Ecodesign preparatory study for product specific measures on scarce, environmentally relevant and critical raw materials and on recycled content

Study Report

Phase 1: Prioritisation of materials and product

Final Draft

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Contents

Tables

Figures

1. INTRODUCTION

1.1. About the study

The purpose is to conduct an Ecodesign preparatory study on potential product-specific requirements on recycled content and on scarce, environmentally relevant and critical raw materials, and to propose possible implementing measures under the Ecodesign and energy labelling regulatory framework.

The study objectives are:

- investigating in more detail the materials and the products that could be subject to these requirements,
- investigating the technical, economic, environmental, market and societal impacts of these potential requirements, and
- providing the elements needed for the identification of policy options in the subsequent impact assessment

If, on the basis of the study findings, the Commission considers it appropriate to develop implementing measures under the Ecodesign legal framework and/or the Energy Labelling Regulation, the study shall also draft working documents, in particular the draft Ecodesign Regulation and the draft Energy Labelling Regulation.

The study consists of two phases:

- Phase 1: Prioritisation of materials and product groups: This is a scoping phase aiming at identifying products and materials combinations to be proposed for the detailed studies in Phase 2. The prioritisation is based on on assessment of products in scope and data for these products with certain selected criteria related to materials and products.
- Phase 2: Execution of the preparatory study: The preparatory study contains five mini Ecodesign studies, following Methodology for Ecodesign of Energy-related Products (MEErP) focusing on recycled content and on scarce, environmentally relevant and critical raw materials for the products and materials selected in Phase 1. Based on the outcome of these studies, draft working documents for regulations will be prepared and presented to Member States and stakeholders.

Stakeholder consultations take place during both phases. These consultations are supported by a study website (www.ecodesignmaterials.eu) with published documents, information on the study and news and with an option of registrering for being included in the distribution list and for meetings.

The study includes at least three stakeholder meetings (one online stakeholder introductory meeting and two hybrid (online and physical presence) meetings) followed by the opportunity of submitting written comments. The online introductory meeting was held on 9 October 2023 and the second meeting was held on 2 July 2024. Presentations and minutes from the meetings can be found at www.ecodesignmaterials.eu/documents.

1.2. Political context

Highlights of the political context for this study include:

- The Circular Economy Action Plans (December 2015 and March 2020) (CEAP)
- The Ecodesign Directive (2009/125/EC) (ED)
- The Energy Labelling Framework Regulation ((EU) 2017/1369)
- The Sustainable Products Initiative (SPI) and the Ecodesign for Sustainable Products Regulation substituting the Ecodesign Directive
- The Ecodesign and Energy Labelling Working Plan 2022-2024 and specifically the horizontal aspect of recycled content and of scarce, environmentally relevant and critical raw materials, including the technical study behind the Working Plan (Preparatory study for the Ecodesign and Energy Labelling Working Plan 2020-2024)[1]
- European Critical Raw Materials Act (CRMA) - Proposal for a Regulation of the European Critical Raw Materials Act including the fifth list of 34 CRMs[2]

The Ecodesign Directive requires product manufacturers to improve the environmental performance of their products by meeting minimum energy efficiency requirements, as well as other environmental requirements such as water consumption, emission levels or minimum durability of certain components. The Energy Labelling Regulation complements Ecodesign by enabling end-users to identify the better-performing products, via the well-known A-G/green-to-red labelling grading.

The Circular Economy Action Plans (CEAP) target how products are designed, promoting circular economy processes and sustainable consumption, and aiming to ensure that waste is prevented, and the resources used are kept in the EU economy for as long as possible. CEAP 2020[3] announces a sustainable product policy legislative initiative to make products fit for a climate neutral, resource efficient and circular economy, reduce waste and ensure that the performance of frontrunners in sustainability progressively becomes the norm.

The aim of the Sustainable Products Initiative (SPI) is to revise the Ecodesign Directive to set out the EU policy framework necessary to achieve the CEAP objectives. The initiative also addresses the presence of harmful chemicals in products such as electronics and ICT equipment. A proposal for Ecodesign for Sustainable Products Regulation was published by the Commission on 30 March 2022[4]. On 5 December 2023, the Council and the European Parliament reached a provisional agreement on new ecodesign requirements for sustainable products.

The Preparatory study for the Ecodesign and Energy Labelling Working Plan 2022-2024 (carried out by Viegand Maagøe, VHK and Oeko-institut) recommended after detailed analyses of a broad range of product groups and horizontal initiatives among others to include in the Ecodesign and Energy Labelling Working Plan two horizontal initiatives,

[1] https://www.Ecodesignworkingplan20-24.eu/

[2] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/european-critical-raw-materials-act_en

[3] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

[4] https://environment.ec.europa.eu/publications/proposal-Ecodesign-sustainable-products-regulation_en

namely post-consumer recycled content and scarce and critical raw materials. Implementation of measures for recycled content was assessed as having a very high saving potential, estimated at 160 PJ.

In May 2022, the Commission published the Working Plan and in addition to product specific priorities, three horizontal aspects contributing to the circular economy were selected, of which recycled content and scarce, environmentally relevant and critical raw materials were two of these aspects and durability, firmware and software as the third one.

The Working Plan emphasises the following focus points as background for selecting recycled content and scarce, environmentally relevant and critical raw materials as important horizontal aspects:

- They are a continuation of prior circular economy measures in the Ecodesign work for energy-related product, especially the measures adopted in 2019 and they should contribute to the transition to the ESPR (Ecodesign for Sustainable Products Regulation)
- Horizontal standards on material efficiency aspects for energy-related products under Mandate 543 are now in place, which can be the basis for developing product-specific material efficiency standards for energy-related products.
- The Methodology of Ecodesign for Energy-related Products (MEErP) and the corresponding EcoReport Tool (ERT) have been updated introducing a more systematic way of covering circular economy aspects for studies on specific product groups. it is expected to be published soon.

The Working Plan states that the Commission will assess the possibility and appropriateness of establishing product-specific requirements on recycled content and scarce, environmentally relevant and critical raw materials for energy related products, where dedicated preparatory studies will be needed to help identifying the product categories that are most relevant for potential regulatory approaches. The current study has been designed to provide technical assistance to the Commission for establishing these product-specific requirements.

1.3. Scope

1.3.1. Product scope

The product scope for the study is energy related products covered by the Ecodesign Directive 2009/125[5] with a focus on products that are already regulated[6].

1.3.2. Material scope

The material scope is both non-plastic materials (ferrous and non-ferrous metals) and plastic materials, which are more commonly present in energy related products and with a focus on scarce, environmentally relevant and critical raw materials.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009L0125-20121204

[6] https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products_en

1.3.3. Typology of requirements

The typology of requirements to be analysed within the mini-preparatory studies include, but are not limited to:

- Information requirements (on material weight, weight range, recycled raw material content)
- Requirements on the ease of dismantling (in order to recover more easily the material and/or the component
- Requirements setting a minimum level of content of recycled raw materials
- Requirements based on the definition of product specific indexes on product recyclability
- Other requirement on recyclability and product reusability

1.4. Introduction to recycled content

Recycled material for manufacturing of new products is a very effective measure for material efficiency and with a very high estimated potential (160 PJ in primary energy savings).[7] It is an important element of the circular economy where recycled materials play a significant role in reducing the environmental footprint of manufacturing processes by conserving raw materials including critical raw materials, reducing energy consumption, and minimising waste. It is also important for reducing the dependence of the industry on extra-EU imports. A standard providing a methodology on assessing the proportion of recycled material content in energy-related products has been developed and is publicly available.[8]

Therefore, it is strategically important to assess fundamentally new directions for the circular economy and potential Ecodesign regulatory measures.

Recycled content can be broadly categorised into two main types: post-consumer recycled content and pre-consumer (or post-industrial) recycled content. Each type has its unique sources and applications in the production of new goods. The term “consumer” should be understood broadly i.e. not restricted to household consumers.

Post-consumer recycled content refers to materials that have been used and disposed of by consumers, then collected, processed, and repurposed into new products. This type of recycled content is pivotal in closing the loop of product lifecycles, encouraging circular economy principles. The process of recycling post-consumer materials often involves collection, sorting, cleaning, and processing to make them suitable for use in manufacturing new products.

Pre-consumer (or post-industrial) recycled content comes from materials that were discarded during the manufacturing process before reaching the consumer. This category includes scraps, trimmings, and other by-products that are recovered and reused in new or similar products, thus preventing waste and reducing the demand for virgin materials. The utilisation

[7] Preparatory study for the Ecodesign and Energy Labelling Working Plan 2020-2024. Task 3 Preliminary Analysis of Product Groups and Horizontal Initiatives

[8] EN 45557:2020: General method for assessing the proportion of recycled material content in energy-related products

of pre-consumer recycled content can also take place by industrial symbiosis, where waste from one process becomes the raw material for another.

In the Preparatory study for the Ecodesign and Energy Labelling Working Plan 2022-2024, the assessments were based on post-consumer recycled content, which also will be the main focus for the current study, but without discarding assessing opportunites for pre-consumer recycled content in the following mini-preparatory studies in Phase 2. Use of pre-consumer recycled content can especially be relevant if the material is not recycled in the same production process from where it has been recovered, but e.g. at a third party recycler, possibly mixed with post-consumer materials.

Waste can be used directly as a raw material in the production of products that have recycled content. Or the waste can be transformed into recycled-based feedstock. In all cases, means of verification should be considered.Recycled content is the amount of recycled material that goes into the manufacturing of a new product, expressed either as a fraction of the total material input (in %) or in absolute numbers (kg per unit, million tonnes Mt in aggregates). The scope is to increase the amount recycled content a part of a holistic and balanced material efficiency policy, also within Ecodesign.

Generally, there are two typical basic recycling loops:

- Recycled content from recycling of the same product type or even of the manufacturer's own products via take-back schemes
- Recycled content from generic sources via recycled materials suppliers, both as mechanical and chemical recycled materials

When considering requirements on recycled content, they should be agnostic to recycling technology, source of material etc.

Topics to assess further (mainly in Phase 2 of this study) include:

- Sufficient supplies of recycled materials of sufficient quality and competitive price
- Technology readiness of recycled materials and content in final product
- Reliable determination and verification of amount of recycled content of a product without excessive administrative burden and laboratory costs
- Needs for additional test standards
- Impact on costs and the economy
- Impact on the environment

An area of specific focus in recent years is recycling of plastics. A Circular Plastics Alliance has been established with currently over 330 signatorees from European plastics value chains. The signatories commit to take action to boost the EU market for recycled plastics up to 10 million tonnes by 2025.[9,10] By reaching this goal, the EU will attain an almost 20 % success rate of recycled plastics uptake into new products for all applications.[11]

Further information on recycled content policies, test standards, market figures, usages, technologies, availability and quality of the material, market surveillance, impact on energy,

[9] https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/circular-plastics-alliance_en

[10] https://circular-plastics-alliance.com/en/

[11] Preparatory study for the Ecodesign and Energy Labelling Working Plan 2020-2024. Task 3 Preliminary Analysis of Product Groups and Horizontal Initiatives

emissions and costs and saving potential as of 2021 can be found in the Preparatory study for the Ecodesign and Energy Labelling Working Plan 2022-2024.[12]

1.5. Introduction to scarce, environmentally relevant and critical raw materials

1.5.1. Approach for materials

The Preparatory study for the Ecodesign and Energy Labelling Working Plan 2022-2024 recommended including as a priority topic in the Working Plan critical raw materials (CRMs) due to their supply risks and scarcity from an EU perspective, and in a broader sense, other raw materials with high environmental and/or social risks and impacts.

The reasons for looking at raw materials in a broader sense is that the concept of CRM is mainly based on supply risk and thereby economic factors. This means that the CRM concept focuses on the scarcity of the materials rather than on their environmental impact, although some environmental aspects are indirectly addressed in the evaluation of the supply risk.

However, the consideration of environmental aspects in the assessment of the raw material supply situation (criticality) is also gaining further relevance for economic operators such as manufacturers and suppliers, as environmental damage caused e.g. by disaster events such as tailing dam failures can increasingly represent a reputational risk for downstream companies. Additionally, for example, the Product Environmental Footprint (PEF) method and the new EcoReport Tool includes a category “Resource use, minerals and metals”.

Furthermore, the fact that many mining and processing practices are associated with substantial environmental impacts (such as ecosystem damage, soil removal, and the use of water, energy, and chemicals) can represent a future supply risk if such external environmental and social costs are increasingly internalised through effective implementation of standards and requirements, which can lead to an increase in raw material prices (ecological raw material availability).

1.5.2. Critical Raw Materials

The most recent list of CRMs[13] (the fifth list) was published as part of the proposal for a Critical Raw Materials Act in 2023[14] containing 34 CRMs. The CRM list consists of raw materials meeting the requirements according to the published EU criticality methodology[15]. The methodology to define the Strategic Raw Materials (SRM) relevant for the green and digital transition as well as defence and aerospace applications is set out in

[12] https://www.ecodesignworkingplan20-24.eu/documents

[13] https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1

[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023PC0160

[15] https://data.europa.eu/doi/10.2873/769526

Annex I. The CRM are regarded as such for their importance to key sectors combined with a risk of demand outstipping supply and expected difficulties in increasing supply to compensate for the lack of CRM and SRM. SRM are considered CRM even if they do not simultaneously meet the CRM criteria. This is the case for copper and nickel.

Other non-CRM materials with high environmental impacts are e.g. gold, lead, molybdenum, rhenium, selenium, silver, tellurium and zinc.

All CRMs of the agreed list were considered in the study.

1.5.3. Potential implementing measures

Potential measures on CRMs and other raw materials related to product design and information include:

- Implementing measures facilitating durability of the products and/or components containing relevant CRMs and other raw materials.
- Implementing measures facilitating the recyclability of those products and/or components containing relevant CRMs and other raw materials, such as
  - requirements on design for disassembly;
  - requirements on information and declaration for facilitating recycling operations based on the guidance of standard EN 45558:2019 with regard to substance, amount and location in components of the energy related products; and
  - requirements on dismantling information for facilitating recycling operations such as the sequence of dismantling steps, tools or technologies needed to access the targeted component.
- Promoting the use of recycled raw materials via
  - design requirements setting a minimum share of recycled raw materials, and
  - labelling requirements on the applied share of recycled raw materials
- Implementing measures for enhancing the recovery rate from the waste flows or streams.
- Increasing the collection or take back rate of appliances and goods that contain CRMs.

As it can be seen, potential measures on CRMs and other raw materials in product design are much linked to measures on facilitating recycling and including recycled content, as well as to product durability. These measures could contribute to reduce the pace of further resource extraction, thus reducing the associated environmental impacts, and, insofar as extraction also occurs within the EU, facilitate a reduction in the import dependence of EU industry on non-EU sources.

Implementing measures on raw materials in ErP (energy-related products) taking additionally into account environmental and social risks and impacts could further reduce emerging economical or reputational risks in the global supply chains of EU manufacturers.

Further information on recycled content policies, test standards, market figures, usages, technologies, availability and quality of the material, market surveillance, impact on energy, emissions and costs and saving potential as of 2021 can be accessed in Preparatory study for the Ecodesign and Energy Labelling Working Plan 2022-2024, Task 3 preliminary analysis of product groups and horizontal initiatives.[16]

[16] https://www.ecodesignworkingplan20-24.eu/documents

1.6. This report

This report presents the results of Phase 1: Prioritisation of materials and product groups. It was updated after the stakeholder meeting on 2 July 2024.

2. AIM AND METHODOLOGY OF PHASE 1: PRIORITISATION OF MATERIALS AND PRODUCT GROUPS

2.1. Aim and outcome

The aim of Phase 1 is to identify the most relevant and suitable materials and products that could be subject to requirements on recycled content and on scarce, environmentally relevant and critical raw materials.

The outcome is a prioritisation list of relevant materials and products, which could be subject to legal requirements, in particular by identifying a number of priority combination of a material (or group of materials) and one or more product(s) or component(s) in energy related products, using a multi criteria analysis.

The prioritisation list is the result of the analyses and is the suggestion for five product and material combinations for successive further mini-preparatory studies.

Before the final selection was adopted in collaboration with the Commission, stakeholders were consulted via a stakeholder meeting followed by written consultation.

2.2. Methodology

Phase 1 consists of the following four tasks:

- Task 1: Establish the criteria for the prioritisation of materials and products
- Task 2: Collecting data and analyses
- Task 3: Final list of priority ‘bins’
- Task 4: Stakeholder consultation

These are detailed in the following.

3. TASK 1: ESTABLISH THE CRITERIA FOR THE PRIORITISATION OF MATERIALS AND PRODUCTS

3.1. Elements of the multi-criteria analyses

Several criteria have been considered and assessed. Some were given by the technical specifications; others were considered based on the main data source, Ecodesign Impact Accounting and some were proposed by stakeholders.

The recommended type of criteria to be used for the prioritisation and the recommendation on product-material bins for the following detailed studies consist of:

1. Scope for coverage of products and materials provided by the European Commission in the ToR (Terms of Reference) for the study
2. Environmental impact of and material use for all materials in the products including CRMs
3. CRM supply risk
4. Legislative feasibility

Number 2 and 3 criteria are quantitative while number 1 and 4 are qualitative.

These types of criteria were selected on the basis of the study scope hereinunder the Ecodesign and Energy Labelling Working Plan 2022-2024 and the data availability. They are detailed in the following.

A supporting Excel data and prioritisation tool has been developed. It includes a very large dataset necessary to calculate the environmental impact and material use and the CRM supply risk. The tool has also been used for setting individual and weighted scores to assist the prioritisation. See further in Section 4.

Data were collected and assessed for both 2020 and 2030.

3.2. Scope for coverage of products and materials

Products in scope are products that are already regulated under the Ecodesign and Energy Labelling policy[17] as well as other energy related products, i.e. which are in scope of the Ecodesign Directive 2009/125.[18]

To ensuring representation of materials and products in the studies, a first and overall set of criteria was provided by the European Commission in the ToR (Terms of Reference) for the study:

- In terms of choice of materials:

[17] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rulesand-requirements/energy-label-and-ecodesign/energy-efficient-products_en

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02009L0125-20121204

- at least two of the five ‘mini’ Ecodesign preparatory studies shall be based on plastic materials;
- at least two of the five ‘mini’ Ecodesign preparatory studies shall be based on non-plastic materials;

- In terms of choice of products/product groups:
  - at least one of the five ‘mini’ Ecodesign preparatory studies shall analyse ICT/electronic product(s) (such as computers, servers, power supplies, smartphones, etc.);
  - at least one of the five ‘mini’ Ecodesign preparatory studies shall analyse industrial and/or business to business product(s) (such as industrial fans, electric motors, ventilation units, power transformers, etc.);
  - at least one of the five ‘mini’ Ecodesign preparatory studies shall analyse white good(s) (such as washing machines, refrigerators, vacuum cleaners, etc.);
  - at least one of the five ‘mini’ Ecodesign preparatory studies shall analyse heat and cooling product(s) (air conditioners, heat pumps, boilers, etc.).

If relevant, there might be different combinations of materials and products.

3.3. Environmental impact and material use

3.3.1. Life cycle stages

Next criterion is the environmental impact and material use in the production phase (material and manufacturing impacts). In this prioritization phase, it seems preferable with respect to the aim of this study not to include the distribution phase and the use phase. Use phase impacts would be dominant and hide the differences between production impacts.

Packaging, refrigerants and mercury have been excluded, because they are already being addressed in other regulations and initiatives.

It would be relevant to include end-of-life impacts, but the treatment of the EoL phase in the 2014 EcoReport Tool, which is the main source of EoL data, is disputable, and the shares for EoL destinations (e.g. recycling, landfill) might be outdated.

The study team therefore recommends not to include the EoL data for this prioritization phase.

3.3.2. Impact categories

The following list of 15 impact categories are included in the 2014 EcoReport Tool and EIA are included under environmental impact and material use:

- Materials (kton)
- Primary energy (PJ)
- GHG emissions ($MtCO_2$)
- Process water (Mm^3)
- Cooling water (Mm^3)

- Hazardous waste (kton)
- Non-hazardous waste (kton)
- Acidification (ktSO_2)
- Volatile organic compounds (ton)
- Persistent organic pollutants (g i-Teq)
- Heavy metals to air (t Ni eq)
- Polycyclic aromatic hydrocarbons (t Ni eq)
- Particulate matter (kton)
- Heavy metals to water (t Hg/20)
- Eutrophication (t PO_4)

Data are provided for the production phase for all impact categories over the lifetime of the specific product and annually, where impact values are divided by lifetime, and for 2020 and 2030.

3.4. Critical Raw Materials

The first intention was to use the data from the EIA that has collected CRM mass data reported by the preparatory and review studies. However, only relatively few studies provided them, and not all in the same manner and at the same level of detail. It was decided to supplement the EIA data with a breakdown of metals, screens and printed circuit boards into their chemical elements (details in Annex A3).

For the prioritisation of CRMs, the security of supply has been used as a weighting factor. Data exist for "supply risk" (SR) scoring from the latest EU criticality exercise.[19] These scores already consider global supply, EU sourcing, governance in the producing countries, import dependence, trade restrictions, recycling and the availability of substitutes in all applications for each raw material. The scores are available for 70 raw materials and groups of raw materials.

See further details of this method in Section 4.4.3.

3.5. Legislative feasibility

The legislative feasibility is based on how feasible it is to include requirements in ecodesign implementing measures within the Ecodesign Directive and the Ecodesign for Sustainable Products Regulation (ESPR). E.g it would be much easier to include additional requirements on materials for a product, which is in the process of defining or updating the product requirements.

[19] European Commission (2023). Study on the Critical Raw Materials for the EU 2023. Final Report.

The legislative feasibility is included as a qualitative criteron during the final prioritisation of the product-material bins. We have included the following areas for the assessment:

The feasibility depends on:

- The products' regulatory process status with preference for products under preparatory study or review with an expected timeline corresponding to the timeline for the current study:
    - No regulation
    - Regulation underway (under ED or ESPR)
    - Regulation in place
    - Regulation under revision (under ED or ESPR)
- Preference for implementation under the ED, anticipated to have a shorter timeline than under the ESPR

3.6. List of products to analyse

The study team has compiled a list of products to analyse. The basis was the list of products included in the EIA. Other products were assessed if relevant to include:

- Products in the process of being regulated.
- Products that have undergone a preparatory study but are not regulated or are in the process of being regulated.
- Other products assessed previously in the technical studies of the working plans.

Based on the assessment, the following 35 products were selected for analyses:

- Dedicated Water Heater
- Central Heating combi, for space and water heating
- Solid Fuel Boilers
- Total Air Heating & Cooling
- Local Heaters (solid fuel)
- Local Heaters (electric, gas, liquid)
- Room Air Conditioner
- Circulator pumps, incl./excl. double counting
- Ventilation Units, residential and non-residential
- Lighting
- Electronic Displays
- Set Top Boxes (Complex & Simple)
- Game consoles
- Enterprise servers & data storage

- Personal Computers
- Imaging equipment
- Cartridges and Containers (empty)
- Total standby and networked standby
- External Power Supply, incl./excl. double counting
- Phones and Tablets
- Household Refrigerators & freezers
- Commercial Refrigeration
- Professional Refrigeration, incl./excl. double counting
- Cooking Appliances
- Household washing machines and dryers
- Household dishwashers
- Household Laundry Dryers
- Vacuum Cleaners
- Industrial Fans >125W, incl./excl. double counting
- Electric Motors LV 0.12-1000 kW, incl./excl. double counting
- Water pumps
- Welding Equipment
- Utility Transformers
- Photovoltaic panels and inverters (only CRMs assessed)
- Taps and Showers (only CRMs assessed)

For photovoltaic panels and inverters, there is no ED/EL regulation and no information in the EIA. A regulation is in advanced state of preparation.

For taps and showers, there is no ED/EL regulation and no information in the EIA. A regulation is not expected.

For both product groups, the study used total masses for sold products, including CRM data, as reported in an internal DG GROW study (see section 4.1).

4. TASK 2: COLLECTING DATA AND ANALYSES

4.1. Data sources

The main data sources used in the analysis are:

- Ecodesign Impact Accounting 2023, EIA, including “Ecodesign Impact Accounting 2023 – Material contents and Environmental impacts”[20]
- "Preliminary analyses for the prioritization of products and materials”, internal report from DG GROW (Part of the terms of reference for the project)
- “Study on the Critical Raw Materials for the EU 2023. Final Report.” European Commission (2023).[21]
- “Understanding the methodology behind the EU List of Critical Raw Materials.” Fraunhofer (2023)[22]

Several of the sources, especially the EIA, based their data on a broad range of other sources.

4.2. Steps in the analyses

An Excel multi-criteria model has been developed based on the model setup and experiences from the Ecodesign Impact Accounting. It contains all the data from the sources and analyses performed on the data. A scoring system was developed and added to the Excel model for assisting in assessing the various parameters across the criteria.

The overall steps were the following:

1. Add the 35 product groups with sub-categories to the Excel model
2. Select and insert the data selected for all the multi-criteria parameters for all product sub-categories and product groups
3. Establish the scoring system for each of the criteria to analyse and calculate the scores
4. Combine the quantitative multi-criteria analyses with the qualitative assessment of the scope for coverage of products and materials and the regulatory feasibility for the implementation of the requirements on materials and recycled content, see the previous section on Task 1.

[20] https://vhk.nl/eia.html

[21] https://op.europa.eu/s/zh3O

[22] https://publica.fraunhofer.de/entities/publication/86220653-0096-42b0-99e8-d54c98c470d4/details

4.3. Product list

The product list presented above (Section 3.6) is the basis for the analyses. For each product, all product sub-categories according to the regulation are entered in the Excel model, e.g. “DWH1, EIWH Electric Instant. < 12 kW (secondary)” meaning Domestic Water Heater, Electric Instantaneous heater below 12 kW. All the product sub-categories are summed up to product category level, e.g. “DWH Dedicated Water Heater”.

Totally, 35 product groups are included in Excel, of which some are built into higher-level regulated products and the analysis takes place for both levels of integration (see remarks on double counting in section 4.4.1).

4.4. Data collection and analysis

The following data points were collected from the sources presented above and inserted into the Excel model. Details of background information and the analysis methodology including data sources, and the detailed results from the Excel model are provided in Annex A. The methodology description is quite comprehensive and therefore in the following we have only included the most important information and results from this annex in a summarised form.

4.4.1. Material content

The material content for each product type is a main data source for calculation of the environmental impact and resource use. The process consisted of:

- Bills-of-Materials (BoMs) for reference products including quality of BOMs
- Map BoMs to more than 300 base case products of the EIA
- Material content incl. CRMs per unit base case product
- Multiply unit masses by sales for a given year
- Sum to 35 product group total masses

Comments and details of the calculations:

- Material content: Material categories and material types from BoMs according to the EcoReport Tool 2013, as used in existing preparatory and review studies:
    - BLK plastics (BLK: Bulk)
    - TEC plastics (TEC: Technical)
    - OTH plastics (OTH: Other, type not specified)
    - Ferrous metals
    - Non-ferrous metals
    - Coatings / platings
    - Electronics
    - Miscellaneous

- BoMs: Quality and year is variable and there are no time-series; quality has been judged using:
    - Year of last check / elaboration of the BoM (Table 4 in Annex)
    - Year of the original BoM
    - Share of 2020 sales mass for BoMs derived in the EIA:
        - Over 94% of the declared mass was available from BoMs in the preparatory and review studies; the remaining 6% of the mass comes from BoMs that have been derived in the EIA by similarity with other product base cases.
    - Share of 2020 sales units for which no BoM is available.
        - For 13% of sold products there was no BoM available. Although the mass of these products is unknown, almost all are small products regulated only for their standby, so that the missing mass[23] is expected to be far less than 13%. Not counting the standby products, for 0.1% of sold products there was no BoM available.
        - For products regulated only for their standby, the BoM information is scarce (see above), leading to the suggestion to exclude them from the final selection.
        - Water heating by central heating boilers (combis) is not listed as a separate product group. Their material content is assumed covered by central heating boilers (CHB). The drawback is that materials for hot water storage vessels are not included in the accounting.
- Product unit material masses have been taken from the product BoMs, and sales quantities from the EIA 2023. Environmental impacts (see next section), including material resource use, have been analysed at two levels:
    - Total production impacts (for products sold in a given year).
    - Annualised production impacts, computed as the total impacts divided by the average lifetime of the products (taken from the EIA 2023). Considering impacts per year of lifetime follows the spirit of the revised MEErP, as the best way to compare design options with different lifetimes. In addition, annualised values better indicate how fast regulatory measures can have an impact. The annualised value has therefore been used for comparison between the products and as input for the prioritisation.
- Double counting:
    - Some regulated products also appear as components in higher-level regulated products. Depending on the contents of the BoMs, this could mean that the same mass can be counted twice. There is a double counting issue for Circulators (CIRC), External Power Supplies (EPS), Condensing Units of

[23] The missing mass is almost all for products that are regulated only for their standby, which are a heterogeneous collection of various types of products, that would be difficult to assess in Phase 2. They include e.g. radios, electric toothbrushes, speakers, media boxes and sticks, small appliances, home and office network equipment, motor-operated building elements, height-adjustable desks, etc. Sales in 2020 are 400 mln of which nearly half is for small appliances. This is 13% of the sales of all regulated products, but the average weight of these standby products is much smaller than the average weight of the other products. Hence, missing weight will be much smaller than 13%.

Professional Refrigeration (PF), Industrial Fans (FAN) and Electric Motors (MT). For these product groups the information is provided inclusive (i) and exclusive (e) the double counted amount. When computing total impacts over all products, the double counted amounts have to be excluded. However, for the prioritization in this study it is preferable to include double counted amounts, so that the full potential impact of measures can be considered. (unless the double counting is relevant between the final 5 selected product-material combinations).

Figure 1 shows the material mass contained in products projected to be sold in 2030, per product group and per material category. More detailed charts are available in Annex A.

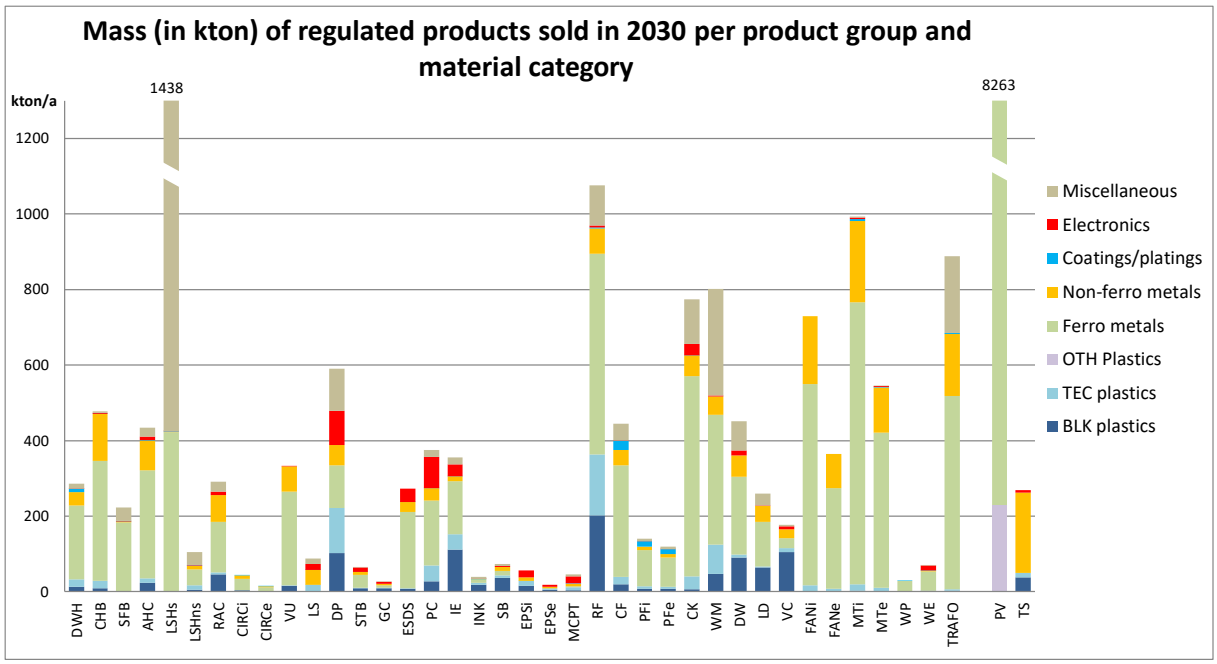


Figure 1: Material mass contained in products projected to be sold in 2030, per material category and product group. LSHs and PV are truncated.

DWH	Dedicated Water Heater	**EPS**	External Power Supplies
CWH	Central Heating Combi, Water Heating	**RF**	Household Refrigeration
CHB	Central Heating Boiler or Combi	**CF**	Commercial Refrigeration
SFB	Solid Fuel Boilers	**PF**	Professional Refrigeration
AHC	Central Air Heating & Cooling	**CK**	Cooking Appliances
LSH	Local Space Heaters	**WM**	household Washing Machines
RAC	Room Air Conditioner	**DW**	household Dishwashers
CIRC	Circulator pumps <2.5 kW	**LD**	household Laundry Dryer
VU	Ventilation Units	**VC**	Vacuum Cleaners
LS	Light Sources	**FAN**	Industrial Fans >125W
DP	Electronic Displays	**MT**	Motors 0.12-1000 kW
STB	Set Top Boxes	**WP**	Water pumps
GC	Game Consoles	**WE**	Welding Equipment
ESDS	Enterprise Servers & Data Storage	**TRAFO**	Utility Transformers
PC	Personal Computers	**TYRE**	Tyres
IE	Imaging Equipment	**PV**	Photovoltaic panels and Inverters
INK	Ink/toner Cartridges/Containers (empty)	**TS**	Taps and Showers
SB	Products regulated for Standby		

4.4.2. Environmental impact of materials

The environmental impacts are based on the EIA 2023 EcoReport Tool, which implements the 2014 EcoReport Tool.

The revised EcoReport Tool, which is part of the revised MEErP (Methodology for Ecodesign of Energy-related Products), has been examined in detail but cannot be directly applied to the regulated products because the existing studies do not provide all required input information.

In addition, the sets of impact indicators available in the draft tool were not complete at the time of preparation this report, and it is often not clear which impacts are covered by the various items (materials, processes) and how the items have to be combined to capture the total impacts [24].

Therefore, it was decided not to use the revised tool in the prioritisation phase.

The revised EcoReport Tool is intended to be used for coming studies, including for the five mini-preparatory studies to be carried out in Phase 2 of this study. For these new studies, updated material data in line with the revised EcoReport Tool will be collected and used for calculations in the tool.

As mentioned previously, the prioritization scores are based only on production impacts (material and manufacturing impacts) and not the distribution phase and the use phase. Use phase impacts would be dominant – for products currently regulated by Ecodesign - and hide the differences between production impacts. If the use phase enviromental impacts would have been included in the prioritisation, the results would have been skewed and would not provide the solid ground of selecting product / materials combinations, which is the focus of this study.

As also stated previously, it would be relevant to include end-of-life impacts, but the treatment of the EoL phase in the EIA ERT and 2014 ERT is uncertain. For coming further studies in Phase 2 using the revised ERT, EoL assessment will be included as far as the data available allows.

For each of the 35 product groups and all sub-categories (plus variants including and excluding double counting where relevant), the environmental impacts from the production phase are calculated for the 15 impact categories, see Section 3.3.2.

As explained in the previous section on materials, data have been calculated and provided for both 2020 and 2030 (year of sale of product) based on the historic and modelled future sales data. Data for 2030 have been used for the prioritisation, because this year would be closer to the year in which the anticipated regulations will take effect.

In addition, both total and annualised (divided by lifetime) environmental impacts have been computed, where the latter have been used in the prioritisation assessments. This follows the methodological choice described in the previous section, enabling better comparison between products with different lifetimes.

[24] Only for the material impacts from plastics (without manufacturing processes), and only for primary energy impacts and GHG emissions, the impacts from the 2014 ERT and the draft 2023 ERT could be compared, leading to the same prioritization scores of product groups for plastic impacts.

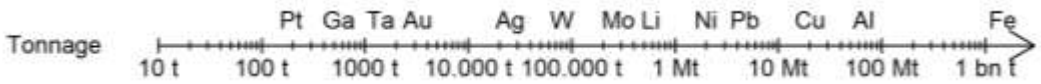
4.4.3. Supply risk of Critical Raw Materials

The environmental impacts of CRM are included in the environmental impacts computed based on the BoMs (previous section), because the CRM mass is part of the BoM masses for metals and electronics. Insufficient information was available to compute the environmental impacts specifically for the CRMs. The prioritization is therefore based on CRM masses, but, as mentioned in Section 3.4, the supply risk of CRMs and the world production of CRMs were used as weighting factors. See explanation of the supply risk in Section 3.4.

Prioritization of product groups for their CRM (and non-CRM) content involves resolution of two problems:

1- The various types of CRMs do not have the same importance: the contributions have to be "weighted" in some way. Since "security of supply" is the aspect that should be highlighted, it is proposed to perform the weighting using the "supply risk" scoring from the latest EU criticality exercise[25]. These scores already consider global supply, EU sourcing, governance in the producing countries, import dependence, trade restrictions, recycling, and the availability of substitutes in all applications for each raw material. The scores are available for 70 raw materials and groups of raw materials.

2- The masses of CRMs and non-CRMs contained in sold regulated products vary by a factor of nearly a million, e.g. from 778 kton of copper in 2020 to 0.001 kton for bismuth or platinum. These amounts have to be weighted somehow to yield adequate comparisons between different product groups, otherwise copper would dominate the prioritization. The global market size of the CRMs and non-CRMs has been used as a weighting factor[26]:



That ensures that 1 ton of gold "weighs" more than 1 ton of copper in the sum because:

$$\frac{1\ t\ Au}{global\ Au\ production} \gg \frac{1\ t\ Cu}{global\ Cu\ production}.$$

If SR_m is the supply risk score for raw material m, then the CRM and non-CRM overall prioritization score has been determined as:

$$Product\ priority = \sum_m SR_m \times \frac{mass\ of\ m\ in\ EU\ market\ for\ product}{total\ market\ tonnage\ m}$$

To assess the prioritisation of the products, the score for CRM is used in parallel with the score for the environmental impacts and material use. No attempt has been made to combine the two scores in a single one.

See details in Annex A3.3.

[25] European Commission (2023). Study on the Critical Raw Materials for the EU 2023. Final Report. Available online at https://single-market-economy.ec.europa.eu/publications/study-critical-raw-materials-eu-2023-final-report_en.

[26] Tercero Espinoza, Luis (2023). Understanding the methodology behind the EU List of Critical Raw Materials.

4.4.4. Legislative feasibility

Table 1 presents the regulatory process status of the selected product groups.

Table 1: Regulatory process status

Product groups		Ecodesign Regulation	Energy Labelling Delegated Regulation	Regulatory process status
DWH	WH dedicated Water Heater	814/2013	812/2013	IA ongoing
CHB	CHB Central Heating boiler < 400 kW	813/2013	811/2013	IA ongoing
SFB	SFB Solid Fuel Boilers	2015/1187	2015/1189	IA ongoing
AHC	AHC total Air Heating & Cooling	2016/2281		IA ongoing
LSHs	LH Local Heaters (solid fuel)	2015/1185	2015/1186	IA ongoing
LSHns	LH Local Heaters (electric, gas, liquid)	2015/1188	2015/1186	IA/WD ED ready, Co-Label study
RAC	RAC Room Air Conditioner	206/2012	626/2011	IA/WD ED ready, Co-Label study
CIRC	CIRC Circulator pumps, incl. double	641/2009		Status unknown
VU	VU Ventilation Units, res + non-res	1253/2014	1254/2014	IA phase to start 2024
LS	LS Lighting	2019/2020	2019/2015	Review due December 2024
DP	DP Electronic Displays	2019/2021	2019/2013	Evaluation & IA ongoing
STB	STB set top boxes (Complex & Simple)	Voluntary agreement		Not relevant
GC	Game consoles	Voluntary agreement		Not relevant
ESDS	ES + DS total	2019/424		Review ongoing, target June 2024
PC	PC Personal Computers	617/2013		Review ongoing
IE	EP & IJ imaging equipment	Voluntary agreement		Preparatory study ongoing
INK	Cartridges and Containers (empty)	Voluntary agreement		Preparatory study ongoing
SB	Total (networked) SB (excl. double)	2023/826		New regulation published in 2023
EPS	EPS incl. Double	2019/1782		IA ongoing
MCPT	Phones and Tablets	C(2023)3538	C(2023)1672	Regulations published 2023
RF	RF Household Refrigerators & freezers	2019/2019	2019/2016	Review due December 2025
CF	CF Commercial Refrigeration	2019/2024	2019/2018	Review due December 2023
PF	PF Professional Refrigeration, incl. Double	2015/2095	2015/1094	Review ongoing
CA	CA Cooking Appliances	66/2014	65/2014	IA ongoing
WM	WM-WD Total household Washing	2019/2023	2019/2014	Review due December 2025
DW	DW Household Dishwashers	2019/2022	2019/2017	Review due December 2025
LD	LD Household Laundry Dryers	932/2012	392/2012	New regulations published 2023
VC	VC Vacuum Cleaners (incl. cordless, robots)	666/2013		IA ongoing
FAN	FAN Industrial Fans >125W, incl. double	327/2011		IA/WD almost ready
MT	MT Elec. Motors LV 0.12-1000 kW, incl. double	2019/1781		To be reviewed before November 2023
WP	WP Water pumps	574/2012		IA ongoing
WE	WE Welding Equipment	2019/1784		Review due November 2024
TRAFO	TRAFO Utility Transformers	548/2014		Review started 2023/06, target 2024/06

PV	Photovoltaic panels and inverters 2020			IA ongoing
TS	Taps and Showers 2020			Status unknown

Some of the products currently undergoing preparatory or review studies or impact assessment will get implementing measures under the ED (Ecodesign Directive), others under the ESPR (Ecodesign for Sustainable Products Regulation). The priority of this study is to carry out amendments to existing regulations under the current ED. The following product groups are anticipated to be carried out under ED based on information from the Commission:

- Photovoltaic panels
- Space and combination heaters
- Water heaters
- Solid fuel local space heaters
- Air conditioners inc. A-A HPs
- Solid fuel boilers
- Air heating / cooling products
- Ventilation units
- Vacuum cleaners
- Cooking appliances
- Water pumps
- Industrial fans
- Circulators
- External power supplies
- Computers
- Servers and data storage products
- Power transformers
- Professional refrigeration
- Imaging equipment

4.5. Product group scoring system

The aim of the scoring system is to enable assessment of the environmental impact over the 15 impact categories together with the CRM and non-CRM impacts via scores that will assist the study team in providing the recommendation on the final list of priority bins. The scoring system is built into the Excel multi-criteria model.

Scores have been set for all the environmental impact categories including material content and for the supply risk of CRMs. The scoring principle for CRMs is described in Section 4.4.3.

Scores for environmental impacts follow these principles:

For each combination of environmental category (15), material category (7), year (2) and time-scale (2: full impacts or annualised impacts divided by average product lifetime), the procedure provides production impact values for 33 product groups (excluding PV systems and taps and shower heads[27]).

For each combination, the range between the maximum and minimum impact values per product group is divided in six subranges: A product group whose impact falls in the highest subrange is assigned a prioritization score of 1.0, in the next highest range 0.8, then 0.6, 0.4, 0.2 and 0.0 for the lowest range.

The prioritization scores are summarized in a MAX score (maximum score for any of the 15 environmental parameters) and a SUM score (sum of scores over the 15 parameters). There are separate scores for year 2020 and year 2030, with differences due to relative changes in sales quantities. No data were available for expected changes in material compostion.

The SUM score for each material category was used for the prioritisation because this score best represents the total environmental impact. This method corresponds to a weight for each impact category equal to one. Other weighting methods were considered, including the method provided in the PEF (Product Environmental Footprint) guidelines.

The CRM supply risk score is not included in the SUM score, it is presented as a separate score. However, as said, the environmental impacts of CRMs are indirectly included in the SUM score like the impacts of all other material types.

The prioritization scores for environmental impacts have been examined for all materials together and separately per material category (plastics, ferrous metals, non-ferrous metals, coating / plating, electronics and miscellaneous).

[27] These product groups are not currently regulated and thus no material and impact information were available in the Ecodesign Impact Accounting and required additional resources exceeding available resources in Phase 1 of this study.

5. TASK 3: FINAL LIST OF PRIORITY 'BINS'

In this section, we provide the recommended list of priority bins based on scoring for environmental impact and for CRM supply risk and on the qualitative criteria.

5.1. Scoring for environmental impact and for CRM supply risk

For the environmental impacts (including material use) and the CRM supply risk, Table 2 highlights the product groups that are most interesting for further study in Phase 2, per material category. Numbers in red indicate the product groups with the highest ranking (1 to 10, 1 is highest rank) for annualised (per year of lifetime) environmental impacts from the production phase and for the weighted CRM and non-CRM content[28]. For reference, see the tables in Annex A2.2.1-2.2.7 and A3.3 and further details and remarks in the annex.

[28] For circulators, external power supplies, professional refrigeration, electric motors and industrial fans, the table considers only the values including double counted amounts. For this reason, some rankings may be missing. See Annex A for the full tables that report amounts including and excluding double counted amounts.

