices, total taxes less subsidies on products) are used as a benchmark. This means that the above-mentioned macroeconomic data is used as target row and column sums when nowcasting the national IO tables for year T-2.

The sources and the last years for real data (as opposed to nowcasted data) for the above-mentioned input data varies for the geographical areas included in the database. For EU27, United Kingdom and the United States, data is mainly based on the following data sources:

- **National supply, use and IO tables** are gathered from Eurostat for EU27. Member states are obliged to submit these under the European system of accounts (ESA) 2010 transmission programme (available 36 months after the end of the reference period). For the United States, input output tables are based on the official country data and industries/products are reclassified by Eurostat from the North American Industry Classification Scheme (NAICS) to NACE and CPA.
- **Trade data** for goods are gathered from the international trade in goods database published by Eurostat (also called EU COMEXT) (Eurostat, 2024e) and the United Nations International Trade Statistics Database (UN Comtrade) (United Nations, 2024). Services trade data are gathered from the international trade in services statistics (TiS) and from balance of payments datasets.
- **Macroeconomic aggregates** are mainly collected from Eurostat (submitted under the ESA 2010 transmission programme) and completed with OECD data for non-EU countries. These are used to now-cast the IO-tables up to year T-2.

For remaining geographical areas in the FIGARO tables (16 major economies and "rest of the world"), data are gathered from the OECD inter-country input-output (ICIO) tables. The OECD ICIO tables are produced from the OECD's STructural ANalysis (STAN) database. STAN is in turn based on OECD member countries' national accounts data, with OECD estimates covering gaps in the data. Many of the data points in STAN are therefore estimated and do not represent official member country submissions (OECD, 2024). The OECD ICIO tables currently (February 2024) cover a time series from 1995-2020. Therefore, data from OECD ICIO is nowcasted in FIGARO for the missing years. Documentation regarding the now-casting of these tables is less clear than for the geographical areas mentioned above. Furthermore, as the

OECD ICIO tables are now-casted themselves (OECD, 2023b), it is difficult to find information regarding the last year for real data for the IO tables of each country included in FIGARO.

One problem that arises when constructing MRIO tables is that there exist asymmetries in the reported bilateral trade flows between countries. The reported export from country A to country B may not match the import reported for country B from country A. According to Rémond-Tiedrez & Rueda-Cantuche (2019), these differences may arise for various reasons, for example:

- different valuation of exports and imports value
- different classification of products
- time lag between exports and imports – for example products leaving country A in one year and entering country B next year.
- goods passing through a third country.

To adjust for the above-mentioned problems, the bilateral trade data need to be balanced when constructing the inter country IO tables. For the FIGARO dataset, bilateral trade data have been balanced according to a generalized RAS-balancing method (GRAS) (Rémond-Tiedrez & Rueda-Cantuche, 2019).

### FIGARO environmental extensions

There are plans to provide FIGARO environmental vectors to be used with the MRIO tables. In February 2024, these are not yet available on the official FIGARO webpage. However, carbon footprints are available as a FIGARO application (Eurostat, 2024a). Here, carbon footprints are estimated for the 46 geographical areas, with a breakdown of 64 NACE rev. 2 industries (plus one household category) for each of the 46 counterpart geographical areas. The method applied to calculate the environmental footprints is an EE MRIO analysis where Leontief type of modelling is applied. Here, FIGARO MRIO tables were used as main input combined with $CO_2$ emissions as environmental extension. To compile the $CO_2$ vector, the following data was used:

- Air emissions accounts (for EU27, United Kingdom, Norway, Switzerland, and Turkey)
- Eurostat's own estimates of $CO_2$ emissions for the remaining 14 countries + 'rest of the World'. These are based on the International Energy Agency (IEA) $CO_2$ emissions from fuel combustion, and the Joint Research Centre (JRC) EDGAR database.

Carbon footprints by private households were not included in the calculations as they are not covered in the FIGARO MRIO tables. Therefore, they were added separately to the final results.

The most recent release of the environmental footprints was in the FIGARO 2022 edition. This release included environmental footprints

for the time series of 2010 to 2020. The $CO_2$ vector that was used to produce these carbon footprints is available upon request from Eurostat.

### Summary of sources and final years of real input data

Table 1 summarizes the sources and last years with real data for the FIGARO input data.

**Table 1 - FIGARO input data: Sources and final years of real data. T is publication year for FIGARO, covering a time series from 2010 to T-2 (2021 for the 2023 release).**

| FIGARO input data category | Final year for real data used in FIGARO | Sources for input data |
|---|---|---|
| Macroeconomic data (as benchmark) | T-2 (2021 for FIGARO 2023 edition) | Eurostat and OECD data. |
| National supply, use and input-output tables | T-3 for EU27 (2020 for FIGARO 2023 edition).<br>Mixed years for other countries. | Eurostat (ESA 2010 transmission programme)<br>National input output tables<br>OECD ICIO |
| Bilateral trade data | T-2 for EU COMEXT (2021 for FIGARO 2023 edition) | For goods: EU COMEXT and UN Comtrade<br>For services: international trade in services statistics (TiS) and from balance of payments datasets |
| $CO_2$ emissions | 2020 (FIGARO 2022 edition) | Air emissions accounts<br>Eurostat's own estimates of CO2 emissions<br>IEA CO2 emissions from fuel combustion<br>JRC EDGAR database |

## EXIOBASE

EXIOBASE is an environmentally extended multi-regional input output (EE MRIO) database. It is the result of international research collaborations within the EU projects EXIOPOL, CREEA, and DESIRE (Stadler et al., 2018). It has been updated multiple times to extend the time series. The most recent version, EXIOBASE 3 (more specifically EXIOBASE 3.8.2), was released in September 2021 and builds upon the previous versions of the database: EXIOBASE 1 and 2.

The most recent release of EXIOBASE was announced in 2021. It includes a time series ranging from 1995 to 2022 (where data for 2020 to 2022 mainly were based on forecasts). As the updates of the EXIOBASE database depends on financing, any new updates have not been made since the release in 2021. Prior to that, the database was generally updated annually and was announced on EXIOBASEs Google Group page (EXIOBASE announcements, 2024). Any information regarding when the database will be updated again is not available on the website. However, according to some email correspondence with the EXIOBASE working group, version 3.9 of EXIOBASE will soon be available on Zenodo.

## Geographical coverage and classification

EXIOBASE 3 covers the world economy as subdivided into 49 geographical areas: 27 EU Member States, 17 major economies and five rest-of-the-world regions (Stadler et al., 2021). A full list of the geographical areas is presented in Appendix B.

## Industry and product classification

EXIOBASE 3 provides supply, use and IO tables. The IO tables are provided as either product by product or industry by industry tables. In EXIOBASE, 163 industries and 200 product groups are represented. The database is under the NACE rev 1 classification scheme. The Exiobase multiregional supply, use and IO tables are provided in current, basic prices (Million EUR).

## Input data and methodology for monetary MRIO tables

The compilation of EXIOBASE 3 is described in the methodological papers from the DESIRE project (Stadler et al., 2015, 2018) with some additional information regarding data in the Read Me files at the download pages at Zenodo (Stadler et al., 2021).

The base in EXIOBASE 3 is rectangular supply-use tables which are used to construct the monetary MRIO tables (Stadler et al., 2018). The most recent official supply use tables and IO tables incorporated in the EXIOBASE 3 tables are from 2011. Therefore, EXIOBASE 3 relies heavily on now- and forecasting economic structure (and specifically intermediate supply and use tables) to extend the time series.

The compilation of the monetary supply use tables in EXIOBASE 3 follows a top-down approach, where real data on macroeconomic aggregates, industry/product output, and trade are used to now-cast the supply, use, and IO tables from previous reference years in EXIOBASE. The base year for the supply use tables is 2007. The methodology of the now-casting follows some main principles, described in Stadler et al. (2018):

(1) Ensure absolute consistency with macroeconomic data.
(2) Capture structural changes. This includes among other things technological improvements and shifts in sectoral and product composition of economies and final demand.
(3) Capture changes in national levels of production and consumption compared to trade.
(4) Provide consistency with international data sources as far as possible.

When following the principles above, absolute compliance to national level monetary supply use tables is not prioritized. Instead, internationally, and temporally consistent datasets are prioritized throughout the compilation process.

Data for the above-mentioned steps are gathered from a wide range of different sources, where the last year for real data differs. Below, the main data sources are described.

**National supply, use, and IO-tables** have been gathered from Eurostat and national statistical offices. These data cover the time period of 1995 to 2011. However, these data suffer from data gaps, changed classifications over time and changing volumes over time. Therefore, wherever data is missing, different techniques to estimate, interpolate and extrapolate the missing technical coefficients have been applied and are described in more detail in Stadler et al. (2018). The most recent official SUT and/or IOT data incorporated in EXIO BASE are from 2011, and remaining years in the time series relies heavily on "now-casting" economic structure. Therefore, Stadler et al. (2021) describe the data as “likely good” for global analysis, and country level estimates. However, the uncertainty relative to official data at transaction level is likely to be considerably higher.

