LIFE CYCLE INVENTORY DATA AND ENVIRONMENTAL METRICS FOR THE PRIMARY ALUMINIUM INDUSTRY – 2015 DATA

Critical Review Report

prepared by Rolf Frischknecht, Walter Klöpffer and Kurt Buxmann

for the International Aluminium Institute

June 2017

1 Subject of review, procedure

The life cycle assessment work "LIFE CYCLE INVENTORY DATA AND ENVIRONMENTAL METRICS FOR THE PRIMARY ALUMINIUM INDUSTRY – 2015 DATA" (Available at: http://www.world-aluminium.org/publications/tagged/life%20cycle/), performed by the *International Aluminium Institute* (IAI) was subject to a critical review by a panel of three independent, external experts according to the ISO standard 14040 and 14044, Clause 6.3 (*International Organization for Standardization* (ISO) 2006a, b). IAI commissioned the critical review panel on 5 July 2016. The critical review panel was able to accompany the study from its very beginning. The following interactions between the commissioner, the practitioner and the review panel took place:

- Kick-off meeting 28 September 2016 (Teleconference): Discussion about the goal and scope of the LCI data update 2015, system boundaries, treatment of data gaps, new data issues;
- Meeting 29 November 2016 (Teleconference): Discussion of the findings of the data review;
- Meeting 16 February 2017 (Teleconference): Discussion of revised LCI data;
- Meeting 26 May 2017 (Teleconference): Discussion of LCI report including LCIA chapter.

The review panel members had access to the following documents:

- Alumina Energy 2015 data.xlsx (October 2017 and January 2017)
- Aluminium Energy 2015 data.xlsx (October 2017 and January 2017)
- BR for LCI.xlsx (October 2017 and January 2017)
- Casting Energy 2015 data.xlsx (October 2017 and January 2017)
- PFC 2015 data.xlsx (October 2017 and January 2017)
- LCI Survey Data 2015 for Reviewers - Oct 2016 - DRAFT (1).xlsx
- LCI Survey Data 2015 (inc. 2010) for Review Jan 2017.xlsx
- Regionalised Summary Tables for Review - Jan 2017.xlsx
- LCIA Examples for Review.docx (December 2016)
- Draft LCI Report 2015 for Review.docx (April 2017)
- LCA Report 2015 for Review May 2017.docx

Discussions have taken place at the phone conferences and all questions of the reviewers were answered and addressed sufficiently. Upon the reviewer's request revisions had taken place concerning LCI data and in particular regarding the systematic treatment of zero and non-reported values and the calculation

of average values. During LCI data review only few data errors were identified, which were corrected in the revised version.

The critical review process took place in an open and constructive atmosphere.

All comments of the reviewers given in the earlier stages of the review process are well reflected in the study report and the LCI dataset.

The present final version of the review report takes into account the revisions made by the *International Aluminium Institute* (IAI) after submitting the feedback on the pre-final reports circulated in April 2017 (LCI) and May 2017 (LCIA).

2 Purpose of the critical review

According to the ISO standard 14044, Clause 6.1 "the critical review process shall ensure that:

- the methods used to carry out the LCA are consistent with this International Standard,
- the methods used to carry out the LCA are scientifically and technically valid,
- the data used are appropriate and reasonable in relation to the goal of the study,
- the interpretations reflect the limitations identified and the goal of the study, and
- the study report is transparent and consistent."

The following sections contain the statements of the critical review panel on the five aspects mentioned above.

3 Consistency of the methods with the ISO standards

The LCI dataset on the global and regional aluminium supply chains is state-of-the-art.

The inventory analysis methods applied are consistent with the ISO standards 14040 and 14044. The extensive Excel workbooks are well structured and facilitated an in-depth review of the data provided by the individual sites.

The declared unit and reference flow are 1'000 kg of product and 1'000 kg of primary aluminium ingot. This is considered appropriate for the goal and scope of this study and the reference units are used consistently along the aluminium supply chain.

Main modelling choices were made in a conservative manner, i.e. rather resulting in overestimated mass and energy flows. Non-reporting and zero values are treated consistently and systematically. There were neither critical nor decisive allocation issues to be dealt with.

The impact assessment methods chosen are in line with the ISO 14044 standards. They are critically discussed, emphasising weaknesses and shortcomings as far as existing. The indicators chosen facilitate the comparison with the 2010 LCI dataset on world aluminium. For future updates it is recommended to consider using globally recommended indicators like the ones recently published in Frischknecht & Jolliet (2016).

4 Scientific and technical validity of the methods applied

The life cycle inventories are established with an attributional approach. This choice is appropriate and all models and data are in line with this approach. The derivation of average unit processes from raw data and information, and the inventory models are scientifically and technically valid.

The impact category indicators (Acidification potential, Depletion of fossil energy resources, Eutrophication potential, Global warming potential, Ozone depletion potential, Photo-oxidant creation potential, Water scarcity footprint) addressed are the same as in the predecessor Environmental Metrics Report (LCI Data 2010). This choice ensures the continuity and allows for a comparison of the environmental performance of the aluminium supply chains of 2010 and 2015. The impact category indicators are considered relevant with the exception of Ozone depletion potential, to which the aluminium supply chain contributes only marginally.