Table 2: Survey of product groups with the highest rankings (1 is ranked highest) for annualised environmental impacts from the production phase, per material category, and ranking for CRM content for year 2030

Product group	**Ranking for Environmental impact per year of lifetime**							**Ranking for Supply risk**
	All Materials	**Plastics**	**Ferrous metals**	**Non-ferrous metals**	**Coating / Plating**	**Electronics**	**Miscellaneous**	**CRM**
DWH Dedicated Water Heater	18	16	18	23	**8**	12	13	32
CHB Central Heating boilers	18	14	13	**6**	10	12	13	22
SFB Solid Fuel Boilers	28	16	23	26	10	12	13	30
AHC Air Heating & Cooling	18	16	13	**10**	10	12	13	18
LH Local Heaters (solid fuel)	17	16	12	26	10	12	**9**	23
LH Local Heaters (electric, gas, liquid)	28	16	25	26	10	12	13	34
RAC Room Air Conditioner	24	16	21	**9**	10	12	13	14
CIRC Circulator pumps	28	16	25	26	10	12	13	37
VU Ventilation Units	18	16	13	17	10	12	13	27
LS Light Sources	28	16	25	26	10	12	13	**4**
DP Electronic Displays	**5**	**4**	18	**6**	10	**3**	**4**	**7**
STB Set Top Boxes	24	16	11	23	10	**8**	13	**10**
GC Game consoles	28	16	25	26	10	12	13	28
ESDS Servers and Data Storage	**4**	16	**4**	**5**	**4**	**4**	13	**3**
PC Personal Computers	**2**	**5**	**9**	**2**	10	**2**	13	**1**
IE imaging equipment	**3**	**2**	**10**	21	**5**	**5**	11	**9**
INK Cartridges and Containers (empty)	11	**3**	23	17	10	12	**6**	39
SB Products regulated only for ‘standby’	28	**9**	25	23	10	12	12	33
EPS External Power Supplies	16	**10**	25	20	10	**6**	13	16
MCPT Phones and Tablets	**1**	16	25	21	**7**	**1**	**3**	**5**
RF Household Refrigerators & freezers	**7**	**1**	**8**	11	10	12	**6**	15
CF Commercial Refrigeration	**10**	**10**	**6**	13	**1**	12	**10**	31
PF Professional Refrigeration	28	16	20	26	**2**	12	13	36
CK Cooking Appliances	**8**	16	**5**	12	**6**	**7**	**4**	**6**
WM (household) Washing Machines	11	**7**	**2**	26	10	12	**8**	11
DW (household) Dishwashers	13	**8**	**7**	19	10	**8**	**2**	12
LD (household) Laundry Dryers	24	13	25	14	10	12	13	21
VC Vacuum Cleaners	13	**6**	25	15	10	**8**	13	**8**
FAN Industrial Fans	13	16	13	**4**	10	12	13	17

Product group	Ranking for Environmental impact per year of lifetime							Ranking for Supply risk
	All Materials	Plastics	Ferrous metals	Non-ferrous metals	Coating / Plating	Electronics	Miscellaneous	CRM
MT Electric Motors	**6**	12	**1**	**1**	**8**	12	13	13
WP Water pumps	28	16	25	26	10	12	13	35
WE Welding Equipment	24	16	25	26	10	**8**	13	20
TRAFO Utility Transformers	18	16	13	**6**	10	12	**1**	25
PV Photovoltaic panels and inverters								**2**
TS Taps and showerheads								24

5.2. Final selection

For the final list of priority bins, we assess the recommended four types of criteria:

1. Scope for coverage of products and materials provided by the European Commission in the ToR (Terms of Reference) for the study (see Section 3.2)
2. Environmental impacts including material use
3. CRM supply risk
4. Legislative feasibility (see 4.4.4)

The recommended five product-material bins are presented in the table below. Details on materials and environmental impacts are provided in the Annex. Table 3 also shows the weighted average lifetime of the products. This information may be relevant for some circular economy policies, in particular for end-of-life requirements that will have no immediate impact but only when the first regulated products reach their end-of-life. Furthermore, details on the most relevant materials in percentages of the masses are indicated (details in the Annex); the CRM supply risk and the legislative feasibility are provided, together with comments, where relevant as background for the recommendations.

Table 3: Recommended five product-material bins with details relevant to the prioritisation

Product-material bin	Environmental ranking	Supply risk ranking CRM	Legislative feasibility	Life-time	Comments
Household refrigerators and freezers (white goods) / Plastics	Plastics: 1 All materials: 7 3 highest amounts of materials: - Ferro: 49% - Bulk plastics: 19% - Technical plastics: 15%	15 Top 5: - Bauxite/Al - Silicon metal - Palladium - Coking coal - Copper	Review due December 2025 under ESPR	16.0	Results from this study would need to await the review.
Imaging equipment (ICT / electronics) / Plastics	Plastics: 2 All materials: 3 3 highest amounts of materials: - Ferro: 40% - Bulk plastics: 31% - Technical plastics: 11%	9 Top 5: - Palladium - (Tin) - Bismuth - Bauxite/Al - Antimony	Preparatory study ongoing under ED	5.3	
Electric motors (industrial /B2B) / Ferrous & non-ferrous metals	Ferrous metals: 1 Non-ferrous metals: 1 All materials: 6 3 highest amounts of materials: - Ferro: 75% - Non-ferro: 22% - Technical plastics: 2%	13 Top 5: - Bauxite/Al - Silicon metal - Palladium - Coking coal - Copper	Due for review under ESPR	9.3	No other industrial / B2B are relevant. Results from this study would need to await the review.
Personal computers (ICT / electronics) / Electronics and non-ferrous metals	Electronics: 2 Non-ferrous metals: 2 All materials: 2 3 highest amounts of material categories: - Ferro: 46% - Electronics: 22% - Plastics: 18%	1 Top 5: - Tantalum - Cobalt - Palladium - Bauxite/Al - Magnesium	Review ongoing under ED	5.2	
Household washing machines (white goods) / Ferrous metals	Ferrous metals: 2 All materials: 11 3 highest amounts of material categories: - Ferro: 43% - Misc.: 35% - TEC Plastics: 10%	11 Top 5: - Nickel - Bauxite/Al - (Chromium) - Palladium - Coking coal	Preparatory study ongoing under ESPR	14.9	

6. TASK 4: STAKEHOLDER CONSULTATION

6.1.1. Introduction

On the 19 October 2023, a first online stakeholder consultation meeting was held to inform stakeholders on the recently initiated study and to gather input, feedback, and insights from various stakeholders on the study topic. A total of 244 participants from approximately 160 organisations attended the meeting. During the meeting the background and objectives of the study were presented, and participants shared their opinions, raised any concerns, and provide suggestions. The study team welcomed written comments and inputs from stakeholders on specified topics and related inputs for a period of 5 weeks until 24th of November 2023. A total of 24 written comments from 9 different stakeholders were received after the first stakeholder meeting. These are summarised below.

A second stakeholder meeting (online and physical). was held on 2 July 2024. 27 Member State organisations and 150 other organisations (industry associations, manufacturers, recyclers, consumer and enviromental NGOs, etc.) were represented at the meeting. Written comments on this task 1 report could be submitted for a period of up to 4 weeks from the meeting. Written comments were submitted by 31 stakeholders. Comments on the report were submitted in a stakeholder commenting form, while other comments and inputs could be submitted in a free form. All comments were registered and processed. The comments on Task 1 report related mainly to a need for clarifying or detailing text. Many comments provided related to Task 2 of the study.

6.1.2. Outcome

Input provided during the meeting covering both comments raised in plenum and those posted in the meeting chat were appropriately collected and assessed.

The comments covered a broad range of inquiries and considerations related to the study.

They include questions about the scope, methodology alignment with ESPR, and the impact of different mass balance accounting methods for recycled content. There were concerns about the possible expansion of the Critical Raw Materials (CRM) list and the differentiation between various levels of recycled materials. Other queries pertain to the consideration of recycled material availability, the prioritisation approach, and the examination of EU minimum requirements for plastics.

The comments also highlighted the need to consider the long list of ICT products, to adopt horizontal approach, and to account for substance consumption in production and recycling. Suggestions were made to verify claims on recycled content and consider other EU legislations. Concerns about the evolution of market demand, molding conditions for recycled materials, provisions for exemptions, and the use of alternative non-fossil feedstock were raised. Additionally, there was a proposal to link RoHS/REACH with the Ecodesign Directive and a reminder to consider the implications of the Net-Zero Industry Act when evaluating the supply-demand situation of recycled material and corresponding requirements.

The most relevant comments touched the topics:

- Life cycle assessment, environmental impact and monetary assessment
- Use of recycled content and critical raw materials

- Double counting results
- Use of hazardous substances
- Trade flows, dependencies and supply risk
- Study approach and expected results

The study team took all the comments into account, which is described hereafter. The comments on data for materials used in the study; technology/area of the study; presentation improvements; use of abreviations and tap and shower data were either out of scope of the study or related to clarifications or to editorial changes.

6.1.3. Life cycle assessment, environmental impact and monetary assessment

The comments highlighted the importance of considering the entire life cycle assessment and the environmental impact to expand beyond a mass-based approach, when analysing material content. There were suggestions regarding the study's focus on raw material volumes, with a recommendation to include other values for a more comprehensive analysis. There was an emphasis on conducting assessments for critical and scarce materials, aligning with the upcoming European Critical Raw Materials Act (ECRMA).

In response to feedback a consensus emerged regarding the significance of incorporating the environmental impact of products as a criterion for prioritization. This acknowledgment indicated a shift away from solely depending on a mass-based approach, emphasizing a more comprehensive evaluation of the ecological footprint of products.

How study team took the comments into account:

- Additional environmental assessments were included in prioritisation using the data and information available at this level of assessments.
- Horizontal vs product-by-product approach: It is anticipated that for the Phase 2 studies, a horizontal approach in materials assessments will be performed accross the relevant product groups. As a first pririty, the results of these assessments will be implemented in the selected product groups, however, the requirements may be used as a basis for amendments in other regulations. Further implementation of horizontal material regulations would require extensive and very resource demanding studies and they would have to be implemented under the ESPR.

6.1.4. Use of recycled content and critical raw materials

The comments on recycled content presented concerns and recommendations. Participants sought clarity on the inclusion of chemical recycling and stress the economic impact of recycled material costs for minimum ecodesign requirements. Challenges mentioned include the absence of a common methodology and issues with market surveillance.

Conflicting suggestions arose for recycled content targets, with some advocating for exclusive counting of Post Consumer Recycled content (PCR) and others proposing the inclusion of post-industrial waste. Challenges in using post-consumer recycled materials were stated including compliance with RoHS and food-contact requirements, and considerations for material compatibility and careful criteria use were emphasised.

The prioritisation of critical raw materials (CRM) content was highlighted, with a suggestion to include old scrap availability. Participants also noted recent regulations defining recycled content requirements and question whether the study will consider the quality and quantity of available recycled materials.

How study team took the comments into account:

- The various types of recycled materials and of scarce materials have been detailed in this report in order to differentiate these types.
- For the priorisation of products-materials combination, the amount of data for various types of recycled materials and content is not sufficient to distinguish between the types of recycled materials. However, for the studies in Phase 2, it is expected that better and more detailed data on materials can be collected.
- A new method for assessment the CRMs has been developed and applied

6.1.5. Double counting results

The comments expresses apprehension regarding the possibility of manufacturers of finished goods, for example, facing dual regulation. This concern is specifically tied to the existence of varying regjulations for both finished products and their components, including motors, fans, and lighting. A suggestion is put forth to take into account the ongoing negotiations concerning the Critical Raw Materials Act. The suggestions advocates refraining from establishing specific requirements until the negotiations' outcomes are clarified. The overarching recommendation emphasizes the importance of aligning and coordinating requirements to prevent redundancy in regulations**.**

How study team took the comments into account:

- Double counting has already been taken into account in the assessments by having the concerned product groups in two versions; one including double counting and one excluding double counting
- Additionally, the comment will be taken into account for the analyses and policy options to be developed in Phase 2 of this study. As part of these studies, overlapping regulations will be assessed.

6.1.6. Use of hazardous substances

A comment was submitted, emphasizing the Directive 2011/65/EU of the European Parliament, which addresses an exemption regarding the use of cadmium and lead in plastic profiles found in electrical and electronic windows and doors. This exemption specifically applies to profiles containing recovered rigid polyvinyl chloride.

How study team took the comments into account:

- Hazardous waste is included in the environmental impact assessment
- Further inclusion can be included in Phase 2, where more details can be assessed regarding possible challenges for recycled content due to hazardous substances

6.1.7. Trade flows, dependencies, and supply risk

A concern was raised regarding the scope of the study, particularly whether it will include aspects such as trade flows, dependencies, and supply risks in the prioritization of products.

How study team took the comments into account:

- For the priorisation of products-materials combination, the amount of available data for trade flows, dependencies, and supply risks not sufficient to include in this phase. However, for the studies in Phase 2, it is expected that better and more detailed data can on these topics can be collected.

6.1.8. Study approach and expected results

There is also an inquiry into the study's role in advising the European Commission and the potential impact assessment for proposed measures. Additionally, there's a request for details on the study's purpose within the new EU Ecodesign for Sustainable Products Regulation, seeking information about expected results and prioritized product groups. Overall, the comments indicate a collective desire for a more efficient and impactful approach to address environmental concerns.

Additionally, cautious inquiry was expressed about the study's product-by-product approach, with a call for a horizontal, cross-category approach to optimize opportunities and avoid concentrating recycled materials in a few products. The suggested alternative is a swift definition of material-specific recycled content requirements, followed by product-specific definitions, seen as more positively framed and effective for addressing urgent environmental concerns.

Question was raised on the narrow selection of relevant and specific technologies/areas without considering other sectors such as agriculture and medical products.

Stakeholders highlighted another essential consideration for prioritization – Critical Raw Materials (CRM). During the stakeholders meeting, the study team clarified that the study would not redefine what qualifies as a scarce or environmentally relevant material. Instead, the forthcoming regulation would be founded on prevailing or prospective technical capabilities at the time the requirements are implemented. This comprehensive evaluation is scheduled for Phase 2 of the study and subsequent policy processes, ensuring a strong and well-informed approach to the prioritization of materials and their environmental considerations.

How study team took the comments into account:

- The environmental impact has been taking into account
- Other comments relate to more overall concerns not within the scope of the study

ANNEX A: BACKGROUND DATA AND INFORMATION ON THE EXCEL MODEL FOR THE MULTI-CRITERIA ANALYSES OF MATERIALS AND CRMS

A0 Introduction

This annex provides background information, explains the elaboration methodology including data sources, and summarizes the results for:

- the material content of products (A1),
- the environmental impacts in the production phase (A2),
- CRM content (A3).

The methodology description is quite comprehensive and therefore for the main report, we have only included the most important information and results from this annex in a summarised form.

A1 Material content

A1.1 Methodology for material content

All Ecodesign and Energy Labelling studies provided Bills-of-Materials (BoMs) for representative products within the studied product group. These data have been collected and elaborated in the Ecodesign Impact Accounting (EIA)[29], which VHK carries out for the European Commission.

All the available BoMs use the material categories and material types of the 2013 EcoReport Tool (ERT)[30], which are identically used in the EIA 2023 EcoReport Tool implementation (EIA ERT). Where the studies defined “Extra materials”, these have been taken into account.

The BoMs for representative products have been assigned to the 340 base case products distinguished in the EIA. The match is not one-to-one, and for some EIA products no BoM was available. In these cases, where reasonably feasible, the BoM was derived by the EIA team from available BoMs for similar products, e.g. by scaling for product capacity, but some EIA products remained without a BoM:

- Over 94% of the reported mass comes from BoMs in the preparatory and review studies; 6% of the mass comes from BoMs that have been derived in the EIA by similarity with other product base cases.
- For 13% of sold products there was no BoM available. Although the mass of these products is unknown, almost all are small products regulated only for their standby, so that the missing mass is expected to be far less than 13%. Not counting the standby products, for only 0.1% of sold products there was no BoM available.

[29] Ecodesign Impact Accounting 2023, Material content and Environmental impacts (draft), VHK for the European Commission, DG Energy, Unit B3, October 2023

[30] The existing studies do not provide the input information necessary for the application of the 2023 revised EcoReport Tool.

The BoMs in the preparatory studies are typically valid for the year in which the study was performed. Later review studies often used the same BoMs, sometimes elaborating the previous data. In general, there is no time-series for product material content.

The quality of the BoMs is varying: some studies report only the distribution of masses over the main material categories (bulk plastics, technical plastics, ferrous metals, non-ferrous metals, coating and plating, electronics and miscellaneous materials) while others are very detailed, per material type and sometimes even per component inside the product.

Table 4 shows the quality of the Bills-of-Materials (BoMs) per product group: year of last check or elaboration of the BoM, year of the original BoM, share of 2020 sales mass for which a BoM was derived in the EIA, share of 2020 sales units for which no BoM was available. Years vary from 2008 to 2021.

Circulators (CIRC), External Power Supplies (EPS), Condensing Units of Professional Refrigeration (PF), Industrial Fans (FAN) and Electric Motors (MT) are regulated as products, but partly also included in the BoMs of other products in which they appear as components. Hence there is a potential double counting issue for material masses (and related environmental impacts). For these product groups the information is provided inclusive (i) and exclusive (e) the double counted amount. When computing totals over all products, the double counted amounts are excluded. For the prioritization in this study, it is preferable to consider the information including double counted amounts (unless the double counting is relevant between the final 5 selected product-material combinations).

For photovoltaic panels and inverters (PV), and taps and shower heads (TS) there is no ED/EL regulation (yet) and thus no information in the EIA. For these product groups, material content information has been taken from a GROW study [31], but it is available there only as a total for all sold products [32].

Tyres have been excluded from the data collection, not being covered by ED or EL.

Water heating by central heating boilers (combis) is not listed as a separate product group. Their material content is assumed covered by central heating boilers (CHB) for the space heating function. The drawback is that materials for hot water storage vessels are not included in the accounting.

[31] Annex 2 of the Terms of Reference (TOR) for the project, and associated Excel file.

[32] In the GROW study there is no information per unit base case product, nor on the environmental impacts. Such information could probably be derived from the preparatory studies for PV and TS, but these data have not been elaborated (yet).

Table 4: Quality of the Bills-of-Materials (BoMs) per product group: year of last check or elaboration of the BoM; year of the original BoM; share of 2020 sales mass for the specific product group for which a BoM was derived in the EIA; share of 2020 sales units for which no BoM was available.

		Year of last BoM check / elaboration	Year of original BoM	Derived BoMs (share of 2020 sales mass)	Missing BoMs (share of 2020 sales units)
DWH	WH dedicated Water Heater	2019	2007	0%	0%
CHB	CHB Central Heating boiler < 400 kW	2019	2007-2019	2%	0%
SFB	SFB Solid Fuel Boilers	2009	2009	0%	0%
AHC	AHC total Air Heating & Cooling	2012	2012	36%	0.8%
LSHs	LH Local Heaters (solid fuel)	2012	2012	0%	0%
LSHns	LH Local Heaters (electric, gas, liquid)	2019	2012	0%	0%
RAC	RAC Room Air Conditioner	2018	2012	0%	0%
CIRCi	CIRC Circulator pumps, incl. double	2008	2008	0%	0%
CIRCe	CIRC Circulator pumps, excl. double	2008	2008	0%	0%
VU	VU Ventilation Units, res + non-res	2019	2009	0%	0%
LS	LS Lighting	2015-2021	2015	14%	0%
DP	DP Electronic Displays	2015	2005	0%	6%
STB	STB set top boxes (Complex & Simple)	2008	2008	0%	0%
GC	Game consoles	2019	2019	0%	0%
ESDS	ES + DS total	2015	2015	70%	0%
PC	PC Personal Computers	2016-2021	2005-2021	3%	0%
IE	EP & IJ imaging equipment	2019	2007	0%	0%
INK	Cartridges and Containers (empty)	2019	2019	0%	0%
SB	Total (networked) SB (excl. double)	2010-2021	2010-2011	0%	93%
EPSi	EPS incl. double	2021	2007	0%	0%
EPSe	EPS excl. double	2021	2007	0%	0%
MCPT	Phones and Tablets	2021	2021	0%	0%
RF	RF Household Refrigerators & freezers	2016	2007	0%	0%
CF	CF Commercial Refrigeration	2007-2021	2007	0%	0%
PFi	PF Professional Refrigeration, incl. double	2021	2011	0%	0%
PFe	PF Professional Refrigeration, excl. double	2021	2011	0%	0%
CK	CA Cooking Appliances	2021	2009-2011	0%	0%
WM	WM-WD Total household Washing	2017	2017	0%	0%
DW	DW Household Dishwashers	2017	2017	0%	0%
LD	LD Household Laundry Dryers	2019	2019	0%	0%
VC	VC Vacuum Cleaners (incl. cordless, robots)	2019	2009-2015	0.4%	0%
FANi	FAN Industrial Fans >125W, incl. double	2008	2008	0%	0%
FANe	FAN Industrial Fans >125W, excl. double	2008	2008	0%	0%
MTi	MT Elec. Motors LV 0.12-1000 kW, incl. double	2014	2014	31%	0%
MTe	MT Elec. Motors LV 0.12-1000 kW, excl. double	2014	2014	31%	0%
WP	WP Water pumps	2008	2008	0%	0%
WE	WE Welding Equipment	2012	2012	0%	0%
TRAFO	TRAFO Utility Transformers	2011-2017	2011	0%	0%
	TOTAL all regulated products, excl. double			**6%**	**13%**

For a selected year, the unit product masses can be multiplied by the sales in that year, by the stock, or by the number of units reaching End-of-Life (EoL) in the year. Data have been processed for years 2020 and 2030. Table 5 shows the average lifetimes, sales, stock and EoL-units per product group, in both years.

Table 5: Average lifetimes and quantity of products sold, in stock, or reaching End-of-Life in 2020 and 2030, in thousands of units, and increments (2030-2020)/2020 in %

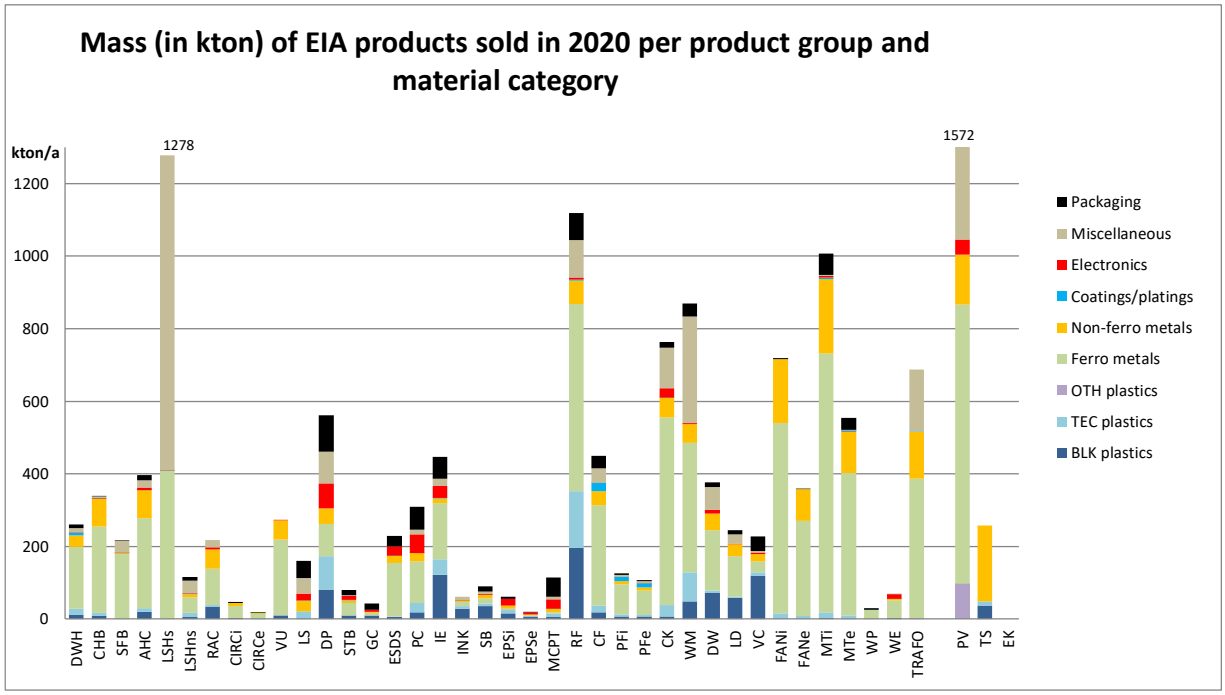
Thousands of units	Lifetime (years)			Sales (000 units)			Reaching End-of-Life (000 units)			Stock (000 units)		
	2020	2030	Inc.	2020	2030	Inc.	2020	2030	Inc.	2020	2030	Inc.
Dedicated Water Heat	15.54	15.55	0%	8515	9632	13%	9199	8338	-9%	135345	138297	2%
Central Heating boiler	18.3	18.3	0%	5548	5904	6%	5036	5338	6%	102939	105357	2%
Solid Fuel Boilers	18.66	18.69	0%	400	403	1%	365	592	62%	9068	7783	-14%
Air Heating & Cooling	15.92	16.0	0%	694	750	8%	513	646	26%	10039	11219	12%
Local Heaters (solid)	22.28	22.19	0%	3728	3892	4%	2273	3008	32%	68306	79960	17%
Local Heaters (other)	14.31	14.31	0%	17130	17113	0%	18420	17530	-5%	258437	243388	-6%
Room Air Conditioner	11.81	11.85	0%	4377	5878	34%	4883	4148	-15%	46089	59641	29%
Circulators, incl. double	10.0	10.0	0%	14184	14651	3%	13071	14184	9%	136929	145048	6%
Circulator, excl. double	10.0	10.0	0%	3277	2791	-15%	3503	3277	-6%	33773	30277	-10%
Ventilation Units	17.0	17.0	0%	2119	4169	97%	1226	1579	29%	27754	49232	77%
Light Sources	30.0	29.08	-3%	1508971	582010	-61%	1339052	376515	-72%	10793278	12658317	17%
Electronic Displays	9.4	9.5	1%	59668	73151	23%	43043	59668	39%	521649	626211	20%
Set Top Boxes	5.0	5.0	0%	34666	34666	0%	39423	34666	-12%	174828	173332	-1%
Game consoles	7.0	7.0	0%	10600	10600	0%	10600	10600	0%	74200	74200	0%
Servers, Data storage	5.7	5.7	0%	3771	5084	35%	3272	4282	31%	20263	27041	33%
Personal Computers	5.3	5.2	0%	67386	103278	53%	69227	85749	24%	348578	506664	45%
Imaging equipment	5.3	5.3	0%	19707	17823	-10%	19090	18743	-2%	106994	96121	-10%
Cartridges/Containers	1.0	1.0	0%	243802	158234	-35%	243802	158234	-35%	243802	158234	-35%
Standby (excl. double)	7.4	7.3	-1%	393499	434295	10%	376850	405695	8%	2818608	3057383	8%
EPS incl. double	4.0	4.0	0%	429653	436316	2%	421020	434204	3%	1708761	1738987	2%
EPS excl. double	4.3	4.3	0%	136543	139505	2%	129879	138369	7%	578822	595058	3%
Phones and Tablets	3.4	4.4	28%	196252	146881	-25%	208117	149101	-28%	686897	652611	-5%
Household Refrig.	16.0	16.0	0%	16732	17242	3%	15324	16254	6%	258072	269539	4%
Commercial Refrig.	9.4	9.4	0%	1587	1696	7%	1502	1594	6%	14413	15448	7%
Professional Refrig., incl. double	8.4	8.4	0%	1011	1149	14%	906	1033	14%	8122	9225	14%
Professional Refrig., excl. double	8.5	8.505	0%	821	929	13%	739	837	13%	6685	7554	13%
Cooking Appliances	16.25	16.19	0%	37026	38898	5%	31940	34698	9%	557536	605113	9%
Washing Machines	14.91	14.91	0%	12464	11993	-4%	11707	11541	-1%	174734	180352	3%
Dishwashers	15.0	15.0	0%	7833	9727	24%	4796	6833	42%	96528	125977	31%
Laundry Dryers	12.0	12.0	0%	4489	4700	5%	3367	4383	30%	45609	55430	22%
Vacuum Cleaners (incl. cordless, robots)	7.7	7.2	-6%	35390	37461	6%	31535	37701	20%	271040	279816	3%
Fans, incl. double	15.0	15.0	0%	16349	16626	2%	12499	14801	18%	214407	244105	14%
Fans, excl. double	15.0	15.0	0%	8175	8313	2%	6249	7400	18%	107203	122053	14%
Motors, incl. double	9.3	9.3	0%	42449	44185	4%	38882	42498	9%	380084	402700	6%
Motors, excl. double	9.3	9.3	0%	23347	24302	4%	21385	23374	9%	209046	221485	6%
Water pumps	10.5	10.5	0%	1494	1665	12%	1252	1487	19%	14526	16511	14%
Welding Equip.	6.3	6.3	0%	486	497	2%	485	490	1%	3049	3111	2%
Transformers	32.38	32.06	-1%	184	225	23%	98	119	22%	4401	5355	22%
TOTAL, excl. double				**2870681**	**1913706**	**-33%**	**2658151**	**1632789**	**-39%**	**18822510**	**21258070**	**13%**

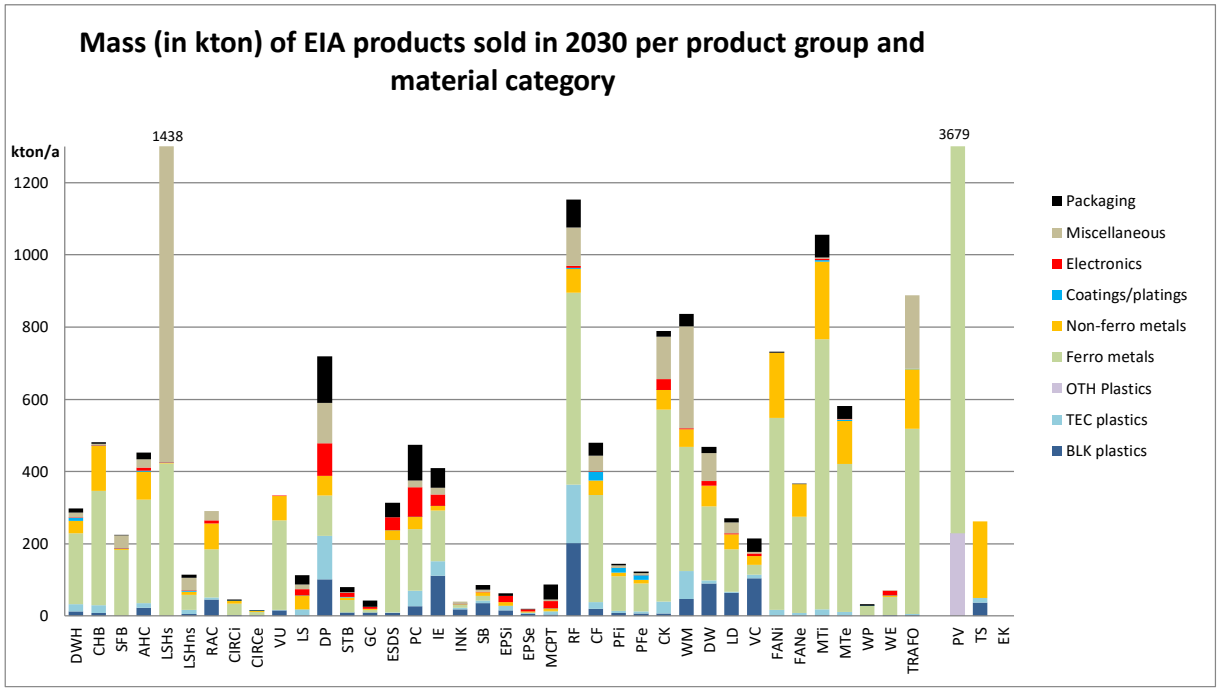
A1.2 Results for material content

The graphs below show the total mass contained in considered products sold in 2020 and 2030, per product group and material category. A breakdown for plastics, metals and electronics is also presented. Note that the bar-graphs for solid fuel local space heaters (LSHs) and photovoltaic panels and inverters (PV) are truncated.

Remarks:

- Photovoltaic panels and inverters (PV) have the highest overall mass in 2020, and this is projected to more than double in 2030. The next highest mass is for solid-fuel-fired local space heaters (LSHs; a large part is refractory ceramics in the miscellaneous category), followed by (household) refrigerators and freezers (RF), electric motors (MTi, incl. double counted), washing machines (WM) and cooking appliances (CK).
- The highest plastics mass is in (household) refrigerators and freezers (RF), followed at a distance by electronic displays (DP), imaging equipment (IE; projected in decline in 2030), washing machines (WM) and vacuum cleaners (VC). Plastics in sold dishwashers are projected to increase in 2030.
- The highest metals mass is in electric motors (MTi, incl. double counted) and photovoltaic panels and inverters (PV; with strong increase projected for 2030), followed by industrial fans (FANi, incl. double counted), (household) refrigerators and freezers (RF), cooking appliances (CK) and distribution transformers (TRAFO).
- The highest electronics mass (incl. screens) is in electronic displays (DP), followed by personal computers (PC) and photovoltaic panels and inverters (PV).
- Around 47% of the total product mass are ferrous metals, 11% non-ferrous metals, 14% plastics, 3% electronics, 21% miscellaneous materials (incl. e.g. refractory ceramics, glass, concrete, mineral oil) and 5% packaging.

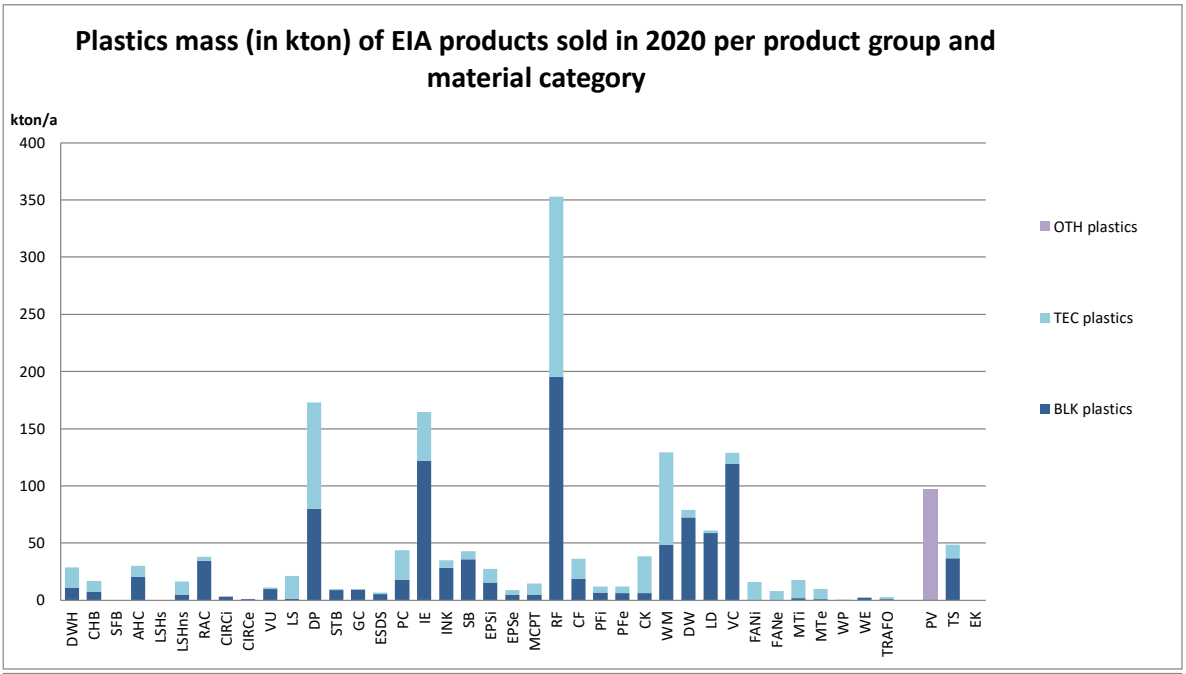


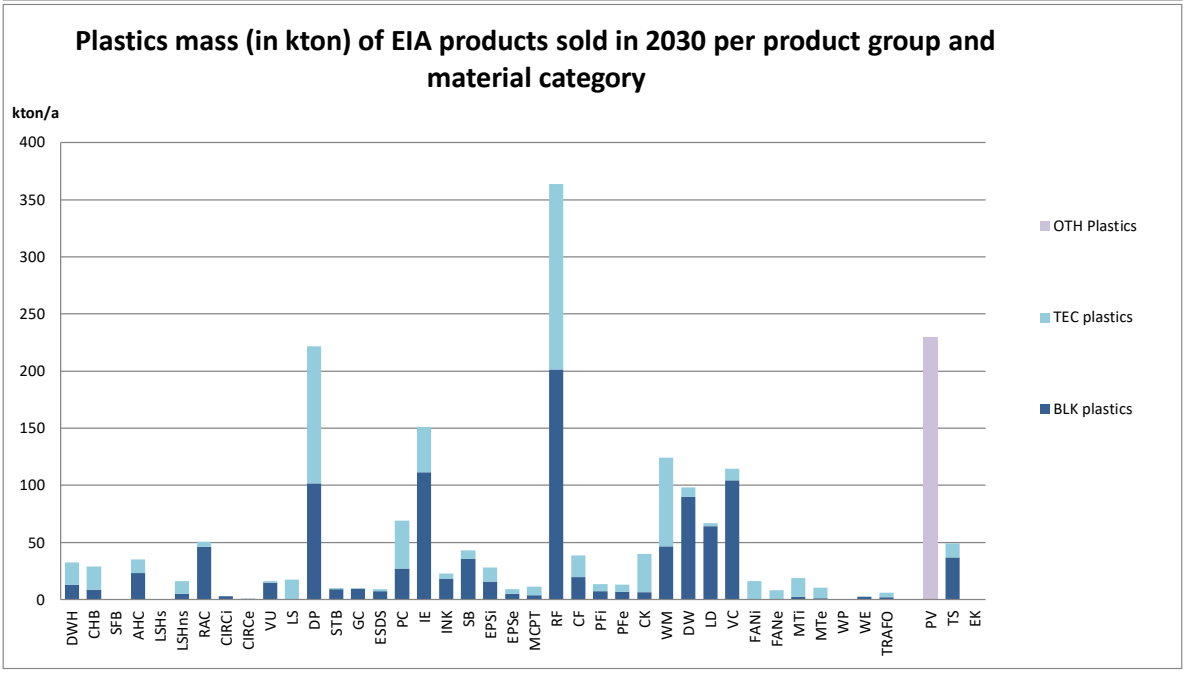


DWH	Dedicated Water Heater	EPS	External Power Supplies
CWH	Central Heating Combi, Water Heating	RF	Household Refrigeration
CHB	Central Heating Boiler or Combi	CF	Commercial Refrigeration [33]
SFB	Solid Fuel Boilers	PF	Professional Refrigeration
AHC	Central Air Heating & Cooling	CK	Cooking Appliances
LSH	Local Space Heaters	WM	household Washing Machines
RAC	Room Air Conditioner	DW	household Dishwashers
CIRC	Circulator pumps <2.5 kW	LD	Household Laundry Dryer
VU	Ventilation Units	VC	Vacuum Cleaners
LS	Light Sources	FAN	Industrial Fans >125W
DP	Electronic DisPlays	MT	Motors 0.12-1000 kW
STB	Set Top Boxes	WP	Water pumps
GC	Game Consoles	WE	Welding Equipment
ESDS	Enterprise Servers & Data Storage	TRAFO	Utility Transformers
PC	Personal Computers	TYRE	Tyres
IE	Imaging Equipment	PV	Photovoltaic panels and Inverters
INK	Ink/toner Cartridges/Containers (empty)	TS	Taps and Showers
SB	Products regulated for Standby	EK	Electric Kettles

Figure 2: Total mass contained in regulated products sold in 2020 and 2030, per product group and material category.

[33] Refrigerating appliances with a direct sales function


Plastics mass (in kton) of EIA products sold in 2020 per product group and material category
kton/a
400
350
300
250
200
150
100
50
0
DWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK
OTH plastics
TEC plastics
BLK plastics


Plastics mass (in kton) of EIA products sold in 2030 per product group and material category
kton/a
400
350
300
250
200
150
100
50
0
DWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK
OTH Plastics
TEC plastics
BLK plastics

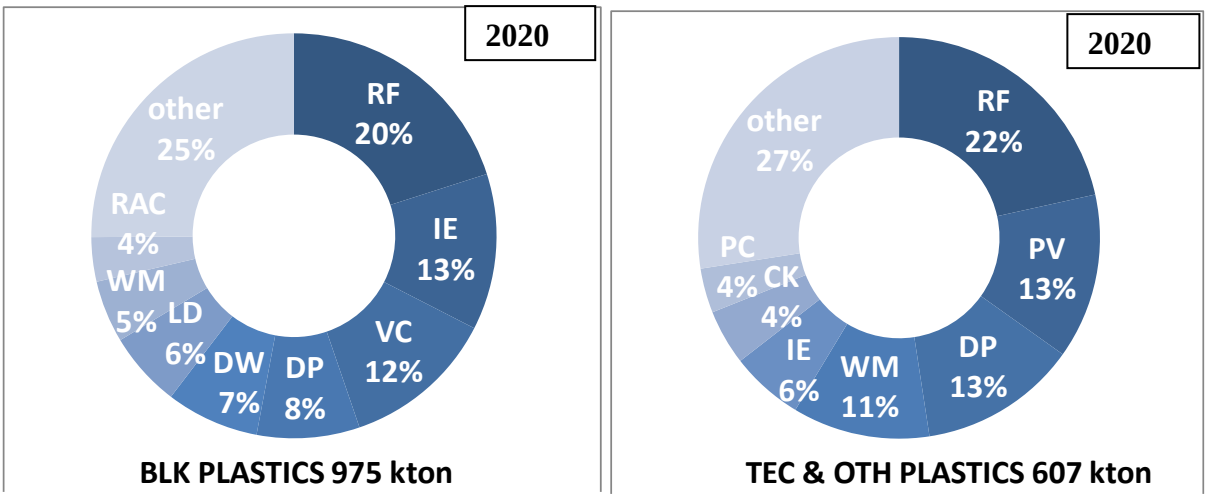
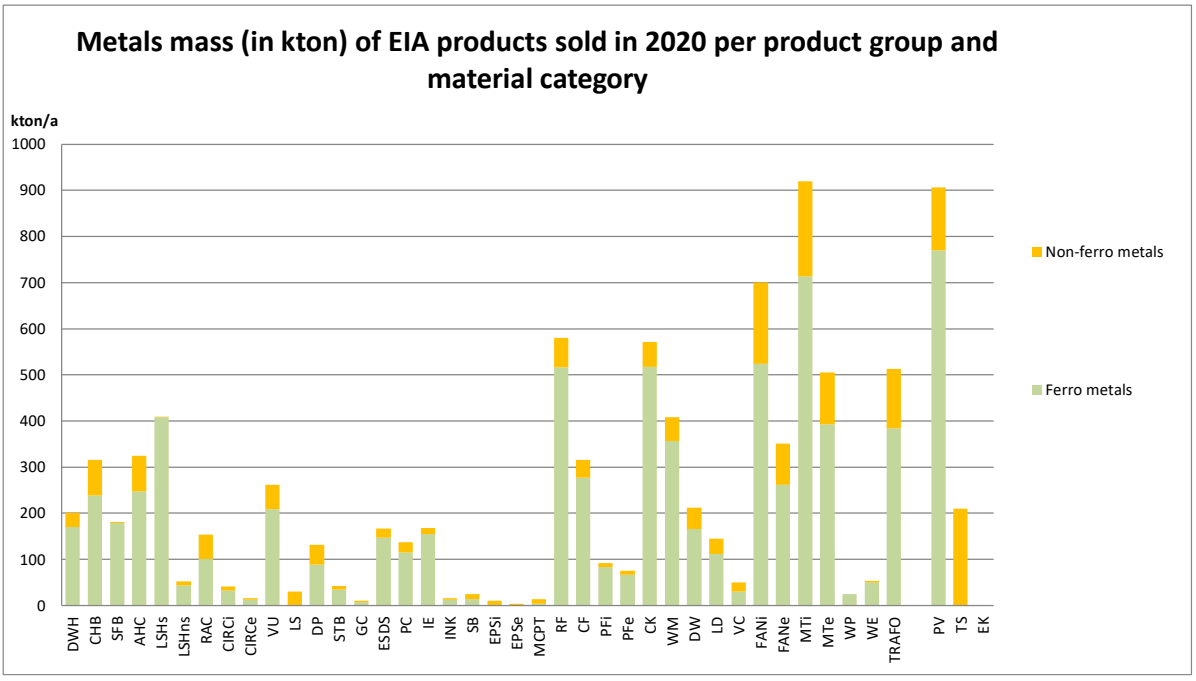


Figure 3: Plastic mass contained in regulated products sold in 2020 and 2030, per product group, split in Bulk plastics and Technical plastics. For PV no division for the two categories was available, and the entire amount is indicated as "other plastics". See Table 4 or Figure 2 for abbreviations used.