**Macroeconomic data** are used as benchmarks to now-cast the supply, use, and IO tables. The macroeconomic data set consist of data in current and constant prices on:

- Value added, taxes and subsidies per broad sector.
- Final demand by category
- Total imports and exports (in free on board [f.o.b.] values)
- GDP (which is an aggregate of the above categories)

The macroeconomic data is gathered from the UN National Accounts Main Aggregates Database and completed with some additional information from national statistical offices, for the Republic of China (R.O.C.). Only minimal refining steps were necessary to obtain consistent macroeconomic data. The last year for real data from the UN is 2019 (Stadler et al., 2021). To further extend the time series, GDP & gross import/export projections until 2024 from IMF were used.

**Industry and product output per country data** were gathered from a wide range of national account databases and international databases, including the Food and Agriculture Organization statistical database (FAOSTAT) and International Energy Agency's (IEA) energy balances. Gross output per broad sector was based on the UN National Accounts Main Aggregates Database, using ratios between value added and output when available, and proxy values when not.

**Trade data** for products and services were retrieved from the BACI database (which is a balanced product trade database based on the UN Comtrade), the IEA database, and the UN services trade database. Furthermore, data on re-exports and re-imports are retrieved from UN Comtrade to estimate the share of re-exports over time of the total exports. Real trade data from BACI has been updated in EXIOBASE 3 to 2018.

To compile the final EXIOBASE supply, use and MRIO tables, several adjustment steps are needed. These include among other things the balancing of technical coefficients with macroeconomic data and the balancing of bilateral trade data. Earlier versions of EXIOBASE used a quadratic programming approach to balance the matrices. However, with the release of EXIOBASE 3.8.1 the balancing was redone, using a cross entropy approach (Stadler et al., 2021).

## Environmental extensions

### EXIOBASE environmental extensions

One advantage of using EXIOBASE is that the database provides environmental extensions to be used with the MRIO tables. Here, 417 emission categories are available as well as 662 material and resource categories.

EXIOBASE provides industry specific and final demand data on air emissions for 27 pollutants. These cover each country individually. According to the Read Me files at EXIOBASE download page (Stadler et al., 2021), energy and energy-related emissions at detailed level is updated to year 2015 IEA energy balances. At an aggregate level, all $CO_2$ fossil emissions are updated to year 2019 based on the Edgar Database, while all other GHG emissions are updated to 2017 based on PRIMAP database, with sectoral (IPCC based) emissions by gas available. Therefore, more recent data are based on now-casts. However, no documentation regarding how these data have been nowcasted has been found within this project. Household use of energy does not fit the data structure of the main MRIO dataset. Therefore, it is available as auxiliary to the main tables in disaggregated form by EXIOBASE product.

### Summary of sources and final years of real input data

Table 2 summarize the sources and final years of real input data in the EXIOBASE 3 MRIO tables.

**Table 2 - EXIOBASE 3.8.2 input data: Sources and final years of real data**

| EXIOBASE input data category | Final year for real data used in EXIOBASE | Source for input data |
|---|---|---|
| Macroeconomic data (as benchmark) | 2019 | World Bank |
| Technical coefficients (national supply and use tables and/or input-output tables) | 2011 | National Statistical Offices |
| Bilateral trade data | 2018 | BACI database |
| Industry/product output data | 2015-2019 dependant on source | Countries' own National Accounts data, UNData, FAOSTAT and IEA energy balances |

| EXIOBASE input data category | Final year for real data used in EXIOBASE | Source for input data |
|---|---|---|
| $CO_2$ emissions from combustion | 2019 | EDGAR |
| Other GHG emissions | 2017 | PRIMAST database |

After email correspondence with the EXIOBASE research group, we got some information regarding the data sources and last years for real data incorporated in the soon available EXIOBASE 3.9. This information is summarised below in Table 3.

The most interesting update with the new release of the EXIOBASE 3.9 is that the FIGARO supply use tables are used as input data for the years 2010 to 2020. The EXIOBASE classification is based on NACE 1.1 while the FIGARO tables are available in NACE rev2 classification. To match the classifications of the databases, the FIGARO tables was aggregated from 64 to 46 sectors before they were used to scale the EXIOBASE estimates.

**Table 3 - EXIOBASE 3.9 input data: Sources and final years of real data**

| EXIOBASE input data category | Final year for real data used in EXIOBASE | Source for input data |
|---|---|---|
| Macroeconomic data (as benchmark) | 2021 | World Bank |
| Supply and use tables (42 sector level) | 2020 | Eurostat FIGARO |
| Technical coefficients (national supply and use tables and/or input-output tables) | Various | National Statistical Offices |
| Bilateral trade data | 2020 | BACI database (original source Comtrade) |
| Industry/product output data | 1995-2021 dependant on source | Countries' own National Accounts data, UNData, FAOSTAT and IEA energy balances |
| Energy balances including basis for GHG emissions from fuel combustion at EXIOBASE detail | 2020 | IEA |
| $CO_2$ emissions from combustion at aggregate sector level | 2021 | EDGAR |
| Other GHG emissions at sector level | 2022 | PRIMAP database |

## Other potential databases and sources

Other than the MRIO tables and environmental vectors provided by FIGARO and EXIOBASE, there exist other databases and sources which could be used as input data to produce statistics on environmental

pressures from consumption. The most relevant sources are briefly described below.

#### OECD inter country input output (ICIO) tables

One of the most relevant alternatives to the monetary MRIO tables of FIGARO and EXIOBASE is the OECD ICIO database (OECD, 2023a). The most recent version of OECD ICIO covers 76 countries plus one "Rest of the world" region, and 45 industries classified according to ISIC rev. 4. The database is updated annually, and the latest release (2023) include a time series of 26 years (1995-2020). Just like for FIGARO and EXIOBASE, the OECD ICIO database relies heavily on nowcasting the supply, use and IO tables.

According to (Rémond-Tiedrez & Rueda-Cantuche, 2019) OECD and Eurostat work together to coordinate and provide consistency between the OECD ICIO and FIGARO tables. This work includes, among other things exchange of data and experiences. For example, FIGARO use data from OECD for most non-EU countries. Furthermore, the FIGARO tables contribute to the OECD ICIO tables by providing data for the EU and its Member States (Eurostat, 2024d).

#### Environmental data

Other than the environmental vectors provided by EXIOBASE, and the $CO_2$ vector provided by FIGARO, there are other potential sources which could be used as input data to produce statistics on environmental pressures from consumption.

**The Trade in embodied $CO_2$ (TECO2) database** is based on the OECD ICIO database and combined with statistics on $CO_2$ emissions from fuel combustion and other industry statistics. It presents several different indicators including among others $CO_2$ emissions embodied in domestic final demand, and country origin of emissions in final demand. The methodology for the indicators in the database is described in Yamano & Guilhoto (2020). These data could potentially be used in combination with FIGARO. However, this database only includes $CO_2$ emissions and has a different classification system than the FIGARO tables.

**The PRIMAP-hist dataset** is a research project that combines several datasets to create a comprehensive set of emission pathways for every country and each Kyoto gas. The most updated time series cover the years 1750 to 2022, and most countries in the world. The methodology is described in Gütschow et al. (2016) and the database can be downloaded on Zenodo (Gütschow & Pflüger, 2023). The database only present territorial emissions and related classifications. Therefore, to be used with the FIGARO MRIO tables, an extensive work to match classifications would be needed. PRIMAP data is used as one of the input data sources to create the EXIOBASE environmental vectors.

**The Emissions Database for Global Atmospheric Research (EDGAR)** is a global database of anthropogenic emissions of greenhouse gases

and air pollution on Earth. The database is developed by the joint research centre (JRC) and can be accessed at its dedicated page at the European Commission (Directorate-General for 'Joint Research Centre', 2024). EDGAR provides independent emission estimates using international statistics and a consistent IPCC methodology. Therefore, the estimates may differ from what is reported by European Member States and by Parties under the United Nations Framework Convention on Climate Change (UNFCCC). The database present territorial emissions and related classifications. Therefore, in order to be used with the FIGARO MRIO tables, an extensive work to match classifications would be needed. EDGAR data is used as one of the input data sources to create both the EXIOBASE and the FIGARO environmental vectors.

**Eurostat's air emission accounts** present data on greenhouse gases and other air emissions from a production perspective for the member states (Eurostat, 2024b). The database is mainly based on statistics reported by the member states and use the international standards of the System of Environmental-Economic Accounting (SEEA) framework. The database follows the classification NACE Rev. 2, which is the same classification as the FIGARO tables. The main drawback of this database is that it only includes data for the EU member states.

## Quantitative comparison of EXIOBASE and FIGARO carbon dioxide emissions

A quantitative comparison between the data for carbon dioxide emissions with a production perspective from FIGARO and EXIOBASE was carried out.

In order to perform this comparison, the EXIOBASE production-based $CO_2$ data was converted in the FIGARO geographical and product wise classification levels according to the conversion matrices explained elsewhere in this report.

