

## Good Practice Guidance for Calculation of Primary Aluminium and Precursor Product Carbon Footprints

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### Abstract



This guidance addresses the life cycle environmental impact category “climate change”. It specifies the principles, requirements and methodologies for quantifying and communicating greenhouse gas (GHG) emissions from primary aluminium production processes and the associated cradle-to-gate partial carbon footprints of their products and pre-cursors (e.g. bauxite, alumina). This guidance is aligned with international (ISO) standards for environmental management and greenhouse gas emissions calculation and the communication of carbon footprint information but represents a specified approach to the aluminium sector and its products. Employment of this best practice guidance enables bauxite and/or other ores, alumina and aluminium producers (their customers and other stakeholders) to calculate and communicate harmonized and comparable carbon footprints of a product or set of products. While there is significant cross-over with corporate accounting principles (greenhouse gas inventories of an entity, company or set of companies) – including default data, calculation methodologies and relevant processes – the scope of emissions accounting can differ between CORPORATE and PRODUCT carbon footprint metrics (even within given companies). This guidance is applicable to the development of product carbon footprints – for guidance on corporate accounting, alternative sources should be used.

**Keywords:** Carbon footprint, Bauxite, Alumina, Anode, Primary Aluminium.

### 1. Introduction

This guidance addresses the life cycle environmental impact category “climate change”. It specifies the principles, requirements and methodologies for quantifying and communicating greenhouse gas (GHG) emissions from primary aluminium production processes and the associated cradle-to-gate partial carbon footprints of their products and pre-cursors (e.g. bauxite, alumina).

This guidance is aligned with international (ISO) standards [1,2,3,4,5]. for environmental management and greenhouse gas emissions calculation and the communication of carbon footprint information, but represents a specified approach to the aluminium sector and its products. This guidance is applicable to the development of product carbon footprints – for guidance on corporate accounting, alternative sources should be used.

### 2. Goal and Scope

#### 2.1 General

The climate change impact of a product, expressed as carbon dioxide equivalents (CO<sub>2</sub>e), is the summation of all GHG emissions and removals over the partial (cradle-to-gate) life cycle of the product (or process). This guidance does not address avoided emissions or actions taken to

mitigate released emissions. This guidance is also not designed to be used for quantifying GHG reductions from offsets or claims of carbon neutrality.

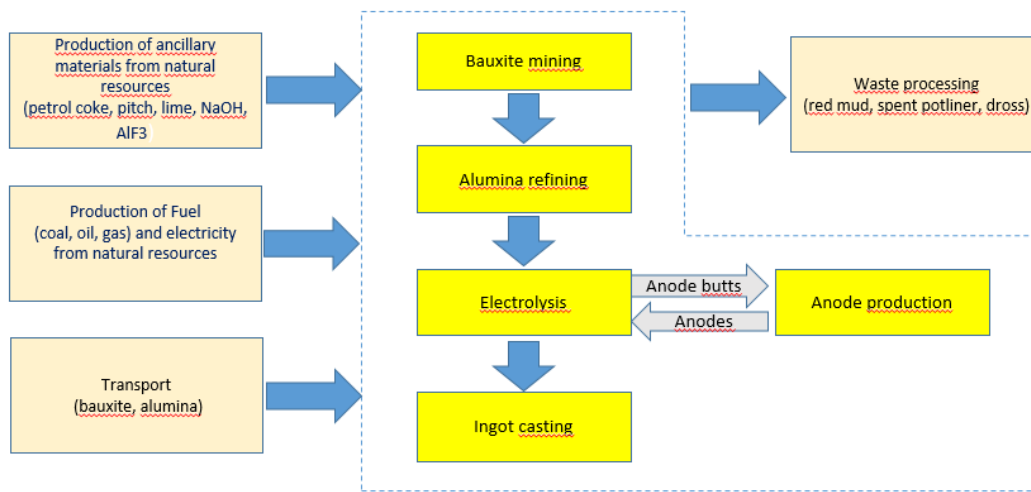
## 2.2 Product Category

The goal of this guidance is to provide practitioners with a standardised approach to the calculation of climate change impact of a given mass of primary aluminium and precursor products, including:

- Dry bauxite and/or other ores
- Aluminium hydroxide (Al(OH)<sub>3</sub>, commonly known as “hydrate”)
- Aluminium oxide (Al<sub>2</sub>O<sub>3</sub>, commonly known as “alumina”)
- Primary aluminium tapped from electrolytic cells or pots during the electrolytic reduction of metallurgical alumina, excluding alloying additives and recycled aluminium.
- Alloyed and unalloyed primary aluminium in different forms produced in the cast-house of aluminium smelters from liquid primary aluminium

## 2.3 System Boundary

The system boundary can be illustrated by the following flow-chart. The yellow boxes refer to the core processes which are under the responsibility of the aluminium industry.



**Figure 1. System boundary of primary aluminium production.**

For primary aluminium this includes the unit processes bauxite and/or other ores mining, alumina production (hydrate production & calcination), anode production, electrolysis, ingot casting, raw materials transport, electricity generation, and waste processing. It also includes the production of ancillary materials and fuels required for primary aluminium production. It does not include the stages of “production of semi-finished products from raw material”, “use” and “end-of-life”.

## 3. Life Cycle Impact Assessment

This carbon footprint study uses only one impact category: climate change. The different substances which have been considered as GHG emissions and the selected characterization factors shall be reported.

- 1) Specified product to which the calculated cradle-to-gate carbon footprint relates and declared unit, e.g. 1 tonne
- 2) The percentage of climate change impact that is derived from secondary data, if any
- 3) Source of global warming potential (GWP) values used
- 4) If input materials include scrap, elements contained in section 7.2.3.2 are recommended to be disclosed

The product in question covered by this guidance is listed under section 2.2.

## 9. References

1. ISO 14044:2006/Amd 2:2020, Environmental management — Life cycle assessment — Requirements and guidelines — Amendment 2 (<https://www.iso.org/standard/76122.html>)
2. ISO 14064-1:2018, Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals (<https://www.iso.org/standard/66453.html>)
3. ISO/DIS 19694-4, Stationary source emissions — Determination of greenhouse gas (GHG) emissions in energy-intensive industries — Part 4: Aluminium industry (<https://www.iso.org/standard/73182.html>)
4. ISO 14067:2018, Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification (<https://www.iso.org/standard/71206.html>)
5. ISO 14026 :2017 Environmental labels and declarations — Principles, requirements and guidelines for communication of footprint information (<https://www.iso.org/standard/67401.html>)
6. 2019 IPCC Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use, Chapter 4: Metal Industry Emissions, Section 4.4 Primary Aluminium Production( [https://www.ipccnggip.iges.or.jp/public/2019rf/pdf/3\\_Volume3/19R\\_V3\\_Ch04\\_Metal\\_Industry.pdf](https://www.ipccnggip.iges.or.jp/public/2019rf/pdf/3_Volume3/19R_V3_Ch04_Metal_Industry.pdf))
7. Greenhouse Gas Protocol Product Life Cycle Accounting and Reporting Standard (2011) (<https://ghgprotocol.org/product-standard>)
8. Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2011) (<http://www.ghgprotocol.org/standards/scope-3-standard>)
9. Greenhouse Gas Protocol Technical Guidance for Calculation Scope 3 Emissions (2013) (<http://ghgprotocol.org/feature/scope-3-calculation-guidance>)
10. Greenhouse Gas Protocol Calculation tools:  
The Aluminium Sector Greenhouse Gas Protocol (2006)
  - Guidance: [www.ghgprotocol.org/sites/default/files/ghgp/aluminium\\_1.pdf](http://www.ghgprotocol.org/sites/default/files/ghgp/aluminium_1.pdf)
  - Worksheet: [http://www.ghgprotocol.org/sites/default/files/ghgp/Aluminium%20Sector%20GHG%20Workbook%20-%20version%202\\_1\\_0.xls](http://www.ghgprotocol.org/sites/default/files/ghgp/Aluminium%20Sector%20GHG%20Workbook%20-%20version%202_1_0.xls)
11. Allocation of GHG Emissions from a Combined Heat and Power (CHP) Plant (2006)
  - Guidance: [https://ghgprotocol.org/sites/default/files/CHP\\_guidance\\_v1.0.pdf](https://ghgprotocol.org/sites/default/files/CHP_guidance_v1.0.pdf)
  - Worksheet: [https://ghgprotocol.org/sites/default/files/CHP\\_tool\\_v1.0.xls](https://ghgprotocol.org/sites/default/files/CHP_tool_v1.0.xls)
12. GHG Emissions from Stationary Combustion (2005)
  - Guidance: [http://www.ghgprotocol.org/sites/default/files/ghgp/Stationary\\_Combustion\\_Guidance\\_final\\_1.pdf](http://www.ghgprotocol.org/sites/default/files/ghgp/Stationary_Combustion_Guidance_final_1.pdf)
  - Worksheet: [http://www.ghgprotocol.org/sites/default/files/ghgp/Stationary\\_combustion\\_tool\\_%28Version4-1%29.xlsx](http://www.ghgprotocol.org/sites/default/files/ghgp/Stationary_combustion_tool_%28Version4-1%29.xlsx)
13. GHG Emissions from Purchased Electricity (2015)
  - Worksheet: [http://www.ghgprotocol.org/sites/default/files/ghgp/Purchased\\_Electricity\\_Tool\\_Version-4\\_8\\_0.xlsx](http://www.ghgprotocol.org/sites/default/files/ghgp/Purchased_Electricity_Tool_Version-4_8_0.xlsx)
14. GHG Emissions from Transport or Mobile Sources (2015)