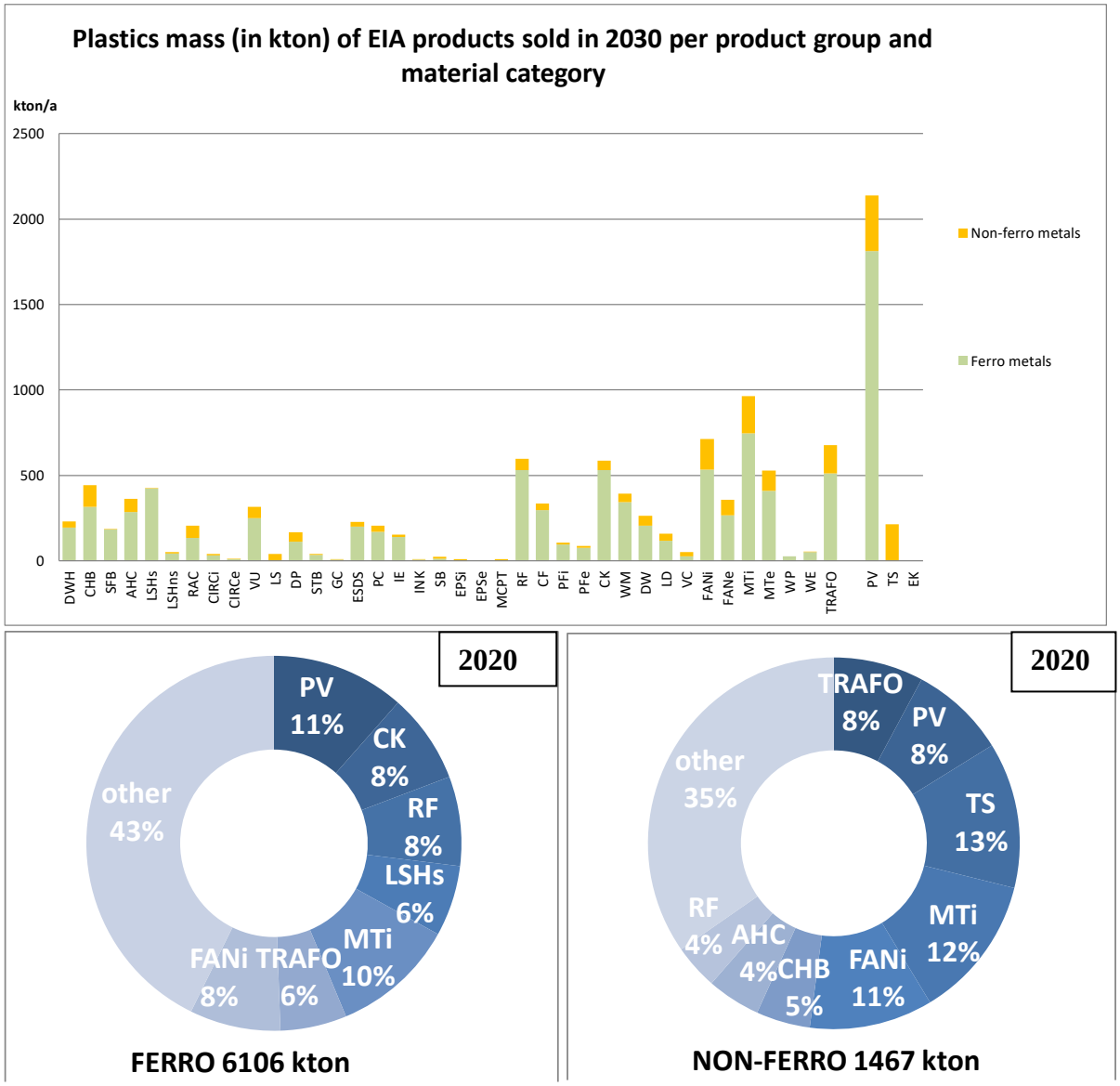
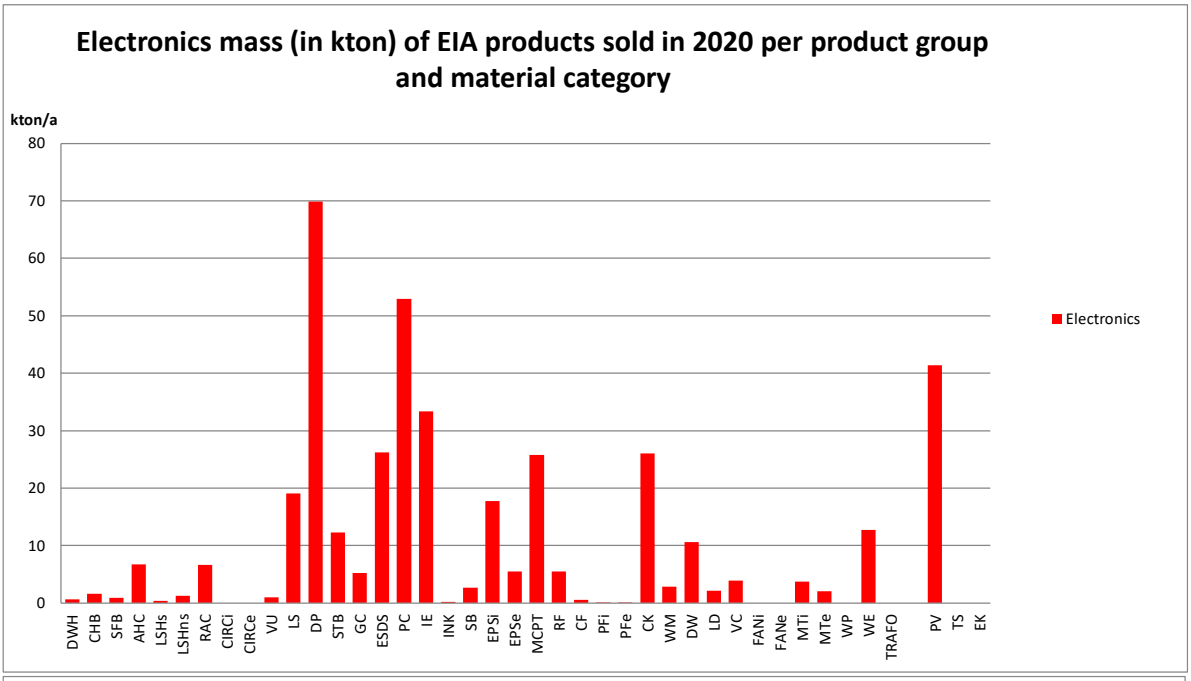
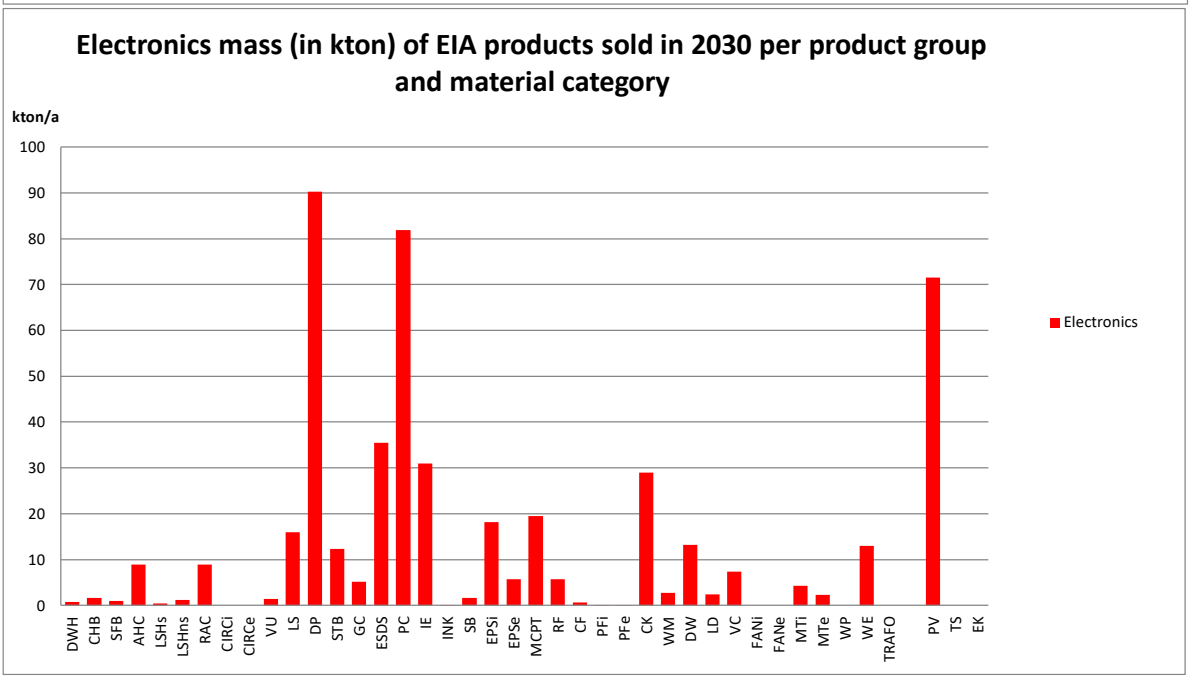


Figure 4: Metal mass contained in regulated products sold in 2020 and 2030, per product group, split in Ferrous metals and Non-ferrous metals. See Table 4 or Figure 2 for abbreviations used.


Electronics mass (in kton) of EIA products sold in 2020 per product group and material category
kton/a
80
70
60
50
40
30
20
10
0
DWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK
Electronics


Electronics mass (in kton) of EIA products sold in 2030 per product group and material category
kton/a
100
90
80
70
60
50
40
30
20
10
0
DWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK
Electronics

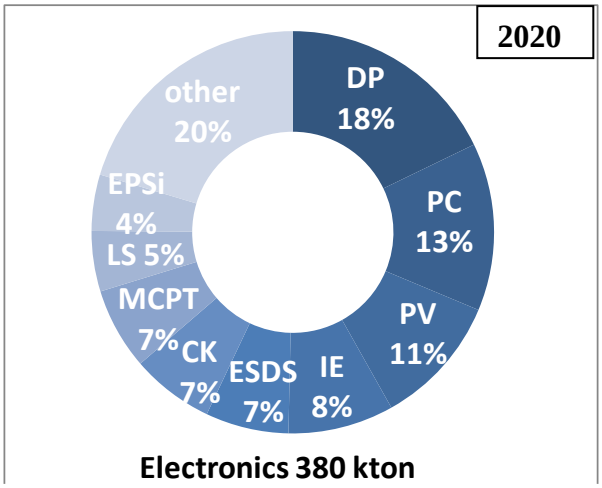
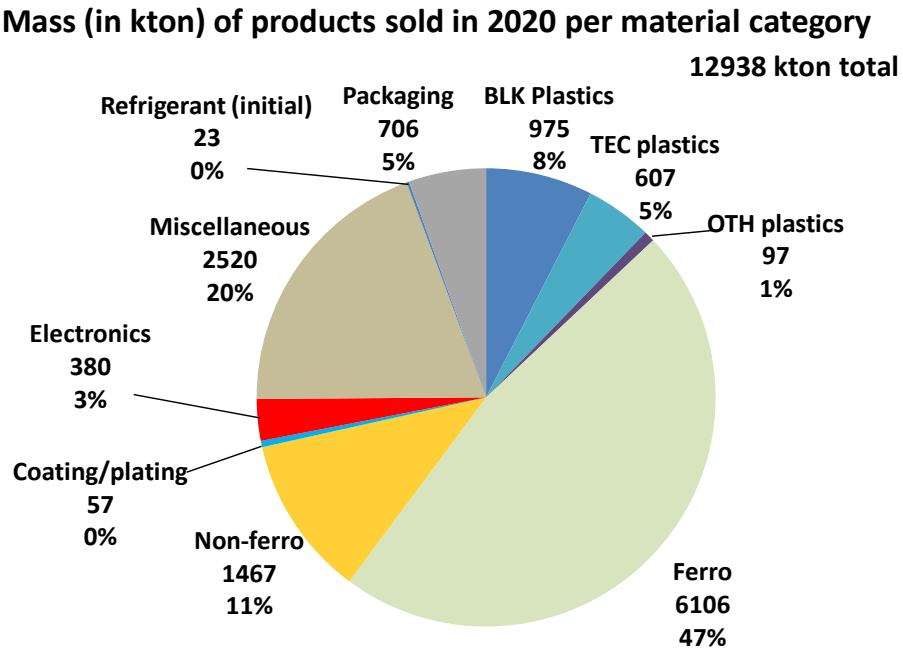


Figure 5: Metal mass contained in regulated products sold in 2020 and 2030, per product group, split in Ferrous metals and Non-ferrous metals. See Table 4 or Figure 2 for abbreviations used.



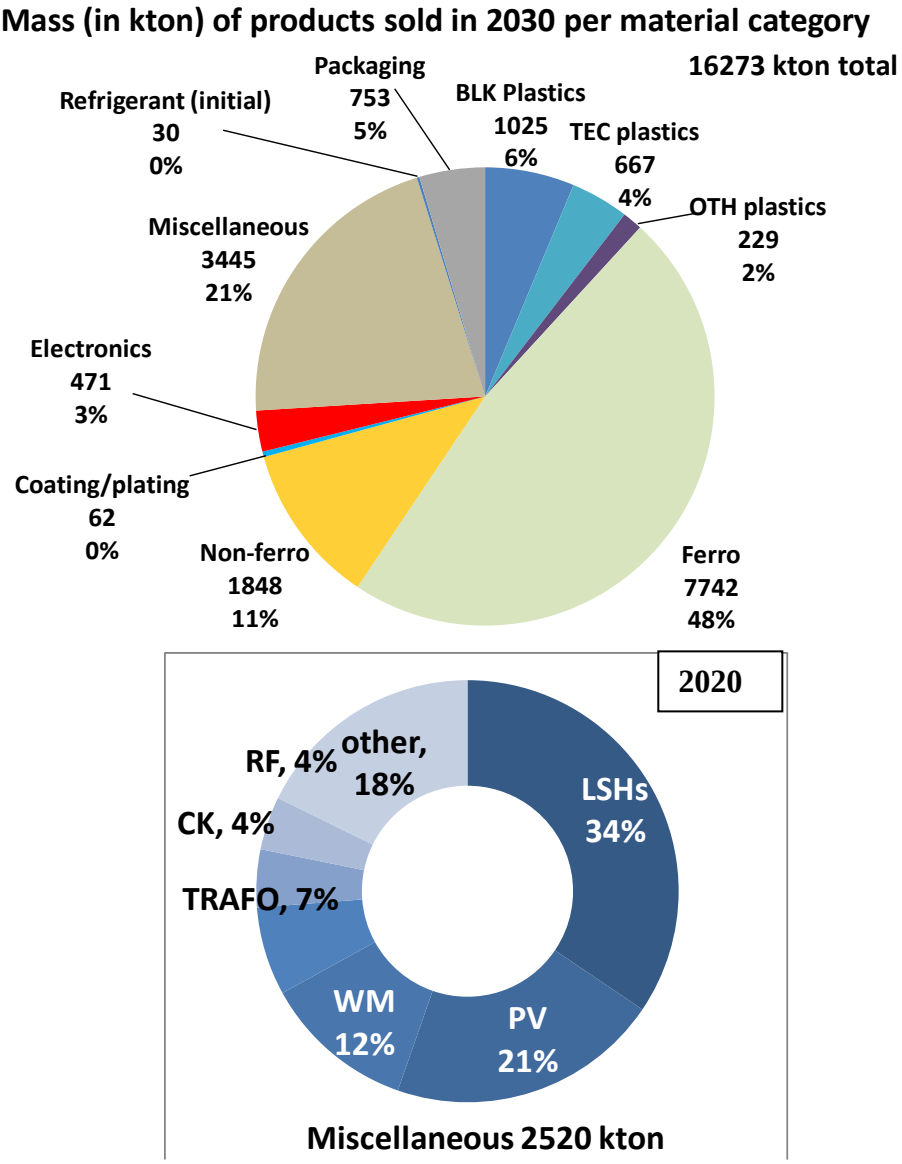


Figure 6: Distribution of the mass contained in regulated products sold in 2020 and 2030 over the material categories, and distribution of the miscellaneous materials over the product groups. See Table 4 or Figure 2 for abbreviations used.

A2 Environmental impacts

A2.1 Methodology for environmental impacts

The environmental impacts for products regulated by Ecodesign or Energy Labelling have been taken from the Ecodesign Impact Accounting (EIA) 2023 EcoReportTool (ERT)[34]. This tool uses the material types and categories, the environmental impact categories, unit impact indicators [35], and computational scheme of the 2013 EcoReportTool, which is associated to the 2013 Methodology for the Ecodesign of Energy-related Products (MEErP). The product-specific inputs for the tool, e.g. the Bill-of-Materials, product volumes, end-of-life destination shares, come from the Ecodesign preparatory and review studies. Sales, stock, energy consumption, primary energy factor for electricity, and GHG intensity factors come from the EIA.

The draft revised 2023 EcoReportTool has been examined but cannot be directly applied to the regulated products because the existing studies do not provide the required input information. In addition, the sets of impact indicators available in the draft tool are not complete, and it is often not clear which impacts are covered by the various items (materials, processes) and how the items have to be combined to capture the total impacts. For the mini-preparatory studies in Phase 2, it is the intention to use the revised EcoReport Tool if it will be published before start of Phase 2.

Only for the material impacts from plastics (without manufacturing processes), the 2023 EcoReportTool could be applied. For primary energy and GHG emissions the impacts from the 2013 ERT and 2023 ERT could be compared. They lead to the same prioritization scores of product groups for plastic impacts.

The environmental impacts in the ERT are subdivided per phase of the product lifecycle: Production (PRD, split in Materials and Manufacturing), Distribution (DIST), Use, and End-of-Life (EoL). For the prioritization phase of this study, only Production impacts are considered:

- Use-phase impacts, from the consumption of energy and consumables during product use, are generally dominant, and would thus overshadow differences in production impacts between the product groups. During the prioritization phase of the project, for the selection of product-material combinations, use-phase impacts are not relevant, and have not been considered.
- Distribution impacts resulting from the 2013 ERT are usually small. The approach in the 2013 ERT is simplified and not all studies used the input-options in a consistent manner, possibly leading to differences between the product groups that are not realistic. The revised 2023 ERT detailed the computational methodology for distribution impacts, but, as said, the existing studies do not provide the inputs needed for application of the new approach. Distribution impacts have therefore not been considered for the prioritization phase, and this is not considered a drawback.
- End-of-life impacts (credits and debits) in the 2013 ERT suffer from unclarities and errors in the 2013 ERT Excel sheet. In addition, results depend on the distribution of materials over the EoL destinations (re-use, recycling, heat recovery, incineration,

[34] 'EIA 2023 Materials and Environmental Impacts report', VHK for the European Commission DG ENER, October 2023.

[35] Typically impacts per kg of material in the final product.

landfill / missing / fugitive). The choice of these destination shares in the various studies is not consistent and especially for the older studies they seem outdated, possibly leading to differences between the product groups that are not realistic. The revised 2023 ERT completely changed the computational methodology for end-of-life impacts, but, as said, the existing studies do not provide the inputs needed for application of the new approach. It has therefore been preferred not to consider End-of-Life impacts in the prioritization phase.

As regards production impacts, the full impacts can be considered, or the impacts per year of product lifetime. Comparing two product groups that have similar full production impacts but different lifetimes, the one with the lowest lifetime (higher impacts per year) is more interesting for selection in this study. It has therefore been preferred to base the prioritization on impacts per year of lifetime.

The environmental impacts are initially derived for over 300 unit base case products. These unit impacts are multiplied by the product sales quantities for year 2020 or 2030, optionally divided by the product lifetime, and then summed to total impacts for 33 product groups.

As regards the difference in impacts between years 2020 and 2030, the amount of material contained in a unit product is the same in both years (no time-series for the Bills-of-Materials). Only sales quantities change [36].

The environmental impacts are initially derived for nearly 100 material types, but contributions are summed to 7 material categories: bulk plastics (BLK), technical plastics (TEC), ferrous metals (FE), non-ferrous metals (NFE), coating and plating (CP), electronics (ELEC), and miscellaneous (MISC). Impacts for BLK and TEC plastics are sometimes combined to a single total for all plastics. For the prioritization phase of this study, the additional three categories, refrigerants (REFR), mercury (HG) and packaging (PCK) are not considered [37].

[36] The energy efficiency (and thus the energy consumption), the primary energy factors for electricity, and the GHG-intensity factors for electricity also change with the year, but that has effect only on the use-phase impacts, not on the production impacts.

[37] Refrigerants are addressed in the F-gas regulation; Mercury is addressed in the RoHS regulation; a separate regulation is being developed for packaging materials.

The 15 environmental impact categories considered are those of the 2013 ERT:

- Material mass (MAT)
- Primary energy (PE)
- Process water (WP)
- Cooling water (WC)
- Hazardous waste (WH)
- Non-hazardous waste (WNH)
- Greenhouse gas emissions (GWP)
- Acidification emissions (AD)
- Volatile Organic Compounds (VOC)
- Persistent Organic Pollutants (POP)
- Heavy Metals to air (HMa)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Particulate Matter (PM)
- Heavy Metals to water (HMw)
- Eutrophication (EP)

For each combination of environmental category (15), material category (7), year (2) and time-scale (2: full impacts or per year of life), the procedure provides production impact values for 33 product groups. For each combination, the range between the maximum and minimum impact values per product group is divided in six subranges. A product group whose impact falls in the highest subrange is assigned a prioritization score of 1.0, in the next highest range 0.8, then 0.6, 0.4, 0.2 and 0.0 for the lowest range.

Table 6 provides an example for the derivation of prioritization scores. The example is for production impacts per year of lifetime, for primary energy (in PJ/year) and for acidification (in ktSO2eq/year). The table shows the impacts per year for each product group. At the bottom of the table the subranges for determination of the scores are indicated. The scores themselves, for each product group, are indicated in separate columns. Scores higher than 0.5 are high-lighted. Zero scores are in grey font. Such scores are derived for all environmental impact parameters listed above, and then for each product group the maximum score for any parameter (MAX) or the sum of scores over all parameters (SUM) is computed (see tables in the results section).

The prioritization score for a product group is thus relative to all other product groups. A prioritization score of 0.0 does not mean that impacts for the product group are zero, but that impacts are low compared to those of other product groups. If the score in year 2030 increases compared to year 2020, this can mean that the impacts for the product group increased (for example due to higher sales quantities in 2030), but it can also be that impacts for other groups decreased or increased less.

Table 6: Example for the determination of prioritization scores. This example is for the primary energy impact (in PJ/a) and the acidification impacts (in ktSO2eq/a) of the production phase, per year of lifetime.

		Primary Energy impact of production (PJ per year of lifetime)	Prioritization score for Primary Energy		Acidification impact of production (ktSO2eq per year of lifetime)	Prioritization score for Acidification
DWH	WH dedicated Water Heater	1	0.0		0	0.0
CHB	CHB Central Heating boiler < 400 kW	2	0.0		1	0.0
SFB	SFB Solid Fuel Boilers	0	0.0		0	0.0
AHC	AHC total Air Heating & Cooling	3	0.0		1	0.0
LSHs	LH Local Heaters (solid fuel)	1	0.0		0	0.0
LSHns	LH Local Heaters (electric, gas, liquid)	1	0.0		0	0.0
RAC	RAC Room Air Conditioner	2	0.0		1	0.0
CIRCi	CIRC Circulator pumps, incl. double	0	0.0		0	0.0
CIRCe	CIRC Circulator pumps, excl. double	0	0.0		0	0.0
VU	VU Ventilation Units, res + non-res	1	0.0		1	0.0
LS	LS Lighting	1	0.0		0	0.0
DP	DP Electronic Displays	34	1.0		6	0.4
STB	STB set top boxes (Complex & Simple)	2	0.0		1	0.0
GC	Game consoles	1	0.0		0	0.0
ESDS	ES + DS total	15	0.4		7	0.6
PC	PC Personal Computers	26	0.8		10	0.8
IE	EP & IJ imaging equipment	13	0.4		5	0.4
INK	Cartridges and Containers (empty)	4	0.0		1	0.0
SB	Total (networked) SB (excl. double)	2	0.0		1	0.0
EPSi	EPS incl. double	4	0.0		2	0.2
EPSe	EPS excl. double	1	0.0		1	0.0
MCPT	Phones and Tablets	10	0.2		12	1.0
RF	RF Household Refrigerators & freezers	5	0.0		2	0.0
CF	CF Commercial Refrigeration	4	0.0		1	0.0
PFi	PF Professional Refrigeration, incl. double	1	0.0		0	0.0
PFe	PF Professional Refrigeration, excl. double	1	0.0		0	0.0
CK	CA Cooking Appliances	7	0.2		3	0.2
WM	WM-WD Total household Washing	3	0.0		2	0.0
DW	DW Household Dishwashers	4	0.0		2	0.0
LD	LD Household Laundry Dryers	2	0.0		1	0.0
VC	VC Vacuum Cleaners (incl. cordless, robots)	5	0.0		2	0.2
FANi	FAN Industrial Fans >125W, incl. double	2	0.0		1	0.0
FANe	FAN Industrial Fans >125W, excl. double	1	0.0		1	0.0
MTi	MT Elec. Motors LV 0.12-1000 kW, incl. double	6	0.2		4	0.4
MTe	MT Elec. Motors LV 0.12-1000 kW, excl. double	3	0.0		2	0.2
WP	WP Water pumps	0	0.0		0	0.0
WE	WE Welding Equipment	2	0.0		1	0.0
TRAFO	TRAFO Utility Transformers	2	0.0		1	0.0
	Subranges for prioritization score:					
	max	34			12	
	rank (1), above	29			10	

		Primary Energy impact of production (PJ per year of lifetime)	Prioritization score for Primary Energy		Acidification impact of production (ktSO2eq per year of lifetime)	Prioritization score for Acidification
	rank (0.8), above	23			8	
	rank (0.6), above	17			6	
	rank (0.4), above	11			4	
	rank(0.2), above	6			2	
	min (rank (0))	0			0	

This Annex separately reports the production impact prioritization scores for all materials together, for plastics, for ferrous metals, for non-ferrous metals, for coating/plating, for electronics and for miscellaneous materials.

To avoid presenting 60 scores for each of these material categories, the scores for the 15 environmental categories are summarized in two overall scores:

- MAX score: the highest score for the product group for any environmental category
- SUM score: the sum of scores for the product group over all 15 environmental categories (this is a simple sum, without weighting)

Both scores are presented for years 2020 and 2030 and considering the full impacts or the impacts per year of lifetime, for a total of 8 scores per material category.

For the final prioritization score, the sum of scores for impacts per year of lifetime in 2030 is considered.

In the tables of the following sections:

- MAX scores (ranging from 0.0 to 1.0) are highlighted in red if they are > 0.5
- SUM scores (ranging from 0.0 to 15.0) are highlighted in orange if they are > 2.0
- Scores that are zero are printed in grey font.

For circulator pumps, external power supplies, professional refrigeration, industrial fans and electric motors, scores are shown for impacts including doubled counted and excluding double counted. These products can be part of other regulated products and be included in their Bills-of-Materials, which would lead to a double counting of impacts. For the prioritization in this study, it is preferable to consider the information including double counted amounts (unless the double counting is relevant among the final 5 selected product-material combinations).

Please consider also the notes following the tables in each section.

A2.2 Results for environmental impacts

In the following sections, we provide the results in the form of prioritization scores for:

- All materials i.e. considering all materials together
- Plastics
- Ferrous metals
- Non-ferrous metals
- Coating / plating
- Electronics
- Miscellaneous

A2.2.1 Prioritization scores for all materials

For the derivation of prioritization scores, see Section A2.1 Methodology for environmental impacts.

Table 7 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering all materials together. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 8 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 7.

Remarks:

1- Relative **impacts per year of lifetime for products sold in 2030 are high** (sum of scores > 2.0 in Table 7) for:
   a. phones and tablets (rank 1),
   b. personal computers (rank 2),
   c. imaging equipment (rank 3),
   d. servers and data storage (rank 4),
   e. electronic displays (rank 5),
   f. electric motors (rank 6),
   g. refrigerators/freezers (rank 7)

2- Products that have a relatively **long lifetime** can have a high score when considering full impacts and a low(er) score when considering impacts per year of life (Table 8). This is the case for example for utility transformers, cooking appliances, washing machines, dishwashers, and light sources (LEDs).

3- The **difference in scores for 2020 and 2030** mainly depends on differences in variations of sales quantities. For Phones and Tablets the new regulations cause a drop in sales in 2030, which redefines the subranges in 2030 compared to 2020 for several impact parameters, and thus potentially causes a higher (relative) score for other product groups. If sales for this other product group increase faster than the average, the score will increase further. However, the product groups with a high impact in 2030 are the same as those in 2020.

Table 7: Prioritization scores for environmental production impacts per year of lifetime in 2030 from all materials. The last column shows the ranking of the materials based on the sum of scores. Some materials have same sum of scores and therefore also same ranking.

ALL materials, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18
CHB	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
AHC	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18
LSHs	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.6	0.6		17
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
RAC	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.2		24
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
VU	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
DP	0.6	1.0	1.0	0.0	1.0	0.0	0.0	0.4	0.0	0.2	0.0	0.2	0.6	0.0	0.0		1.0	5.0		**5**
STB	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.2		24
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
ESDS	0.4	0.4	0.4	0.2	0.0	0.4	1.0	0.6	0.0	0.6	0.0	0.4	1.0	0.0	0.0		1.0	5.4		**4**
PC	0.8	0.8	1.0	0.2	0.6	0.4	0.2	0.8	0.6	0.4	0.0	1.0	0.2	0.0	0.0		1.0	7.0		**2**
IE	0.6	0.4	0.4	0.0	0.8	0.4	0.8	0.4	0.0	0.4	0.0	1.0	0.4	0.0	0.0		1.0	5.6		**3**
INK	0.4	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.6	1.0		11
SB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
EPSi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.4	0.0	0.0	0.0		0.4	0.6		16
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
MCPT	0.0	0.2	0.4	1.0	0.8	1.0	0.4	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0		1.0	8.8		**1**
RF	0.8	0.0	0.0	0.0	0.8	0.0	0.2	0.0	0.0	0.2	0.0	0.8	0.2	0.0	0.0		0.8	3.0		**7**
CF	0.4	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.4	0.0	0.2	0.0	0.0	0.0		0.4	1.4		**10**
PFi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
PFe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
CK	0.4	0.2	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.4	0.0	0.0	0.4	0.0	0.0		0.4	2.0		**8**
WM	0.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.6	1.0		11
DW	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0		0.4	0.8		13
LD	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.2		24
VC	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	0.8		13
FANi	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0		0.4	0.8		13

ALL materials, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
FANe	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18
Mti	1.0	0.2	0.2	0.0	0.0	0.0	0.4	0.4	0.0	1.0	0.0	0.0	0.0	0.0	0.0		1.0	3.2		**6**
Mte	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0		0.6	1.6		**9**
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		28
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0		0.2	0.2		24
TRAFO	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.4		18

DWH	Dedicated Water Heater
CWH	Central Heating Combi, Water Heating
CHB	Central Heating Boiler or Combi
SFB	Solid Fuel Boilers
AHC	Central Air Heating & Cooling
LSH	Local Space Heaters
RAC	Room Air Conditioner
CIRC	Circulator pumps <2.5 kW
VU	Ventilation Units
LS	Light Sources
DP	electronic DisPlays
STB	Set Top Boxes
GC	Game Consoles
ESDS	Enterprise Servers & Data Storage
PC	Personal Computers
IE	Imaging Equipment
INK	Ink/toner Cartridges/Containers (empty)
SB	Products regulated for Standby
EPS	External Power Supplies
RF	Household Refrigeration

CF	Commercial Refrigeration [38]
PF	Professional Refrigeration
CK	Cooking Appliances
WM	household Washing Machines
DW	household Dishwashers
LD	household Laundry Dryer
VC	Vacuum Cleaners
FAN	Industrial Fans >125W
MT	Motors 0.12-1000 kW
WP	Water pumps
WE	Welding Equipment
TRAFO	Utility Transformers
TYRE	Tyres
PV	Photovoltaic panels and Inverters
TS	Taps and Showers
EK	Electric Kettles

For CIRC, EPS, PF, FAN, MT, suffixes:

i	Including double counted amounts
e	Excluding double counted amounts

Table 8: Prioritization scores for environmental impacts from production when considering all materials, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

Scores for Production Impacts from ALL materials	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030
DWH Dedicated Water Heater	0.0	0.2	0.0	0.4		0.2	0.2	0.6	0.6
CHB Central Heating boilers	0.2	0.2	0.2	0.4		0.2	0.4	0.6	1.0
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.2	0.2	0.4	0.4		0.4	0.4	1.6	1.6
LH Local Heaters (solid fuel)	0.6	0.6	0.6	0.6		1.0	1.0	1.6	1.6
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.2	0.2	0.2	0.2		0.2	0.4	0.4	1.0
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. Double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VU Ventilation Units	0.2	0.2	0.2	0.4		0.4	0.4	1.0	1.2
LS Light Sources	0.0	0.0	0.0	0.0		0.6	0.8	0.6	0.8
DP Electronic Displays	1.0	1.0	4.2	5.0		1.0	1.0	4.8	6.2

[38] Refrigerating appliances with a direct sales function

Scores for Production Impacts from ALL materials	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030
STB Set Top Boxes	0.0	0.2	0.0	0.2		0.2	0.2	0.2	0.2
GC Game consoles	0.0	0.0	0.0	0.0		0.2	0.2	0.2	0.2
ESDS Servers and Data Storage	1.0	1.0	4.0	5.4		1.0	1.0	3.0	4.6
PC Personal Computers	0.8	1.0	3.8	7.0		0.4	1.0	2.8	5.0
IE imaging equipment	1.0	1.0	6.0	5.6		1.0	0.6	4.0	4.0
INK Cartridges and Containers (empty)	0.8	0.6	2.0	1.0		0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.4	0.4	0.4	0.6		0.0	0.0	0.0	0.0
EPS External Power Supplies excl. Double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MCPT Phones and Tablets	1.0	1.0	11.0	8.8		1.0	1.0	8.4	7.6
RF Household Refrigerators & freezers	1.0	0.8	3.4	3.0		1.0	1.0	5.4	5.4
CF Commercial Refrigeration	0.4	0.4	1.4	1.4		0.6	0.4	1.4	1.4
PF Professional Refrigeration, incl. Double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. Double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CK Cooking Appliances	0.6	0.4	2.0	2.0		1.0	1.0	5.4	5.6
WM (household) Washing Machines	0.6	0.6	1.2	1.0		0.6	0.6	3.4	3.6
DW (household) Dishwashers	0.4	0.4	0.6	0.8		1.0	1.0	2.6	3.2
LD (household) Laundry Dryers	0.2	0.2	0.2	0.2		0.2	0.2	0.2	0.4
VC Vacuum Cleaners	0.2	0.2	0.6	0.8		0.2	0.2	0.2	0.6
FAN Industrial Fans, incl. Double	0.6	0.4	1.2	0.8		0.6	0.6	1.8	1.8
FAN Industrial Fans, excl. Double	0.2	0.2	0.4	0.4		0.2	0.2	0.6	0.6
MT Electric Motors, incl. double	1.0	1.0	3.2	3.2		1.0	1.0	4.0	4.0
MT Electric Motors, excl. double	0.6	0.6	1.4	1.6		0.6	0.6	1.8	1.8
WP Water pumps	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WE Welding Equipment	0.2	0.2	0.2	0.2		0.0	0.0	0.0	0.0
TRAFO Utility Transformers	0.2	0.2	0.2	0.4		0.6	0.8	3.0	3.4

A2.2.2 Prioritization scores for plastics

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 9 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only plastics. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 10 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 9.

Remarks:

1- Relative **impacts per year from plastics in products sold in 2030 are high** (sum of scores > 2.0 in Table 9) for:
    a. (household) refrigerators and freezers (rank 1),
    b. imaging equipment (rank 2),
    c. cartridges and containers (rank 3),
    d. electronic displays (rank 4),
    e. personal computers (rank 5),
    f. vacuum cleaners (rank 6),
    g. washing machines (rank 7),
    h. dishwashers (rank 8).

2- The task description for the study prescribes that two products shall be selected for potential measures on plastics.

3- **Household refrigerators and freezers** have the highest sum of scores for impacts per year in 2030 (11.8) and the second highest score in 2020 (9.8). Of the total mass, 34% is plastics, mainly rigid polyurethane (PUR) for the thermal insulation, and Polystyrene (PS) for the inner liner (Figure 7). Further study in Phase 2 may consider the recent Electrolux reward for 70% recycled contents of the inner liner and ongoing research on the recycling of PUR. This is a **priority choice for further study on plastics**.

4- **Imaging equipment** has the second highest sum of scores for impacts per year in 2030 and the third highest score in 2020. The product group has a high share of various types of plastics, and overall a 43% share of plastic contents (Figure 8). This is the **second candidate for further study on plastics**.

5- The highest sum of scores for impacts per year in 2020 (10.8) and the third highest score in 2030 (8.8) is for **(empty) cartridges and containers**. These are not typical Ecodesign products, because they do not consume energy. The studies on imaging equipment considered them as separate products for their material resource consumption and environmental impacts, and that is the reason they are included in the EIA. Cartridges and containers were addressed in the Voluntary Agreement on imaging equipment and measures for them are currently being discussed elsewhere. They have high prioritization scores only when considering impacts per year (in the modelling lifetime is assumed to be only 1 year, see *Table* 10). As they are not currently regulated under Ecodesign and already addressed elsewhere, they are **not a priority product for further study on plastics in this study**.

6- **Electronic displays** have the fifth highest sum of scores for impacts per year in 2020 (5.0) and the fourth highest in 2030 (8.4). Of the total mass of DPs sold in 2020, 38% is plastics, including various types **(**Figure 9**).** Traditionally, recycling of plastics from DPs was problematic due to the use of flame retardants, but the latest ED regulation could have solved at least part of this. To be considered as a **backup candidate for further study on plastics**, especially if interesting for electronics / CRM as well.

7- **Vacuum cleaners** have the fourth highest sum of scores for impacts per year in 2020 and the fifth highest in 2030. VCs have a high concentration (68%) of plastics in the

total mass, with ABS as dominant material type (Figure 10). To be considered as a **backup candidate for further study on plastics**, depending also on the contents of the new regulation, expected for 2024.

8- **Washing machines**: Plastics cover 16% of the total WM mass sold in 2020 (Figure 11). The 'real' plastics mass is mainly PP and ABS, but the highest mass accounted under plastics is E-glass fiber reinforcement used in the tub[39]. A high share of the impacts in almost all categories is due to this E-glass fiber reinforcement, and this is a major reason for the relatively high prioritization scores. Compared to other product groups, this is **not a priority choice for further study on plastics**. Nevertheless, should this product group be selected for analysis in the phase 2 of the study, it could be in any case worth analyzing requirements (also) related to plastics.

9- **Dishwashers**: Plastics cover 22% of the total DW mass sold in 2020 (Figure 12). The dominant plastic is PP (63% of plastics mass), used for the tub [40]. Other PP parts have glass fiber filling, but that mass is relatively low. DW are one of the top 5 product groups for the use of PP (for products sold in 2020). Compared to other product groups, this is **not a priority choice for further study on plastics**.

10- **Personal computers** have a moderate sum of scores for impacts per year from plastics in 2020, but a relatively high score in 2030 (rank 5). The difference is due to a projected increase in sales quantities, from 67 mln units in 2020 to 103 mln in 2030. Scores are relatively high only when considering the impacts per year of life, not for the full impacts. Plastics cover 18% of the total PC mass sold in 2030 (Figure 13). The main plastic types in Personal Computers are PC, PA6 and ABS, but part of the high score comes from a relatively small mass of LDPE which has a high unit impact for e.g. VOC. Not entirely clear from data if this LDPE mass is fully or partly packaging or not. Compared to other product groups, this is **not a priority choice for further study on plastics**.

Table 9: Prioritization scores for environmental production impacts per year of lifetime in 2030 from plastics.

Plastics, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16

[39] The definition/identification of the material used in the WM tub will be subject to a more thorough analysis, in case the product is prioritised for phase II of the study.

[40] The most recent BoMs for dishwashers indicate that some of the polypropylene parts have glass fiber filling, but mass for these fibers is low (small part of 'other' in the fgure). According to online sources, talcum filler is also used in the main PP parts, but this does not result on the BoM of the review study.