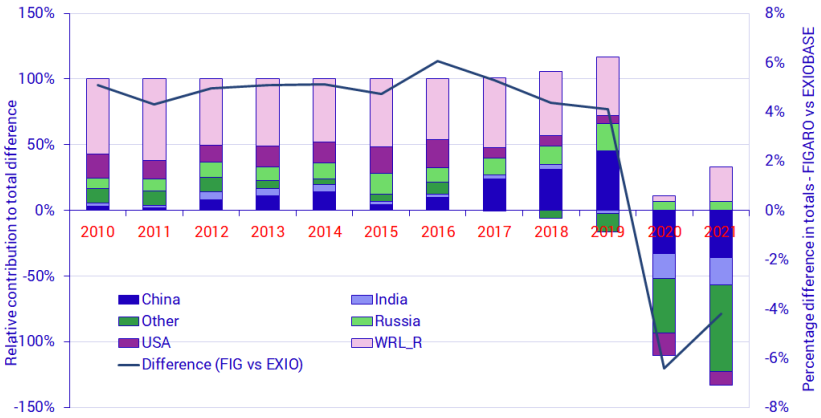


**Figure 1**: Time series for the percentage difference between production-based $CO_2$ emissions according to FIGARO and EXIOBASE (FIGARO minus EXIOBASE) – total emissions (line – right hand axis) and per country/region (bars – left hand axis). WRL_R is the FIGARO "rest of the world" category. Other are all countries given in the FIGARO classification not otherwise given in the figure or the FIGARO "rest of the world" category.

Figure 1 shows the time series for the percentage difference between production-based $CO_2$ emissions according to FIGARO and EXIOBASE (FIGARO minus EXIOBASE). The line in the figure shows the difference between the total emissions (right hand axis) according to each dataset. This shows that between 2010 and 2019 that EXIOBASE has lower emissions compared to FIGARO by about 5 percent. In 2020 and 2021 however, EXIOBASE has higher emissions levels. This variation over the time series is due to the fact that EXIOBASE data for 2020 and 2021 are projections that in particular do not appear to fully take into account effects of the Corona pandemic. The differences calculated per country/region show that the differences for 2010 through 2019 arise mainly for the FIGARO rest of the world region, with some differences also arising for China, India, USA and Russia. The class "other" is not significant over this time period compared to the previously mentioned countries/regions. For the time period 2020 through 2021, the class "other" as shown in the figure becomes the dominant contribution to the differences.

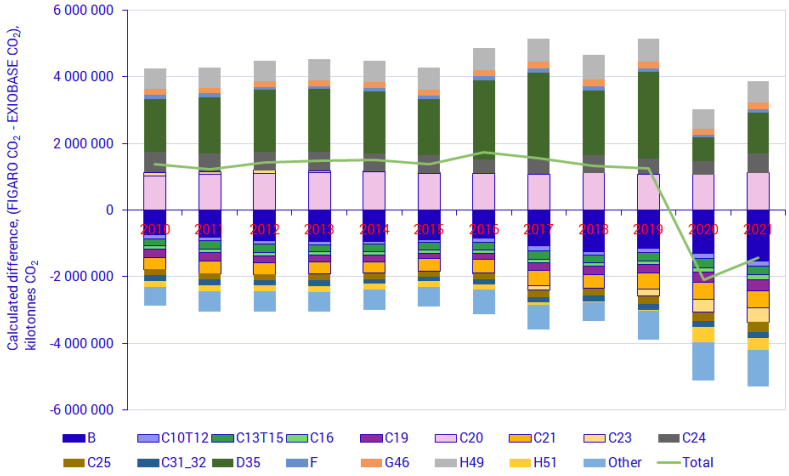


**Figure 2:** Time series for the absolute difference between production-based CO2 emissions according to FIGARO and EXIOBASE (FIGARO minus EXIOBASE) – total emissions (line chart) and per product group (stacked bars). B – mining and quarrying products, C10T12 – Food products, C13T15 – Textiles, garments, C16 – wood products, C19 – Coke and refined petroleum, C20 – Chemicals and chem products, C21 – Pharmaceutical products, C23 – non-metallic mineral products, C24 – Basic metals, C31_32 – Furniture and other manufacturing, D35 – Electricity, gas, steam and air conditioning, F – Construction, G46 – Wholesale trade, H49 – Land transport, H51 – Air transport, Other – all other product groups

Figure 2 shows the difference between FIGARO and EXIOBASE classified by product group. The line in the figure shows the same difference in total emissions as in the line in Figure 1. Figure 2 shows that on a productwise basis, there is a certain variation in the emissions levels between EXIOBASE and FIGARO. For the whole time series, FIGARO shows higher emissions for D35 (energy), C20 (chemicals), H49 (land transport) than for EXIOBASE. Figure 2 also shows that the emissions for B (mining products), F (construction) and C21 (pharmaceutical products) are consistently lower for FIGARO.

This analysis shows that though the FIGARO and EXIOBASE emissions data are of a very similar order of magnitude as far as totals are concerned, larger differences do arise for the higher level of disaggregation applied in the modelling.

# Method for FIGARO implementation

In this chapter we describe the methodology for creating an experimental time series over Sweden's consumption-based emissions when using FIGARO tables as input data.

## Methodological issues on the implementation of FIGARO input and output statistics

In this section we present a proposal for an alternative method to produce statistics on consumption-based greenhouse gas emissions. The method is based on relevant statistics and new methods will be overviewed in this section.

It is also important to emphasise that FIGARO is a unique development considering the high degree of geographical and sector detail, the quality of the input data and the institutional commitment to updating the data and the evaluation proposed can contribute to the innovation and further harmonization of input-output-based methods.

A comparison with EXIOBASE is most relevant because it too is a high-quality dataset with a high level of detail and similar coverage to FIGARO. Furthermore, the work will explore and develop environmental vectors for FIGARO tables which are not currently available but available in the EXIOBASE.

## Calculation procedures

The following section describes in short, the steps behind the calculation of the environmental impact using the EXIOBASE input and output statistics. For more technical details the reader recommends reading the full Eurostat report *Producing environmental account with environmentally extended input and output analysis* (Brown et al., 2021) and Palm et al. (2019). EXIOBASE incorporates a family of closely related methods. Statistics New Zealand and Eurostat both use a single region input-output (SRIO) method, assuming domestic technology for imports. Statistics Sweden applies a simplified single country national accounts consistent (SNAC) method. These two approaches use the same method for the calculation of domestic environmental pressures but differ in the calculation of environmental pressures arising due to imported products.

In both methods, the environmental pressures arising from final demand in the economy $S_{tot}$ can be expressed as the sum of those arising domestically, $S_{dom}$ and those arising abroad (due to imports), $S_{imp}$:

$$S_{tot} = S_{dom} + S_{imp}, \quad (1)$$

In both methods, domestic environmental pressures as given in Equation 1 are calculated according to

$$S_{dom} = e_{dom}\,(I - A_{dom})^{-1} Y_{dom} + H_{dom}, \quad (2)$$

where $e_{dom}$ is the environmental pressure per unit gross output, $A_{dom}$ is the domestic intermediate demand, $Y_{dom}$ is the final demand for domestically produced products in the economy and $H_{dom}$ are direct environmental pressures from households. Eurostat uses the same method to calculate domestic energy use.

In the single region input output model (SRIO) with data technology assumption (DTA), emissions arising in total, both domestically and abroad can be calculated as

$$S_{tot} = e_{dom}\,(I - A_{tot})^{-1}\, Y_{tot} + H_{dom}. \quad (3)$$

where $A_{tot}$ is the total intermediate demand ($A_{tot} = A_{dom} + A_{imp}$) and $Y_{tot}$ is the final demand of both domestic and imported products. Emissions arising abroad only, can then be calculated as the residual through:

$$S_{imp} = S_{tot} - S_{dom}. \quad (4)$$

Here, $S$ can be interpreted as either a scalar (total environmental pressure), a vector (environmental pressure per product consumed) or a matrix (environmental pressure per product consumed and per component of final demand, of which one of the components could also be exports).

The environmental pressures of imports are thus calculated as if the imports had been produced in the economy in question. One interpretation of this method is that these environmental pressures represent those avoided domestically by importing the products. Eurostat does not aim to include imports when calculating domestic energy use with EXIOBASE.

In the simplified SNAC, the environmental intensity for imported products is calculated using a global MRIO table. Denote elementwise multiplication and division by $\circ$ and $\oslash$ respectively. In a first step, production intensities around the globe are calculated as:

$$e_{world} = (e_{GMRIO}{}^{\mathrm{T}} \circ (I - A_{GMRIO})^{-1} \circ \mathrm{y}_{GMRIO}) \oslash \mathrm{y}_{GMRIO}, \quad (5)$$

where $e_{world}$ is the environmental intensity per product and country/region included in the MRIO, $e_{GMRIO}$ is the environmental intensity of gross output in the MRIO and $A_{GMRIO}$ is intermediate demand per unit of gross output in the MRIO. Note that matrices in Equation 5 are disaggregated both by product type and geographical

area (in single countries or groups of countries). To derive import intensities for the importing nation, the following calculation is performed:

$$e_{imp} = B \circ e_{world}\, a. \qquad (6)$$

Where $B$ is a matrix of import shares from each geographical area in the MRIO by product group for the importing country or region and $a$ is a simple summation vector. This gives $e_{imp}$ as the import intensities by product group according to the specific import shares for the importing country and according to the environmental pressure intensities and economic structure of the MRIO used. According to the simplified SNAC method used, *Simp* can then be calculated as:

$$S_{imp} = e_{imp}\, A_{imp}\, (I - A_{dom})^{-1} Y_{dom} + e_{imp}\, Y_{imp}. \qquad (7)$$

Where $A_{imp}$ is the intermediate demand for imported goods per unit output and $Y_{imp}$ is the direct final demand for imported goods. Other terms are as before.