Toxicity and land use related impact category indicators are not used. It is recommended to address these topics in the next regular update of the LCI data of the aluminium supply chain and to use more recent versions of the impact category indicators' characterisation factors.

5 Appropriateness of data

Data used in the foreground are solid, quality checked, reasonable and as complete as possible. The lack of primary data on Chinese mines, smelters and refiners is bridged with sensible and conservative assumptions. IAI was able to establish regional averages of each step of the aluminium supply chain, except for the mines, for which only one global average dataset is available.

The reviewers had access to the detailed and complete *Microsoft Excel* workbooks, in which all single reporting units are documented and the regional and global averages are calculated. All calculations were accessible and were checked for correctness and appropriateness. Only a few errors were detected, which are considered a proof for the exceptionally high quality of data inquiry and data processing at IAI. It was recommended to include information (data) about the current market mixes of Bauxite, Alumina, Aluminium and Aluminium Ingots from the perspective of the "user markets" such as Europe, USA, China or Japan.

The transfer from the original primary information to the Excel workbooks was not reviewed (not part of the scope of review work).

6 Assessment of the interpretation in view of limitations and goal and scope

The report includes thorough analyses of the life cycle inventories of bauxite mining, alumina production, anode production, aluminium electrolysis and ingot casting and of the environmental impacts caused by five different archetypical scenarios of aluminium supply chains.

The interpretation includes a description of the major deviations from the LCI data and results presented in the previous survey (2010 data), distinguishing between the two main reasons namely technical improvements (performance driven changes) as well as sample size and error issues (data driven changes).

The environmental impacts of five archetypical scenarios are assessed in detail with further materiality analyses related to climate change impacts. The results are discussed critically highlighting significant issues and limitations. The conclusions reflect these significant issues as well as the major limitations.

Special emphasis is put on the contribution of electricity supply, in particular Chinese electricity supply to the aluminium industry, to the overall environmental impacts. The explanations and estimations of climate change impact reductions may be more explicit in how the reductions in greenhouse gas emissions were assessed.

7 Transparency and consistency of dataset and report

The report is clearly structured and well-readable. It includes all parts required in an LCA report. All necessary information was given to the reviewers, if not included into the report.

The confidentiality of plant specific data does not affect reading and understanding of the report because full transparency is provided with horizontally averaged unit processes per life cycle stage.

The newly added Chapter on life cycle impact assessment helps the reader to better understand the life cycle inventory data and provides guidance on how to link the life cycle inventory data with background data and with life cycle impact assessment methods.

The report successfully continues the long-term tradition of the aluminium industry to provide relevant life cycle inventory data on a unit process level.

8 Recommendations for future updates

The update of the life cycle inventory data 2015 of the global aluminium supply chain was used to introduce a number of significant improvements. The LCI data inquiry covered land occupation and transformation as well as water withdrawal, use and discharge. The latter was combined with information on the location of the sites to allow for a regionalised assessment of the water footprint.

For future updates it is recommended to continue trying to increase the data coverage of Chinese production sites and of mining sites. In particular, the provision of regionalised datasets of bauxite mining would be highly beneficial. It is recommended including the treatment of red mud into the life cycle inventory, quantifying the energy and material requirements as well as resource demand (land use) and emissions from red mud storage and disposal.

It is also recommended to revisit the selection of environmental impact category indicators in view of the scientific progress and the progress made in international harmonisation activities led by the *United Nations Environment Programme* (UNEP-SETAC Life Cycle Initiative). The progress made in indicators describing biodiversity impacts due to land use, water scarcity impacts as well as human and eco toxicity should allow addressing these environmental impacts in the next update.

9 Conclusions

Collecting and evaluating relevant LCA (LCI and LCIA) data in regular intervals belongs to the greatest services industry associations can provide for the industry concerned as well as to the scientific, environmental and political associations. This service has been provided by IAI on a global basis for many years. The interval of 5 years is well chosen and also used by European Aluminium.

The reviewed LCI and LCA study fully complies with the requirements of the ISO standards 14040 and 14044. The LCI of global primary aluminium supply is comprehensive and thorough. The goal and scope are appropriately defined. The methods used are scientifically and technically valid. The environmental impact category indicators are reasonable although partly a bit dated. The data compiled and processed are appropriate and reasonable in view of the goal and scope of the study and form a solid foundation for any future LCA of products containing primary aluminium. The report is complete, clearly structured and well-readable. The presentation of unit process dataset representing the different steps of the supply chain of primary aluminium production is highly appreciated. Conclusions and recommendations are based on the results of the analyses, respecting the limitations and the goal and scope.

We recommend publishing the entire LCI dataset as well as the report including this review report.

Uster, 2 June 2017

Dr. Rolf Frischknecht
on behalf of the critical review panel

10 References

Frischknecht R, Jolliet O (2016) Global Guidance for Life Cycle Impact Assessment Indicators: Volume 1. UNEP United Nations Environment Programme, Paris, FR

International Organization for Standardization (ISO) (2006a) Environmental management - Life cycle assessment - Principles and framework. Geneva, Switzerland

International Organization for Standardization (ISO) (2006b) Environmental management - Life cycle assessment - Requirements and guidelines. Geneva, Switzerland