Plastics, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
CHB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		0.2	0.2		14
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
AHC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
LSHs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
RAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
VU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
DP	1.0	1.0	1.0	0.4	0.6	0.6	0.8	1.0	0.0	0.0	0.0	0.0	1.0	0.2	0.8		1.0	8.4		**4**
STB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
ESDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
PC	0.4	0.6	0.6	0.2	0.4	0.6	0.4	0.6	0.6	0.0	0.0	0.0	0.6	0.4	0.4		0.6	5.8		**5**
IE	1.0	1.0	1.0	0.4	1.0	0.6	0.8	1.0	0.4	0.0	0.0	1.0	1.0	0.2	0.4		1.0	9.8		**2**
INK	1.0	1.0	1.0	0.4	0.8	1.0	0.8	0.8	0.0	0.0	0.0	0.0	0.8	0.6	0.6		1.0	8.8		**3**
SB	0.2	0.2	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	1.6		**9**
EPSi	0.2	0.2	0.2	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	1.4		**10**
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
MCPT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
RF	1.0	0.8	0.8	1.0	1.0	1.0	1.0	1.0	0.2	0.0	0.0	1.0	1.0	1.0	1.0		1.0	11.8		**1**
CF	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2		0.2	1.4		**10**
PFi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
PFe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
CK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
WM	0.2	0.2	0.2	0.4	0.4	0.2	0.4	0.2	0.0	0.2	0.0	0.0	0.4	0.6	0.6		0.6	4.0		**7**
DW	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.2	1.0	0.0	1.0	0.0	0.2	0.0	0.0		1.0	3.2		**8**
LD	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.4		13
VC	0.6	0.6	0.6	0.2	0.4	0.4	0.4	0.4	0.2	1.0	0.0	0.0	0.6	0.0	0.4		1.0	5.8		**6**
FANi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
FANe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
MTi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4		0.4	0.6		12
MTe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		0.2	0.2		14
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16
TRAFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		16

Table 10: Prioritization scores for environmental impacts from production when considering only plastics, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

Scores for Impacts from Plastics	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030

Scores for Impacts from Plastics	Impacts per year of lifetime					Full impacts		
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030
DWH Dedicated Water Heater	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CHB Central Heating boilers	0.0	0.2	0.0	0.2		0.0	0.2	0.0	0.4
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LH Local Heaters (solid fuel)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VU Ventilation Units	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LS Light Sources	0.2	0.0	0.4	0.0		0.2	0.0	0.2	0.0
DP Electronic Displays	0.6	1.0	5.0	8.4		0.6	0.8	4.2	5.0
STB Set Top Boxes	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
GC Game consoles	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
ESDS Servers and Data Storage	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PC Personal Computers	0.6	0.6	2.6	5.8		0.2	0.2	0.2	1.4
IE imaging equipment	1.0	1.0	8.8	9.8		0.4	0.4	3.4	2.8
INK Cartridges and Containers (empty)	1.0	1.0	10.8	8.8		0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.2	0.2	1.2	1.6		0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.2	0.2	1.2	1.4		0.0	0.0	0.0	0.0
EPS External Power Supplies excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MCPT Phones and Tablets	0.2	0.0	0.2	0.0		0.0	0.0	0.0	0.0
RF Household Refrigerators & freezers	1.0	1.0	9.8	11.8		1.0	1.0	12.2	12.2
CF Commercial Refrigeration	0.2	0.2	0.6	1.4		0.0	0.0	0.0	0.0
PF Professional Refrigeration, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CK Cooking Appliances	0.0	0.0	0.0	0.0		0.2	0.2	0.4	0.4
WM (household) Washing Machines	0.6	0.6	3.6	4.0		0.6	0.6	4.8	4.2
DW (household) Dishwashers	1.0	1.0	2.0	3.2		1.0	1.0	2.6	3.0
LD (household) Laundry Dryers	0.0	0.2	0.0	0.4		0.2	0.2	0.2	0.2
VC Vacuum Cleaners	1.0	1.0	5.2	5.8		1.0	1.0	3.6	2.6
FAN Industrial Fans, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
FAN Industrial Fans, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MT Electric Motors, incl. double	0.4	0.4	0.4	0.6		0.2	0.2	0.2	0.2
MT Electric Motors, excl. double	0.2	0.2	0.2	0.2		0.0	0.0	0.0	0.0
WP Water pumps	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WE Welding Equipment	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
TRAFO Utility Transformers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0

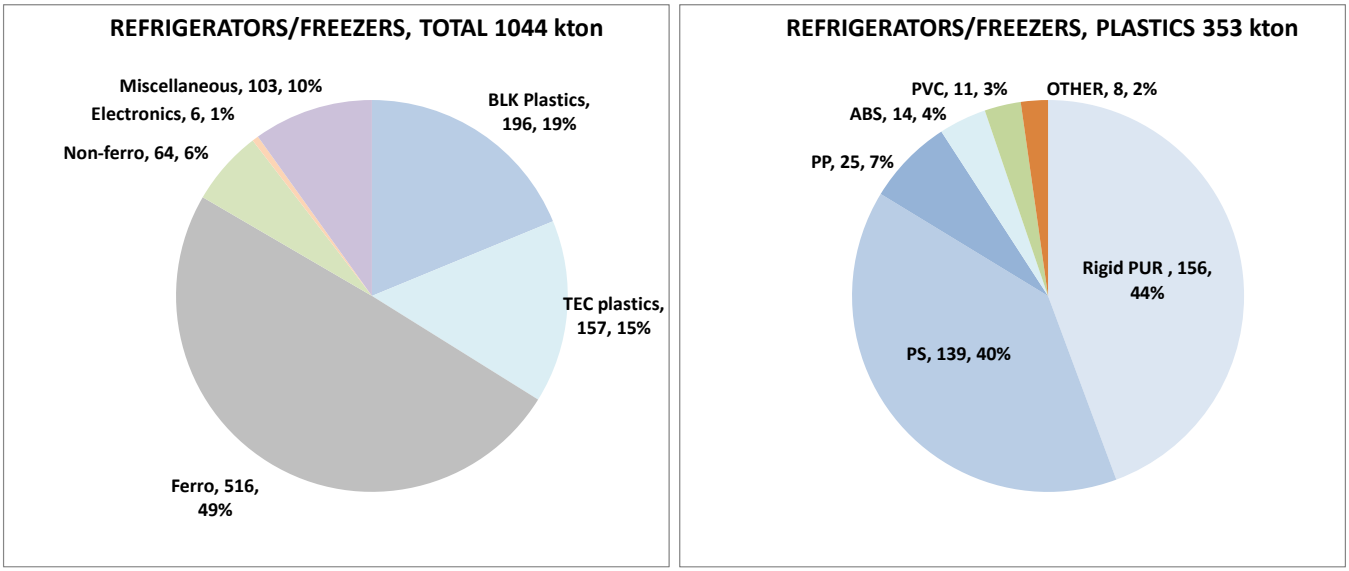


Figure 7: Distribution of total mass for (household) refrigerators / freezers sold in 2020 over the material categories, and distribution of plastics mass over the plastic types. (packaging and refrigerants excluded)

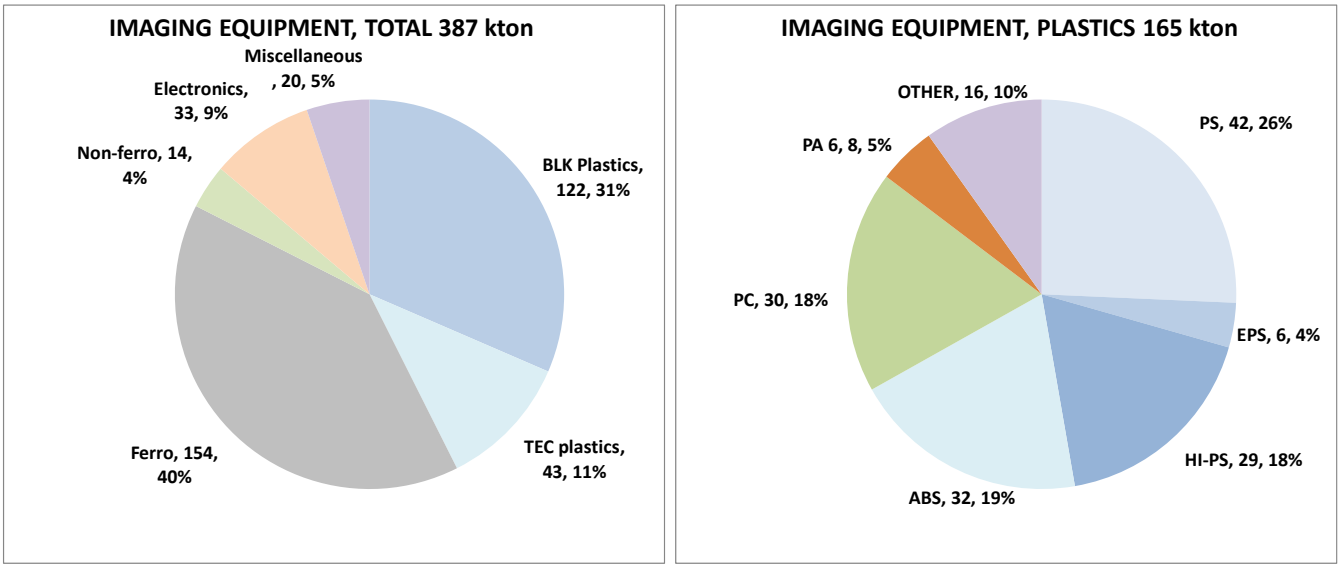


Figure 8: Distribution of total mass for imaging equipment sold in 2020 over the material categories, and distribution of plastics mass over the plastic types. (packaging excluded)

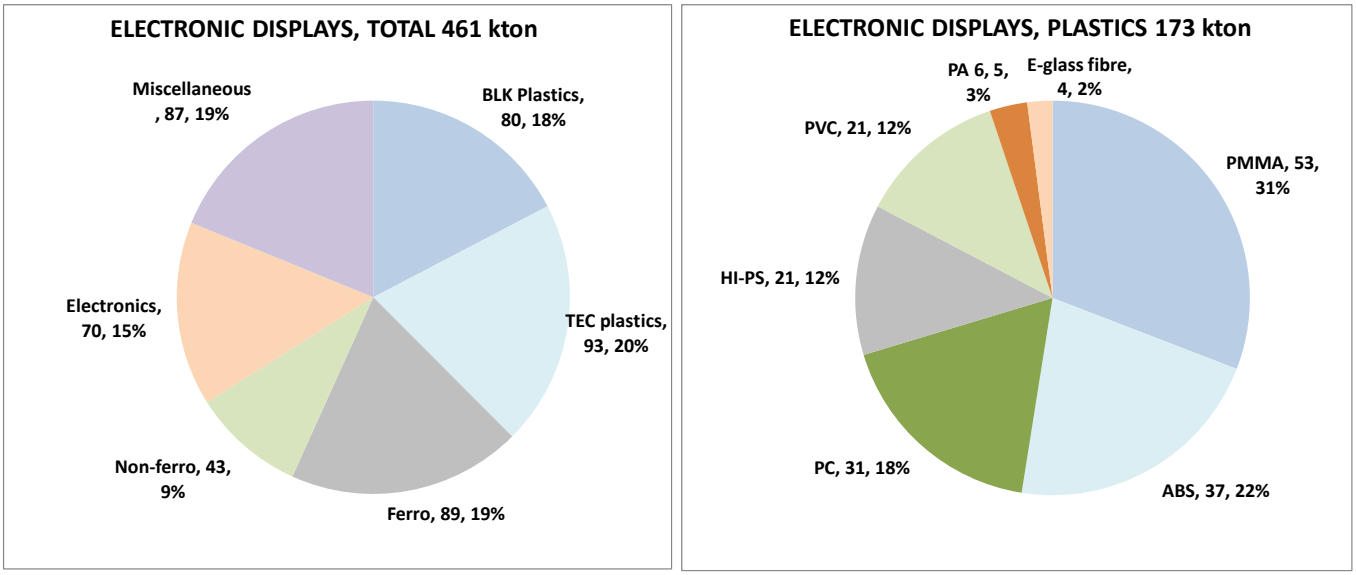


Figure 9: Distribution of total mass for electronic displays sold in 2020 over the material categories, and distribution of plastics mass over the plastic types. (packaging excluded)

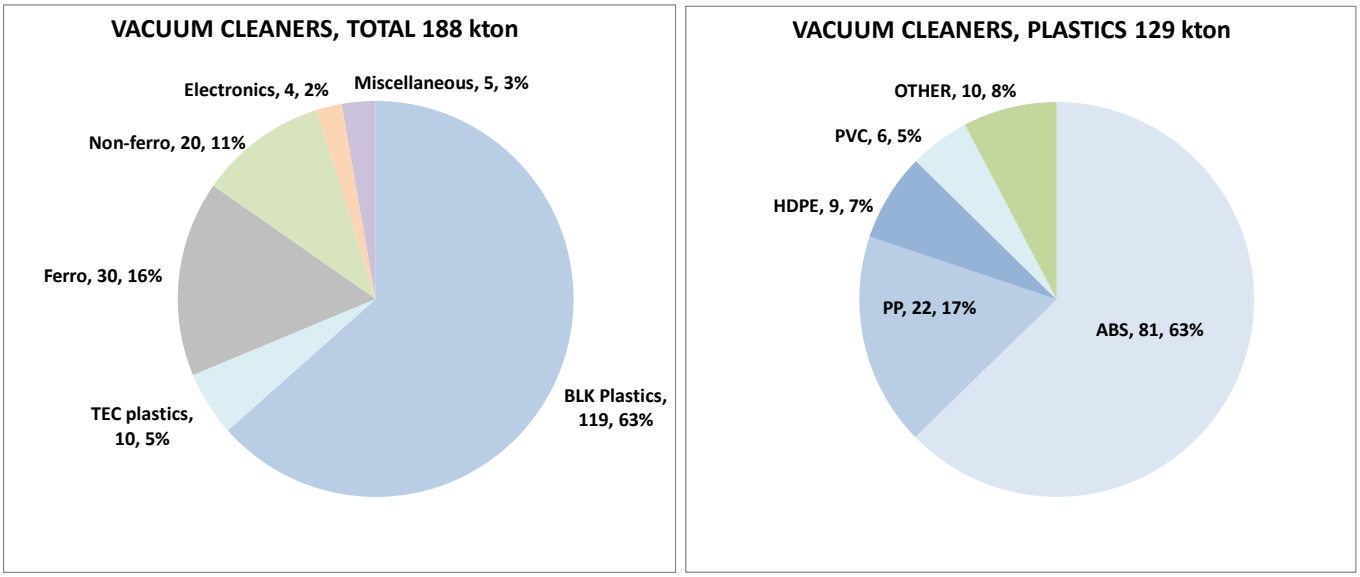


Figure 10: Distribution of total mass for vacuum cleaners sold in 2020 over the material categories, and distribution of plastics mass over the plastic types. (packaging excluded)

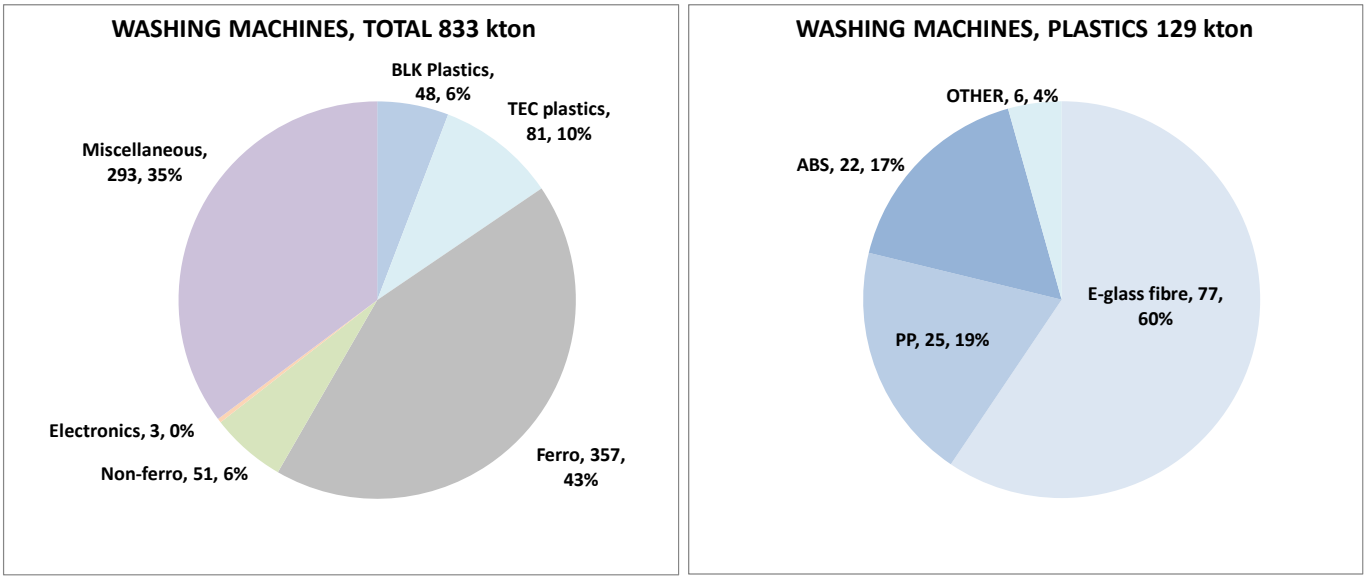


Figure 11: Distribution of total mass for washing machines sold in 2020 over the material categories, and distribution of plastics mass over the plastic types. (packaging excluded)

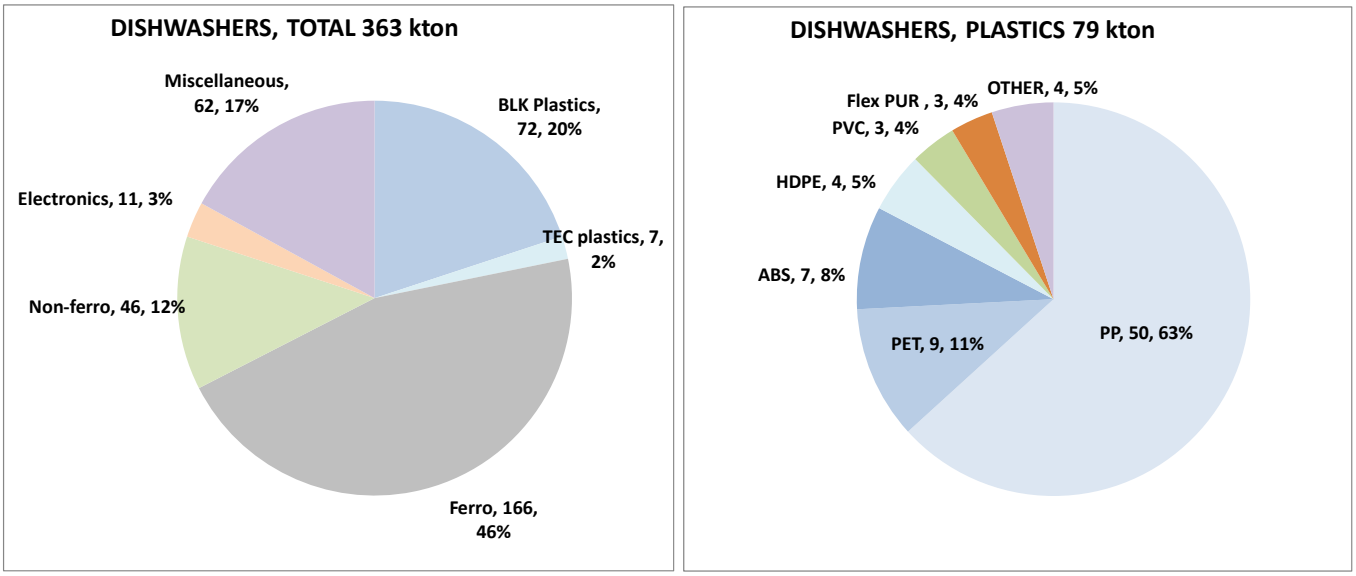


Figure 12: Distribution of total mass for dishwashers sold in 2020 over the material categories, and distribution of plastics mass over the plastic types (packaging excluded)

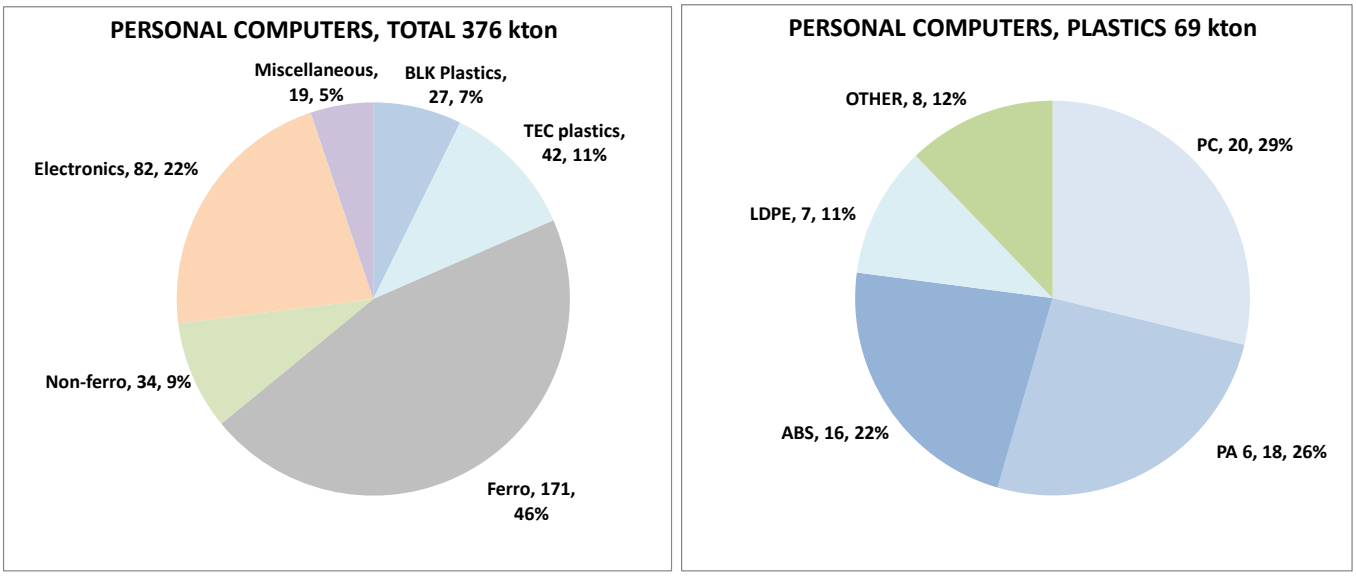


*Figure 13: Distribution of total mass for personal computers sold in **2030** over the material categories, and distribution of plastics mass over the plastic types (packaging excluded)*

A2.2.3 Prioritization scores for ferrous metals

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 11 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only ferrous metals. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 12 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 11.

Remarks:

1- There are **many product groups with a high prioritization score for impacts per year from ferrous metals for products sold in 2030**. The highest sum of scores is found for:
   a. electric motors (rank 1 incl. double or rank 3 excl. double),

b. washing machines (rank 2),
c. servers and data storage products (rank 4),
d. cooking appliances (rank 5).

2- For **electric motors**, 75% of the total mass is ferrous metal, and most of it (66%) has been registered as galvanized steel sheet in the EcoReports. Cast iron covers 20% and steel tubes and profiles 14% (Figure 14). MT have the highest sum of scores for impacts per year in 2030 (9.6) and would be a **priority choice for further study on ferrous metals**.

3- For **washing machines**, 43% of the total mass is ferrous metal, and most of it (63%) has been registered as stainless steel in the EcoReports. Galvanized steel sheet covers 28%, cast iron 6% and steel tubes and profiles 3% (Figure 15). WM have the second highest sum of scores for impacts per year in 2030 (8.4) and the highest for full impacts in 2020 and 2030 and would be a **priority choice for further study on ferrous metals**.

4- For **cooking appliances**, 82% of the total mass is ferrous metal, and most of it (90%) has been registered as galvanized steel sheet in the EcoReports (Figure 16). CK have the fifth highest score for impacts per year in 2030 (5.2), and the third highest score for full impacts in 2020 and 2030. This could be a candidate for further study on recycled content of ferrous metals, but with **lower priority** than for electric motors and washing machines.

5- For **servers and data storage products**, 74% of the total mass is ferrous metal, and almost all of this (99%) has been registered as galvanized steel sheet in the EcoReports (Figure 17). ESDS have the fourth highest sum of scores for impacts per year in 2030 (5.6), but a lower score for full impacts. This could be a candidate for further study on recycled content of ferrous metals, but with **lower priority** than for electric motors and washing machines.

Table 11: Prioritization scores for environmental production impacts per year of lifetime in 2030 from ferrous metals.

Ferrous metals, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.6		18
CHB	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.8		13
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	0.2		23
AHC	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.8		13
LSHs	0.2	0.0	0.2	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.8	0.0	0.0		0.8	1.8		12
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
RAC	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0		0.4	0.6		21
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
VU	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.8		13

Ferrous metals, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
DP	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.6		18
STB	0.0	0.2	0.2	0.4	0.2	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.4	0.4		0.4	2.6		11
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
ESDS	0.6	0.6	0.6	0.0	0.6	0.0	0.6	0.4	0.6	0.6	0.0	0.6	0.4	0.0	0.0		0.6	5.6		**4**
PC	0.4	0.6	0.4	0.0	0.4	0.0	0.4	0.2	0.4	0.4	0.0	0.4	0.2	0.0	0.0		0.6	3.8		**9**
IE	0.4	0.4	0.4	0.0	0.4	0.0	0.4	0.2	0.4	0.4	0.0	0.4	0.2	0.0	0.0		0.4	3.6		**10**
INK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	0.2		23
SB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
EPSi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
MCPT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
RF	0.4	0.4	0.4	0.0	0.6	0.0	0.2	0.2	0.4	0.4	0.0	0.2	0.8	0.0	0.0		0.8	4.0		**8**
CF	0.4	0.6	0.6	0.0	0.4	0.0	0.6	0.4	0.4	0.6	0.0	0.6	0.2	0.0	0.0		0.6	4.8		**6**
PFi	0.0	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.2		20
Pfe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
CK	0.4	0.6	0.6	0.0	0.6	0.0	0.6	0.4	0.4	0.6	0.0	0.6	0.2	0.2	0.0		0.6	5.2		**5**
WM	0.2	0.6	0.6	1.0	0.8	0.0	0.2	1.0	0.2	0.2	1.0	0.2	0.4	1.0	1.0		1.0	8.4		**2**
DW	0.2	0.2	0.4	0.4	0.4	0.0	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.4		0.4	4.2		**7**
LD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
FANi	0.4	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.4	0.2	0.0	0.2	0.0	0.0	0.0		0.4	1.8		13
FANe	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.4		22
Mti	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.6	1.0	1.0	0.0	1.0	1.0	0.0	0.0		1.0	9.6		**1**
Mte	0.6	0.6	0.6	0.0	0.6	0.0	0.6	0.4	0.6	0.6	0.0	0.6	0.6	0.0	0.0		0.6	5.8		**3**
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		25
TRAFO	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.2	0.0	0.0	0.0		0.2	1.8		13

DWH	Dedicated Water Heater
CWH	Central Heating Combi, Water Heating
CHB	Central Heating Boiler or Combi
SFB	Solid Fuel Boilers
AHC	Central Air Heating & Cooling
LSH	Local Space Heaters
RAC	Room Air Conditioner
CIRC	Circulator pumps <2.5 kW
VU	Ventilation Units
LS	Light Sources
DP	electronic DisPlays
STB	Set Top Boxes
GC	Game Consoles
ESDS	Enterprise Servers & Data Storage

CF	Commercial Refrigeration [41]
PF	Professional Refrigeration
CK	Cooking Appliances
WM	household Washing Machines
DW	household Dishwashers
LD	household Laundry Dryer
VC	Vacuum Cleaners
FAN	Industrial Fans >125W
MT	Motors 0.12-1000 kW
WP	Water pumps
WE	Welding Equipment
TRAFO	Utility Transformers
TYRE	Tyres
PV	Photovoltaic panels and Inverters

[41] Refrigerating appliances with a direct sales function

PC	Personal Computers	TS	Taps and Showers
IE	Imaging Equipment	EK	Electric Kettles
INK	Ink/toner Cartridges/Containers (empty)		
SB	Products regulated for Standby	For CIRC, EPS, PF, FAN, MT, suffixes:	
EPS	External Power Supplies	i	Including double counted amounts
RF	Household Refrigeration	e	Excluding double counted amounts

Table 12: Prioritization scores for environmental impacts from production when considering only ferrous metals, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

Score for Impacts from Ferrous metals	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030
DWH Dedicated Water Heater	0.2	0.2	1.4	1.6		0.2	0.4	1.6	2.6
CHB Central Heating boilers	0.2	0.2	1.8	1.8		0.4	0.4	2.8	4.0
SFB Solid Fuel Boilers	0.4	0.2	0.4	0.2		0.4	0.4	1.0	1.0
AHC Air Heating & Cooling	0.2	0.2	1.6	1.8		0.4	0.4	3.4	3.6
LH Local Heaters (solid fuel)	0.8	0.8	1.8	1.8		1.0	1.0	4.0	3.8
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.4	0.4	0.4	0.6		0.2	0.4	0.2	0.8
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VU Ventilation Units	0.2	0.2	1.6	1.8		0.4	0.4	2.6	3.0
LS Light Sources	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
DP Electronic Displays	0.2	0.2	1.0	1.6		0.0	0.2	0.0	1.0
STB Set Top Boxes	0.4	0.4	2.6	2.6		0.0	0.0	0.0	0.0
GC Game consoles	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
ESDS Servers and Data Storage	0.4	0.6	3.6	5.6		0.2	0.4	1.6	2.6
PC Personal Computers	0.4	0.6	3.0	3.8		0.2	0.2	1.2	1.6
IE imaging equipment	0.6	0.4	3.8	3.6		0.2	0.2	1.6	1.6
INK Cartridges and Containers (empty)	0.6	0.2	1.0	0.2		0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
EPS External Power Supplies excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MCPT Phones and Tablets	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RF Household Refrigerators & freezers	0.8	0.8	4.4	4.0		1.0	1.0	6.4	6.6
CF Commercial Refrigeration	0.6	0.6	4.6	4.8		0.4	0.6	3.6	4.4
PF Professional Refrigeration, incl. double	0.2	0.2	0.6	1.2		0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CK Cooking Appliances	0.6	0.6	5.2	5.2		1.0	1.0	8.8	9.0
WM (household) Washing Machines	1.0	1.0	9.4	8.4		1.0	1.0	10.6	10.0
DW (household) Dishwashers	0.4	0.4	2.8	4.2		0.4	0.6	4.0	4.6
LD (household) Laundry Dryers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VC Vacuum Cleaners	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
FAN Industrial Fans, incl. double	0.6	0.4	2.0	1.8		0.8	0.8	3.6	3.4
FAN Industrial Fans, excl. double	0.2	0.2	0.4	0.4		0.4	0.4	1.8	1.6
MT Electric Motors, incl. double	1.0	1.0	9.6	9.6		1.0	1.0	9.0	9.2
MT Electric Motors, excl. double	0.6	0.6	5.6	5.8		0.6	0.6	5.2	5.2
WP Water pumps	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WE Welding Equipment	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
TRAFO Utility Transformers	0.2	0.2	1.4	1.8		0.6	0.8	5.0	6.6

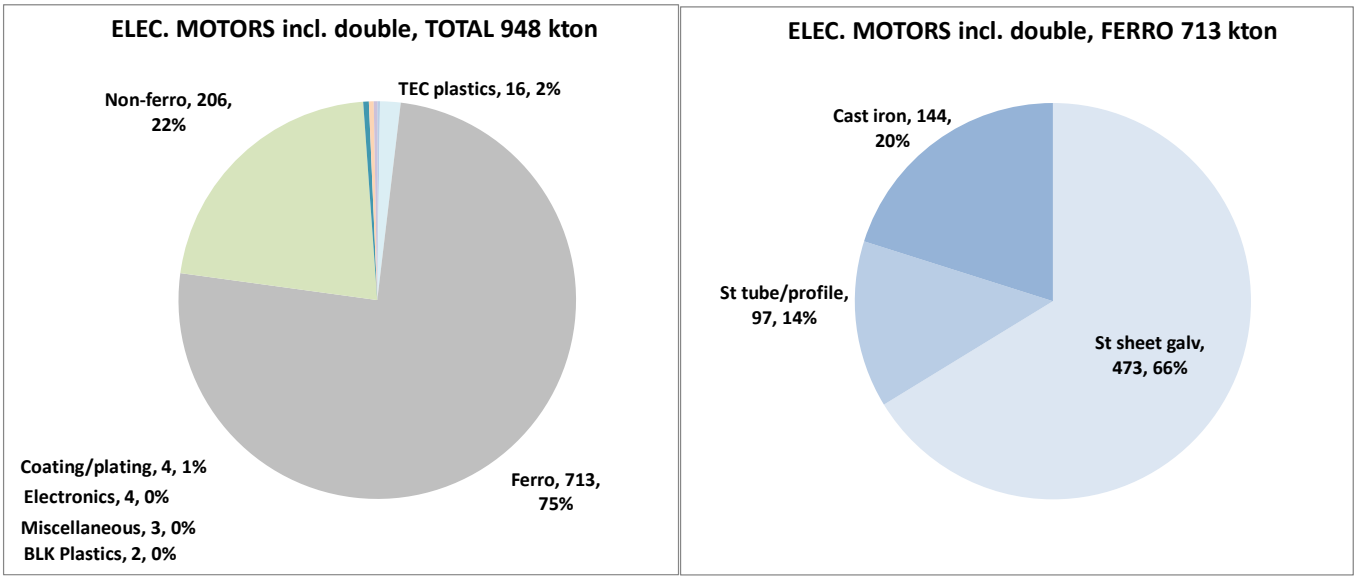


Figure 14: Distribution of total mass for electric motors sold in 2020 over the material categories, and distribution of ferrous metals mass over the types. (packaging excluded)

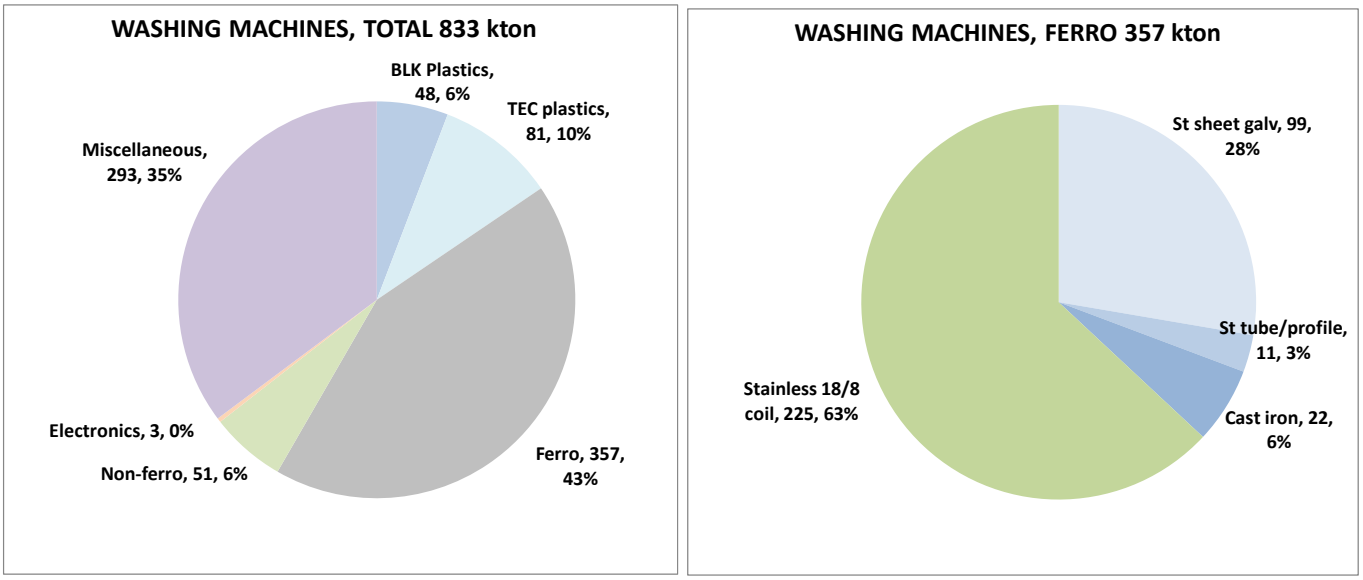
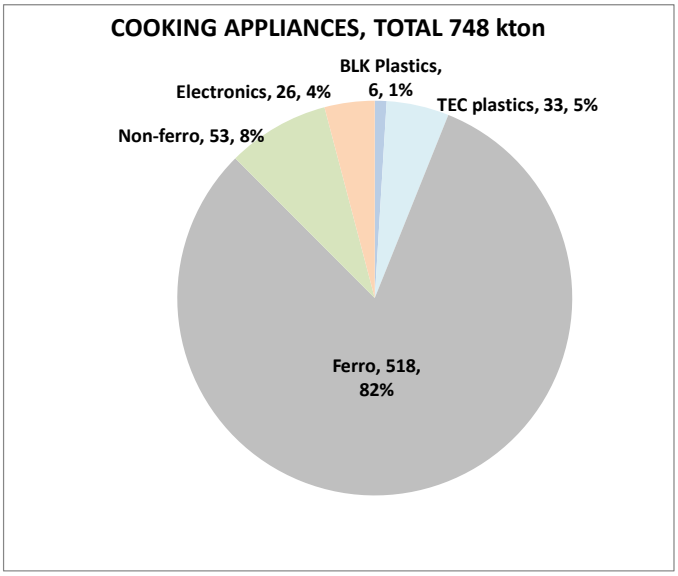


Figure 15: Distribution of total mass for washing machines sold in 2020 over the material categories, and distribution of ferrous metals mass over the types. (packaging excluded)



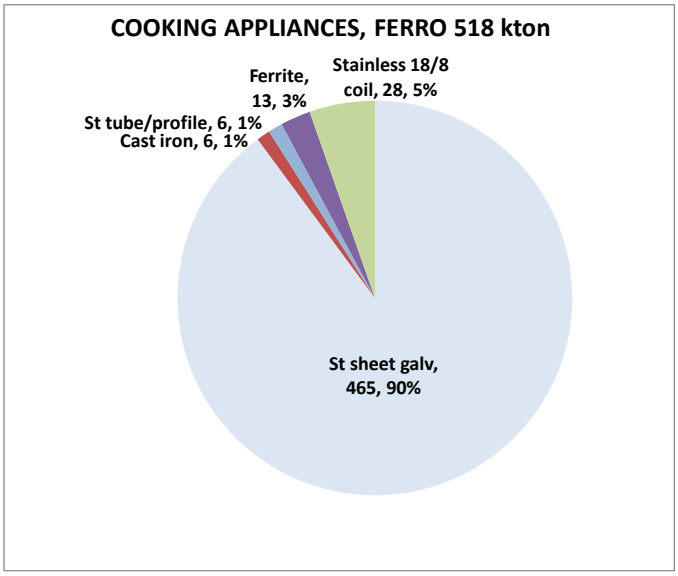
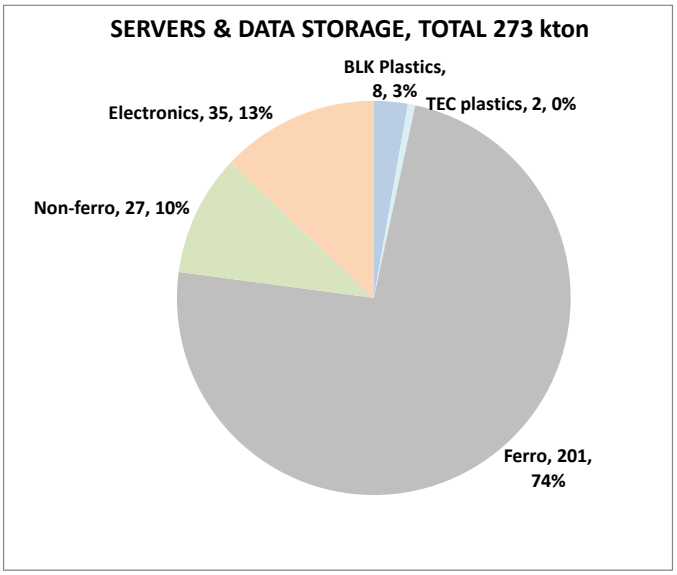


Figure 16: Distribution of total mass for cooking appliances sold in 2020 over the material categories, and distribution of ferrous metals mass over the types. (packaging excluded)



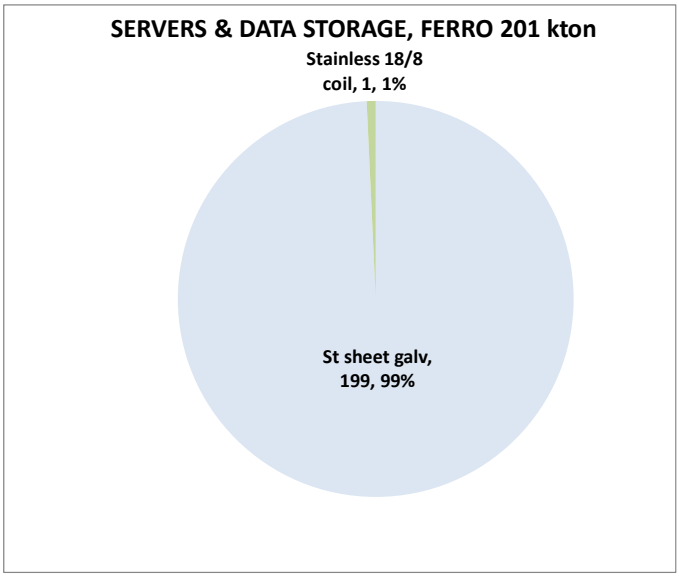


*Figure 17: Distribution of total mass for servers and data storage products projected to be sold in **2030** over the material categories, and distribution of ferrous metals mass over the types. (packaging excluded)*

A2.2.4 Prioritization scores for non-ferrous metals

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 13 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only non-ferrous metals. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 14 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in *Table* 13.

Remarks:

1- There are **many product groups with a high prioritization score for impacts per year from non-ferrous metals for products sold in 2030**. The highest sum of scores per year are found for:
   a. electric motors (rank 1 incl. double; rank 3 excl. double),
   b. personal computers (rank 2),
   c. industrial fans (rank 4 incl. double),
   d. servers and data storage (rank 5),
   e. electronic displays, central heating boilers and transformers (all rank 6).

2- **Electric motors** (incl. double counted) have the highest prioritization scores for sum of impacts per year from non-ferro metals. Of the total mass, 22% is non-ferro metal, of which 56% is Aluminum diecast and 44% Copper winding wire (Figure 18). MT would be a **priority choice for further study on non-ferrous metals**.

3- **Personal Computers** have the second highest prioritization scores in 2030 for the sum of impacts per year from non-ferro metals, and in 2020 the fourth highest score. When considering full impacts, scores are lower. The difference in scores between 2020 and 2030 is due to a projected increase in sales quantities, from 67 mln units in 2020 to 103 mln in 2030. Of the total mass, 9% is non-ferro metal, of which 52% is Copper, 28% Aluminum and 20% Magnesium alloy casting (Figure 20). PCs would be a **candidate for further study on non-ferrous metals, but with lower priority than for motors.**

4- **Industrial fans** (incl. double counted) have the fourth highest prioritization scores for sum of impacts per year from non-ferro metals in 2030, and the third highest score in

2020. Scores for full impacts are high both in 2020 and 2030. Of the total mass, 25% is non-ferro metal, of which 80% is Aluminum diecast and 20% Copper winding wire (Figure 19). It is likely that at least a part of this mass comes from the motors driving the fans. FANs are therefore **not a priority choice for further study on non-ferrous metals**.

5- **Utility transformers** have the second highest sum of scores when considering full impacts. As they have a long lifetime, the scores for impacts per year are lower (sixth highest in 2030). Of the total mass, 19% is non-ferrous metal, of which 76% is Copper winding wire, 15% Aluminum sheet extrusion, and 9% Copper tube/sheet (Figure 21). TRAFOs would be a **candidate for further study on non-ferrous metals, but with lower priority than for motors and personal computers.**

6- **Central Heating Boilers** have the fourth highest sum of scores when considering full impacts in 2030. In 2020 the sum of scores for full impacts are lower. The difference is caused by a general increase in sales quantities, but also due to a shift from gas/oil boilers to electric heat pumps and hybrids. As boilers have a long lifetime, the scores for impacts per year are lower (sixth highest in 2030). Of the total mass in 2030, 26% is non-ferrous metal, of which 28% is Aluminum, 54% Copper and 18% Copper-Zinc casting (Figure 22). Compared to other product groups, CHB have a **lower priority for further study on non-ferrous metals**.

Table 13: Prioritization scores for environmental production impacts per year of lifetime in 2030 from non-ferrous metals.