## Methodological considerations - integration of FIGARO into the extended environmental input and output systems framework

The project starts out with a model using input data from FIGARO MRIO tables. The model was developed by Palm et al. (2019) and can be summarized as follows:

$$S_{\text{tot}} = e_{dom}\, (I - A_{dom})^{-1} Y_{dom} + e_{imp}\, A_{imp}\, (I - A_{dom})^{-1} Y_{dom} + e_{imp}\, Y_{imp} + H_{dom}. \qquad (8)$$

The term $e_{imp}$ represents the global environmental impact pressures earlier being calculated using the EXIOBASE EE MRIO tables.

## Tracing the flows between the systems

According to equation 8 above, to implement and substitute EXIOBASE based multipliers with FIGARO based multipliers $e_{imp}$, a few system modifications are needed before the calibration of the environmental impact is done. In short, EXIOBASE statistics contain data on a slightly more granular basis compared to FIGARO, specifically EXIOBASE contains data on 163 industries available across 49 regions. The equivalent coverage for FIGARO is 64 industries reported over 46 countries. In general, this means that challenges would arise when it comes to tracking the flows between these systems. For more information on industry and country coverage used in FIGARO- and EXIOBASE systems the reader is advised to check appendices. The work process of integrating FIGARO into the consumption-based accounts is summarized in the following steps.

## Adjustment of the matrices in EXIOBASE to FIGARO classification

As discussed previously, the global greenhouse gas multiplier in equation 5, $e_{imp}$, is calculated via:

$$e_{imp} = B \circ e_{world}\, a, \tag{9}$$

$$e_{world} = ((e_{GMRIO})^{T} \circ (I - A_{GMRIO})^{-1} \circ y_{GMRIO}) \oslash y_{GMRIO}. \tag{10}$$

Specifically, the term $e_{GMRIO}$ consist of environmental vectors from EXIOBASE and output vector from FIGARO. EXIOBASE environmental vectors are used as the FIGARO database does not include any environmental vectors yet, other than a $CO_2$-vector. The following environmental variables E are used:

- GHG - greenhouse gases
- $CO_2$ - carbon dioxide
- CH4 - methane
- N2O - nitrous oxide
- F-gas - volatile gases
- SO2 - sulphur oxide
- NOx - nitrogen oxide
- CO - carbon monoxide
- NMVOC - volatile organic compounds
- NH3 - ammonia
- PM2.5 - particles
- PM10 - particles

Because EXIOBASE has a higher resolution of sectors and countries than FIGARO, the environmental vectors are first aggregated into FIGARO sectors of 64 industries and thereafter aggregation proceeds with conversion of EXIOBASE country codes into the 46 countries of FIGARO. By first sorting out industries as columns and countries as rows in the environmental vectors $E_{gmrio}$, the conversion of variables was performed according to following matrix multiplication:

$$E_{gmrio,i} = E_{gmrio,j}\, C_{ji}, \tag{11}$$

$$E_{gmrio,n} = (E_{gmrio,m})^{T}\, C_{mn}, \tag{12}$$

where $C_{ji}$ is a disaggregation matrix of dimension *j x i* where *j* and *i* is the number of sectors in EXIOBASE and FIGARO respectively. The matrix $C_{mn}$ in equation 12 is a disaggregation matrix of dimension *m x n,* where *m* and *n* denote the number of country codes within EXIOBASE and FIGARO respectively. The superscript *T* refers to the transpose of the environmental vectors.

After the process of transforming and adapting of the environmental vectors into the structure of FIGARO 64 industries and 46 countries, the

next step in the mapping process is to convert the variables within equation 10 into the classification of the official statistics of containing 91 industries and 49 countries. The numerator and denominator in the equation 10 is handled separately during the so-called disaggregation conversions. The disaggregation of the $e_{world}$ matrix into 91 industries respectively 49 countries are performed in the same manner as for the conversion of EXIOBASE into FIGARO, see equations 11 and 12. The aggregation- and disaggregation issues are further described in the following subsections.

### Issues regarding the missing country codes

Questions regarding the comparison between country codes in the two statistical sources arise the question how to best conform the values within FIGARO's MRIO system with EXIOBASE existing environmental vectors described above. Argentina and Saudi Arabia are not included as as separate countries in EXIOBASE but they are in FIGARO, which means that FIGARO input data must be adjusted before calculations of the Leontief inverse matrix were done. The demand, output and input requirement set matrices must be adjusted accordingly. Therefore, the values for Argentina and Saudi Arabia were shifted into the FIGAROs Rest of World category.

### Issues on conversion of the sectors from EXIOBASE into FIGARO

Comparing the industry variations, several industries codes are not directly transferable between EXIOBASE and FIGARO industry list. The NACE Rev.2 classification scheme applied and adopted within FIGARO does not perfectly resemble the industry codes in EXIOBASE, the latter using an older definition of sectors following the NACE Rev 1.1 classification. Additional caveats are the fact that the latter source publishing the IO tables over the industry sections combining codes at both the 2- and the 3-digit level of aggregation.

Due to the high variation of the industries, integration of FIGARO with the existing environmental vectors from EXIOBASE is possible via the conversion matrix mapping FIGARO 64 unique sectors with the EXIOBASE 163 industry sectors. This straight conversion method easily transform the environmental vectors into FIGARO system.

### Issues on conversion of the geographical areas from FIGARO into the official statistics

Before proceeding with the calculation of the global emission matrix:

$$\mathrm{ELY}_{\mathrm{world}} = ((e_{GMRIO})^{\mathrm{T}} \circ (I - A_{GMRIO})^{-1} \circ \mathrm{y}_{GMRIO}), \qquad (13)$$

the adjustments of matrices must conform into 49 regions due to the requirements of the official statistics of Statistics Sweden. The coverage regarding the regional dimension when comparing both systems are good, only two out of forty-nine countries could not be directly

identified within the EXIOBASE database. As mentioned above, Argentina and Saudi Arabia were not available in EXIOBASE country codes.

Otherwise, the rest of the world (RoW) region within FIGARO is divided into five rest of the world codes within EXIOBASE, these are:

- RoW Asia and Pacific
- RoW America
- RoW Europe
- RoW Africa
- RoW Middle East

In addition, Taiwan, and China is reported as different countries in EXIOBASE but in the FIGARO country code system China includes Taiwan. This means that approximately 4 percent respectively 96 percent of the total output value of China in FIGARO is divided between China and Taiwan. The country-specific production shares used for the country disaggregation matrix are derived from EXIOBASE country-specific output distribution.

The computations follow the same principle stated along the equation 11 and 12 above, where the matrix C now represents a disaggregation matrix instead of aggregation matrix which was earlier mentioned. The disaggregation matrix smooths the values into a matrix containing 49 country codes.

### Issues on conversion of the sectors from FIGARO into the NACE Rev.2 classification

According to the same reasoning as mentioned in the previous section's discussion of country conversion, when publishing the environmental statistics at Statistics Sweden, information from a more refined industry level is used because some cells or combinations of cells contain confidential information.

The work processes of conversion of disaggregation of sectors follows the same adjustment as for the previous subsection, except for the process of transforming the 64 industries into 91 industry groups using a disaggregation matrix like disaggregation matrix applied for country conversions.

# Results and discussion

## Comparison of the statistical quality in FIGARO and EXIOBASE

Table 4 present a comparison between the FIGARO and EXIOBASE 3.8.2 tables. Both databases have different advantages and shortcomings. The EXIOBASE tables have a higher level of detail than FIGARO as data is presented according to a larger number of industries, product groups and geographical areas. However, the FIGARO tables have the advantage of using real supply, use and IO data to a higher extent for updating the matrix of intermediate use. The last year for real supply, use and IO tables in EXIOBASE is 2011, while FIGARO includes real data up to year T-3 for each release (2020 in the 2023 edition). However, both databases use now-casting techniques to extend the time series, where real data on macroeconomic aggregates and industry/product output are used as benchmark. As the last update of EXIOBASE is from 2021 and FIGARO from 2023, FIGARO use real macroeconomic data up to 2021 while EXIOBASE 3.8.2 use real data up to 2019.

One advantage of FIGARO compared to EXIOBASE is that the database is updated annually with a time lag of T-2. Instead, the updates of EXIOBASE depends on financing and have not been updated since 2021 (but will be updated soon).

When it comes to environmental data, one clear advantage of EXIOBASE is that it already comes with several different environmental vectors and with the same classification of product groups and industries as the MRIO tables. However, FIGARO already comes with a CO2 vector (available upon request) and environmental vectors for other emission types are under development.