- Worksheet: [http://ghgprotocol.org/sites/default/files/ghgp/Transport\\_Tool\\_v2\\_6.xlsx](http://ghgprotocol.org/sites/default/files/ghgp/Transport_Tool_v2_6.xlsx)
- 15. J. Atherton. Declaration by the Metals Industry on Recycling Principles. The International Journal of Life Cycle Assessment volume 12, page 59–60 (2007). (<http://dx.doi.org/10.1065/lca2006.11.283>)
- 16. International Aluminium Institute (2018) Life Cycle Inventory Data and Environmental Metrics for the Primary Aluminium Industry (<https://international-aluminium.org/resource/life-cycle-inventory-data-and-environmental-metrics/>)
- 17. International Aluminium Institute (2020) Good Practice Guidance: Measuring Perfluorocarbons (<https://international-aluminium.org/resource/good-practice-guidance-measuring-perfluorocarbons/>)
- 18. IAI (2021a). Aluminium Sector Greenhouse Gas Pathways to 2050 (<https://international-aluminium.org/resource/aluminium-sector-greenhouse-gas-pathways-to-2050-2021/>)
- 19. IAI (2021b). Alucycle (<https://alucycle.international-aluminium.org/>)
- 20. IEA (2017). CO<sub>2</sub> Emissions from Fuel Combustion: Highlights. (<https://www.iea.org/publications/freepublications/publication/CO2EmissionsfromFuelCombustionHighlights2017.pdf>)
- 21. IPCC (2014). Fifth Assessment Report: Climate Change 2014. (<https://www.ipcc.ch/report/ar5/>)
- 22. IPCC (2006). Guidelines for National Greenhouse Gas Inventories. (<https://www.ipcc-nggip.iges.or.jp/public/2006gl/>)
- 23. European Aluminium (2018) Environmental Profile Report (<https://european-aluminium.eu/resource-hub/environmental-profile-report-2018/>)
- 24. Aluminum Association (2010). The Environmental Footprint of Semi Finished Aluminum Products in North America.
- 25. ISO 21930:2017, Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services (<https://www.iso.org/standard/61694.html>)