Non-Ferrous metals, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.2		23
CHB	0.2	0.2	0.2	0.0	1.0	0.0	0.4	0.0	0.0	0.2	0.4	0.6	0.4	0.4	0.2		1.0	4.2		**6**
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
AHC	0.2	0.2	0.2	0.0	0.8	0.0	0.4	0.0	0.0	0.0	0.2	0.6	0.4	0.2	0.0		0.8	3.2		**10**
LSHs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
RAC	0.2	0.2	0.2	0.0	1.0	0.0	0.4	0.0	0.0	0.0	0.2	0.6	0.4	0.4	0.2		1.0	3.8		**9**
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
VU	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.2	0.0	0.0		0.2	1.4		17
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
DP	0.2	0.4	0.4	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.4	0.4	0.4	1.0	0.4		1.0	4.2		**6**
STB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0		0.2	0.2		23
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
ESDS	0.2	0.4	0.4	0.0	0.6	0.0	0.6	0.0	0.2	0.0	0.0	1.0	0.8	0.2	0.0		1.0	4.4		**5**
PC	0.2	0.4	0.6	1.0	1.0	1.0	0.4	0.2	0.2	0.0	0.2	0.8	0.6	0.6	0.2		1.0	7.4		**2**
IE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0		0.2	0.6		21

Non-Ferrous metals, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
INK	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.0		0.4	1.4		17
SB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0		0.2	0.2		23
EPSi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4	0.2		0.4	0.8		20
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
MCPT	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0		0.2	0.6		21
RF	0.2	0.2	0.2	0.0	0.6	0.0	0.4	0.0	0.0	0.0	0.2	0.6	0.4	0.4	0.0		0.6	3.2		11
CF	0.2	0.2	0.2	0.0	0.6	0.0	0.4	0.0	0.0	0.0	0.0	0.6	0.4	0.2	0.0		0.6	2.8		13
PFi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
Pfe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
CK	0.0	0.2	0.2	0.2	0.6	0.2	0.4	0.0	0.0	0.0	0.0	0.6	0.4	0.2	0.0		0.6	3.0		12
WM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
DW	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0		0.4	1.0		19
LD	0.0	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.2	0.6	0.4	0.4	0.2		0.6	2.8		14
VC	0.0	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.2	0.4	0.2	0.4	0.2		0.4	2.4		15
FANi	0.6	0.4	0.4	0.0	0.6	0.2	0.8	0.2	0.6	0.8	0.2	0.6	0.6	0.0	0.2		0.8	6.2		**4**
FANe	0.2	0.2	0.2	0.0	0.2	0.0	0.4	0.0	0.2	0.4	0.0	0.2	0.2	0.0	0.0		0.4	2.2		16
Mti	1.0	1.0	1.0	0.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	0.2	1.0		1.0	12.8		**1**
Mte	0.6	0.6	0.6	0.0	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.4	0.6	0.0	0.6		0.6	7.2		**3**
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		26
TRAFO	0.2	0.4	0.4	0.0	0.2	0.4	0.2	0.4	0.2	0.0	0.4	0.4	0.4	0.2	0.4		0.4	4.2		**6**

DWH	Dedicated Water Heater	CF	Commercial Refrigeration [42]
CWH	Central Heating Combi, Water Heating	PF	Professional Refrigeration
CHB	Central Heating Boiler or Combi	CK	Cooking Appliances
SFB	Solid Fuel Boilers	WM	household Washing Machines
AHC	Central Air Heating & Cooling	DW	household Dishwashers
LSH	Local Space Heaters	LD	household Laundry Dryer
RAC	Room Air Conditioner	VC	Vacuum Cleaners
CIRC	Circulator pumps <2.5 kW	FAN	Industrial Fans >125W
VU	Ventilation Units	MT	Motors 0.12-1000 kW
LS	Light Sources	WP	Water pumps
DP	electronic DisPlays	WE	Welding Equipment
STB	Set Top Boxes	TRAFO	Utility Transformers
GC	Game Consoles	TYRE	Tyres
ESDS	Enterprise Servers & Data Storage	PV	Photovoltaic panels and Inverters
PC	Personal Computers	TS	Taps and Showers
IE	Imaging Equipment	EK	Electric Kettles
INK	Ink/toner Cartridges/Containers (empty)		
SB	Products regulated for Standby	For CIRC, EPS, PF, FAN, MT, suffixes:	
EPS	External Power Supplies	i	Including double counted amounts
RF	Household Refrigeration	e	Excluding double counted amounts

Table 14: Prioritization scores for environmental impacts from production when considering only non-ferrous metals, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

Score for Impacts from Non-Ferrous metals	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum

[42] Refrigerating appliances with a direct sales function

Product group	2020	2030	2020	2030		2020	2030	2020	2030
DWH Dedicated Water Heater	0.4	0.2	0.6	0.2		0.4	0.2	0.8	0.4
CHB Central Heating boilers	0.6	1.0	2.0	4.2		0.8	1.0	4.4	7.0
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.8	0.8	3.4	3.2		1.0	0.8	5.8	5.2
LH Local Heaters (solid fuel)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RAC Room Air Conditioner	1.0	1.0	3.4	3.8		0.8	0.8	3.6	3.8
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VU Ventilation Units	0.0	0.2	0.0	1.4		0.2	0.2	2.6	2.6
LS Light Sources	0.0	0.0	0.0	0.0		0.2	0.2	0.8	1.4
DP Electronic Displays	1.0	1.0	3.4	4.2		1.0	1.0	2.8	3.4
STB Set Top Boxes	0.2	0.2	0.4	0.2		0.0	0.0	0.0	0.0
GC Game consoles	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
ESDS Servers and Data Storage	1.0	1.0	3.4	4.4		0.6	0.4	1.8	1.8
PC Personal Computers	1.0	1.0	5.6	7.4		0.6	1.0	2.2	3.2
IE imaging equipment	0.2	0.2	1.2	0.6		0.2	0.0	0.2	0.0
INK Cartridges and Containers (empty)	0.8	0.4	3.4	1.4		0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.0	0.2	0.0	0.2		0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.4	0.4	1.0	0.8		0.2	0.0	0.2	0.0
EPS External Power Supplies excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MCPT Phones and Tablets	0.4	0.2	2.6	0.6		0.2	0.0	0.2	0.0
RF Household Refrigerators & freezers	0.8	0.6	3.6	3.2		1.0	0.8	6.0	4.8
CF Commercial Refrigeration	0.8	0.6	3.2	2.8		0.6	0.4	2.6	2.4
PF Professional Refrigeration, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CK Cooking Appliances	0.8	0.6	3.6	3.0		1.0	1.0	7.0	5.8
WM (household) Washing Machines	0.2	0.0	0.8	0.0		0.2	0.2	2.8	2.0
DW (household) Dishwashers	0.4	0.4	0.6	1.0		0.4	0.4	1.2	1.2
LD (household) Laundry Dryers	0.6	0.6	2.4	2.8		0.6	0.6	3.0	3.0
VC Vacuum Cleaners	0.4	0.4	2.0	2.4		0.2	0.2	0.4	0.4
FAN Industrial Fans, incl. double	0.8	0.8	7.0	6.2		1.0	1.0	10.4	8.2
FAN Industrial Fans, excl. double	0.4	0.4	2.8	2.2		0.4	0.4	4.4	3.0
MT Electric Motors, incl. double	1.0	1.0	13.4	12.8		1.0	1.0	13.2	11.4
MT Electric Motors, excl. double	0.6	0.6	8.0	7.2		0.6	0.6	7.0	5.6
WP Water pumps	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WE Welding Equipment	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
TRAFO Utility Transformers	0.4	0.4	3.0	4.2		1.0	1.0	10.2	11.2

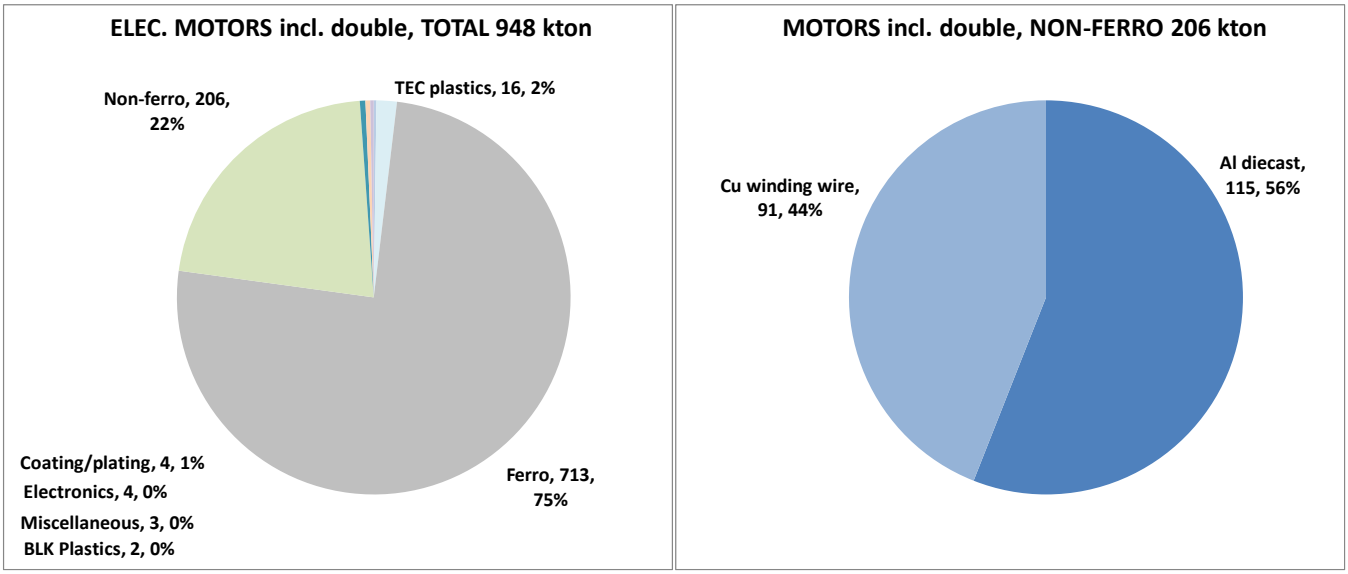


Figure 18: Distribution of total mass for electric motors sold in 2020 over the material categories, and distribution of non-ferrous metals mass over the types. (packaging excluded)

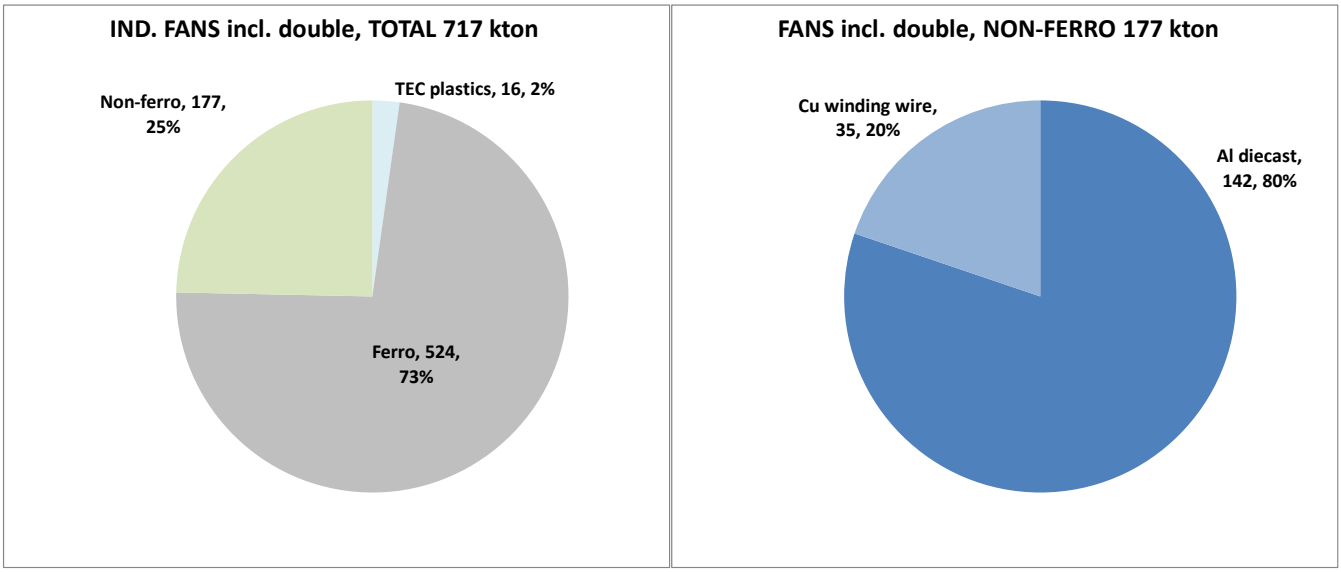


Figure 19: Distribution of total mass for industrial fans sold in 2020 over the material categories, and distribution of non-ferrous metals mass over the types. (packaging excluded)

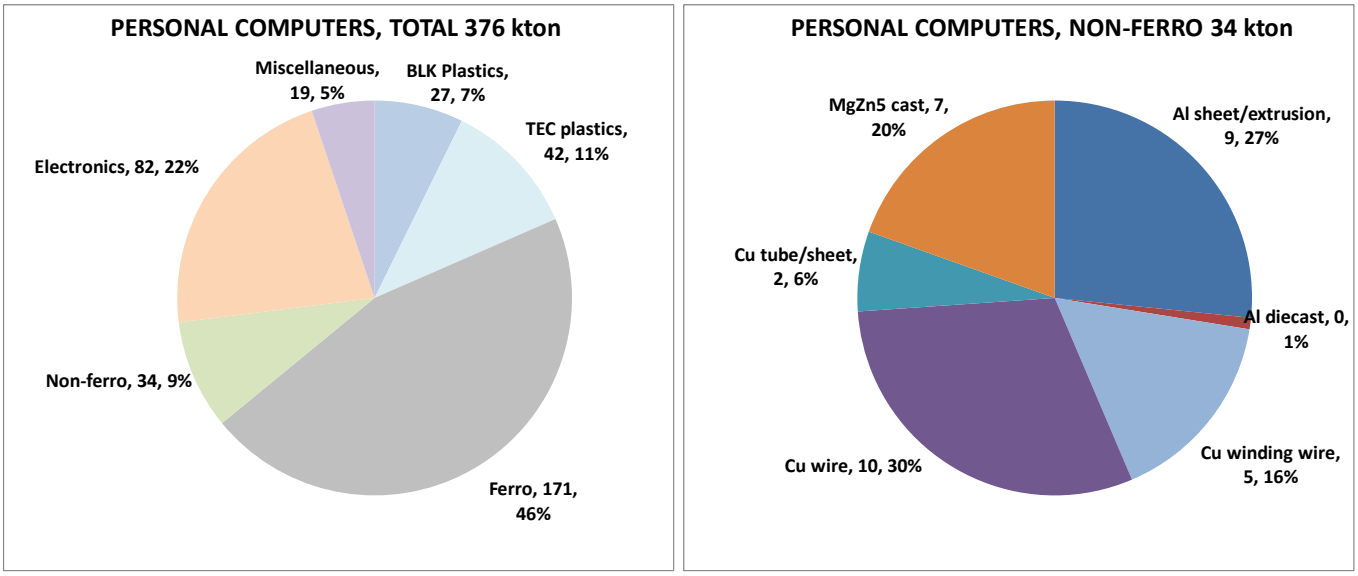


*Figure 20: Distribution of total mass for personal computers projected to be sold in **2030** over the material categories, and distribution of non-ferrous metals mass over the types. (packaging excluded)*

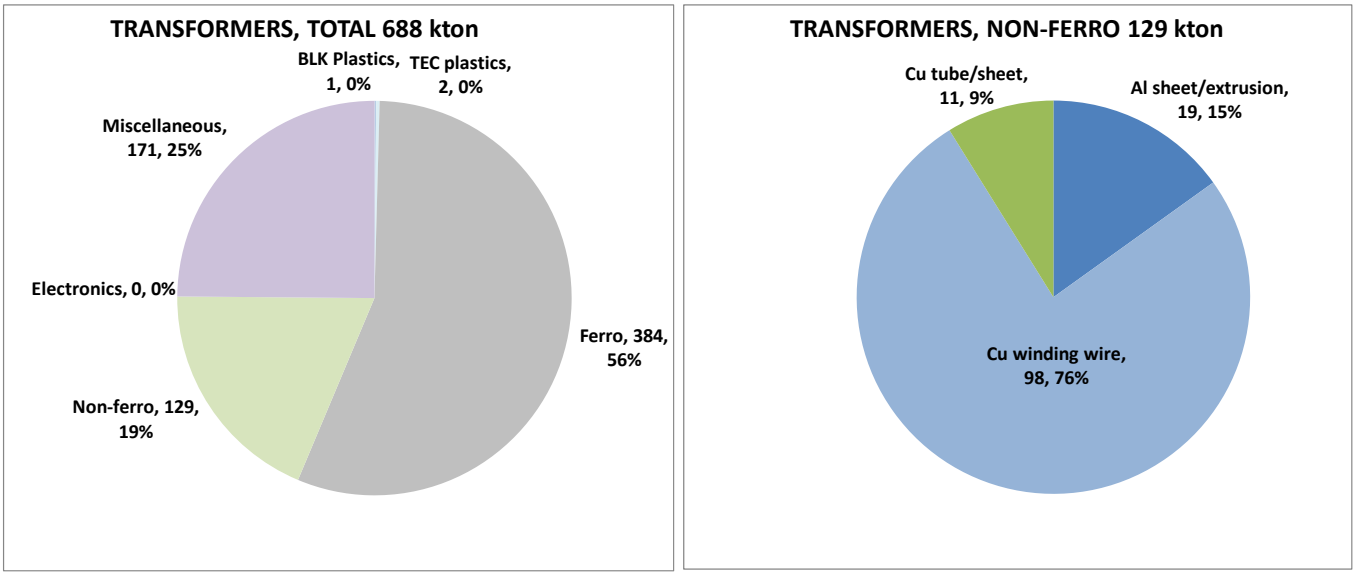


Figure 21: Distribution of total mass for utility transformers sold in 2020 over the material categories, and distribution of non-ferrous metals mass over the types. (packaging excluded)

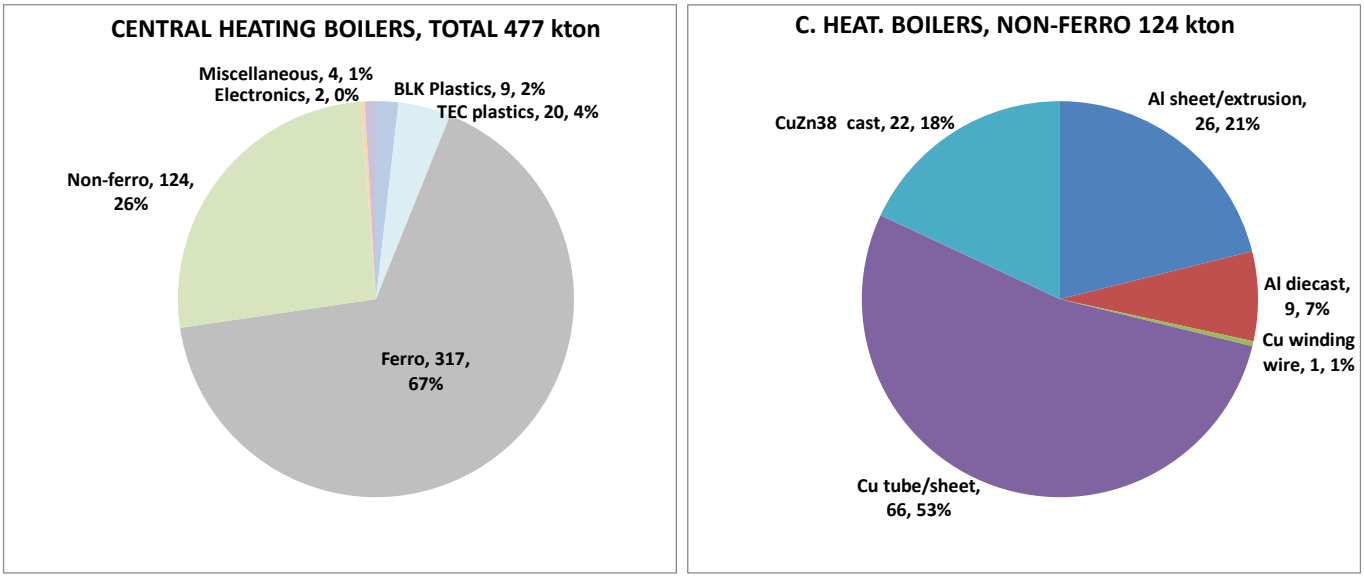


*Figure 22: Distribution of total mass for central heating boilers projected to be sold **in 2030** over the material categories, and distribution of non-ferrous metals mass over the types. (packaging excluded)*

A2.2.5 Prioritization scores for coating / plating

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 15 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only coating and plating. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 16 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 15.

Remarks:

1- The mass for coating / plating in products sold in 2020 is small: approximately 0.5% of the total product mass. However, this mass includes materials like Copper, Nickel, Chromium, Gold, Platinum and Palladium, which have a high monetary value, relatively high environmental impacts, and some are Critical Raw Materials or scarce materials.

2- The general impression from studying the EcoReports for all products is that coating and plating has not been consistently considered on the BoMs. The accounting of coating / plating masses and associated environmental impacts in the EIA could be incomplete.

3- The **product groups with the highest sum of scores** for environmental impacts per year from coating and plating for products sold in 2030 are:
   a. Refrigeration with a direct sales function (CF, rank 1)
   b. Professional refrigeration (rank 2).

4- **Commercial refrigeration** (CF, direct sales function) is the product group with the highest scores for impacts from coating / plating. Main impacts come from pre-coating coil and powder coating for 'other supermarket models', ice cream freezers and spiral vending machines. The Bill-of-Materials for ‘other supermarket models’, and hence the related environmental impacts, have **higher uncertainty** because they were estimated by similarity. The type of coating and the materials involved are not known at the moment, so it is **hard to judge how relevant further study could be** for CRMs or recyclability / recycled content.

5- **Professional refrigeration** (PF) has the second highest sum of scores for impacts from coating / plating. Main impacts come from pre-coating coil for vertical frozen or chilled storage cabinets. The type of coating and the materials involved are not

known at the moment, so it is **hard to judge how relevant further study could be** for CRMs or recyclability / recycled content.

6- **Cooking appliances** (CK) have a relatively high sum of scores for full impacts from coating / plating. As their lifetime is relatively long, the scores for impacts per year are lower. Main impacts come from Cu/Ni/Cr plating for electric ovens. CK could be a **candidate for further study, but with lower priority** compared to other products.

7- **Phones and tablets** have a high score for impacts per year in 2020, but due to the drop in sales following the 2023 regulation, the score is lower for 2030. When considering full impacts, scores are low. High impacts come mainly from smartphones and tablets, for Au/Pt/Pd plating, and some from Cu/Ni/Cr plating. Compared to other products, this is **not a priority choice for further study**, also considering that recent regulation addressed resource efficiency.

8- **Imaging equipment** has the fourth highest sum of scores for coating / plating impacts per year in 2020, but the score decreases in 2030 due to decreasing sales quantities. Scores for full impacts are relatively low. High impacts come from Inkjet MFD (from Au/Pt/Pd plating) and Laser printer mono (from pre-coating coil and powder coating). Compared to other products, this is **not a priority choice for further study on coating/plating**.

9- **Servers and data storage products** have the third highest sum of scores for coating / plating impacts per year in 2030. Scores for full impacts are relatively low. Highest scores derive from Au/Pt/Pd plating for blade servers. Compared to other products, this is **not a priority choice for further study on coating/plating.**

10- **Dedicated water heaters** have a high sum of scores for full impacts from coating / plating, but the scores for impacts per year of lifetime are low. Highest scores derive from powder coating for electric storage DWHs > 30 ltr (and some from DWH heat pumps). Compared to other products, this is **not a priority choice for further study on coating/plating.**

Table 15: Prioritization scores for environmental production impacts per year of lifetime in 2030 from coating / plating.

Coating / Plating, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2		0.2	1.8		8
CHB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
AHC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
LSHs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10

Coating / Plating, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
RAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
VU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
DP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
STB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
ESDS	0.0	0.2	0.4	0.0	0.0	0.4	1.0	1.0	0.0	0.0	1.0	0.0	0.2	0.0	0.0		1.0	4.2		**4**
PC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
IE	0.0	0.2	0.2	0.0	0.0	0.4	0.8	0.8	0.0	0.0	0.8	0.0	0.2	0.0	0.0		0.8	3.4		**5**
INK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
SB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
EPSi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
MCPT	0.0	0.0	0.2	0.0	0.0	0.2	0.4	0.4	0.0	0.2	0.6	0.0	0.0	0.2	0.0		0.6	2.2		**7**
RF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
CF	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.6	0.8	0.0	0.0	1.0	1.0	0.2	1.0		1.0	10.6		**1**
PFi	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.2	1.0	0.0	0.0	0.6	0.6	0.0	0.6		1.0	6.6		**2**
Pfe	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.2	1.0	0.0	0.0	0.6	0.6	0.0	0.6		1.0	6.6		**2**
CK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.0	0.6	0.2	0.0	1.0	0.0		1.0	3.0		**6**
WM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
DW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
LD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
FANi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
FANe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
Mti	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2		0.2	1.8		**8**
Mte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10
TRAFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		10

DWH	Dedicated Water Heater
CWH	Central Heating Combi, Water Heating
CHB	Central Heating Boiler or Combi
SFB	Solid Fuel Boilers
AHC	Central Air Heating & Cooling
LSH	Local Space Heaters
RAC	Room Air Conditioner
CIRC	Circulator pumps <2.5 kW
VU	Ventilation Units

CF	Commercial Refrigeration [43]
PF	Professional Refrigeration
CK	Cooking Appliances
WM	household Washing Machines
DW	household Dishwashers
LD	household Laundry Dryer
VC	Vacuum Cleaners
FAN	Industrial Fans >125W
MT	Motors 0.12-1000 kW

[43] Refrigerating appliances with a direct sales function

LS	Light Sources	WP	Water pumps
DP	electronic DisPlays	WE	Welding Equipment
STB	Set Top Boxes	TRAFO	Utility Transformers
GC	Game Consoles	TYRE	Tyres
ESDS	Enterprise Servers & Data Storage	PV	Photovoltaic panels and Inverters
PC	Personal Computers	TS	Taps and Showers
IE	Imaging Equipment	EK	Electric Kettles
INK	Ink/toner Cartridges/Containers (empty)		
SB	Products regulated for Standby	For CIRC, EPS, PF, FAN, MT, suffixes:	
EPS	External Power Supplies	i	Including double counted amounts
RF	Household Refrigeration	e	Excluding double counted amounts

Table 16: Prioritization scores for environmental impacts from production when considering only coating / plating, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

Score for Impacts from Coating / Plating	Impacts per year of lifetime					Full impacts		
	Max	Max	Sum	Sum	Max	Max	Sum	Sum
Product group	2020	2030	2020	2030	2020	2030	2020	2030
DWH Dedicated Water Heater	0.2	0.2	1.8	1.8	0.4	0.4	4.0	4.0
CHB Central Heating boilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LH Local Heaters (solid fuel)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VU Ventilation Units	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LS Light Sources	0.4	0.0	1.0	0.0	0.0	0.0	0.0	0.0
DP Electronic Displays	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STB Set Top Boxes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GC Game consoles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESDS Servers and Data Storage	1.0	1.0	3.8	4.2	1.0	1.0	2.6	2.8
PC Personal Computers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IE imaging equipment	1.0	0.8	4.0	3.4	1.0	0.6	2.8	1.6
INK Cartridges and Containers (empty)	0.2	0.0	1.8	0.0	0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPS External Power Supplies excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MCPT Phones and Tablets	1.0	0.6	5.0	2.2	0.6	0.4	1.4	1.0
RF Household Refrigerators & freezers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CF Commercial Refrigeration	1.0	1.0	10.8	10.6	1.0	1.0	11.0	11.0
PF Professional Refrigeration, incl. double	1.0	1.0	6.0	6.6	1.0	1.0	6.4	6.8
PF Professional Refrigeration, excl. double	1.0	1.0	5.8	6.6	1.0	1.0	6.2	6.8
CK Cooking Appliances	1.0	1.0	3.0	3.0	1.0	1.0	5.4	5.2
WM (household) Washing Machines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW (household) Dishwashers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD (household) Laundry Dryers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VC Vacuum Cleaners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FAN Industrial Fans, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FAN Industrial Fans, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT Electric Motors, incl. double	0.2	0.2	1.8	1.8	0.2	0.2	2.0	2.0
MT Electric Motors, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WP Water pumps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WE Welding Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRAFO Utility Transformers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

A2.2.6 Prioritization scores for electronics

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 17 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only electronics. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 18 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 17.

Remarks:

1- The mass for electronics in products sold in 2020 is small: approximately 3% of the total product mass. However, electronics are responsible for 60% of the primary energy consumption and greenhouse gas emission during production. In addition, many of the critical and scarce raw materials are inside the electronic parts.

2- The product groups with the **highest sum of scores for production impacts per year from electronics** in products sold in 2030 production are:
   a. phones and tablets (rank 1),
   b. personal computers (rank 2),
   c. electronic displays (rank 3),
   d. servers and data storage products (rank 4),
   e. imaging equipment (rank 5).

3- **Phones and Tablets** have the highest score for production impacts from electronics both when considering full impacts or impacts per year. The impacts are due to a large variation of electronic components (the MCPT study defined many extra materials for electronics). Impacts are high especially for water consumption, waste, acidification, VOC, heavy metals emission to air and water and eutrophication. This product group has recently been studied and new regulations were issued in 2023, focusing on resource efficiency. This product group is therefore **not a priority choice for further study**.

4- **Personal Computers** have the second highest score for production impacts from electronics both when considering full impacts or impacts per year. Major impacts come from notebooks (large ICs) and desktops (large ICs, SMD/LEDs and PWBs, depending on impact category). Impacts are high especially for non-hazardous waste, persistent organic pollutants, and polycyclic aromatic hydrocarbons. This product group is a **major candidate for further study**.

5- **Electronic Displays** have the third highest score for production impacts from electronics both when considering full impacts or impacts per year. Highest impacts come from HiNA 'smart' TVs, from the LCD screens and from the Controller Board (depending on the impact category). Impacts are high especially for electronics mass content, primary energy consumption, GHG emissions and cooling water use. This product group is a **major candidate for further study**.

6- **Servers and Data storage products** have the fourth highest score for production impacts from electronics both when considering full impacts or impacts per year. Major impacts come from blade and rack servers, 2-socket, cloud use, mainly from 'Controller board'. Impacts are high especially for non-hazardous waste, persistent organic pollutants and particulate matter, all with score 0.8. This product group is a **candidate for further study, but with lower priority than for the above product groups.**

7- **Imaging equipment** has the fifth highest score for production impacts from electronics. Major impacts come from laser MFDs (controller board, SMD/LEDs, PWBs depending on impact category) and inkjet MFD (controller board, LCD screen, PWBs). Impacts are high especially for non-hazardous waste and persistent organic pollutants. Compared to other product groups, this product group is **not a priority choice for further study on electronics**.

Table 17: Prioritization scores for environmental production impacts per year of lifetime in 2030 from electronics.

Electronics, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
CHB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
AHC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
LSHs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
RAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
VU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
DP	0.6	1.0	1.0	0.0	1.0	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.6	0.0	0.0		1.0	4.8		**3**
STB	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.2	0.2		**8**
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
ESDS	0.4	0.4	0.4	0.2	0.0	0.4	0.6	0.4	0.0	0.6	0.0	0.2	1.0	0.0	0.0		1.0	4.6		**4**
PC	1.0	0.8	1.0	0.2	0.4	0.4	1.0	0.8	0.4	1.0	0.0	1.0	0.2	0.0	0.0		1.0	8.2		**2**
IE	0.4	0.2	0.2	0.0	0.0	0.4	0.4	0.2	0.0	0.4	0.0	0.2	0.4	0.0	0.0		0.4	2.8		**5**

Electronics, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
INK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
SB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
EPSi	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0		0.4	0.8		6
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
MCPT	0.2	0.2	0.4	1.0	1.0	1.0	0.4	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0		1.0	9.2		1
RF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
CF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
PFi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
Pfe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
CK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0		0.4	0.6		7
WM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
DW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	0.2		8
LD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.2	0.2		8
FANi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
FANe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
Mti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
Mte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0		0.2	0.2		8
TRAFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		12

DWH	Dedicated Water Heater
CWH	Central Heating Combi, Water Heating
CHB	Central Heating Boiler or Combi
SFB	Solid Fuel Boilers
AHC	Central Air Heating & Cooling
LSH	Local Space Heaters
RAC	Room Air Conditioner
CIRC	Circulator pumps <2.5 kW
VU	Ventilation Units
LS	Light Sources
DP	electronic DisPlays
STB	Set Top Boxes
GC	Game Consoles
ESDS	Enterprise Servers & Data Storage
PC	Personal Computers
IE	Imaging Equipment
INK	Ink/toner Cartridges/Containers (empty)
SB	Products regulated for Standby
EPS	External Power Supplies
RF	Household Refrigeration

CF	Commercial Refrigeration [44]
PF	Professional Refrigeration
CK	Cooking Appliances
WM	household Washing Machines
DW	household Dishwashers
LD	household Laundry Dryer
VC	Vacuum Cleaners
FAN	Industrial Fans >125W
MT	Motors 0.12-1000 kW
WP	Water pumps
WE	Welding Equipment
TRAFO	Utility Transformers
TYRE	Tyres
PV	Photovoltaic panels and Inverters
TS	Taps and Showers
EK	Electric Kettles

For CIRC, EPS, PF, FAN, MT, suffixes:

i	Including double counted amounts
e	Excluding double counted amounts

Table 18: Prioritization scores for environmental impacts from production when considering only electronics, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

[44] Refrigerating appliances with a direct sales function

Score for Impacts from Electronics	Impacts per year of lifetime					Full impacts		
	Max	Max	Sum	Sum	Max	Max	Sum	Sum
Product group	2020	2030	2020	2030	2020	2030	2020	2030
DWH Dedicated Water Heater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHB Central Heating boilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.6
LH Local Heaters (solid fuel)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.0	0.0	0.0	0.0	0.2	0.4	0.2	0.6
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VU Ventilation Units	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LS Light Sources	0.0	0.0	0.0	0.0	0.6	0.8	1.6	1.2
DP Electronic Displays	1.0	1.0	4.4	4.8	1.0	1.0	6.8	7.0
STB Set Top Boxes	0.2	0.2	0.4	0.2	0.2	0.2	0.6	0.2
GC Game consoles	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
ESDS Servers and Data Storage	1.0	1.0	4.0	4.6	0.8	1.0	4.0	4.8
PC Personal Computers	1.0	1.0	6.0	8.2	1.0	1.0	5.6	7.6
IE imaging equipment	0.6	0.4	3.8	2.8	0.8	0.6	3.6	3.0
INK Cartridges and Containers (empty)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.8	0.4	1.6	0.8	0.6	0.4	1.0	0.6
EPS External Power Supplies excl. double	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0
MCPT Phones and Tablets	1.0	1.0	11.8	9.2	1.0	1.0	9.8	8.4
RF Household Refrigerators & freezers	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.2
CF Commercial Refrigeration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PF Professional Refrigeration, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CK Cooking Appliances	0.4	0.4	1.0	0.6	1.0	1.0	3.8	3.6
WM (household) Washing Machines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW (household) Dishwashers	0.2	0.2	0.2	0.2	0.4	0.4	1.0	1.0
LD (household) Laundry Dryers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VC Vacuum Cleaners	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2
FAN Industrial Fans, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FAN Industrial Fans, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT Electric Motors, incl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT Electric Motors, excl. double	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WP Water pumps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WE Welding Equipment	0.4	0.2	0.6	0.2	0.6	0.2	0.8	0.2
TRAFO Utility Transformers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

A2.2.7 Prioritization scores for miscellaneous

For the derivation of prioritization scores, see section A2.1 Methodology for environmental impacts.

Table 19 shows the prioritization scores for environmental production impacts per year of lifetime in 2030 when considering only miscellaneous materials. For the product group abbreviations used in column 1, see the bottom of the table.

Columns 2 to 16 give the prioritization score separately for each of the 15 environmental parameters. Column 18 (Max score) gives the highest product group score for any environmental parameter. These scores are high-lighted in red if they are > 0.5.

Column 19 (Sum of scores) gives the sum of product group scores over all parameters. These values are high-lighted in orange if they are > 2.0. The last column gives the rank of the product group for the sum of scores. The 10 product groups with the highest environmental impacts are high-lighted in orange.

Table 20 shows how the maximum or summed prioritization scores change when 2020 is considered instead of 2030, or when full impacts are considered instead of impacts per year. In this table, the impacts per year of lifetime for 2030 are the same as those in Table 19.

Remarks:

1- The highest prioritization scores for environmental impacts per year from miscellaneous materials in products sold in 2030 are for:
   a. utility transformers (rank 1),
   b. dishwashers (rank 2),
   c. phones and tablets (rank 3),
   d. electronic displays and cooking appliances (both rank 4),
   e. refrigerators / freezers and cartridges / containers (both rank 6),
   f. washing machines (rank 8).

2- **Utility Transformers** are the product group with highest scores on full impacts from miscellaneous materials, and the highest score in 2030 when considering impacts per year of life. Highest impacts come from **mineral oil**, with additional impacts from wood, paper (as insulation between winding wires) and ceramics. The lifetime of these products is very long (from 20 to 40 years), so any measures on recycled content would have effects from 2050 onwards. This product group therefore **does not seem to be a priority choice for further study**.

3- **Phones and tablets** have the highest sum of scores in 2020 when considering impacts per year of life, and the third highest in 2030, but a low score for full impacts. The highest impacts come from cordless home phones, slate tablets and smartphones, from **glass, silicone and magnets**. This product group has recently been studied and new regulations were issued in 2023, focusing on resource efficiency. This product group is therefore **not a priority choice for further study**.

4- **Dishwashers** have the second highest score for impacts per year in 2030 and for full impacts in both 2020 and 2030. Relatively high impacts derive from **bitumen** and cardboard (bitumen used as sound-deadening material bonded to the tub and the doors). This product group could be **a candidate for further study**.

5- **Cooking appliances** have a relatively high score especially for impacts per year in 2030 (rank 4). Highest impacts derive from **glass** used in electric hobs and ovens. This product group could be **a candidate for further study**, especially if it is chosen also for other material types.

6- **Electronic displays** have a relatively high score especially for impacts per year in 2030 (rank 4), but scores for full impacts are lower. Highest impacts derive from

glass used in HiNA 'smart' TVs. This product group could be **a candidate for further study**, especially if it is chosen also for other material types.

7- **Household refrigerators and freezers** have a relatively high score especially for impacts per year in 2030 (rank 6), and scores for full impacts are also high. Highest impacts derive from **glass**. This product group could be **a candidate for further study**, especially if it is chosen also for other material types.

8- **Cartridges and Containers** have relatively high scores for impacts per year (rank 6 in 2030, rank 4 in 2020). Highest impacts come from **glass** used in toner cartridges. This product group is already being discussed elsewhere, and therefore **not a priority choice for further study**.

9- **Washing machines** have a relatively high score both for full impacts and for impacts per year. Highest impacts come from **glass and concrete**. Compared to other product groups, this is **not a priority choice for further study on miscellaneous materials**.

10- **Local space heaters using solid fuels** have a relatively high score especially for full impacts. This is mainly due to **refractory ceramics**, for slow-heat-release stoves and for open fireplaces. Compared to other product groups, this is **not a priority choice for further study on miscellaneous materials**.

Table 19: Prioritization scores for environmental production impacts per year of lifetime in 2030 from miscellaneous.

Miscellaneous, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
DWH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
CHB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
SFB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
AHC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
LSHs	1.0	0.8	0.8	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.0	2.8		**9**
LSHns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
RAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
CIRCi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
CIRCe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
VU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
LS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
DP	0.2	0.2	1.0	1.0	0.0	1.0	0.2	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0		1.0	4.2		**4**
STB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
GC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
ESDS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
PC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
IE	0.0	0.0	0.4	0.4	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.4	1.4		11

Miscellaneous, 2030, impacts per year	Material mass	Primary Energy	GHG-emissions	Process Water	Cooling Water	Hazardous Waste	Non-Hazardous Waste	Acidification	Volatile Org. Comps.	Persist. Org. Pollutants	Heavy Metals to air	Polyc. Arom. Hydroc.	Particulate Matter	Heavy Metals to water	Eutrophication		Max Score	Sum of scores		Rank for sum of scores
INK	0.0	0.2	1.0	1.0	0.0	1.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.0	3.8		6
SB	0.0	0.0	0.0	0.0	0.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.6	0.8		12
EPSi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
EPSe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
MCPT	0.0	0.2	1.0	0.6	1.0	0.4	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0		1.0	6.2		3
RF	0.0	0.2	1.0	1.0	0.0	1.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.0	3.8		6
CF	0.0	0.2	0.6	0.6	0.0	0.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.6	2.2		10
PFi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
Pfe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
CK	0.2	0.2	1.0	1.0	0.0	1.0	0.2	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0		1.0	4.2		4
WM	0.4	0.0	0.8	0.2	0.0	0.2	0.0	0.6	0.0	0.8	0.2	0.0	0.0	0.0	0.0		0.8	3.2		8
DW	0.0	0.6	0.6	0.4	0.0	0.2	0.2	0.2	1.0	0.0	1.0	0.0	1.0	1.0	0.2		1.0	6.4		2
LD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
FANi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
FANe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
Mti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
Mte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
WP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
WE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		13
TRAFO	0.0	1.0	0.6	0.6	0.8	0.0	0.6	1.0	0.2	0.2	0.2	1.0	0.0	0.0	1.0		1.0	7.2		1

DWH	Dedicated Water Heater
CWH	Central Heating Combi, Water Heating
CHB	Central Heating Boiler or Combi
SFB	Solid Fuel Boilers
AHC	Central Air Heating & Cooling
LSH	Local Space Heaters
RAC	Room Air Conditioner
CIRC	Circulator pumps <2.5 kW
VU	Ventilation Units
LS	Light Sources
DP	electronic DisPlays
STB	Set Top Boxes
GC	Game Consoles
ESDS	Enterprise Servers & Data Storage
PC	Personal Computers
IE	Imaging Equipment
INK	Ink/toner Cartridges/Containers (empty)
SB	Products regulated for Standby
EPS	External Power Supplies
RF	Household Refrigeration

CF	Commercial Refrigeration [45]
PF	Professional Refrigeration
CK	Cooking Appliances
WM	household Washing Machines
DW	household Dishwashers
LD	household Laundry Dryer
VC	Vacuum Cleaners
FAN	Industrial Fans >125W
MT	Motors 0.12-1000 kW
WP	Water pumps
WE	Welding Equipment
TRAFO	Utility Transformers
TYRE	Tyres
PV	Photovoltaic panels and Inverters
TS	Taps and Showers
EK	Electric Kettles

For CIRC, EPS, PF, FAN, MT, suffixes:

i	Including double counted amounts
e	Excluding double counted amounts

Table 20: Prioritization scores for environmental impacts from production when considering only miscellaneous materials, summary of maximum and summed scores for years 2020 and 2030, for full impacts and for impacts per year of lifetime.

[45] Refrigerating appliances with a direct sales function

Score for Impacts from Miscellaneous	Impacts per year of lifetime					Full impacts			
	Max	Max	Sum	Sum		Max	Max	Sum	Sum
Product group	2020	2030	2020	2030		2020	2030	2020	2030
DWH Dedicated Water Heater	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CHB Central Heating boilers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
SFB Solid Fuel Boilers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
AHC Air Heating & Cooling	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LH Local Heaters (solid fuel)	1.0	1.0	2.2	2.8		1.0	1.0	2.8	2.8
LH Local Heaters (electric, gas, liquid)	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
RAC Room Air Conditioner	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CIRC Circulator pumps, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VU Ventilation Units	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
LS Light Sources	0.4	0.0	1.6	0.0		0.4	0.0	1.2	0.0
DP Electronic Displays	0.6	1.0	2.4	4.2		0.4	0.6	1.2	2.0
STB Set Top Boxes	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
GC Game consoles	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
ESDS Servers and Data Storage	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PC Personal Computers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
IE imaging equipment	0.4	0.4	1.4	1.4		0.2	0.0	0.6	0.0
INK Cartridges and Containers (empty)	1.0	1.0	4.4	3.8		0.0	0.0	0.0	0.0
SB Products regulated only for 'standby'	0.4	0.6	0.4	0.8		0.0	0.0	0.0	0.0
EPS External Power Supplies incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
EPS External Power Supplies excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MCPT Phones and Tablets	1.0	1.0	6.6	6.2		0.6	0.4	2.0	1.2
RF Household Refrigerators & freezers	0.6	1.0	2.6	3.8		1.0	1.0	3.8	3.0
CF Commercial Refrigeration	0.4	0.6	1.6	2.2		0.4	0.4	1.2	0.8
PF Professional Refrigeration, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
PF Professional Refrigeration, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
CK Cooking Appliances	0.6	1.0	2.6	4.2		1.0	1.0	4.0	3.8
WM (household) Washing Machines	0.6	0.8	2.4	3.2		1.0	1.0	3.2	2.6
DW (household) Dishwashers	1.0	1.0	5.2	6.4		1.0	1.0	5.2	5.2
LD (household) Laundry Dryers	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
VC Vacuum Cleaners	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
FAN Industrial Fans, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
FAN Industrial Fans, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MT Electric Motors, incl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
MT Electric Motors, excl. double	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WP Water pumps	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
WE Welding Equipment	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
TRAFO Utility Transformers	1.0	1.0	5.2	7.2		1.0	1.0	10.0	10.0

A3 Critical Raw Materials

A3.1 Methodology for CRM masses

Introduction to CRM and non-CRM masses

Some critical raw material masses (CRM) can be defined in the 2013 EcoReportTool (ERT), but separately from the Bill-of-Materials input. These (small) masses are a part of the masses declared on the BoM, in particular part of the electronics mass (PCBs, LEDs and screens), and not additional. The EIA collected the CRM masses reported by the preparatory and review studies, but relatively few studies provided them, and not all in the same manner and at the same level of detail: RAC, LS, ESDS, PC, MCPT, LD, VC, DP (the latter only precious metals).

For the final reporting, the DG GROW study[46] does not use the material breakdown of the 2013 ERT (which uses product-manufacturing-oriented material types, such as galvanized steel sheet, cast iron copper winding wire or CuZn38 casting), but raw mined ores and the extracted single chemical elements (e.g. iron (Fe), nickel (Ni)). The list of materials in the DG GROW study contains all CRMs of the 2023 list, but also various elements that are not on that list, such as Aluminium, Chromium, Gold, Iron (Fe), Iron ore, Lead, Selenium, Silica sand, Silver, Tellurium, Tin and Zinc. These latter materials will be referred to here as non-CRMs.

The DG GROW study derived sales masses per product group for these elements by assuming a breakdown of the available masses for the ERT materials, in particular for metals, LCD screens and PCBs. In addition, assumptions were made for the amounts of coking coal, bauxite, iron ore and silica sand.

To complete the CRM mass information from the EIA, this study followed the same approach as used in the DG GROW study to subdivide the ERT material amounts into the CRMs and other chemical elements, as detailed below.

All materials of the finally agreed CRM list were included in the study. However, natural graphite or graphite as a whole do not appear in the products studied, so this will not change the prioritization.

Construction metals breakdown in chemical elements

All metals used in products are alloys that can contain a large variety of alloying elements, often in small quantities. The Ecodesign studies use the materials available for choice in the ERT as proxies for the real material, and they usually do not specify the precise alloy that is being used. Hence, this study did not attempt to define a detailed average composition of steel, iron, aluminum or copper with all fractions of the alloying elements. Only the most obvious main composing elements are taken into account to further subdivide the BoM entries, as inspired by the DG GROW analysis:

- Al sheet/extrusion and Al diecast of the BoM are counted as 100% aluminium mass, as non-CRM in the CRM accounting.

[46] Annex 2 of the Terms of Reference (TOR) for the project, and associated Excel file

- Cu winding wire, Cu wire and Cu tube sheet of the BoM are counted as 100% copper mass in the CRM accounting. This ignores that Cu winding wire may have around 2.5% of the mass in insulation materials (plastic).
- The BoM masses for steel sheet galvanized, steel tube / profile, cast iron, stainless 18/8, CuZn38 cast, ZnAl4 cast and MgZn5 cast have been (roughly) split over the metal components Fe, C, Zn, Si, Mn, Cr, Ni, Cu, Al, Mg as follows:

	Fe	C	Zn	Si	Mn	Cr	Ni	Cu	Al	Mg
St sheet galvanized	98%	0.5%	1.5%							
Steel tube/profile	99%	1.0%								
Cast iron	96%	2.5%		1.0%	0.5%					
Stainless 18/8	74%					18%	8%			
CuZn38 cast			38%					62%		
ZnAl4 cast			96%						4%	
MgZn5 cast			5%							95%

- The assumed carbon fraction of steel (C) is not directly used. Instead, an amount of coking coal is added to the CRM accounting, set to 0.77 times the mass of Iron (Fe)[47].

Bauxite

The mass for Bauxite has been set to 5.8 times the aluminium mass[48]. Bauxite is on the 2023 CRM list, while aluminium is present in the CRM accounting as a non-CRM. It can be argued that considering both Bauxite and Aluminium for the prioritization is a (partial) double counting. Product group prioritization for CRM and non-CRM content has therefore been performed with and without considering the contribution of Bauxite (see section A3.3). However, considering or not Bauxite does not change the recommendation on the products to be further studied in phase 2.

Iron ore

The mass for Iron ore has been set to 1.82 times the iron (Fe) mass [49]. Iron Fe and iron ore are both present in the CRM accounting as a non-CRM. It can be argued that considering both Iron ore and Iron Fe for the prioritization is a (partial) double counting. Product group prioritization for CRM and non-CRM content has therefore been performed with and without considering the contribution of Iron ore (see section A3.3).

[47] The value of 0.77 has been taken from the DG GROW study in Annex 2 of the TOR.

[48] The value of 5.8 has been taken from the DG GROW study in Annex 2 of the TOR.

[49] The value of 1.82 derives from the statement in the DG GROW study in Annex 2 of the TOR that iron ore contains 55% of iron Fe.

Silica sand

The mass for Silica sand (a non-CRM) has been calculated as 73.6% of the amount of glass (from the BoMs) plus 55.2% times the amount of E-glass fibre (from the BoMs)[50]. The amount of glass declared as extra material on the BoMs for phones and tablets has been included. As glass is not separately present in the CRM accounting, there is no double counting, so the amount of silica sand has always been considered.

LCD screens breakdown in chemical elements

As regards the CRM content of LCD screens, the percentages indicated in the DG GROW study table 12 (copied below) have been applied to the BoM LCD masses for central heating boilers (CHB), Game Consoles (GC), Imaging Equipment (IE), Commercial Refrigeration (CF) and Professional Refrigeration (PF). This leads to (small) contributions for Yttrium (Y), Gadolinium (Gd), Europium (Eu), Cerium (Ce), Indium (In) and Gallium (Ga) [51]. For phones and tablets (MCPT), electronic displays (DP) and computers (PC), the EIA CRM data are assumed to already also cover the LCD screens, and no CRM masses have been added.