**Table 4 - Comparison of FIGARO and EXIOBASE 3.8.2**

| | FIGARO | EXIOBASE 3.8.2 |
|---|---|---|
| Geographical coverage | 46 geographical areas (27 EU member states, 18 main EU trading partners, 1 rest-of-the-world region) | 49 geographical areas (27 EU member states, 17 major economies, 5 rest-of-the-world regions) |
| Industries/products | 64 industries/product groups according to NACE Rev.2 and CPA version 2.1 | 163 industries and 200 product classifications according to NACE Rev. 1 |
| Available time series | 2010-2021 | 1995-2022<br>(2020 and 2021 being forecasts) |
| Data releases (T = year of release) | Annually with a time lag of T-2 | Depends on financing. Latest release was in 2021. Next release during 2024. |
| Final year for real input data | | |

| | FIGARO | EXIOBASE 3.8.2 |
|---|---|---|
| - National supply, use and input output tables (technical coefficients) | Year T-3 for EU countries (2020 for the 2023 version) Mixed years for other countries. | 2011 |
| - Bilateral trade data | Year T-2 (2021 for the 2023 version) | 2018 |
| - Macroeconomic data (as benchmark) | Year T-2 (2021 for the 2023 version) | 2019 |
| - Industry/product output data | Year T-2 (2021 for the 2023 version) | 2015-2019 dependant on source |
| - CO2 emissions | 2020 | 2019 |
| - Other GHG emissions | - | 2017 |
| | | |

## Difficulties and suggestions for improvement

The country codes in Figaro's CO2 vector and MRIO tables are inconsistent. In the environmental vector, “FIGW1”, “GB”, and “GR” are used to denote “rest of the world”, “Great Britain”, and “Greece”, respectively, while the MRIO table uses “WRL_R”, “UK”, and “EL” for the same categories.

The FIGARO MRIO tables provided by Eurostat that are available in CSV are partly separated by comma and partly separated by “tab” within the same file. Therefore, the files are a bit complicated to read from different programs such as SAS and MatLab. Thus, a potential improvement for the FIGARO tables would be to adjust the files so that the format is more user friendly.

This means a lot of work must be prepared to understand and processing the files into the desired system environments. There are also risks that the values are not correctly transformed into the programs and therefore the output from the analysis may be affected.

## Comparing the consumption-based environmental pressure using EXIOBASE- and FIGARO

In this section we analyse the outcome of the experimental time series from Figaro IO system. We start the analysis by presenting the total environmental pressures. As Statistics Sweden already publish statistics on the consumption based GHG emissions, the analysis is now shifted into the part reviewing the alternative sources of publishing the same statistics. One way to proceed is to analyse the experimental time series over time comparing both measures of environmental pressures.

As FIGARO only produce data on $CO_2$ emissions, we will therefore confine our attention in the following to the comparison between FIGARO and EXIOBASE $CO_2$ emissions.

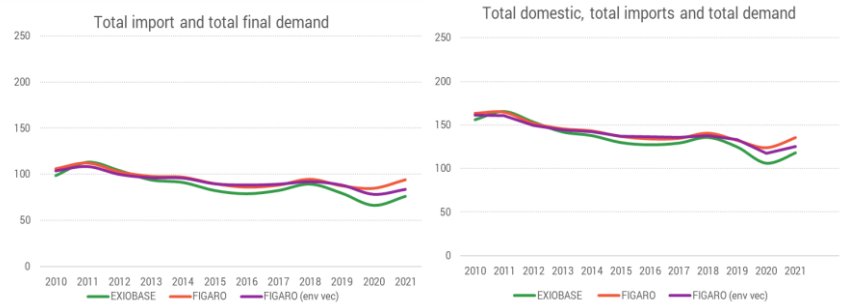


**Figure 3 (a – left) and (b – right) - Time series of the carbon dioxide – emissions expressed in megatons. The environmental vectors using Figaro statistics. Figaro (env_vec) indicates Figaro environmental statistics are used.**

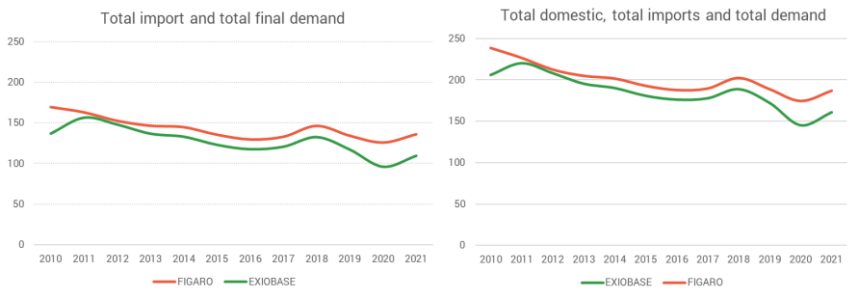


**Figure 4 (a – left) and (b – right): Time series of the greenhouse gas - emissions expressed in megaton.Source: Figaro and Exiobase MRIO systems. Source: Figaro and Exiobase MRIO systems. The environmental vectors using Exiobase statistics.**

The figures above first and foremost shows consistency between both different time series regarding the embedded emissions, it seems like the differences between them mainly consists of level differences. The main impression so far is that the embodied emissions from the final consumption evolves in similar way irrespective of the method used.

One notable difference appears when studying the figures, namely that the consumption-based emissions calculated with FIGARO MRIO tables are somewhat higher during period 2010-2021. Figure 4 (b) measuring the total emissions reveals that GHG emissions are on average 58 megatonnes higher compared to GHG emissions from only imports, see Figure 4 (a).

A cautious comparison between both MRIO systems reveals that the Figaro statistics produces about 8.5 percent higher emissions than Exiobase will do. This phenomenon appears after adjusting the input data according to the definitions and classification of industries and countries. As comparison is obviously complex in its nature, perhaps the gap between the time series is a consequence of adjustments of IO matrices and environmental vectors resulting in higher values using FIGARO method.

Aggregation error is inherent to any input-output analysis. Products and economic sectors are grouped, and these groups are assumed to be homogenous. However, since there are differences between the individual products aggregated within one product group (and the same for economic sectors), the results of input-output analysis suffer from the aggregation error. Aggregation error is a complex phenomenon, which results from aggregating products with different input and sales structures into one product group. If just one – either input structure or sales structure – is similar, the aggregation error is low even if the other one differs greatly.

According to the literature review on the aggregation issues, in de Koning et al. (2015) analysis reports that there are basically two important steps where aggregation error can increase when aggregating the Eurostat RME model where 182 product classification is converted into the 64 NACE rev2 classification: (a) aggregating to the Exiobase classification and (b) the conversion from NACE rev1 to NACE rev2.

The next step in the analysis considers the product composition and therefore raise the question of embedded emissions among the industries. In doing that, we present a figure showing the product-by-product composition over time, comparing the $CO_2$ emission arising from the imports of goods and services. The industries are transformed into the same classification using the conversion tables discussed in the methodological chapter of this reports. This means that Figaro carbon dioxide emissions conforms to the sectoral group reported within EXIOBASE system.

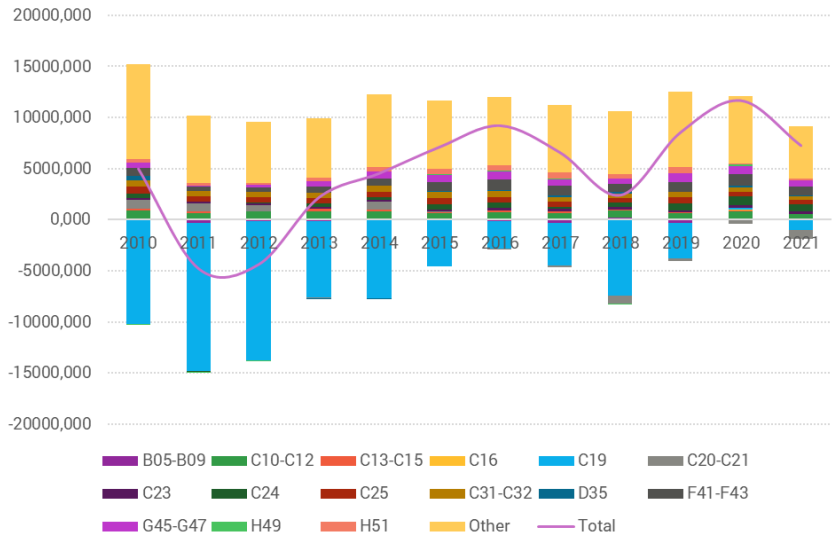


**Figure 5 – Calculated product difference of imported $C0_2$ emission (FIGARO $C0_2$ – EXIOBASE $C0_2$) – kilotons. Source: Figaro and Exiobase input and output statistics. B05-B09 – mining and quarrying products, C10T12 – Food products, C13T15 – Textiles, garments, C16 – wood products, C19 – Coke and refined petroleum, C20 – Chemicals and chem products, C21 – Pharmaceutical products, C23 – non-metallic mineral products, C24 – Basic metals, C31_32 – Furniture and other manufacturing, D35 – Electricity, gas, steam and air conditioning, F – Construction, G46 – Wholesale trade, H49 – Land transport, H51 – Air transport, Other – all other industry groups.**

Analysing the absolute deviation in the $CO_2$ measure reveals an interesting pattern among the sectors. Especially in the early years it seems like the industry C19 “Manufacture of coke and refined petroleum products” driving the main difference in absolute terms of $CO_2$, where Exiobase reporting more emissions than do Figaro in this industry. As this sector considers as a heavy emitter around the globe, the difference in the petroleum industry ultimately derives from different greenhouse gas multipliers. The $CO_2$ multiplier from EXIOBASE is about 30 percent higher than FIGARO.

In addition, the difference pattern shows no clear trends, it seems more like the difference starts to increase again in the beginning of the period of the corona pandemic. Perhaps this could be a result of internal in-house projection of Exiobase statistics same period. The aforementioned results are not to be confused with the quantitative comparison mentioned earlier in this report (see Figure 1) considering difference in $CO_2$ derived from a production perspective.

As a rounding off, we present in the next figure, numbers that represent the differences within countries' emissions of $CO_2$ between the two methods.

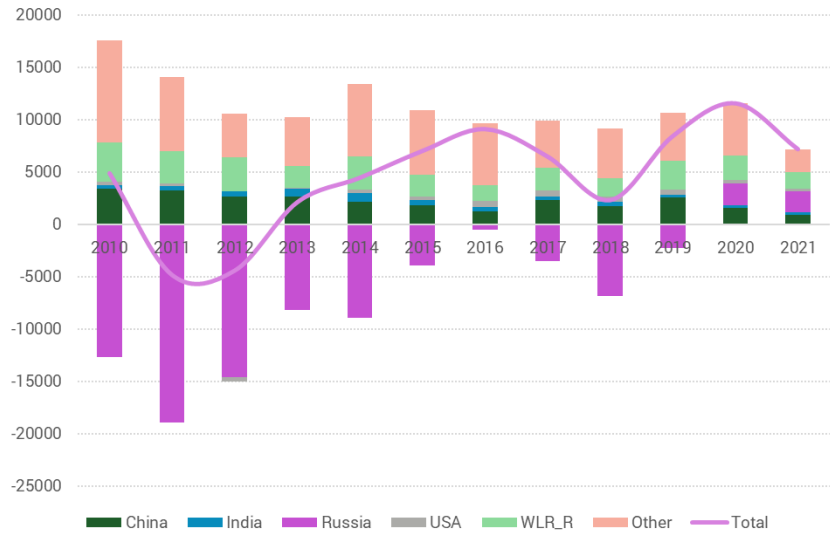


**Figure 6 – Calculated country difference of imported $C0_2$ emission (FIGARO $C0_2$ – EXIOBASE $C0_2$) – kilotons. Note WLR_R is the FIGARO rest of world category.**

As regards the country-wise comparison of the $CO_2$ measure, the absolute differences develop in the same way as in the previous figures. Countries like Russia still tend to dominate the differences along with the Rest of the World country group. The differences between the estimated emissions tend to increase the more granular the data is. Stated another way, country- or industry-level analyses typically yield larger estimated deviations than macro-level differences. Although the calculations of embedded $CO_2$ through import flows essentially follow the same calculation procedure as in the Exiobase method, the differences are difficult to explain in this analysis, as many interacting and complex mechanisms operate in parallel.

# Conclusions and recommendations

Statistics Sweden has extensive experience producing detailed data and statistics on consumption-based environmental pressures for Sweden. Since 2019 we have published official statistics on environmental pressures. The statistics are produced using a method developed in the research project PRINCE – Policy Relevant Indicators for National Consumption and Environment that ran from 2015 to 2018. A key strength of this method is that it makes it possible in a manageable framework to include real data about economic exchanges and environmental pressures across the globe (rather than relying on simplifying assumptions) that contribute to the environmental pressures embodied in the products that the Swedish economy imports.

The data landscape in this field is constantly evolving. A recent significant development is Eurostat's publication and planned yearly updates of the FIGARO tables. The FIGARO tables provide amongst other things a time series of inter-country input-output tables with global coverage and disaggregated for EU member states and major EU trading partners. Considering these factors, the objective of this chapter is to evaluate the potential for the FIGARO tables to be used as input data to produce country-level statistics on environmental pressures from consumption.

The fact that FIGARO is updated on an annually regular basis and adopting new definitions regarding the industry or products calling for reviewing the official statistics on the environmental footprint pressures. The fact that the environmental statistics within the FIGARO context are constantly developing calling for the need of revising our existing official statistics. The preliminary results indicate so far that the results stand the test well, meaning that FIGARO has the potential to be included as a statistical tool in the future production of the Swedish environmental pressure. In general, the analysis shows that the $CO_2$ is found to be in average 8.5 percent higher using the FIGARO IO tables, even though the difference at a more disaggregated level is more pronounced. Before Statistics Sweden fully adopt the FIGARO IO framework into the regular production system, more analysis is needed to understand the effects of disaggregation and aggregation issues and the also analysing the consequences of integrating the full FIGARO environmental data.

The work has shown in general that it is possible to produce time series of high quality for consumption-based greenhouse gas emissions with FIGARO tables. The analysis work has revealed specific areas to focus on for further evaluation and development. Notably there are

significant differences between consumption-based data calculated using FIGARO and using EXIOBASE in the results for the emissions embodied in imported products to satisfy final consumption of C19, petroleum products. This is probably also connected to the large difference in the emissions embodied in imported products arising in Russia, since Russia is a large exporter of petroleum products, that could also be investigated further.

There are questions also about the effect that reaggregation processes performed in this work have on the results. In any future analysis of this, it needs to be noted that aggregation will always be a source of uncertainty in an IO analysis.

In the future it is further interesting to perform calculations using full greenhouse gas vectors for FIGARO provided by Eurostat and compare these with results using other data sources.

Other future work involves ensuring a full time series coverage for data produced using FIGARO, noting that Statistics Sweden's official statistics have a time series starting from 2008, whereas so far data produced with FIGARO have been produced only as far back as 2010.

It is also hoped that the user experience with the FIGARO datasets will be taken on board by the data providers at Eurostat, which will in course facilitate the uptake of the data by more users.

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# Appendix A – FIGARO tables

## Geographical areas FIGARO

| Number | Code | Country (ISO-2) |
|---|---|---|
| 01 | BE | Belgium |
| 02 | BG | Bulgaria |
| 03 | CZ | Czechia |
| 04 | DK | Denmark |
| 05 | DE | Germany |
| 06 | EE | Estonia |
| 07 | IE | Ireland |
| 08 | GR | Greece |
| 09 | ES | Spain |
| 10 | FR | France |
| 11 | HR | Croatia |
| 12 | IT | Italy |
| 13 | CY | Cyprus |
| 14 | LV | Latvia |
| 15 | LT | Lithuania |
| 16 | LU | Luxembourg |
| 17 | HU | Hungary |
| 18 | MT | Malta |
| 19 | NL | Netherlands |
| 20 | AT | Austria |
| 21 | PL | Poland |
| 22 | PT | Portugal |
| 23 | RO | Romania |
| 24 | SI | Slovenia |
| 25 | SK | Slovakia |
| 26 | FI | Finland |
| 27 | SE | Sweden |
| 28 | GB | United Kingdom |
| 29 | NO | Norway |
| 30 | CH | Switzerland |
| 31 | TR | Turkey |
| 32 | US | United States of America |

| | | |
|---|---|---|
| 33 | CA | Canada |
| 34 | MX | Mexico |
| 35 | AR | Argentina |
| 36 | BR | Brazil |
| 37 | RU | Russian Federation |
| 38 | IN | India |
| 39 | CN | China |
| 40 | ZA | South Africa |
| 41 | JP | Japan |
| 42 | KR | Korea, Republic of |
| 43 | ID | Indonesia |
| 44 | AU | Australia |
| 45 | SA | Saudi Arabia |
| 46 | RoW | Rest of the World |

## FIGARO products

| Code | Label |
|---|---|
| CPA_A01 | Products of agriculture, hunting and related services |
| CPA_A02 | Products of forestry, logging and related services |
| CPA_A03 | Fish and other fishing products; aquaculture products; support services to fishing |
| CPA_B | Mining and quarrying |
| CPA_C10T12 | Food, beverages and tobacco products |
| CPA_C13T15 | Textiles, wearing apparel, leather and related products |
| CPA_C16 | Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials |
| CPA_C17 | Paper and paper products |
| CPA_C18 | Printing and recording services |
| CPA_C19 | Coke and refined petroleum products |
| CPA_C20 | Chemicals and chemical products |
| CPA_C21 | Basic pharmaceutical products and pharmaceutical preparations |
| CPA_C22 | Rubber and plastic products |
| CPA_C23 | Other non-metallic mineral products |
| CPA_C24 | Basic metals |
| CPA_C25 | Fabricated metal products, except machinery and equipment |
| CPA_C26 | Computer, electronic and optical products |
| CPA_C27 | Electrical equipment |
| CPA_C28 | Machinery and equipment n.e.c. |
| CPA_C29 | Motor vehicles, trailers and semi-trailers |