	Y	Gd	HREE	Eu	Ce	LREE	In	Ga
share of LCD mass:	0.000267%	0.000271%	0.000538%	0.000005%	0.000017%	0.000022%	0.002259%	0.000271%

Printed Circuit Board (PCB) breakdown in chemical elements

As regards the CRM content of PCBs, the EIA CRM data for Room Air Conditioners (RACs) [52], Light Sources (LS) [53], Servers and Data Storage products (ESDS), personal computers (PC), phones and tablets (MCPT), laundry dryers (LD) and Vacuum Cleaners (VC) have been assumed to already cover this. For the other product groups, the percentages indicated in the DG GROW study figure 13 for low-grade PCBs[54] (copied below) have been applied to the entire electronics mass of the BoM, except the mass of the screens, but including the mass of electronic components, solder and controller board in addition to the mass of PWBs. For electronic displays, where Au, Ag and Pd are already covered by EIA ERT data, only the other CRMs have been added based on electronics mass.

	Sb	Al	Ba	Be	Co	Cu	Au	Fe	Sn	Pb	Cr	Ni
Low-grade PCB	0.10%	6.0%	0.007%	0.0001%	0.0020%	20.0%	0.0053%	9.5%	0.9%	0.2%	0.2%	0.1%
Medium grade PCB	0.10%	6.0%	0.007%	0.0001%	0.0020%	20.0%	0.0053%	9.5%	0.9%	0.2%	0.2%	0.1%
High-grade PCB	0.10%	6.0%	0.007%	0.0001%	0.0020%	20.0%	0.0053%	9.5%	0.9%	0.2%	0.2%	0.1%

	Pd	Ag	Zn	Sr	Bi	support
Low-grade PCB	0.002%	0.005%	0.2%	0.0026%	0.0132%	62.76%

[50] The percentages have been taken from the DG GROW study in Annex 2 of the TOR

[51] Yttrium and Gadolinium are heavy rare earth elements (HREE). Cerium and Europium are light rare earth elements (LREE)

Indium covers both the contents of (backlighting) LEDs and the ITO of the screen.

[52] For RACs, the CRM data from the EIA ERT cover the PCB mass, but not the mass of the Controller board. This has not been modified.

[53] For LS, the CRM data from the EIA ERT cover the LEDs, electrodes and phosphors, but not the PCBs. This has not been modified. (External control gear mass is excluded from the BoMs and thus from the EIA masses).

[54] The DG GROW study in Annex 2 of the TOR distinguishes high grade, medium grade and low grade PCBs for a further material breakdown. For the low-grade PCB this breakdown is shown in Annex 2 figure 13 as a % of the PCB mass, but the breakdown for high and medium grade PCBs could not be found in the given reference (footnote 128).

Medium grade PCB	0.002%	0.005%	0.2%	0.0026%	0.0132%	62.76%
High-grade PCB	0.002%	0.005%	0.2%	0.0026%	0.0132%	62.76%

It is assumed that Cu from PCBs and other electronics is in addition to the Cu declared as wire, tube, sheet on the BoM.

The breakdown for PCBs in the GROW study also has a fraction for PCB support materials (plastics, fillers, reinforcement fibers). This fraction is not counted under plastics of the BoMs because there it is already counted under Electronics.

Elements without mass data

For many CRM and non-CRM items there are no mass data at all (neither in the EIA, nor in the DG GROW study).

In part these 'materials' are mined raw materials or production support materials that are not used in the products as such. For Bauxite, Coking Coal, Iron ore and Silica sand, the DG GROW study makes an overall estimate, multiplying Aluminum, Steel or Glass masses with a factor. For the prioritization study this does not seem necessary.

Other critical raw materials without data are arsenic, borates, feldspar, fluorspar, hafnium, helium, phosphate rock, phosphorous, titanium, vanadium, rhodium, scandium.

PGM and REE materials

For Platinum Group Materials (PGM) and rare earth elements (REE, HREE, LREE), some sources declare masses for the group or subgroup while other sources declare masses for specific materials within the group. This subdivision has been maintained in the Excel file

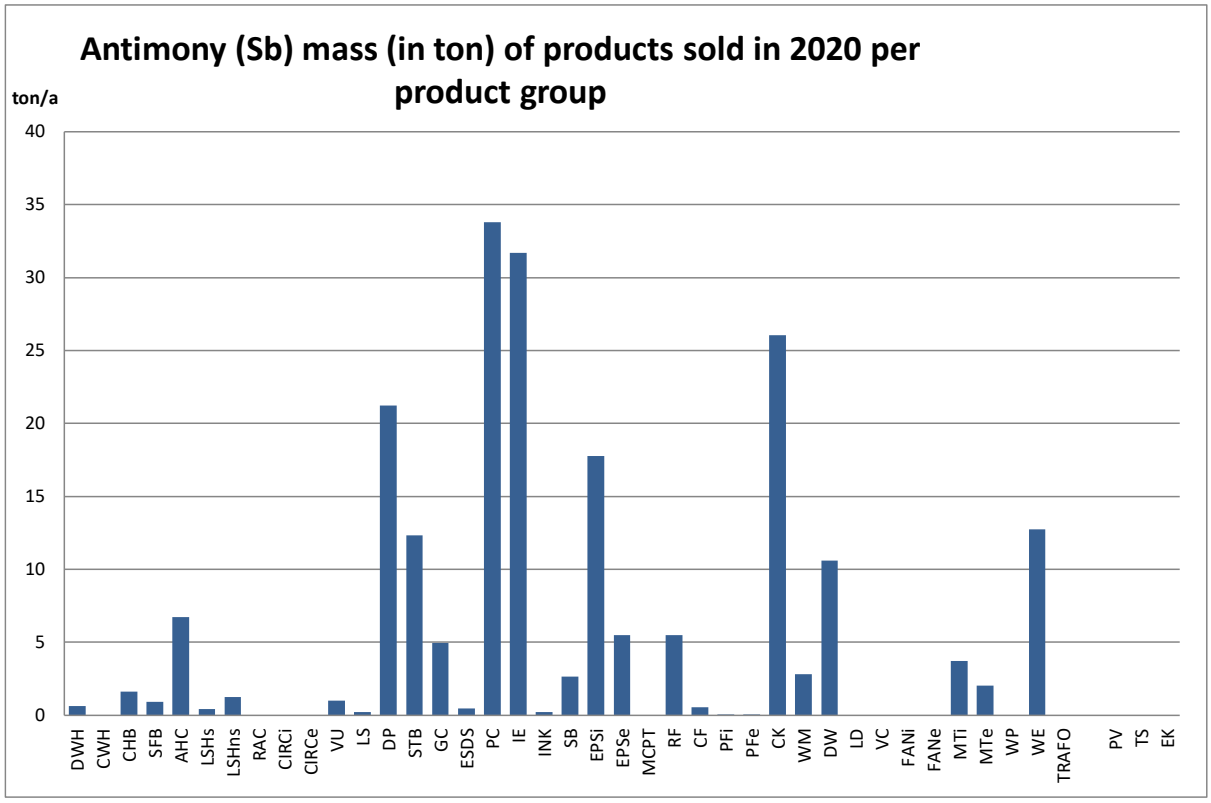
Sales material information for CRM (and non-CRM)

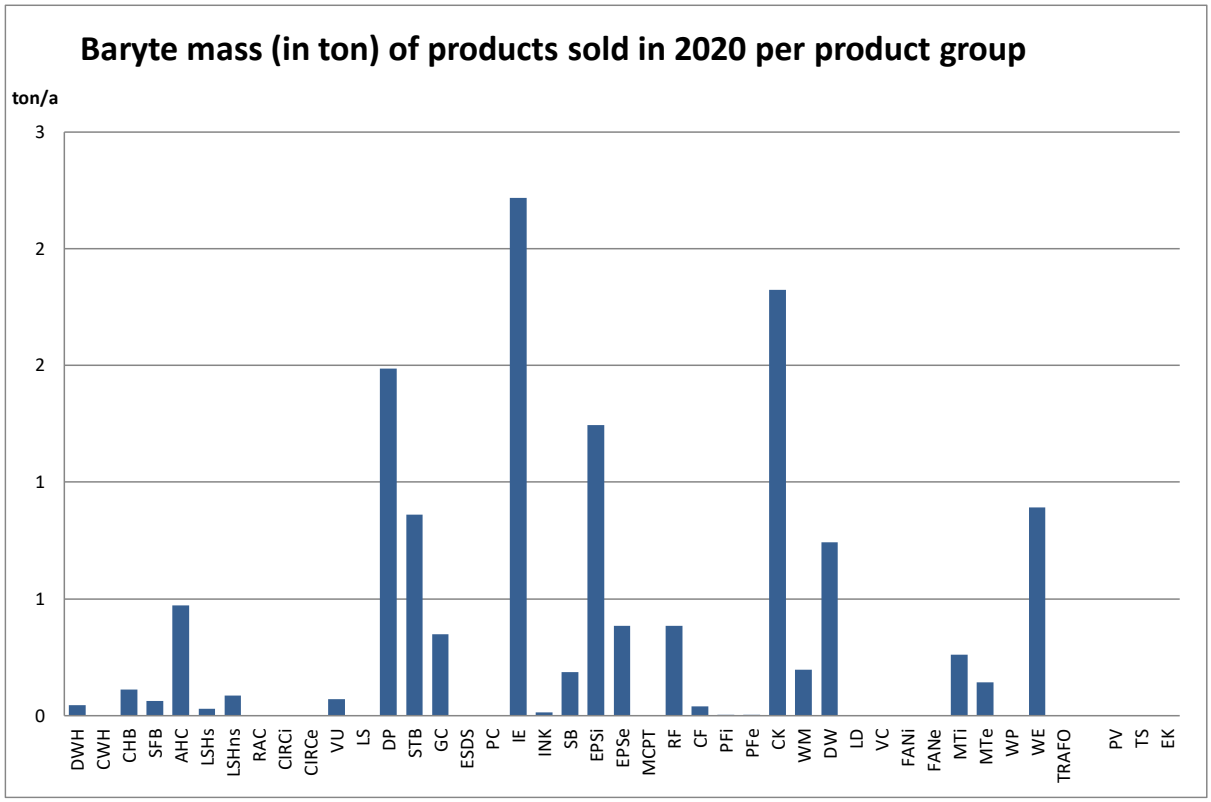
Similar to what was done for the materials from the BoMs (section A1.1), the amounts of CRMs and other chemical elements are initially defined for the more than 300 base case products distinguished in the EIA. These unit masses are then multiplied by the sales quantities for these products in 2020 and 2030. In a next step the masses are summed per product group. This implies the assumption that the CRM (and non-CRM) masses are valid both in 2020 and 2030, i.e. the material composition of the products does not change over the 2020-2030 period (only the sales quantities change).

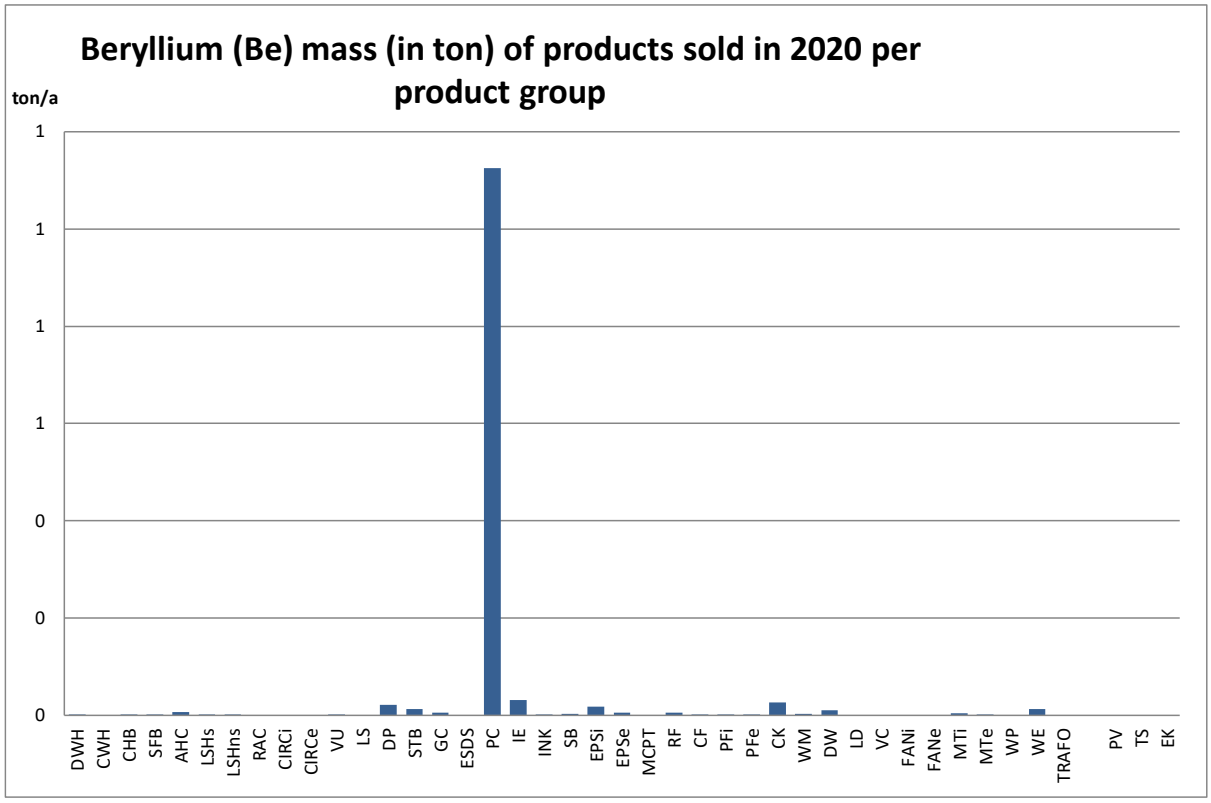
CRM information for photovoltaic panels and inverters (PV) and taps and shower heads (TS) has been added directly from the DG GROW study.

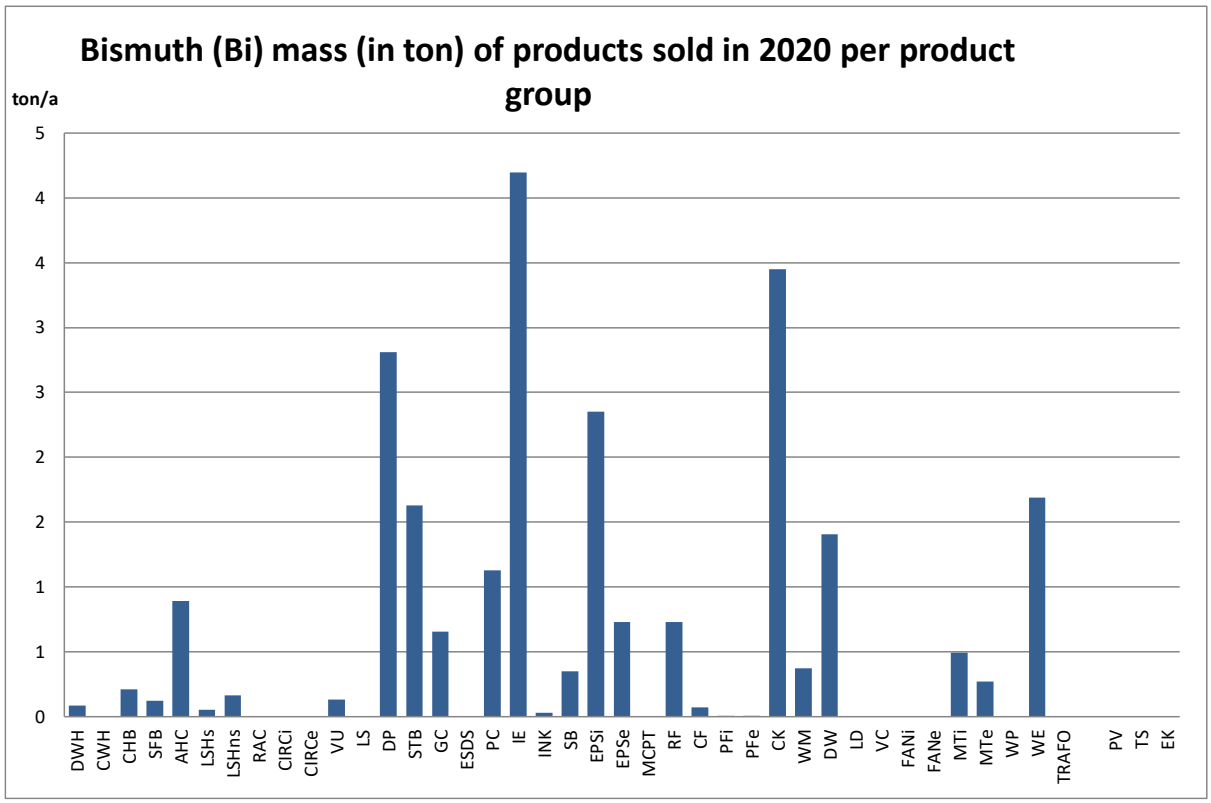
A3.2 Results for CRM masses

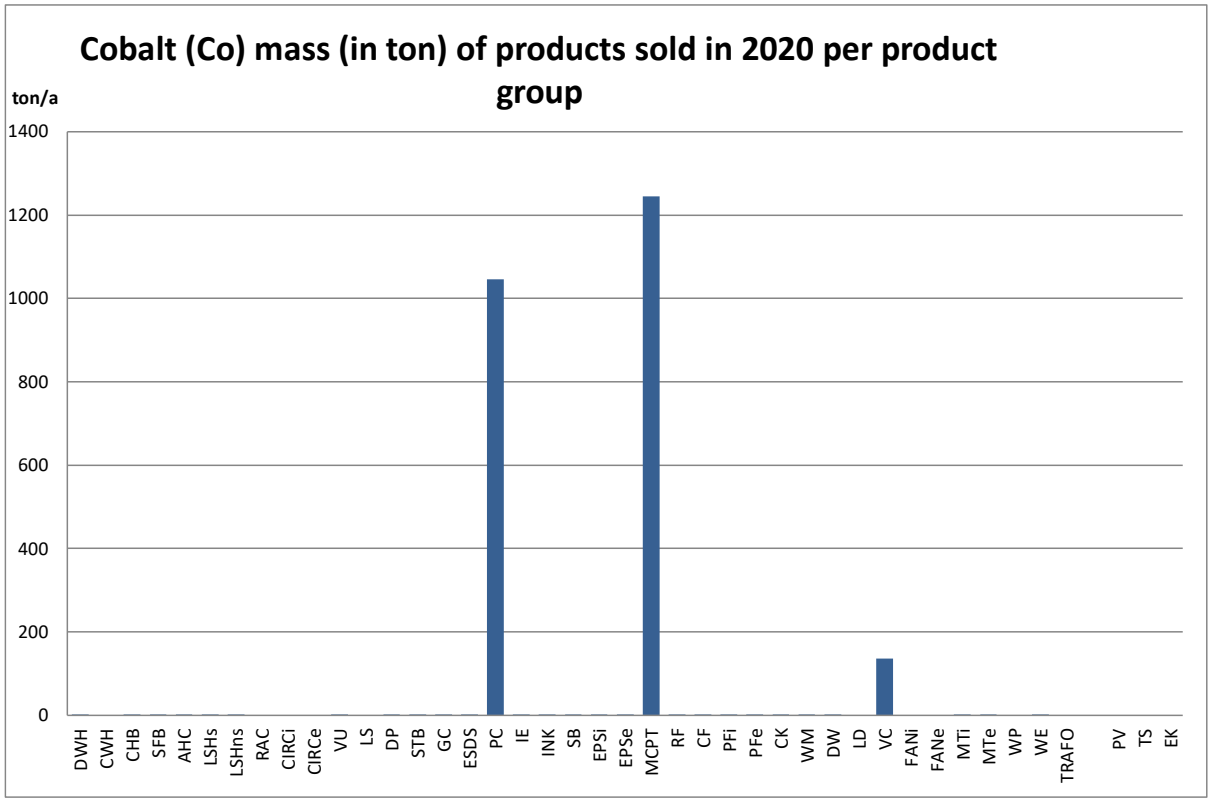
The mass per CRM type shows a high variation, e.g. from 778 kton of copper in 2020 to 0.001 kton for bismuth or platinum. The graphs below (for year 2020) display the CRM and non-CRM amounts for all material types with a non-zero total mass. Note that scales differ from graph to graph and that totals are in ton per year.

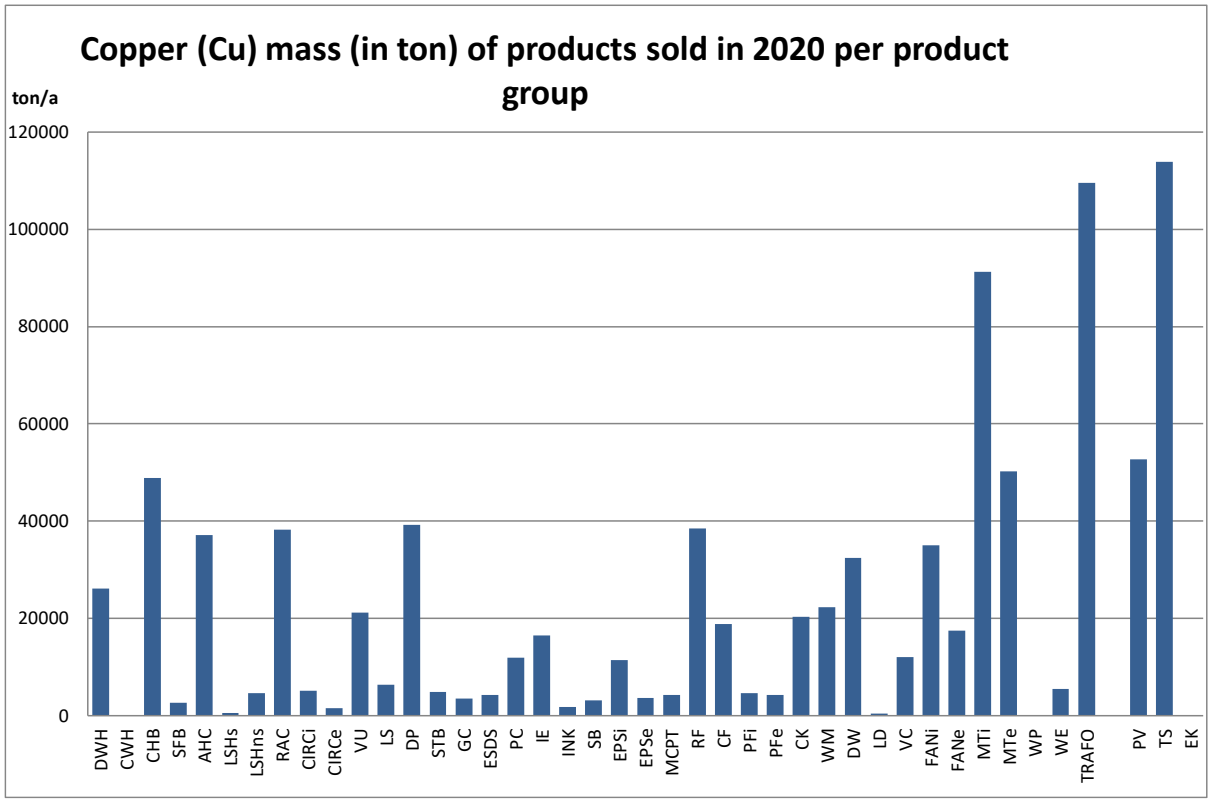

Antimony (Sb) mass (in ton) of products sold in 2020 per product group
ton/a
40
35
30
25
20
15
10
5
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

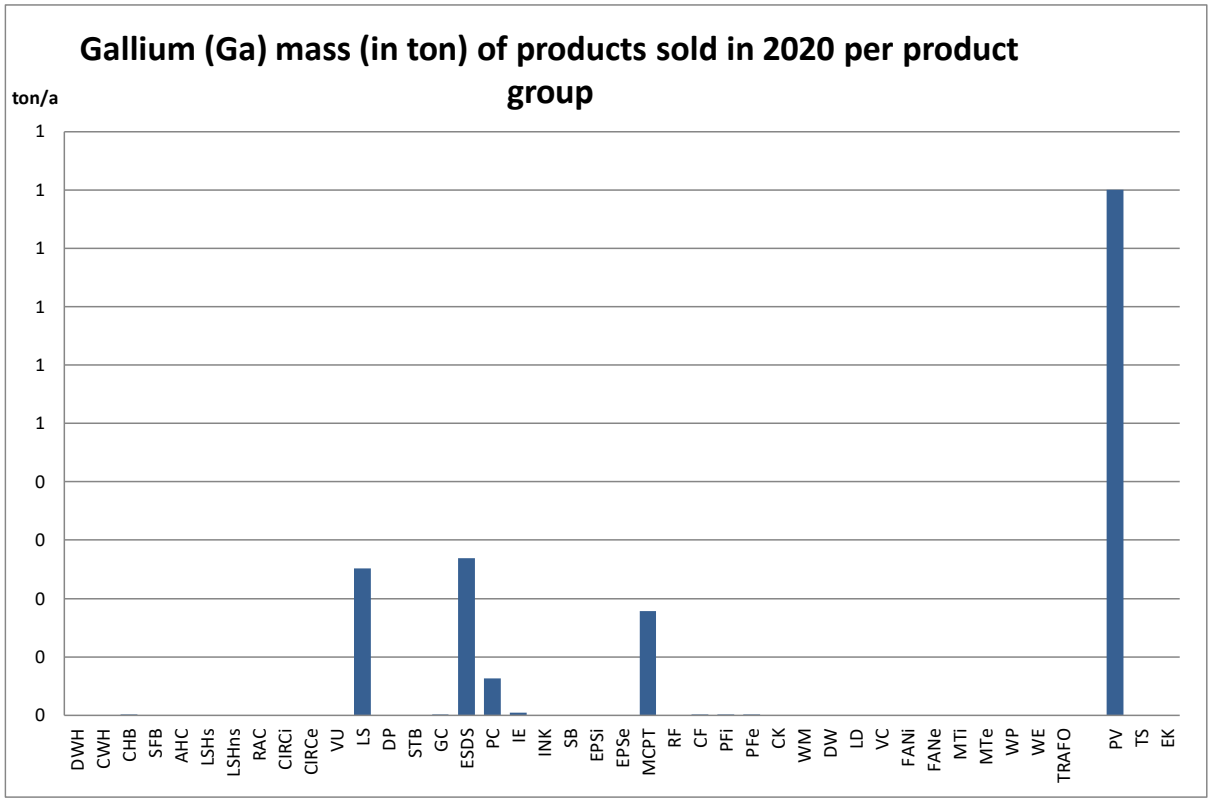

Baryte mass (in ton) of products sold in 2020 per product group
ton/a
3
2
2
1
1
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

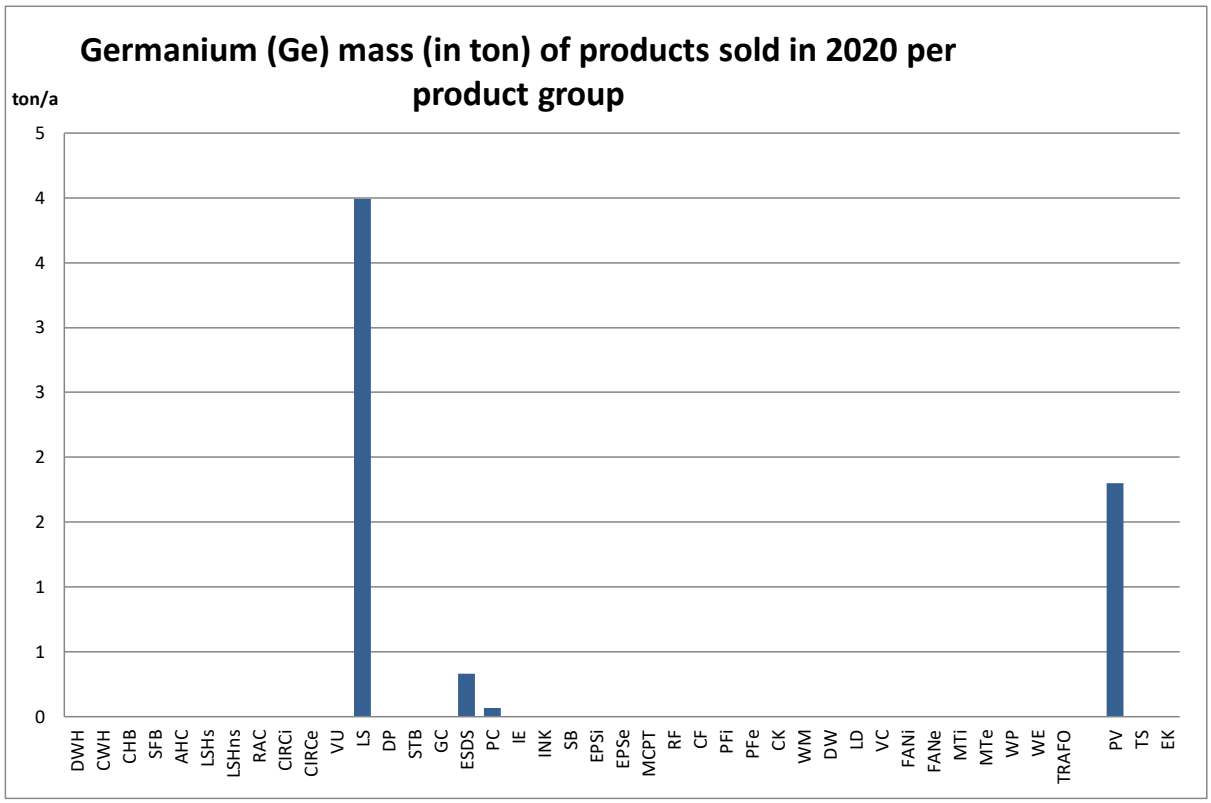

Beryllium (Be) mass (in ton) of products sold in 2020 per product group
ton/a
1
1
1
1
0
0
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

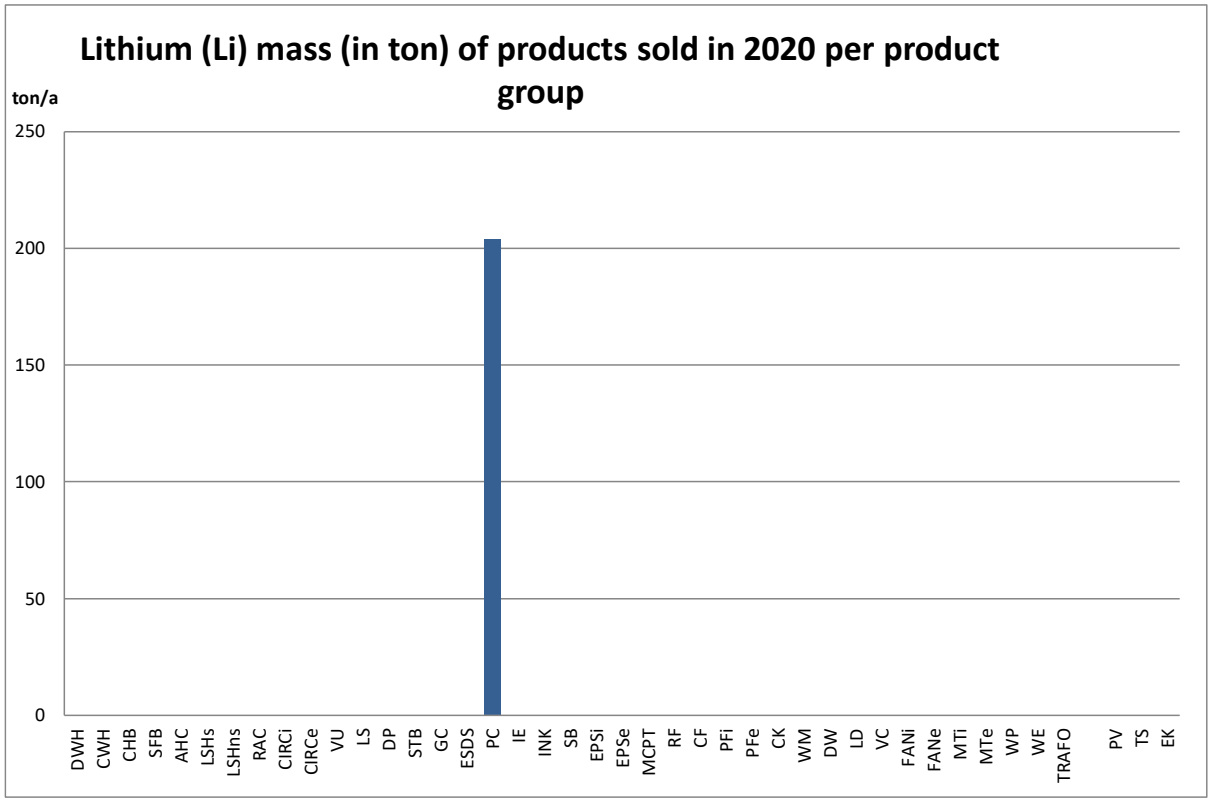

Bismuth (Bi) mass (in ton) of products sold in 2020 per product group
ton/a
5
4
4
3
3
2
2
1
1
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

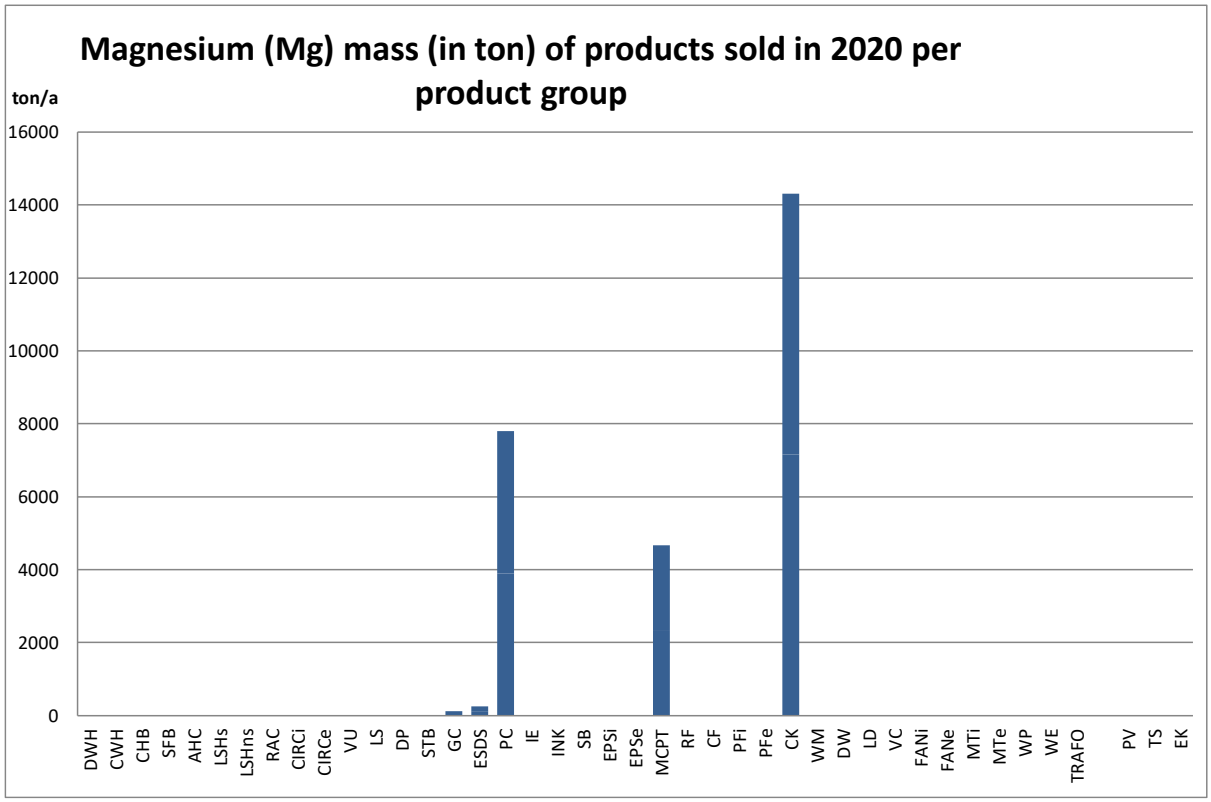

Cobalt (Co) mass (in ton) of products sold in 2020 per product group
ton/a
1400
1200
1000
800
600
400
200
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

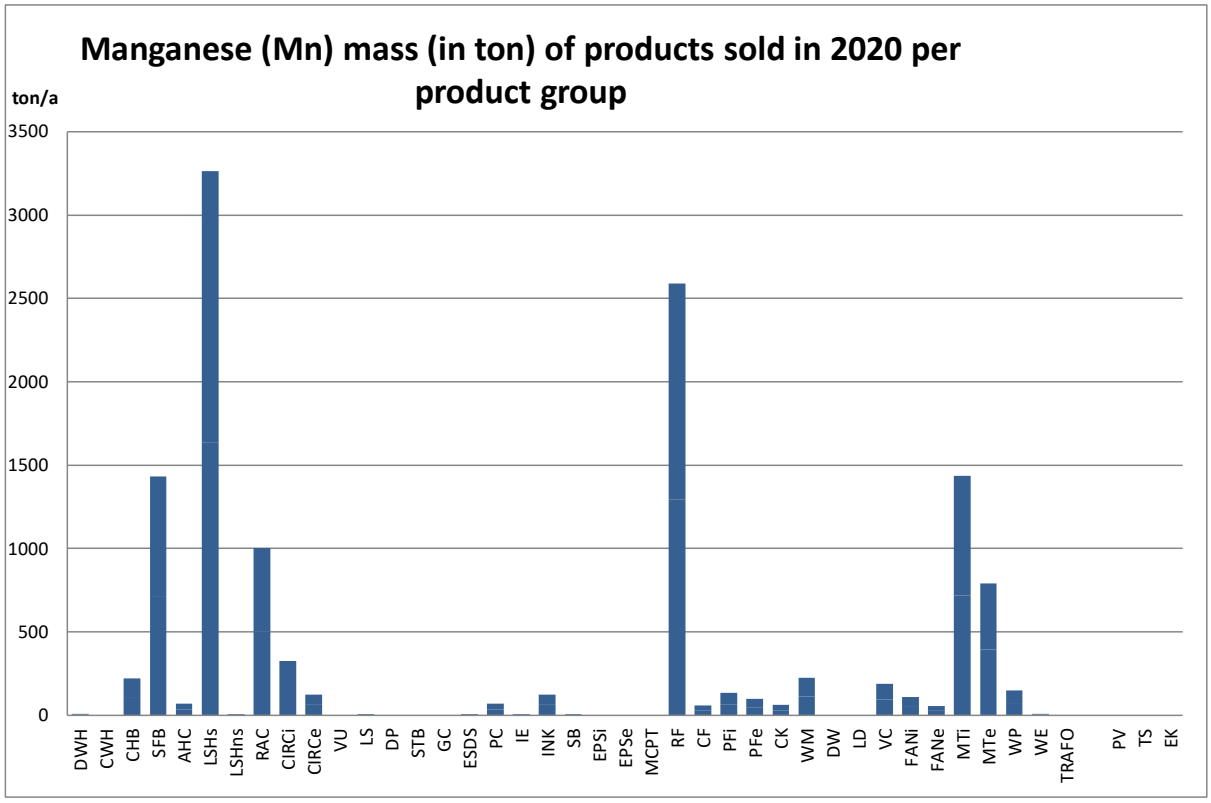

Copper (Cu) mass (in ton) of products sold in 2020 per product group
ton/a
120000
100000
80000
60000
40000
20000
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK


Gallium (Ga) mass (in ton) of products sold in 2020 per product group
ton/a
1
1
1
1
1
1
0
0
0
0
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

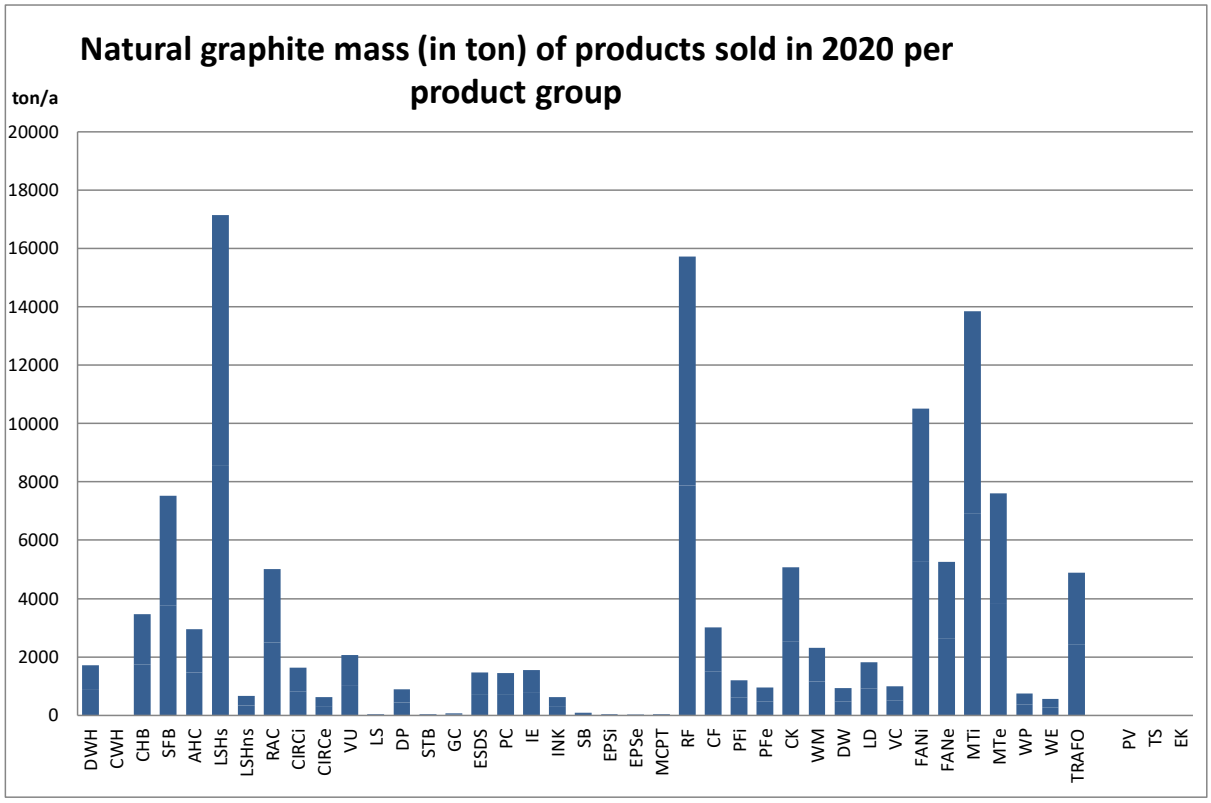

Germanium (Ge) mass (in ton) of products sold in 2020 per product group
ton/a
5
4
4
3
3
2
2
1
1
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

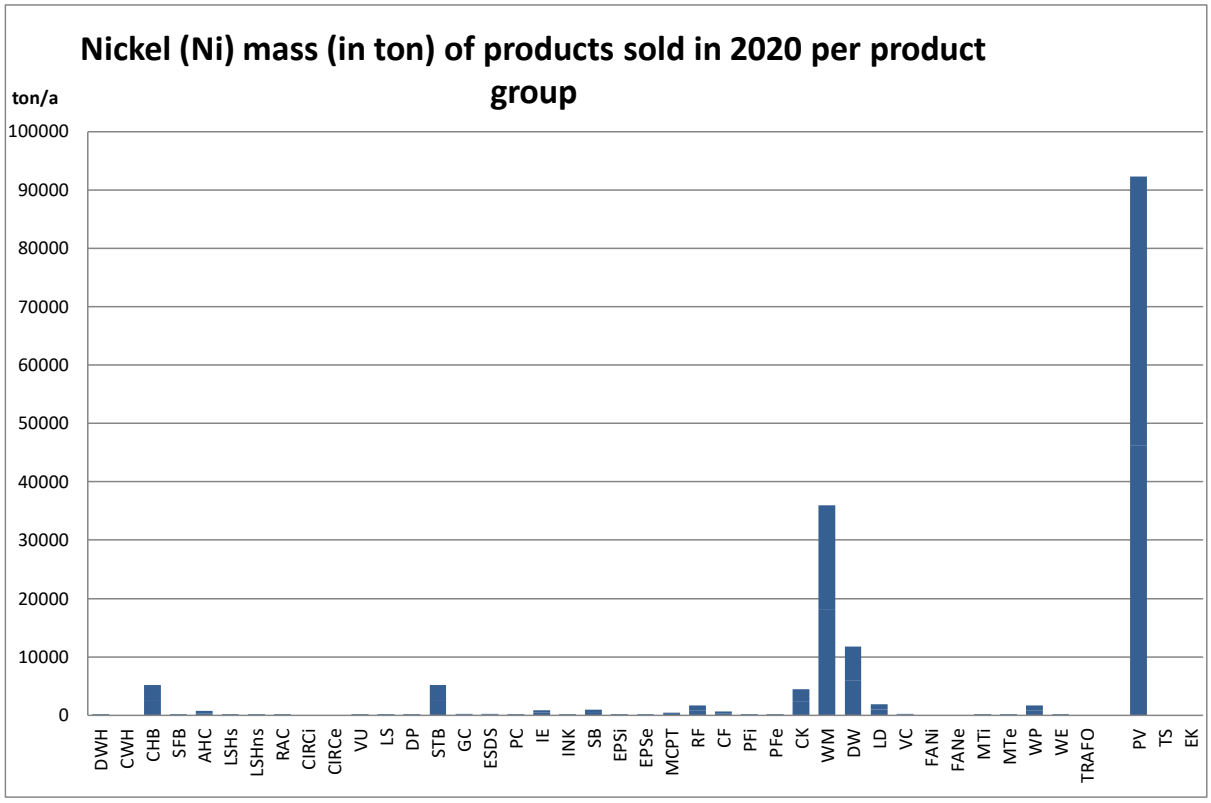

Lithium (Li) mass (in ton) of products sold in 2020 per product group
ton/a
250
200
150
100
50
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