| | |
|---|---|
| CPA_C30 | Other transport equipment |
| CPA_C31_32 | Furniture and other manufactured goods |
| CPA_C33 | Repair and installation services of machinery and equipment |
| CPA_D35 | Electricity, gas, steam and air conditioning |
| CPA_E36 | Natural water; water treatment and supply services |
| CPA_E37T39 | Sewerage services; sewage sludge; waste collection, treatment and disposal services; materials recovery services; remediation services and other waste management services |
| CPA_F | Constructions and construction works |
| CPA_G45 | Wholesale and retail trade and repair services of motor vehicles and motorcycles |
| CPA_G46 | Wholesale trade services, except of motor vehicles and motorcycles |
| CPA_G47 | Retail trade services, except of motor vehicles and motorcycles |
| CPA_H49 | Land transport services and transport services via pipelines |
| CPA_H50 | Water transport services |
| CPA_H51 | Air transport services |
| CPA_H52 | Warehousing and support services for transportation |
| CPA_H53 | Postal and courier services |
| CPA_I | Accommodation and food services |
| CPA_J58 | Publishing services |
| CPA_J59_60 | Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services |
| CPA_J61 | Telecommunications services |
| CPA_J62_63 | Computer programming, consultancy and related services; Information services |
| CPA_K64 | Financial services, except insurance and pension funding |
| CPA_K65 | Insurance, reinsurance and pension funding services, except compulsory social security |
| CPA_K66 | Services auxiliary to financial services and insurance services |
| CPA_L | Real estate services |
| CPA_M69_70 | Legal and accounting services; services of head offices; management consultancy services |
| CPA_M71 | Architectural and engineering services; technical testing and analysis services |
| CPA_M72 | Scientific research and development services |
| CPA_M73 | Advertising and market research services |
| CPA_M74_75 | Other professional, scientific and technical services and veterinary services |
| CPA_N77 | Rental and leasing services |
| CPA_N78 | Employment services |
| CPA_N79 | Travel agency, tour operator and other reservation services and related services |
| CPA_N80T82 | Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services |
| CPA_O84 | Public administration and defence services; compulsory social security services |

| | |
|---|---|
| CPA_P85 | Education services |
| CPA_Q86 | Human health services |
| CPA_Q87_88 | Residential care services; social work services without accommodation |
| CPA_R90T92 | Creative, arts, entertainment, library, archive, museum, other cultural services; gambling and betting services |
| CPA_R93 | Sporting services and amusement and recreation services |
| CPA_S94 | Services furnished by membership organisations |
| CPA_S95 | Repair services of computers and personal and household goods |
| CPA_S96 | Other personal services |
| CPA_T | Services of households as employers; undifferentiated goods and services produced by households for own use |
| CPA_U | Services provided by extraterritorial organisations and bodies |

## FIGARO Industries

| Code | Label |
|---|---|
| A01 | Crop and animal production, hunting and related service activities |
| A02 | Forestry and logging |
| A03 | Fishing and aquaculture |
| B | Mining and quarrying |
| C10T12 | Manufacture of food products; beverages and tobacco products |
| C13T15 | Manufacture of textiles, wearing apparel, leather and related products |
| C16 | Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials |
| C17 | Manufacture of paper and paper products |
| C18 | Printing and reproduction of recorded media |
| C19 | Manufacture of coke and refined petroleum products |
| C20 | Manufacture of chemicals and chemical products |
| C21 | Manufacture of basic pharmaceutical products and pharmaceutical preparations |
| C22 | Manufacture of rubber and plastic products |
| C23 | Manufacture of other non-metallic mineral products |
| C24 | Manufacture of basic metals |
| C25 | Manufacture of fabricated metal products, except machinery and equipment |
| C26 | Manufacture of computer, electronic and optical products |
| C27 | Manufacture of electrical equipment |
| C28 | Manufacture of machinery and equipment n.e.c. |
| C29 | Manufacture of motor vehicles, trailers and semi-trailers |

| | |
|---|---|
| C30 | Manufacture of other transport equipment |
| C31_32 | Manufacture of furniture; other manufacturing |
| C33 | Repair and installation of machinery and equipment |
| D35 | Electricity, gas, steam and air conditioning supply |
| E36 | Water collection, treatment and supply |
| E37T39 | Sewerage, waste management, remediation activities |
| F | Construction |
| G45 | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| G46 | Wholesale trade, except of motor vehicles and motorcycles |
| G47 | Retail trade, except of motor vehicles and motorcycles |
| H49 | Land transport and transport via pipelines |
| H50 | Water transport |
| H51 | Air transport |
| H52 | Warehousing and support activities for transportation |
| H53 | Postal and courier activities |
| I | Accommodation and food service activities |
| J58 | Publishing activities |
| J59_60 | Motion picture, video, television programme production; programming and broadcasting activities |
| J61 | Telecommunications |
| J62_63 | Computer programming, consultancy, and information service activities |
| K64 | Financial service activities, except insurance and pension funding |
| K65 | Insurance, reinsurance and pension funding, except compulsory social security |
| K66 | Activities auxiliary to financial services and insurance activities |
| L | Real estate activities |
| M69_70 | Legal and accounting activities; activities of head offices; management consultancy activities |
| M71 | Architectural and engineering activities; technical testing and analysis |
| M72 | Scientific research and development |
| M73 | Advertising and market research |
| M74_75 | Other professional, scientific and technical activities; veterinary activities |
| N77 | Rental and leasing activities |
| N78 | Employment activities |
| N79 | Travel agency, tour operator and other reservation service and related activities |
| N80T82 | Security and investigation, service and landscape, office administrative and support activities |
| O84 | Public administration and defence; compulsory social security |
| P85 | Education |

| | |
|---|---|
| Q86 | Human health activities |
| Q87_88 | Residential care activities and social work activities without accommodation |
| R90T92 | Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities |
| R93 | Sports activities and amusement and recreation activities |
| S94 | Activities of membership organisations |
| S95 | Repair of computers and personal and household goods |
| S96 | Other personal service activities |
| T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use |
| U | Activities of extraterritorial organisations and bodies |

## FIGARO adjustments and value-added components.

**Adjustments and Value-Added components**

| Code | Label |
|---|---|
| D21X31 | Taxes less subsidies on products |
| OP_NRES | Purchases of non-residents in the domestic territory |
| OP_RES | Direct purchase abroad by residents |
| D1 | Compensation of employees |
| D29X39 | Other net taxes on production |
| B2A3G | Gross operating surplus |

## FIGARO final use components

### Final uses

| Code | Label |
|---|---|
| P3_S13 | Final consumption expenditure of general government |
| P3_S14 | Final consumption expenditure of households |
| P3_S15 | Final consumption expenditure of non-profit institutions serving households |
| P51G | Gross fixed capital formation |
| P5M | Changes in inventories and acquisition less disposals of valuables |

# Appendix B – EXIOBASE tables

## Geographical areas for EXIOBASE

| Number | Code | Label |
|---|---|---|
| 1 | AT | Austria |
| 2 | BE | Belgium |
| 3 | BG | Bulgaria |
| 4 | CY | Cyprus |
| 5 | CZ | Czech Republic |
| 6 | DE | Germany |
| 7 | DK | Denmark |
| 8 | EE | Estonia |
| 9 | ES | Spain |
| 10 | FI | Finland |
| 11 | FR | France |
| 12 | GR | Greece |
| 13 | HR | Croatia |
| 14 | HU | Hungary |
| 15 | IE | Ireland |
| 16 | IT | Italy |
| 17 | LT | Lithuania |
| 18 | LU | Luxembourg |
| 19 | LV | Latvia |
| 20 | MT | Malta |
| 21 | NL | Netherlands |
| 22 | PL | Poland |
| 23 | PT | Portugal |
| 24 | RO | Romania |
| 25 | SE | Sweden |
| 26 | SI | Slovenia |
| 27 | SK | Slovakia |
| 28 | GB | United Kingdom |
| 29 | US | United States |

| | | |
|---|---|---|
| 30 | JP | Japan |
| 31 | CN | China |
| 32 | CA | Canada |
| 33 | KR | South Korea |
| 34 | BR | Brazil |
| 35 | IN | India |
| 36 | MX | Mexico |
| 37 | RU | Russia |
| 38 | AU | Australia |
| 39 | CH | Switzerland |
| 40 | TR | Turkey |
| 41 | TW | Taiwan |
| 42 | NO | Norway |
| 43 | ID | Indonesia |
| 44 | ZA | South Africa |
| 45 | WA | RoW Asia and Pacific |
| 46 | WL | RoW America |
| 47 | WE | RoW Europe |
| 48 | WF | RoW Africa |
| 49 | WM | RoW Middle East |