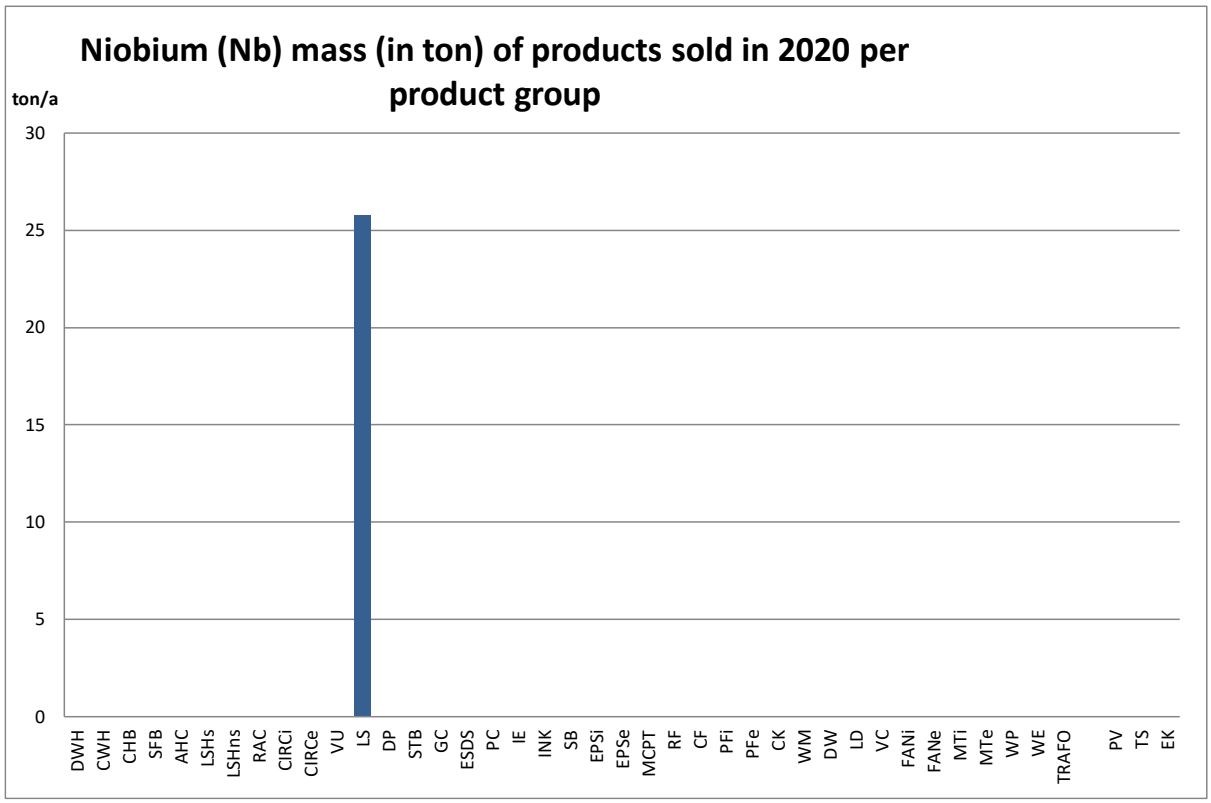

Magnesium (Mg) mass (in ton) of products sold in 2020 per product group
ton/a
16000
14000
12000
10000
8000
6000
4000
2000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

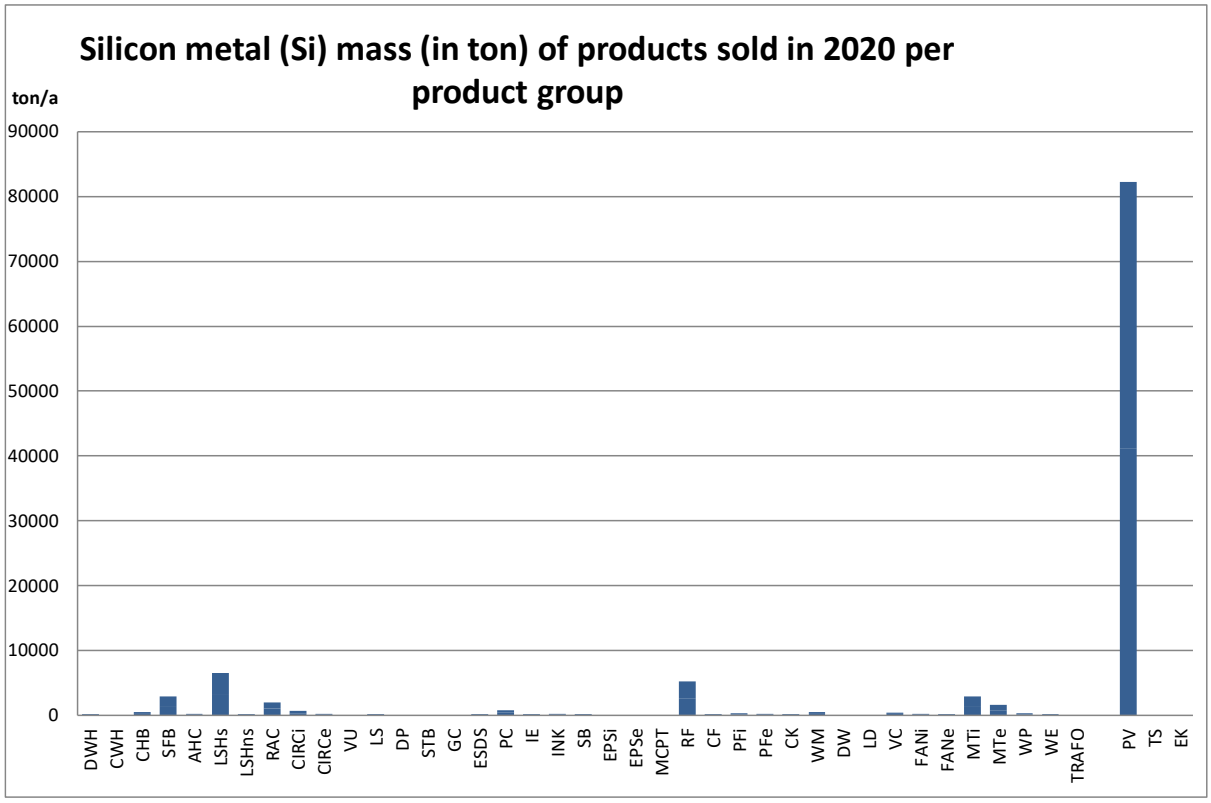


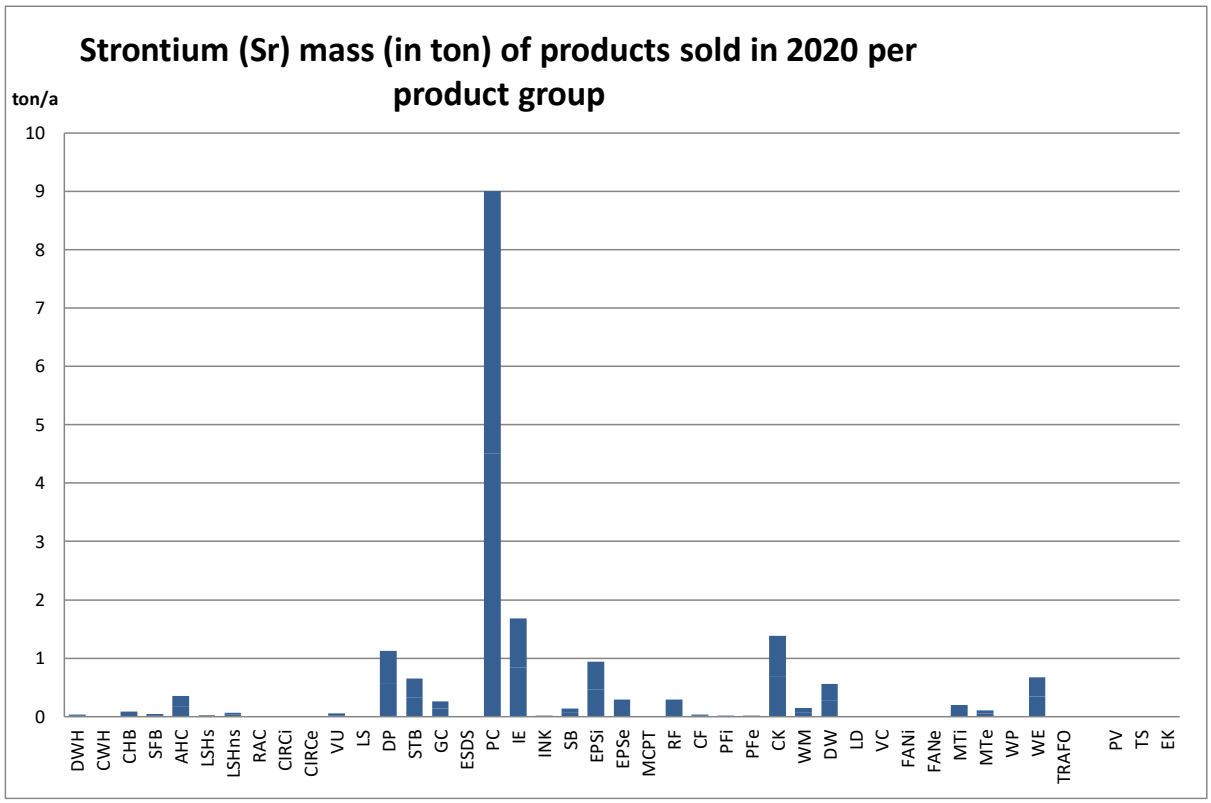
The carbon content of steel is accounted under natural graphite.

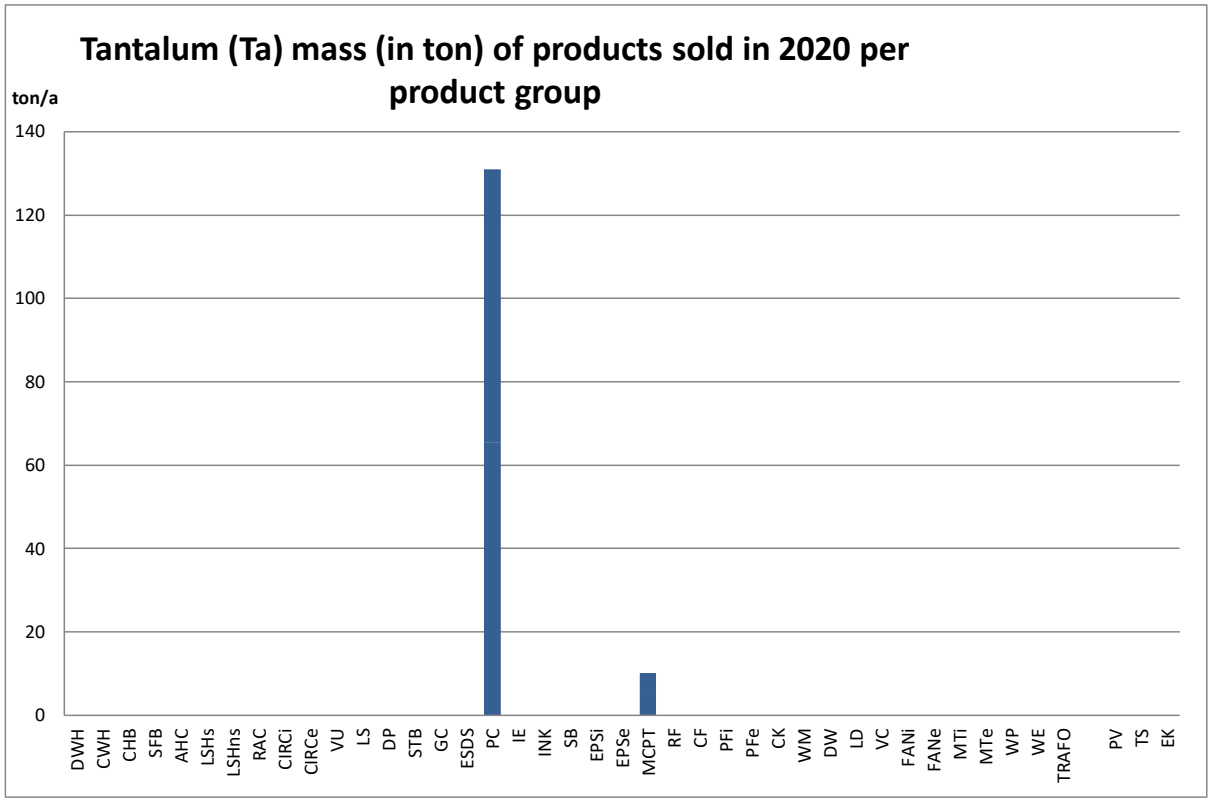


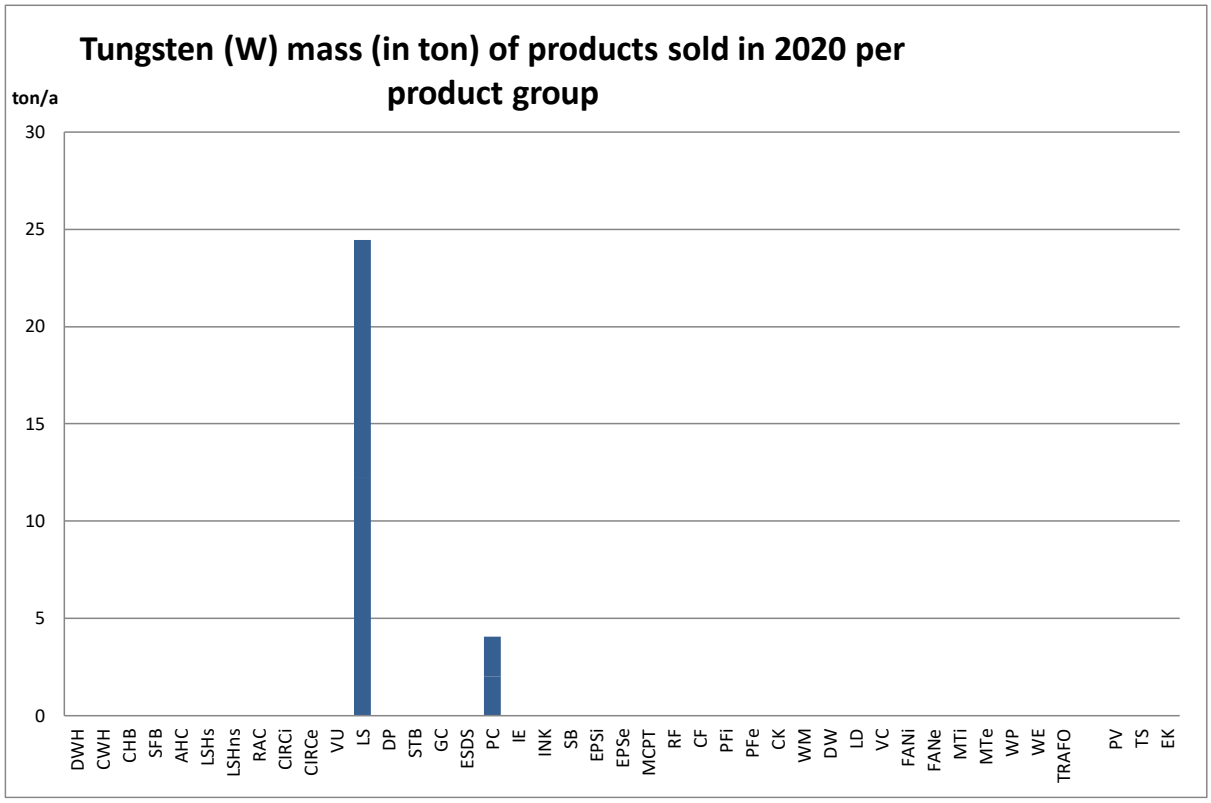

Nickel (Ni) mass (in ton) of products sold in 2020 per product group
ton/a
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK


Niobium (Nb) mass (in ton) of products sold in 2020 per product group
ton/a
30
25
20
15
10
5
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

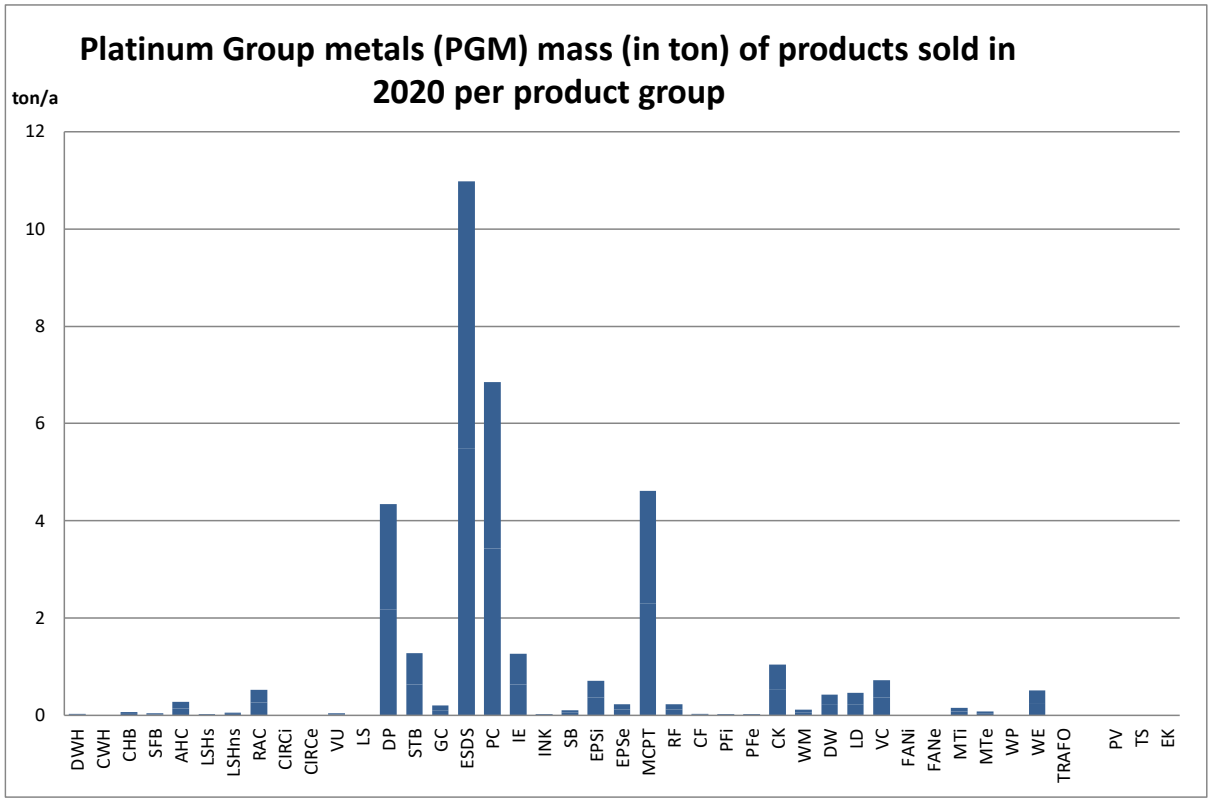

Silicon metal (Si) mass (in ton) of products sold in 2020 per product group
ton/a
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK


Strontium (Sr) mass (in ton) of products sold in 2020 per product group
ton/a
10
9
8
7
6
5
4
3
2
1
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

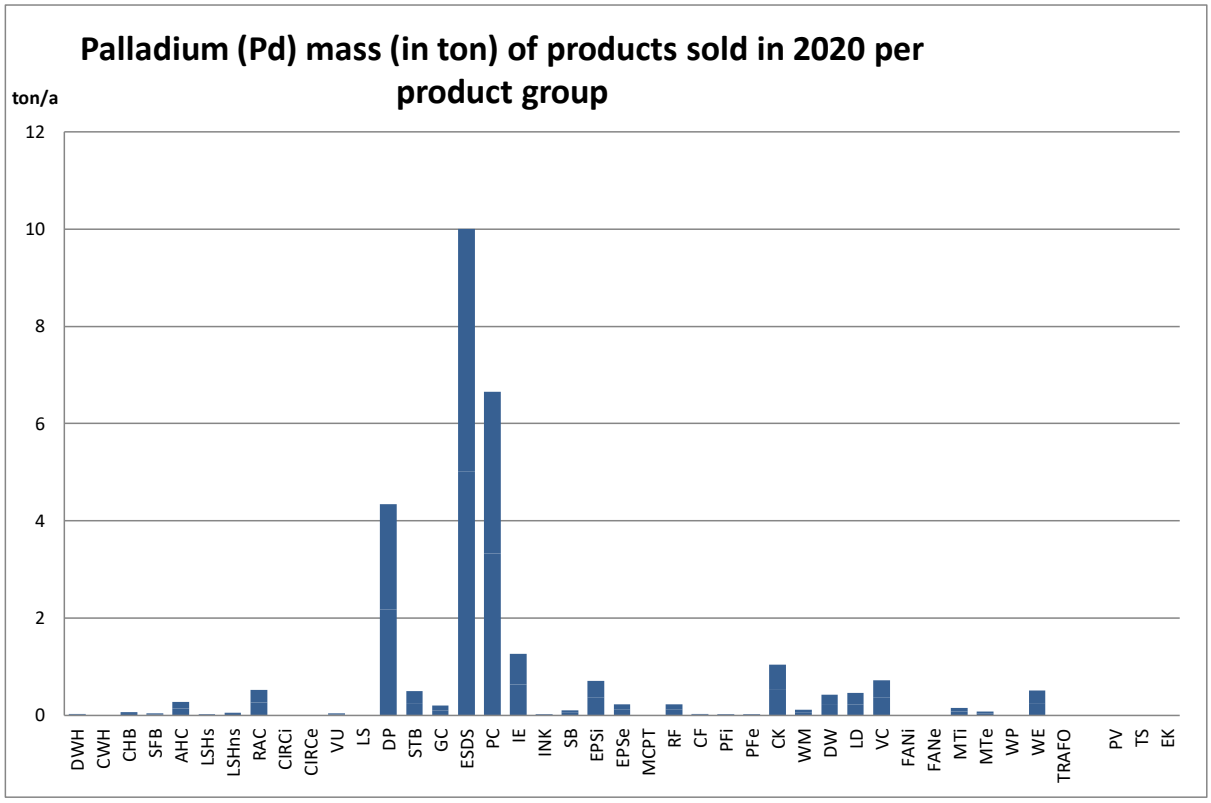




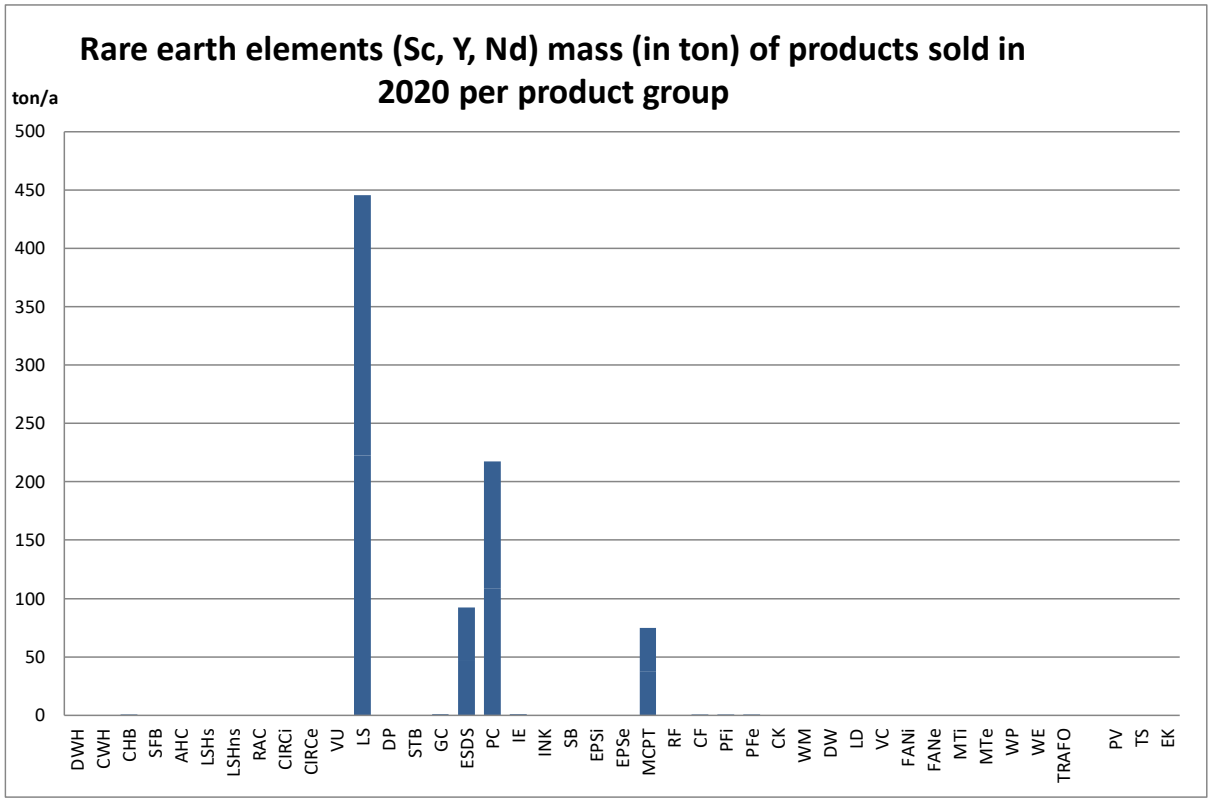
This is the sum of masses declared as PGM, Pt, Pd or Rh.



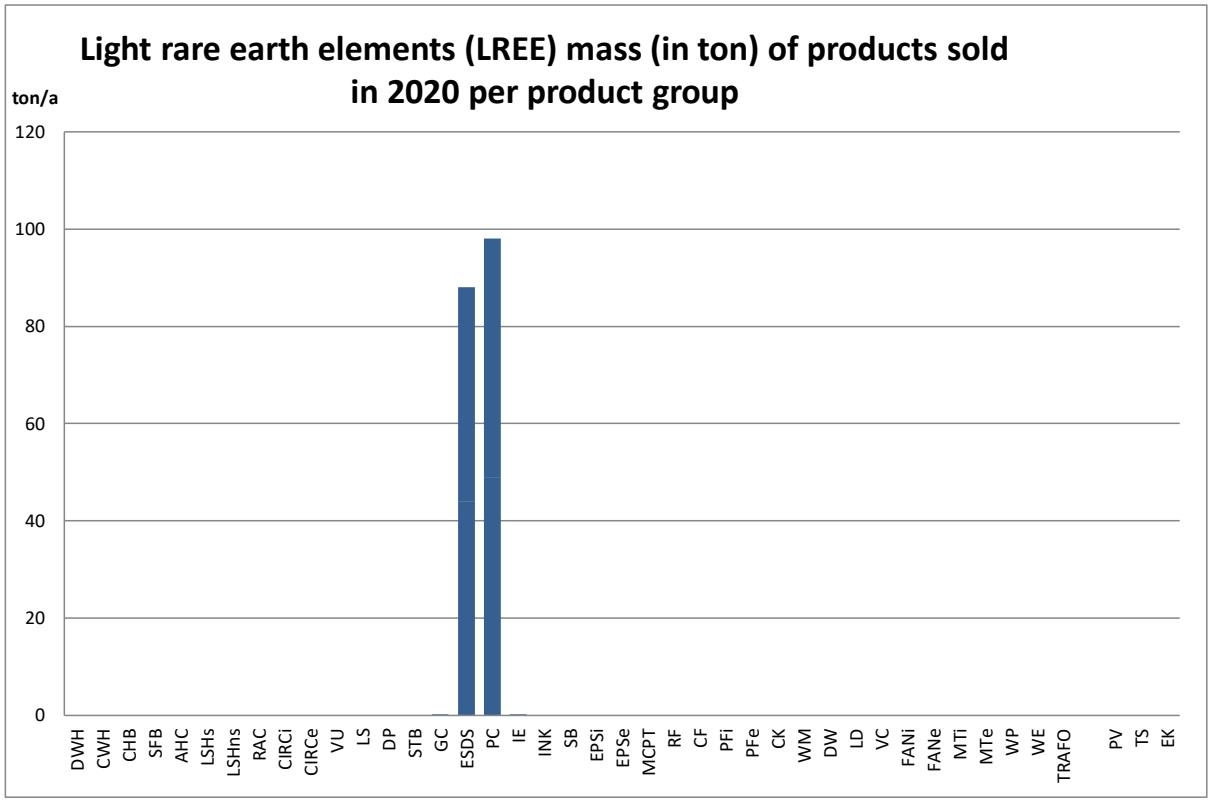
Of which declared as Pd:

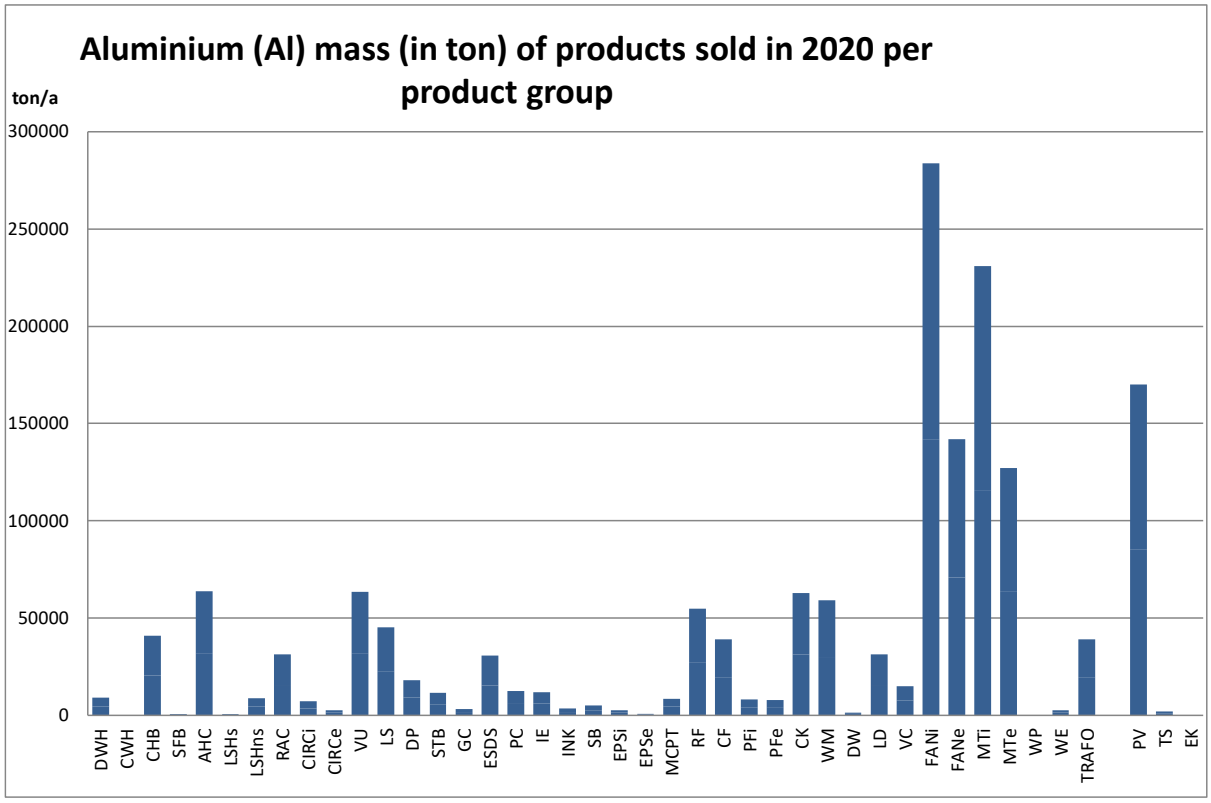


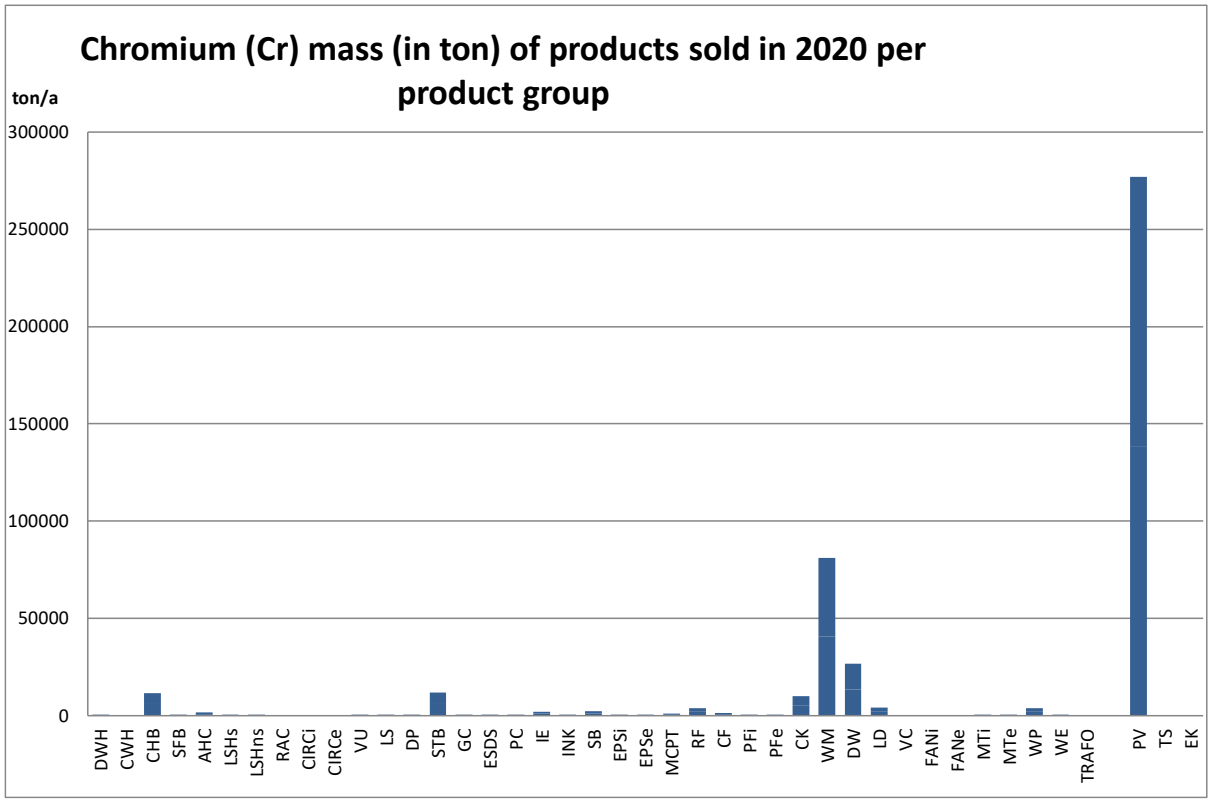
This is the sum of masses declared as REE, LREE or HREE.

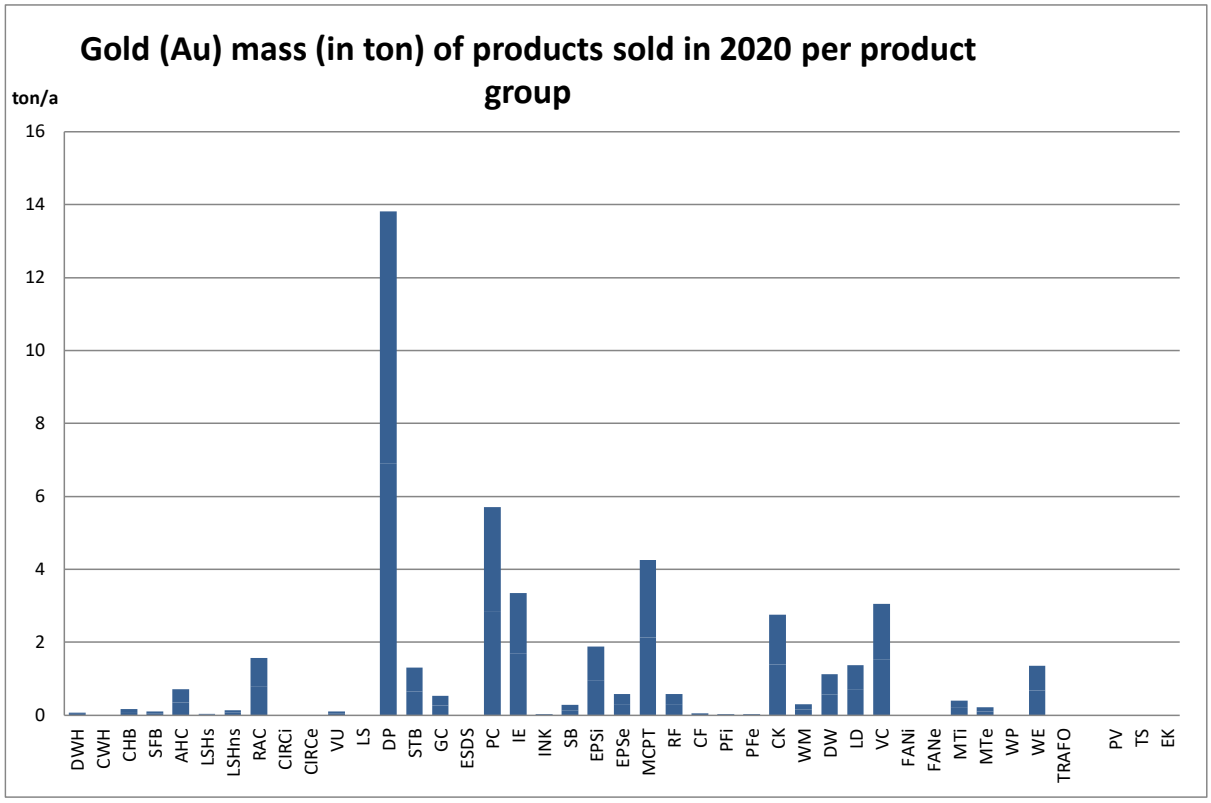


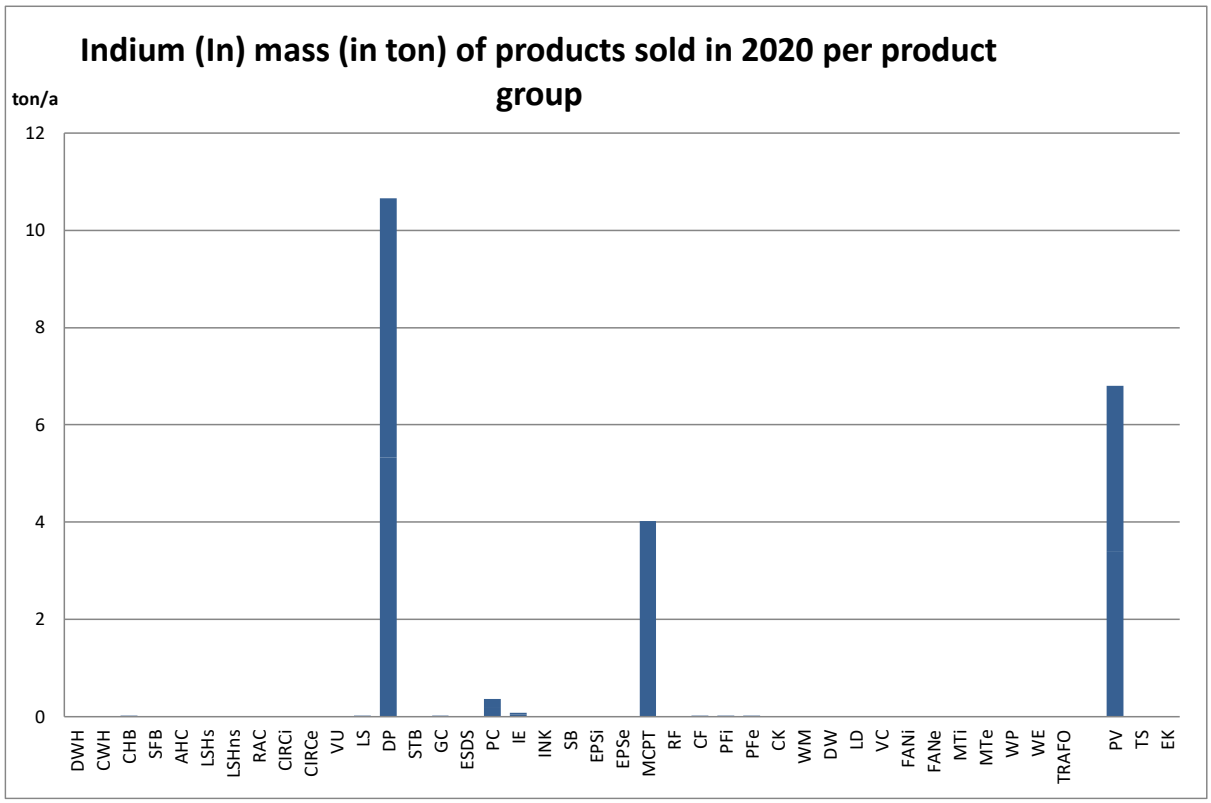
Of which declared as LREE:

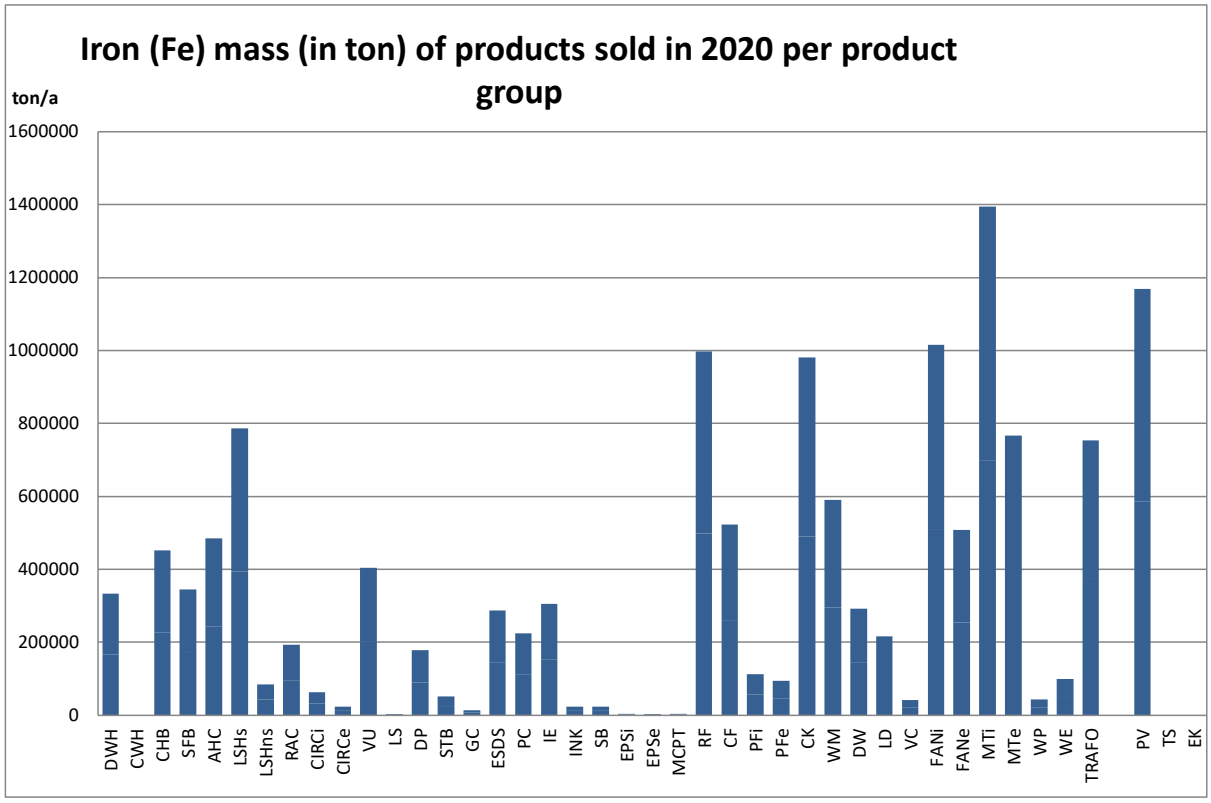


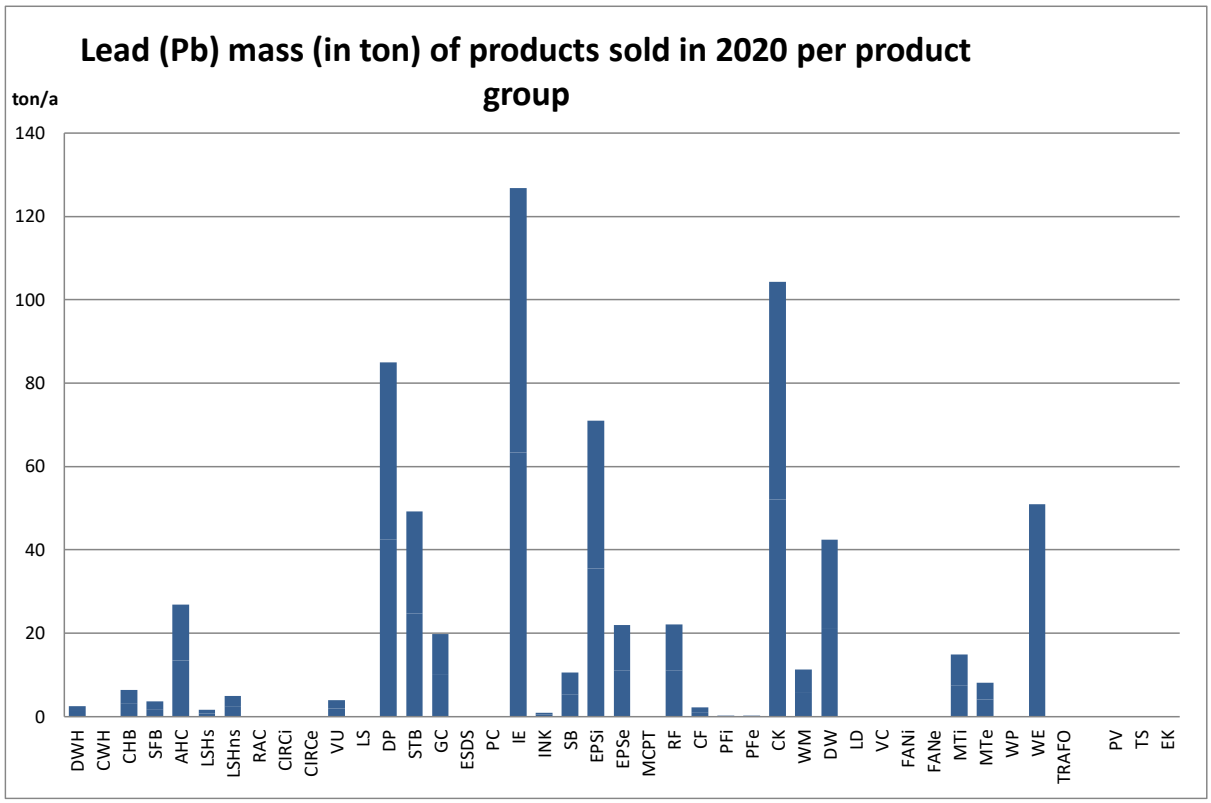

Aluminium (Al) mass (in ton) of products sold in 2020 per product group
ton/a
300000
250000
200000
150000
100000
50000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

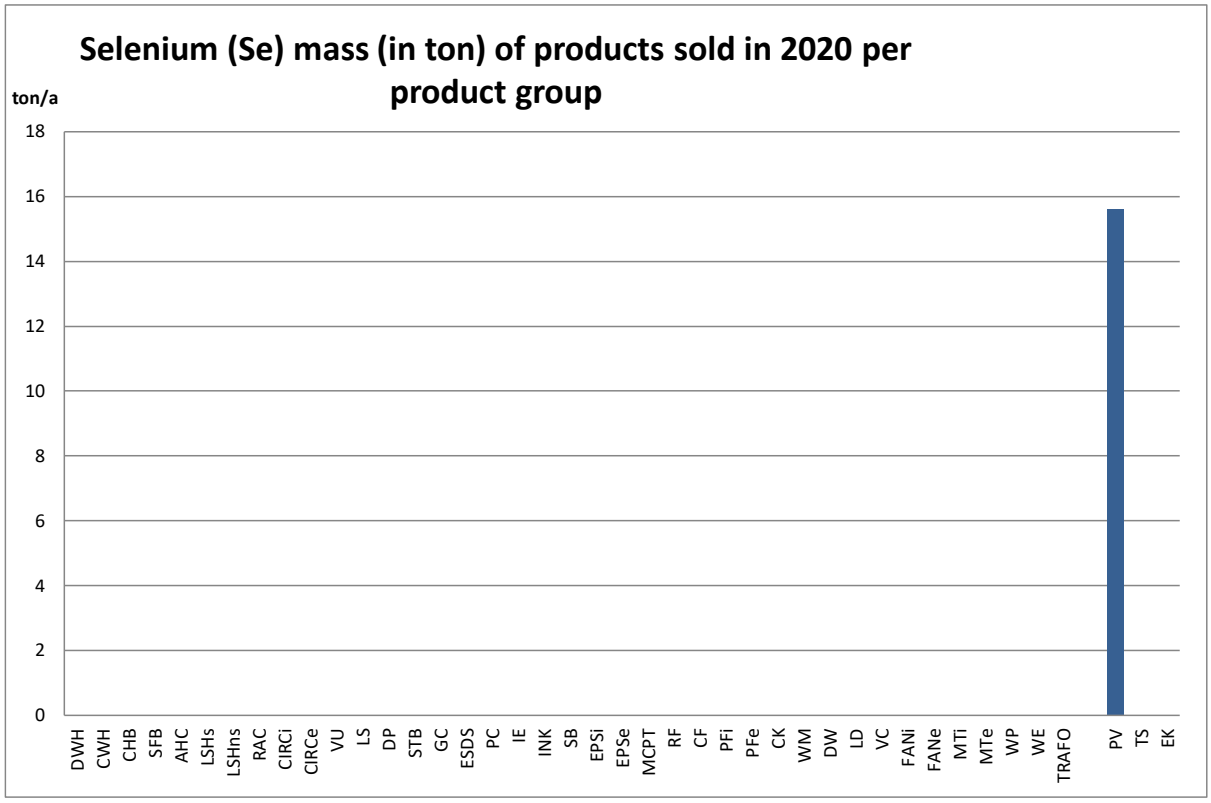

Chromium (Cr) mass (in ton) of products sold in 2020 per product group
ton/a
300000
250000
200000
150000
100000
50000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

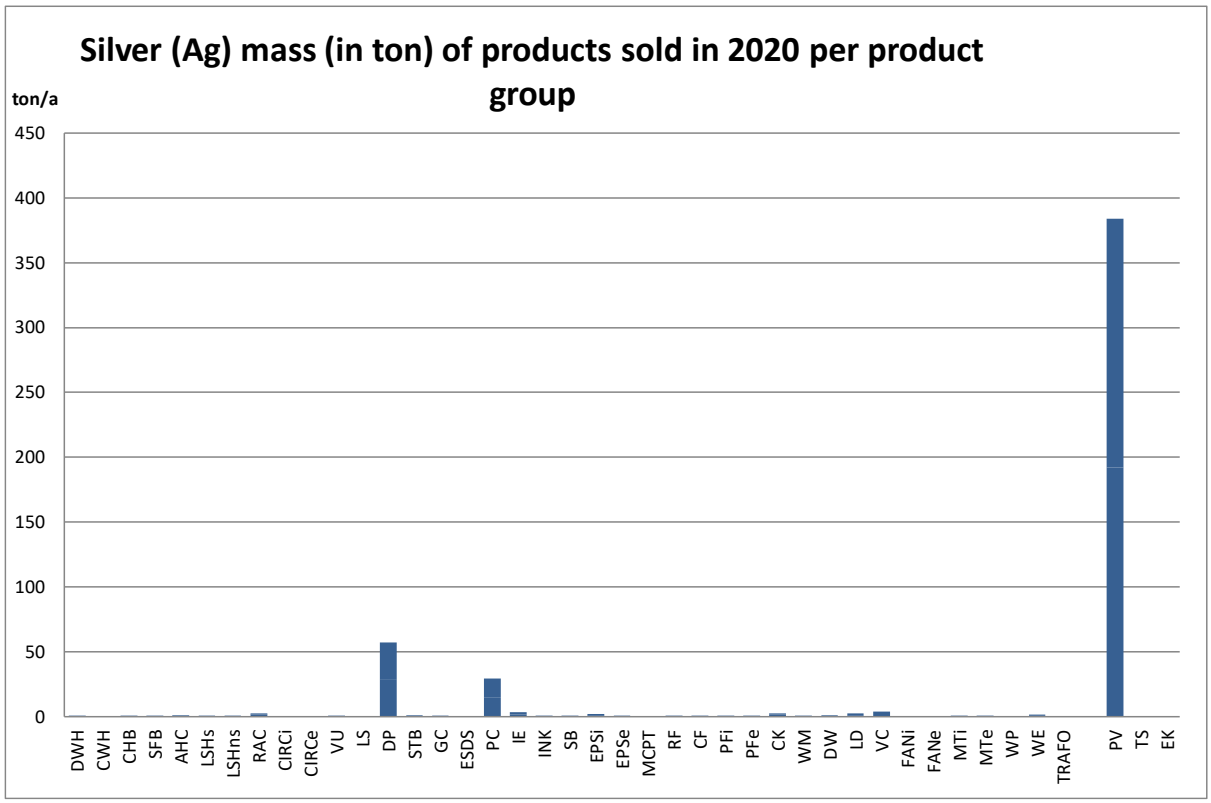

Gold (Au) mass (in ton) of products sold in 2020 per product group
ton/a
16
14
12
10
8
6
4
2
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

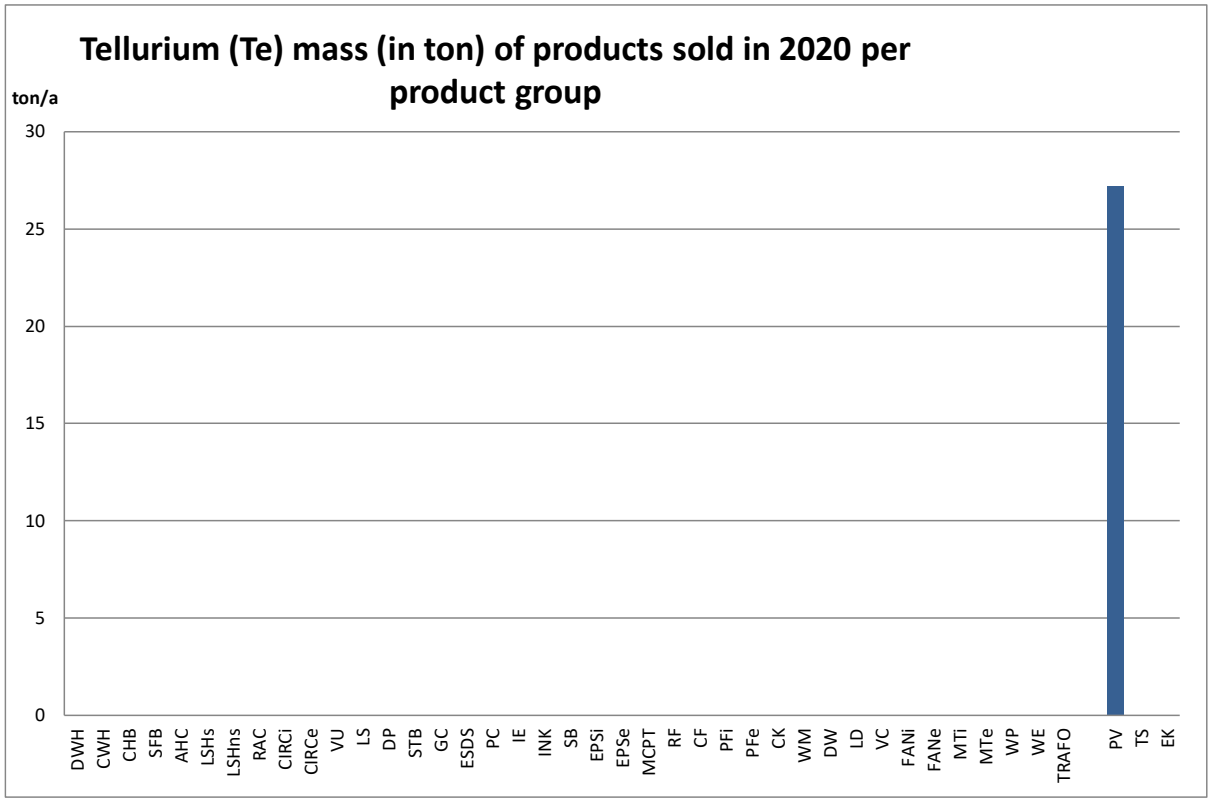

Indium (In) mass (in ton) of products sold in 2020 per product group
ton/a
12
10
8
6
4
2
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

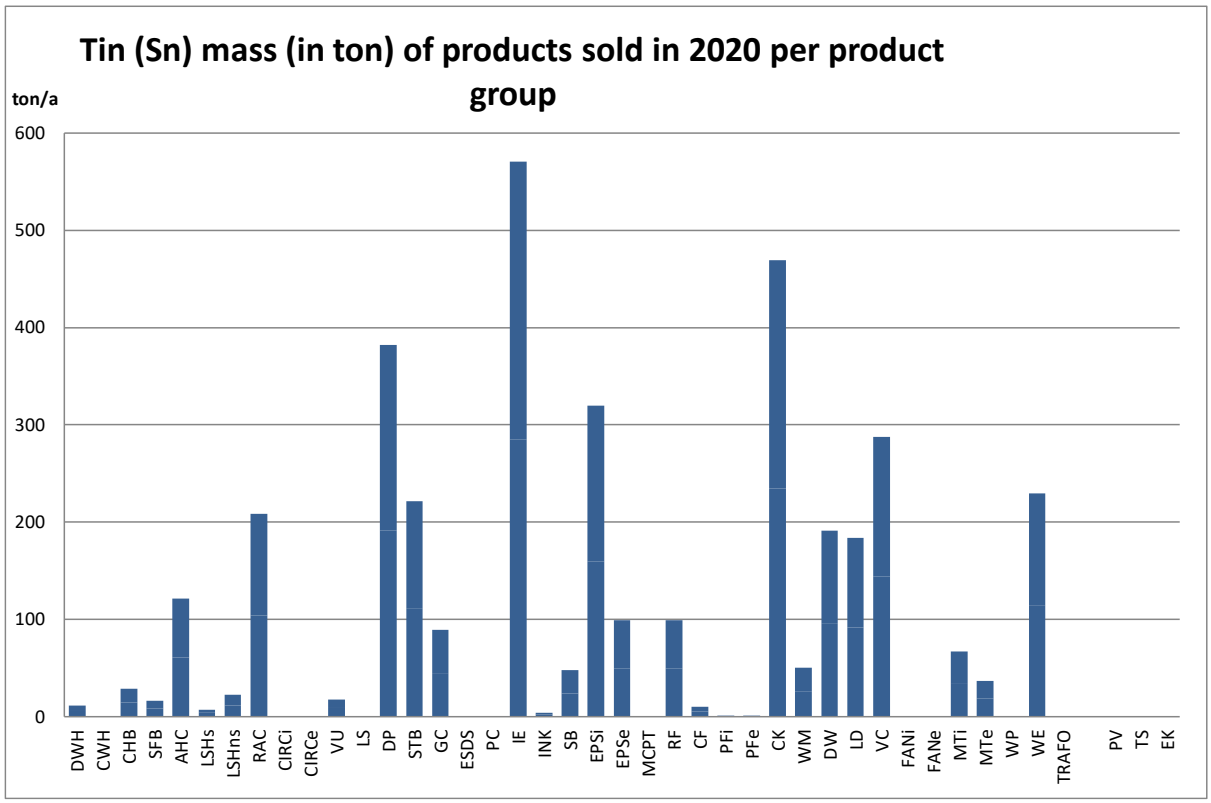

Iron (Fe) mass (in ton) of products sold in 2020 per product group
ton/a
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
DWH CWH CHB SFB AHC LSHs LSHns RAC ClRCi ClRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

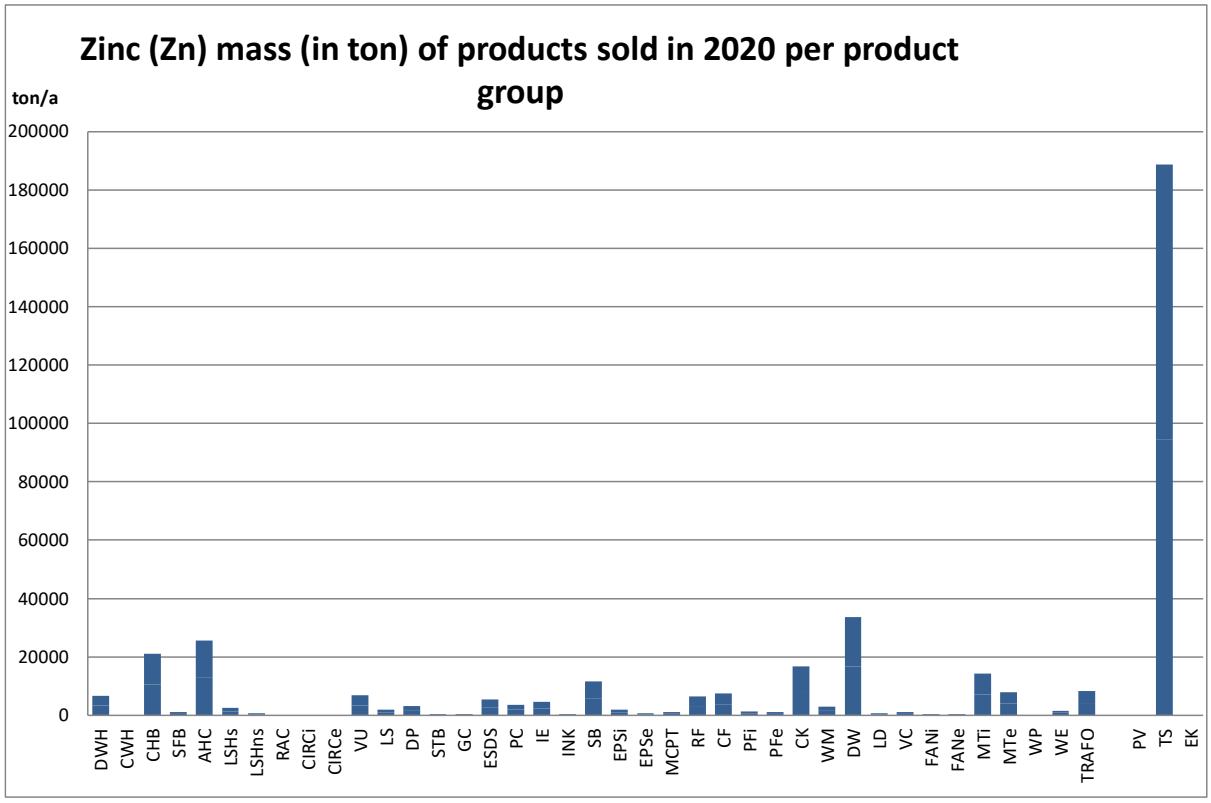

Lead (Pb) mass (in ton) of products sold in 2020 per product group
ton/a
140
120
100
80
60
40
20
0
DWH CWH CHB SFB AHC LSHs LSHns RAC ClRCi ClRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK

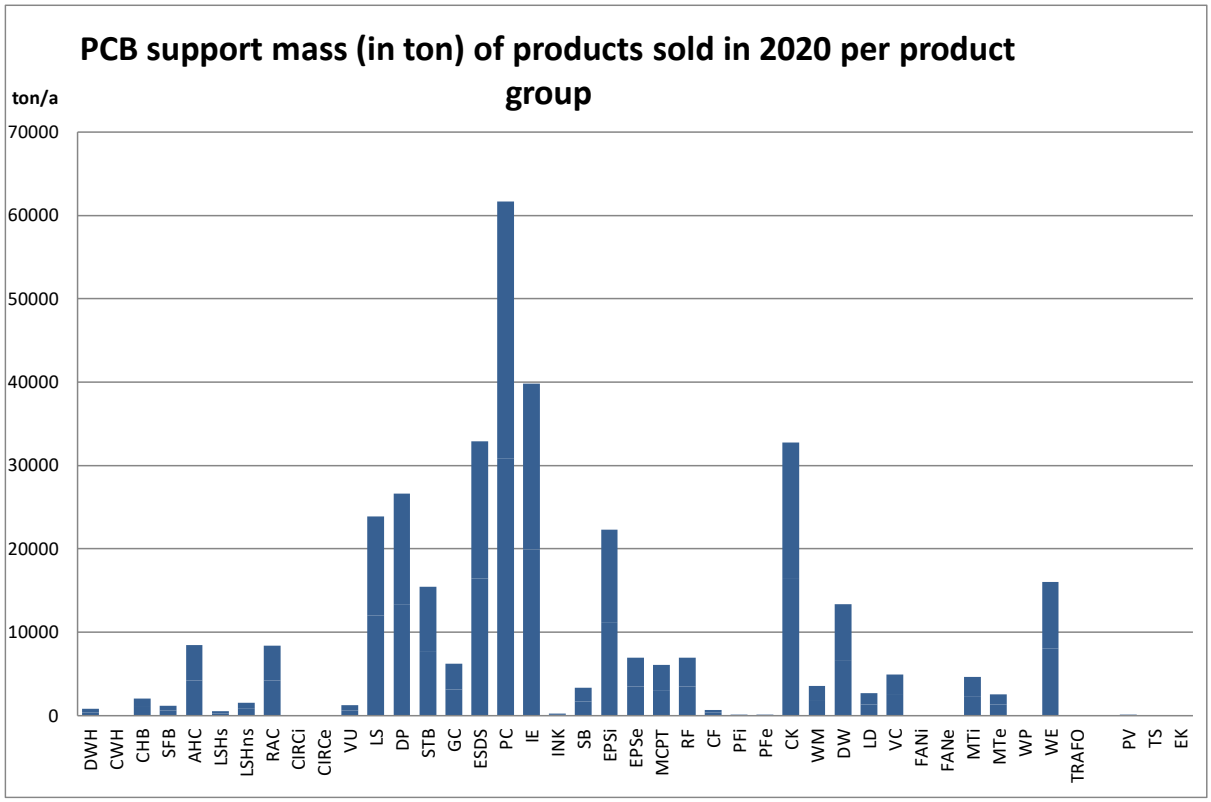

Selenium (Se) mass (in ton) of products sold in 2020 per product group
ton/a
18
16
14
12
10
8
6
4
2
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK


Silver (Ag) mass (in ton) of products sold in 2020 per product group
ton/a
450
400
350
300
250
200
150
100
50
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
ClRCi
ClRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK


Tellurium (Te) mass (in ton) of products sold in 2020 per product group
ton/a
30
25
20
15
10
5
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK


Tin (Sn) mass (in ton) of products sold in 2020 per product group
ton/a
600
500
400
300
200
100
0
DWH CWH CHB SFB AHC LSHs LSHns RAC CIRCi CIRCe VU LS DP STB GC ESDS PC IE INK SB EPSi EPSe MCPT RF CF PFi PFe CK WM DW LD VC FANi FANe MTi MTe WP WE TRAFO PV TS EK


Zinc (Zn) mass (in ton) of products sold in 2020 per product group
ton/a
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
CIRCi
CIRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

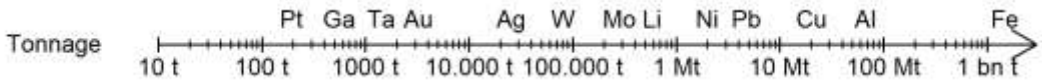

PCB support mass (in ton) of products sold in 2020 per product group
ton/a
70000
60000
50000
40000
30000
20000
10000
0
DWH
CWH
CHB
SFB
AHC
LSHs
LSHns
RAC
CIRCi
CIRCe
VU
LS
DP
STB
GC
ESDS
PC
IE
INK
SB
EPSi
EPSe
MCPT
RF
CF
PFi
PFe
CK
WM
DW
LD
VC
FANi
FANe
MTi
MTe
WP
WE
TRAFO
PV
TS
EK

A3.3 Product group prioritization for CRM

Prioritization of product groups for their CRM (and non-CRM) content involves resolution of two problems:

1- The various types of CRMs do not have the same importance: the contributions have to be “weighted” in some way. Since "security of supply" is the aspect that should be highlighted, it is proposed to perform the weighting using the "supply risk" scoring from the latest EU criticality exercise[55]. These scores already consider global supply, EU sourcing, governance in the producing countries, import dependence, trade restrictions, recycling, and the availability of substitutes in all applications for each raw material. The scores are available for 70 raw materials and groups of raw materials.

2- The masses of CRMs and non-CRMs contained in regulated products sold in 2020 and 2030 vary by a factor of nearly a million, e.g. from 778 kton of copper in 2020 to 0.001 kton for bismuth or platinum. These amounts have to be weighted somehow to yield adequate comparisons between different product groups, otherwise Copper would dominate the prioritization. To tie the security of supply to the CRM and non-CRM amounts used in regulated products sold in 2020 or 2030, it is proposed to use the overall market size of the CRMs and non-CRMs as a weighting factor[56]:



That would ensure that 1 ton of gold "weighs" more than 1 ton of copper in the sum because

$$\frac{1\ t\ Au}{global\ Au\ production} \gg \frac{1\ t\ Cu}{global\ Cu\ production}.$$

If SR_m is the supply risk score for raw material m, then the CRM and non-CRM overall prioritization score could be determined as:

$$Product\ priority = \sum_m SR_m \times \frac{mass\ of\ m\ in\ EU\ market\ for\ product}{total\ market\ tonnage\ m}$$

Table 21 shows the Supply Risk (SR) and the primary production in ton for the CRMs and non-CRMs that are used in the products in focus of this study[57].

For Platinum Group Materials (PGM) and rare earth elements (REE, HREE, LREE), some sources declare masses for the group or subgroup while other sources declare masses for specific materials within the group. This subdivision has been maintained for the prioritization. Weighted average supply risk factors and sums of primary production had to be estimated for these groups. This remains a factor of uncertainty [58].

---

[55] European Commission (2023). Study on the Critical Raw Materials for the EU 2023. Final Report. Available online at https://single-market-economy.ec.europa.eu/publications/study-critical-raw-materials-eu-2023-final-report_en.

[56] Tercero Espinoza, Luis (2023). Understanding the methodology behind the EU List of Critical Raw Materials.

[57] The data are available for other raw materials, but as they do not appear in any of the products considered here, they are not shown in the table.

[58] When the studies declare a mass for PGM or for REE, LREE or HREE, it is unknown to which material types this refers, so any choice of the related SR and primary production mass entails uncertainty. For PGM the mass inside products is low compared to e.g. the Palladium mass so that the potential error is small, but for REE and LREE the masses in products are relatively high.

Table 21: Supply Risk (SR) and primary production (in ton) for CRMs and non-CRMs that are used (non-zero total mass) in the products in focus of this study.

	SR	Primary production, t
Antimony (Sb)	1.8	130000
Baryte	1.3	8800000
Bauxite	1.2	63000000
Beryllium (Be)	1.8	6000
Bismuth (Bi)	1.9	9100
Cobalt (Co)	2.8	130000
Copper (Cu)	0.1	21000000
Gallium (Ga)	3.9	370
Germanium (Ge)	1.8	95
Lithium (Li)	1.9	190000
Magnesium (Mg)	4.1	980000
Manganese (Mn)	1.2	21000000
Natural graphite	1.8	1100000
Nickel (Ni)	0.5	2700000
Niobium (Nb)	4.4	140000
Silicon metal (Si)	1.4	3000000
Strontium (Sr)	2.6	160000
Tantalum (Ta)	1.3	1600
Tungsten (W)	1.2	86000
Platinum Group metals (PGM)	2.7	460
Platinum (Pt)	2.1	180
Palladium (Pd)	1.5	220
Rare earth elements (REE)	4.3	32124
Heavy rare earth elements (HREE)	5.1	9220
Light rare earth elements (LREE)	3.7	138200
Aluminium (Al)	1.2	63000000
Chromium (Cr)	0.7	16000000
Gold (Au)	0.4	3300
Indium (In)	0.6	900
Iron (Fe)	0.5	1500000000
Iron ore	0.5	1500000000
Lead (Pb)	0.1	5000000
Selenium (Se)	0.3	3500
Silica sand	0.3	240000000
Silver (Ag)	0.8	28000
Tellurium (Te)	0.3	600
Tin (Sn)	0.9	290000
Zinc (Zn)	0.2	13000000

Applying the weighting factors of Table 21 to the CRM and non-CRM masses contained in the products sold in 2020 and 2030, and summing the contributions over all CRM and non-CRM types, the product group priorities of Table 24 result. This table does not consider the contributions from Bauxite and Iron ore (see section A3.1). The 10 product groups with the highest impacts in 2030 are high-lighted in red:

1- Personal computers
2- Photovoltaic panels and inverters
3- Servers and data storage products
4- Light sources

5- Phones and tablets
6- Cooking appliances
7- Electronic displays
8- Vacuum Cleaners
9- Imaging equipment
10- Set Top Boxes

It has been verified that summing the contributions only over the elements on the 2023 EU list of CRMs (excluding the non-CRMs) does not significantly change the rankings for the product groups (the first 7 positions remain the same).

*Table 22: Weighted product group priorities and ranking for CRMs and non-CRMs contained in products sold in 2020 or 2030, when **not considering Bauxite and Iron ore**.*

Prioritization scores for CRMs and non-CRMs	2020		2030	
	score	rank	score	rank
DWH Dedicated Water Heater	0.001	33	0.001	32
	0.000	41	0.000	41
CHB Central Heating boilers	0.002	22	0.003	22
SFB Solid Fuel Boilers	0.001	30	0.001	30
AHC Air Heating & Cooling	0.003	19	0.003	18
LH Local Heaters (solid fuel)	0.002	23	0.002	23
LH Local Heaters (electric, gas, liquid)	0.000	34	0.000	34
RAC Room Air Conditioner	0.003	17	0.004	14
CIRC Circulator pumps, incl. double	0.000	36	0.000	37
CIRC Circulator pumps, excl. Double	0.000	40	0.000	40
VU Ventilation Units	0.001	29	0.002	27
LS Light Sources	0.109	**2**	0.069	**4**
DP Electronic Displays	0.022	**7**	0.028	**7**
STB Set Top Boxes	0.007	**10**	0.007	**10**
GC Game consoles	0.001	26	0.001	28
ESDS Servers and Data Storage	0.052	**5**	0.070	**3**
PC Personal Computers	0.132	**1**	0.213	**1**
IE imaging equipment	0.007	**8**	0.007	**9**
INK Cartridges and Containers (empty)	0.000	39	0.000	39
SB Products regulated only for 'standby'	0.001	32	0.001	33
EPS External Power Supplies incl. double	0.004	15	0.004	16
EPS External Power Supplies excl. Double	0.001	28	0.001	29
MCPT Phones and Tablets	0.063	**4**	0.048	**5**
RF Household Refrigerators & freezers	0.004	14	0.004	15
CF Commercial Refrigeration	0.001	31	0.001	31
PF Professional Refrigeration, incl. Double	0.000	37	0.000	36
PF Professional Refrigeration, excl. Double	0.000	38	0.000	38
CK Cooking Appliances	0.038	**6**	0.039	**6**
WM (household) Washing Machines	0.007	**9**	0.007	11
DW (household) Dishwashers	0.005	13	0.006	12
LD (household) Laundry Dryers	0.003	21	0.003	21
VC Vacuum Cleaners	0.006	11	0.012	**8**
FAN Industrial Fans, incl. Double	0.003	16	0.004	17

Prioritization scores for CRMs and non-CRMs	2020		2030	
	score	rank	score	rank
FAN Industrial Fans, excl. Double	0.002	25	0.002	26
MT Electric Motors, incl. double	0.005	12	0.005	13
MT Electric Motors, excl. double	0.003	20	0.003	19
WP Water pumps	0.000	35	0.000	35
WE Welding Equipment	0.003	18	0.003	20
TRAFO Utility Transformers	0.001	27	0.002	25
PV Photovoltaic panels & Inverters	0.095	**3**	0.199	**2**
TS Taps and Showerheads	0.002	24	0.002	24

For the 10 product groups with the highest ranking, Table 23 lists the types of CRMs and non-CRMs with the highest impact on the score.

Except from cooking appliances and vacuum cleaners, all top 10 products are 'electronics' products.

For cooking appliances, magnesium derives from MgZn5 casting, while palladium, tin and bismuth come from the elemental breakdown of PCBs (section A3.1), for which the generic mass of 'controller board' has been used (2 kg per electric hob).

For vacuum cleaners, the Cobalt contributions comes from the batteries in cordless and robots, which are included in the accounting.

*Table 23: CRMs and non-CRMs with the highest weighted impacts for the product groups with highest rankings in Table 22 (**without considering Bauxite and Iron ore**)*

Product group with high ranking for CRMs and non-CRMs	CRMs and non-CRMs with highest contribution (in 2030)
PC Personal Computers	Tantalum, Cobalt, Palladium, Magnesium, REE
PV Photovoltaic panels & Inverters	Germanium, Silicon metal, Gallium, Nickel, Chromium
ESDS Servers and Data Storage	Palladium, Germanium, Platinum, Gallium, HREE
LS Light Sources	Germanium, REE, Gallium, Aluminium, Niobium
MCPT Phones and Tablets	Cobalt, PGM, Magnesium, REE, Tantalum
CK Cooking Appliances	Magnesium, Palladium, Tin, Bismuth, Aluminium
DP Electronic Displays	Palladium, Indium, Gold, Silver, Tin
Vacuum Cleaners	Cobalt, Palladium, Tin, Gold, Aluminium, Silver
IE Imaging Equipment	Palladium, Tin, Bismuth, Antimony, Gold
STB Set Top Boxes	Platinum, Palladium, PGM, Nickel, Tin

When considering also the contributions of Bauxite and Iron ore (see section A3.1), the resulting scores and ranks are shown in Table 24. The 10 product groups with the highest impacts in 2030 are high-lighted in red:

1- Photovoltaic panels and inverters

2- Personal computers

3- Light sources

4- Servers and data storage products

5- Phones and tablets

6- Cooking appliances

7- Electronic displays

8- Industrial fans

9- Electric motors

10- Vacuum cleaners.

Compared to the situation without Bauxite and Iron ore contributions, the first 7 product groups remain the same, but PV and PC exchange ranks 1 and 2, and LS and ESDS exchange ranks 3 and 4. Instead of imaging equipment and set top boxes, industrial fans and electric motors enter in the top 10 due to their aluminium and steel. Vacuum cleaners drop from rank 8 to 10.

It has been verified that summing the contributions only over the elements on the 2023 EU list of CRMs (excluding the non-CRMs) does not significantly change the rankings for the product groups: the first 10 positions remain the same, except that PCs (rank 1) and PVs (rank 2) exchange position.

Table 24: Weighted product group priorities and ranking for CRMs and non-CRMs contained in products sold in 2020 or 2030, ***when including also Bauxite and Iron ore****.*

Prioritization scores for CRMs and non-CRMs	2020		2030	
	score	rank	score	rank
DWH Dedicated Water Heater	0.001	32	0.001	30
	0.000	41	0.000	41
CHB Central Heating boilers	0.005	21	0.007	18
SFB Solid Fuel Boilers	0.001	31	0.001	32
AHC Air Heating & Cooling	0.006	17	0.007	17
LH Local Heaters (solid fuel)	0.002	27	0.002	27
LH Local Heaters (electric, gas, liquid)	0.001	34	0.001	34
RAC Room Air Conditioner	0.005	18	0.007	19
CIRC Circulator pumps, incl. double	0.001	36	0.001	37
CIRC Circulator pumps, excl. Double	0.000	40	0.000	40
VU Ventilation Units	0.005	19	0.006	20
LS Light Sources	0.112	2	0.073	3
DP Electronic Displays	0.023	7	0.030	7
STB Set Top Boxes	0.007	15	0.007	16
GC Game consoles	0.002	29	0.002	29
ESDS Servers and Data Storage	0.054	5	0.073	4
PC Personal Computers	0.133	1	0.214	2
IE imaging equipment	0.008	13	0.008	15
INK Cartridges and Containers (empty)	0.000	38	0.000	39
SB Products regulated only for 'standby'	0.001	33	0.001	33
EPS External Power Supplies incl. double	0.004	23	0.004	24
EPS External Power Supplies excl. Double	0.001	30	0.001	31
MCPT Phones and Tablets	0.063	4	0.048	5
RF Household Refrigerators & freezers	0.007	14	0.008	14
CF Commercial Refrigeration	0.003	25	0.004	25
PF Professional Refrigeration, incl. Double	0.001	35	0.001	35
PF Professional Refrigeration, excl. Double	0.001	37	0.001	36
CK Cooking Appliances	0.041	6	0.043	6
WM (household) Washing Machines	0.010	10	0.010	12

Prioritization scores for CRMs and non-CRMs	2020		2030	
	score	rank	score	rank
DW (household) Dishwashers	0.005	20	0.006	22
LD (household) Laundry Dryers	0.004	22	0.005	23
VC Vacuum Cleaners	0.007	16	0.014	10
FAN Industrial Fans, incl. Double	0.019	8	0.020	8
FAN Industrial Fans, excl. Double	0.010	12	0.010	13
MT Electric Motors, incl. double	0.018	9	0.019	9
MT Electric Motors, excl. double	0.010	11	0.011	11
WP Water pumps	0.000	39	0.000	38
WE Welding Equipment	0.003	26	0.003	26
TRAFO Utility Transformers	0.004	24	0.006	21
PV Photovoltaic panels & Inverters	0.105	3	0.222	1
TS Taps and Showerheads	0.002	28	0.002	28

For the 10 product groups with the highest ranking, Table 25 lists the types of CRMs and non-CRMs with the highest impact on the score.

Note that the contributions for coking coal derive from the assumptions on steel and cast iron (section A3.1). The contributions of silicon metal also derive from the elemental split of steel.

The inclusion of contributions from Bauxite and Iron ore raises the ranking especially for industrial fans and electric motors. For fans all top 5 contributions are related to aluminium and steel.

Table 25: CRMs and non-CRMs with the highest weighted impacts for the product groups with highest rankings in Table 24 ***(with Bauxite and Iron ore)***

Product group with high ranking for CRMs and non-CRMs	CRMs and non-CRMs with highest contribution (in 2030)
PV Photovoltaic panels & Inverters	Germanium, Silicon metal, Bauxite, Gallium, Nickel, Chromium
PC Personal Computers	Tantalum, Cobalt, Palladium, Magnesium, REE
LS Light Sources	Germanium, REE, Bauxite, Gallium, Aluminium, Niobium
ESDS Servers and Data Storage	Palladium, Germanium, Platinum, Gallium, Bauxite, HREE
MCPT Phones and Tablets	Cobalt, PGM, Magnesium, REE, Tantalum
CK Cooking Appliances	Magnesium, Palladium, Bauxite, Tin, Bismuth
DP Electronic Displays	Palladium, Indium, Bauxite, Gold, Silver, Tin
FAN Industrial Fans, incl. double	Bauxite, Aluminium, Coking Coal, Iron ore, Iron Fe
MT Electric Motors, incl. double	Bauxite, Aluminium, Silicon metal, Palladium, Coking Coal, Copper
Vacuum Cleaners	Cobalt, Palladium, Bauxite, Tin, Gold, Aluminium, Silver

A4 Scoring for environmental impact and for CRM supply risk

The following table is related to Section 5.1, Table 2 with the ranking of product / materials combinations. Table 2 is based on the methodological choice of using annualised impacts, i.e. the total environmental impacts of the production phase divided by the average lifetime of the products. For transparency reasons, we provide in the following table the content of Table 2 (columns 'year') supplemented with a column where the ranking is based on total environmental impacts (column 'full'), i.e. not divided with lifetime.

Product group	Environmental impact														Supply risk
	All Materials		Plastics		Ferrous metals		Non-ferrous metals		Coating / Plating		Electronics		Miscellaneous		CRM content
	full	year	full	year	full	year	full	year	full	year	full	year	full	year	full
DWH Dedicated Water Heater	21	18	12	16	14	18	20	23	5	8	17	12	10	13	32
CHB Central Heating boilers	18	18	8	14	9	13	4	6	10	10	17	12	10	13	22
SFB Solid Fuel Boilers	27	28	12	16	19	23	22	26	10	10	17	12	10	13	30
AHC Air Heating & Cooling	14	18	12	16	11	13	7	10	10	10	9	12	10	13	18
LH Local Heaters (solid fuel)	15	17	12	16	10	12	22	26	10	10	17	12	5	9	23
LH Local Heaters (electric, gas, liquid)	27	28	12	16	22	25	22	26	10	10	17	12	10	13	34
RAC Room Air Conditioner	18	24	12	16	21	21	9	9	10	10	9	12	10	13	14
CIRC Circulator pumps	27	28	12	16	22	25	22	26	10	10	17	12	10	13	37
VU Ventilation Units	17	18	12	16	13	13	14	17	10	10	17	12	10	13	27
LS Light Sources	20	28	12	16	22	25	18	26	10	10	7	12	10	13	4
DP Electronic Displays	2	5	2	4	19	18	10	6	10	10	3	3	7	4	7
STB Set Top Boxes	25	24	12	16	22	11	22	23	10	10	12	8	10	13	10
GC Game consoles	25	28	12	16	22	25	22	26	10	10	12	12	10	13	28
ESDS Servers and Data Storage	6	4	12	16	14	4	17	5	6	4	4	4	10	13	3
PC Personal Computers	5	2	7	5	16	9	11	2	10	10	2	2	10	13	1
IE imaging equipment	7	3	5	2	16	10	22	21	8	5	6	5	10	11	9
INK Cartridges and Containers (empty)	27	11	12	3	22	23	22	17	10	10	17	12	10	6	39
SB Products regulated only for 'standby'	27	28	12	9	22	25	22	23	10	10	17	12	10	12	33
EPS External Power Supplies	27	16	12	10	22	25	22	20	10	10	9	6	10	13	16
MCPT Phones and Tablets	1	1	12	16	22	25	22	21	9	7	1	1	8	3	5
RF Household Refrigerators & freezers	4	7	1	1	5	8	8	11	10	10	12	12	4	6	15
CF Commercial Refrigeration	16	10	12	10	8	6	15	13	1	1	17	12	9	10	31
PF Professional Refrigeration	27	28	12	16	22	20	22	26	2	2	17	12	10	13	36
CK Cooking Appliances	3	8	8	16	3	5	5	12	4	6	5	7	3	4	6
WM (household) Washing Machines	9	11	3	7	1	2	16	26	10	10	17	12	6	8	11
DW (household) Dishwashers	11	13	4	8	7	7	19	19	10	10	8	8	2	2	12
LD (household) Laundry Dryers	24	24	10	13	22	25	12	14	10	10	17	12	10	13	21
VC Vacuum Cleaners	21	13	6	6	22	25	20	15	10	10	12	8	10	13	8

Product group	Environmental impact														Supply risk
	All Materials		Plastics		Ferrous metals		Non-ferrous metals		Coating / Plating		Electronics		Miscellaneous		CRM content
FAN Industrial Fans	13	13	12	16	12	13	**3**	**4**	10	10	17	12	10	13	17
MT Electric Motors	**8**	**6**	**10**	**12**	**2**	**1**	**1**	**1**	**7**	**8**	**17**	**12**	**10**	**13**	**13**
WP Water pumps	27	28	12	16	22	25	22	26	10	10	17	12	10	13	35
WE Welding Equipment	27	24	12	16	22	25	22	26	10	10	12	**8**	10	13	20
TRAFO Utility Transformers	**10**	18	12	16	**4**	13	**2**	**6**	10	10	17	12	**1**	**1**	25
PV Photovoltaic panels and inverters															**2**
TS Taps and showerheads															24

Below are the corresponding tables with the recommended five product-material bins, the first one related to production impact per year (the methodological choice) and the second one related to the total production impact showing the recommended changes in product-material bins.

Recommended five product-material bins (production impact per year); lower figure is higher ranked (from the report)

Product-material bin	Environmental and CRM ranking	Legislative feasibility	Comments
Household refrigerators and freezers (white goods) / Plastics	Plastics: 1 All materials: 7 CRM: 15	Review due December 2025 under ESPR	No other white goods are relevant. Results from this study would need to await the review.
Imaging equipment (ICT / electronics) / Plastics	Plastics: 2 All materials: 3 CRM: 9	Preparatory study ongoing under ED	
Electric Motors (industrial /B2B) / Ferrous & non-ferrous metals	Ferrous metals: 1 Non-ferrous metals: 1 All materials: 6 CRM: 13	Due for review under ESPR	No other industrial / B2B are relevant. Results from this study would need to await the review.
Personal Computers (ICT / electronics) / Electronics and non-ferrous metals	Electronics: 2 Non-ferrous metals: 2 All materials: 2 CRM: 1	Review ongoing under ED	
Household washing machines (white goods) / Ferrous metals	Ferrous metals: 2 All materials: 11 CRM: 11	Preparatory study ongoing under ESPR	

Recommended five product-material bins (full production impact); lower figure is higher ranked. Change from above table

Product-material bin	Environmental and CRM ranking	Legislative feasibility	Comments
Household refrigerators and freezers (white goods) / Plastics	Plastics: 1 All materials: 7->4 CRM: 15	Review due December 2025 under ESPR	No other white goods are relevant. Results from this study would need to await the review.
Imaging equipment (ICT / electronics) / Plastics	Plastics: 2->5 All materials: 3->7 CRM: 9	Preparatory study ongoing under ED	
Electric Motors (industrial /B2B) / Ferrous & non-ferrous metals	Ferrous metals: 1->2 Non-ferrous metals: 1 All materials: 6->8 CRM: 13	Due for review under ESPR	No other industrial / B2B are relevant. Results from this study would need to await the review.
Personal Computers (ICT / electronics) / Electronics and non-ferrous metals	Electronics: 2 Non-ferrous metals: 2->11 All materials: 2->5 CRM: 1	Review ongoing under ED	
Household washing machines (white goods) / Ferrous metals	Ferrous metals: 2->1 All materials: 11->9 CRM: 11	Preparatory study ongoing under ESPR	

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