## EXIOBASE industries

| Code | Label |
|---|---|
| i01.a | Cultivation of paddy rice |
| i01.b | Cultivation of wheat |
| i01.c | Cultivation of cereal grains nec |
| i01.d | Cultivation of vegetables, fruit, nuts |
| i01.e | Cultivation of oil seeds |
| i01.f | Cultivation of sugar cane, sugar beet |
| i01.g | Cultivation of plant-based fibers |
| i01.h | Cultivation of crops nec |
| i01.i | Cattle farming |
| i01.j | Pigs farming |
| i01.k | Poultry farming |
| i01.l | Meat animals nec |

| | |
|---|---|
| i01.m | Animal products nec |
| i01.n | Raw milk |
| i01.o | Wool, silk-worm cocoons |
| i01.w.1 | Manure treatment (conventional), storage and land application |
| i01.w.2 | Manure treatment (biogas), storage and land application |
| i02 | Forestry, logging and related service activities |
| i05 | Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing |
| i10 | Mining of coal and lignite; extraction of peat |
| i11.a | Extraction of crude petroleum and services related to crude oil extraction, excluding surveying |
| i11.b | Extraction of natural gas and services related to natural gas extraction, excluding surveying |
| i11.c | Extraction, liquefaction, and regasification of other petroleum and gaseous materials |
| i12 | Mining of uranium and thorium ores |
| i13.1 | Mining of iron ores |
| i13.20.11 | Mining of copper ores and concentrates |
| i13.20.12 | Mining of nickel ores and concentrates |
| i13.20.13 | Mining of aluminium ores and concentrates |
| i13.20.14 | Mining of precious metal ores and concentrates |
| i13.20.15 | Mining of lead, zinc and tin ores and concentrates |
| i13.20.16 | Mining of other non-ferrous metal ores and concentrates |
| i14.1 | Quarrying of stone |
| i14.2 | Quarrying of sand and clay |
| i14.3 | Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c. |
| i15.a | Processing of meat cattle |
| i15.b | Processing of meat pigs |
| i15.c | Processing of meat poultry |
| i15.d | Production of meat products nec |
| i15.e | Processing vegetable oils and fats |
| i15.f | Processing of dairy products |
| i15.g | Processed rice |
| i15.h | Sugar refining |
| i15.i | Processing of Food products nec |
| i15.j | Manufacture of beverages |
| i15.k | Manufacture of fish products |
| i16 | Manufacture of tobacco products |
| i17 | Manufacture of textiles |
| i18 | Manufacture of wearing apparel; dressing and dyeing of fur |

| | |
|---|---|
| i19 | Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear |
| i20 | Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials |
| i20.w | Re-processing of secondary wood material into new wood material |
| i21.1 | Pulp |
| i21.w.1 | Re-processing of secondary paper into new pulp |
| i21.2 | Paper |
| i22 | Publishing, printing and reproduction of recorded media |
| i23.1 | Manufacture of coke oven products |
| i23.2 | Petroleum Refinery |
| i23.3 | Processing of nuclear fuel |
| i24.a | Plastics, basic |
| i24.a.w | Re-processing of secondary plastic into new plastic |
| i24.b | N-fertiliser |
| i24.c | P- and other fertiliser |
| i24.d | Chemicals nec |
| i25 | Manufacture of rubber and plastic products |
| i26.a | Manufacture of glass and glass products |
| i26.a.w | Re-processing of secondary glass into new glass |
| i26.b | Manufacture of ceramic goods |
| i26.c | Manufacture of bricks, tiles and construction products, in baked clay |
| i26.d | Manufacture of cement, lime and plaster |
| i26.d.w | Re-processing of ash into clinker |
| i26.e | Manufacture of other non-metallic mineral products n.e.c. |
| i27.a | Manufacture of basic iron and steel and of ferro-alloys and first products thereof |
| i27.a.w | Re-processing of secondary steel into new steel |
| i27.41 | Precious metals production |
| i27.41.w | Re-processing of secondary preciuos metals into new preciuos metals |
| i27.42 | Aluminium production |
| i27.42.w | Re-processing of secondary aluminium into new aluminium |
| i27.43 | Lead, zinc and tin production |
| i27.43.w | Re-processing of secondary lead into new lead |
| i27.44 | Copper production |
| i27.44.w | Re-processing of secondary copper into new copper |
| i27.45 | Other non-ferrous metal production |
| i27.45.w | Re-processing of secondary other non-ferrous metals into new other non-ferrous metals |

| | |
|---|---|
| i27.5 | Casting of metals |
| i28 | Manufacture of fabricated metal products, except machinery and equipment |
| i29 | Manufacture of machinery and equipment n.e.c. |
| i30 | Manufacture of office machinery and computers |
| i31 | Manufacture of electrical machinery and apparatus n.e.c. |
| i32 | Manufacture of radio, television and communication equipment and apparatus |
| i33 | Manufacture of medical, precision and optical instruments, watches and clocks |
| i34 | Manufacture of motor vehicles, trailers and semi-trailers |
| i35 | Manufacture of other transport equipment |
| i36 | Manufacture of furniture; manufacturing n.e.c. |
| i37 | Recycling of waste and scrap |
| i37.w.1 | Recycling of bottles by direct reuse |
| i40.11.a | Production of electricity by coal |
| i40.11.b | Production of electricity by gas |
| i40.11.c | Production of electricity by nuclear |
| i40.11.d | Production of electricity by hydro |
| i40.11.e | Production of electricity by wind |
| i40.11.f | Production of electricity by petroleum and other oil derivatives |
| i40.11.g | Production of electricity by biomass and waste |
| i40.11.h | Production of electricity by solar photovoltaic |
| i40.11.i | Production of electricity by solar thermal |
| i40.11.j | Production of electricity by tide, wave, ocean |
| i40.11.k | Production of electricity by Geothermal |
| i40.11.l | Production of electricity nec |
| i40.12 | Transmission of electricity |
| i40.13 | Distribution and trade of electricity |
| i40.2 | Manufacture of gas; distribution of gaseous fuels through mains |
| i40.3 | Steam and hot water supply |
| i41 | Collection, purification and distribution of water |
| i45 | Construction |
| i45.w | Re-processing of secondary construction material into aggregates |
| i50.a | Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessoiries |
| i50.b | Retail sale of automotive fuel |
| i51 | Wholesale trade and commission trade, except of motor vehicles and motorcycles |
| i52 | Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods |

| | |
|---|---|
| i55 | Hotels and restaurants |
| i60.1 | Transport via railways |
| i60.2 | Other land transport |
| i60.3 | Transport via pipelines |
| i61.1 | Sea and coastal water transport |
| i61.2 | Inland water transport |
| i62 | Air transport |
| i63 | Supporting and auxiliary transport activities; activities of travel agencies |
| i64 | Post and telecommunications |
| i65 | Financial intermediation, except insurance and pension funding |
| i66 | Insurance and pension funding, except compulsory social security |
| i67 | Activities auxiliary to financial intermediation |
| i70 | Real estate activities |
| i71 | Renting of machinery and equipment without operator and of personal and household goods |
| i72 | Computer and related activities |
| i73 | Research and development |
| i74 | Other business activities |
| i75 | Public administration and defence; compulsory social security |
| i80 | Education |
| i85 | Health and social work |
| i90.1.a | Incineration of waste: Food |
| i90.1.b | Incineration of waste: Paper |
| i90.1.c | Incineration of waste: Plastic |
| i90.1.d | Incineration of waste: Metals and Inert materials |
| i90.1.e | Incineration of waste: Textiles |
| i90.1.f | Incineration of waste: Wood |
| i90.1.g | Incineration of waste: Oil/Hazardous waste |
| i90.2.a | Biogasification of food waste, incl. land application |
| i90.2.b | Biogasification of paper, incl. land application |
| i90.2.c | Biogasification of sewage slugde, incl. land application |
| i90.3.a | Composting of food waste, incl. land application |
| i90.3.b | Composting of paper and wood, incl. land application |
| i90.4.a | Waste water treatment, food |
| i90.4.b | Waste water treatment, other |
| i90.5.a | Landfill of waste: Food |
| i90.5.b | Landfill of waste: Paper |

| | |
|---|---|
| i90.5.c | Landfill of waste: Plastic |
| i90.5.d | Landfill of waste: Inert/metal/hazardous |
| i90.5.e | Landfill of waste: Textiles |
| i90.5.f | Landfill of waste: Wood |
| i91 | Activities of membership organisation n.e.c. |
| i92 | Recreational, cultural and sporting activities |
| i93 | Other service activities |
| i95 | Private households with employed persons |
| i99 | Extra-territorial organizations and bodies |

## Explanatory symbols and abbreviations

| | |
|---|---|
| $CO_2$ | Carbon dioxide |
| CPA | Classification of products by activity |
| DTA | Data technology assumption |
| EDGAR | The Emissions Database for Global Atmospheric Research |
| EEIO | Environmentally extended input-output |
| EE MRIO | Environmentally extended multi regional input-output |
| ESA | European system of accounts |
| EU | European Union |
| FIGARO | Full International and Global Accounts for Research in input-Output analysis |
| FOB | Free on board |
| GDP | Gross domestic product |
| GHG | Greenhouse gas |
| GRAS | Generalized RAS-balancing method |
| ICIO | Inter-country input-output |

| | |
|---|---|
| IEA | International Energy Agency |
| IMF | International Monetary Fund |
| IO | Input-Output |
| IPCC | Intergovernmental Panel on Climate Change |
| ISIC | International Standard Industrial Classification of All Economic Activities |
| JRC | Joint Research Centre |
| MRIO | Multiregional input-output |
| NACE | Statistical classification of economic activities |
| NAICS | North American Industry Classification Scheme |
| OECD | The Organisation for Economic Co-operation and Development |
| PRINCE | Policy Relevant Indicators for National Consumption and Environment |
| SEEA | the System of Environmental-Economic Accounting |
| SNAC | Single country national accounts consistent method |
| SRIO | Single region input-output |
| STAN | OECD's STructural ANalaysis (STAN) database |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |