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Life Cycle Assesment of Aluminium Slugs & Discs

PREPARED FOR

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by ENVIRONMETRICS

3.1 What is Life cycle assessment (LCA)

Life cycle assessment (LCA) is a method used to evaluate the environmental impact of a product or service through its life cycle encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal. This includes emissions to air, water, and land as well as the consumption of energy and other material resources.

3.2 Scope

The scope of the study is to calculate the environmental performance of the production of aluminium slugs and discs associated with the upstream and core processes (from cradle-to-gate). The LCA study has been performed in accordance with the requirements of ISO 14040:2006 and ISO14044:2006.

3.3 System Boundaries

The scope of the study is set to be cradle to gate, including upstream and core processes.

3.4 Declared unit.

The declared unit of the study is 1 kg of aluminium slugs and discs. Data for the inventory and impact assessment in this report are expressed in the basis of the declared unit.

3.5 Cut-off criteria

The cut-off criteria adopted is as stated in ISO 14044:2006. A cut-off rule of 1% is applied. In other words, the included inventory data (not including inventory data of processes that are explicitly outside the system boundary) shall together give rise to at least 99% of the results of any of the environmental impact categories. Also, 99% of the mass of the product content and 99% of the energy use of the product life cycle shall be accounted for. The cut-off rule was applied in different wastes generated through the manufacturing process, such as electronic equipment, lamps, cables, batteries and solvents. Total mass of the excluded flows accounts for under 1% of the mass of products manufactured.

3.6 Assumptions

For this LCA, the main assumptions applied concern:

- Transportation
- Raw material Production
- Electricity generation

For the stage associated with transportation of raw materials although the type of transportation was found in detail through questioners, assumptions regarding the mean of transport and the distances travelled was made.

For untreated scrap for direct use in smelters, it is assumed that according to ‘‘polluter pays principal’’, impacts arising from the generation of these scrap are attributed to the product system generating the waste. Thus, only impacts from the sorting and pressing of this scrap is attributed to ALUMAN.

For some alloying elements (manganese, titanium, iron) it should be noted that they are alloys that contain significant amounts of aluminium.Thus, the proportion of aluminium contained in each alloy is taken into consideration in the modelling.

According to the latest version of Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP SA) Report for ''Residual Energy Mix 2021'' for Greece, the carbon footprint of Greece electricity residual mix is 436,89 g CO2eq/kWh. However, in Ecoinvent 3.8, the carbon footprint for electricity production for Greece is higher because it represents the production mix for 2014. As a result, in order to model the specific residual mix, the two datasets from openLCA egarding the Greek and European mix were combined in a way that the final carbon footprint would be the same with the one from DAPEEP SA. 11,996% of the electricity used is attributed to Greece's dataset while the rest to the European.

3.7 Allocation

Allocation rules have been performed in accordance with the requirements of ISO 14044:2006. Wherever possible, allocation was avoided by dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes. Where allocation cannot be avoided, the inputs and outputs of the system were partitioned between its different products or functions in a way that reflects the underlying physical or economic relationships between them. If a physical relationship between the inventory data and the delivery of co-products cannot be established, the inventory data should be allocated between the co-products in a way that reflects other relationships between them.

3.8 Impact categories

The following environmental performance indicators are chosen to be studied in order to evaluate the environmental impact of the production of aluminium slugs and discs.

The Core Environmental Impact Categories included in the study are:

- Global Warming Potential total (GWP-total)
- Global Warming Potential fossil (GWP-fossil)
- Global Warming Potential biogenic (GWP-biogenic)
- Global Warming Potential land use and land use change (GWP-luluc)
- Ozone Depletion Potential (ODP)
- Acidification Potential (AP)
- Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)
- Eutrophication Potential fraction of nutrients reaching marine end compartment (EP-marine)
- Eutrophication potential, Accumulated Exceedance (EP-terrestrial)
- Formation potential of tropospheric ozone photochemical oxidants (POCP)
- Abiotic depletion potential for non-fossil resources (ADPe)
- Abiotic depletion potential for fossil resources (ADPf)
- Water deprivation potential (WDP)

3.9 RESULTS

The results of life cycle assessment for 1 kg of aluminium slugs and discs are presented.

ENVIRONMENTAL IMPACTS	Unit	Upstream	Core	Total
GWP-total	kg CO2 eq	7,49E+00	4,45E-01	7,93E+00
GWP-fossil	kg CO2 eq	7,29E+00	4,43E-01	7,73E+00
GWP-biogenic	kg CO2 eq	3,82E-02	2,01E-03	4,03E-02
GWP-luluc	kg CO2 eq	1,60E-01	3,82E-04	1,61E-01
ODP	kg CFC-11 eq	9,41E-07	2,63E-09	9,44E-07
AP	mol H+ eq	4,86E-02	1,83E-04	4,88E-02
EP-freshwater	kg P eq	4,09E-03	2,83E-05	4,12E-03
EP-marine	kg N eq	7,40E-03	6,16E-05	7,47E-03
EP-terrestrial	mol N eq	7,01E-02	5,16E-04	7,06E-02
POCP	kg NMVOC eq	2,49E-02	1,46E-04	2,50E-02
ADPe	kg Sb eq	1,98E-05	6,17E-07	2,04E-05
ADPf	MJ	1,18E+02	4,47E-01	1,19E+02
WDP	m3 eq	1,28E+01	1,93E-02	1,28E+01

Global Warming Potential total (**GWP-total) ,** Global Warming Potential fossil **(GWP-fossil) ,** Global Warming Potential biogenic **(GWP-biogenic) ,** Global Warming Potential land use and land use change **(GWP-luluc) ,** Ozone Depletion Potential **(ODP) ,** Acidification Potential **(AP) ,** Eutrophication potential, fraction of nutrients reaching freshwater end compartment **(EP-freshwater) ,** Eutrophication Potential fraction of nutrients reaching marine end compartment **(EP-marine) ,** Eutrophication potential, Accumulated Exceedance **(EP-terrestrial) ,** Formation potential of tropospheric ozone photochemical oxidants **(POCP)** , Abiotic depletion potential for non-fossil resources **(ADPe) ,** Abiotic depletion potential for fossil resources **(ADPf) ,** Water deprivation potential **(WDP)**

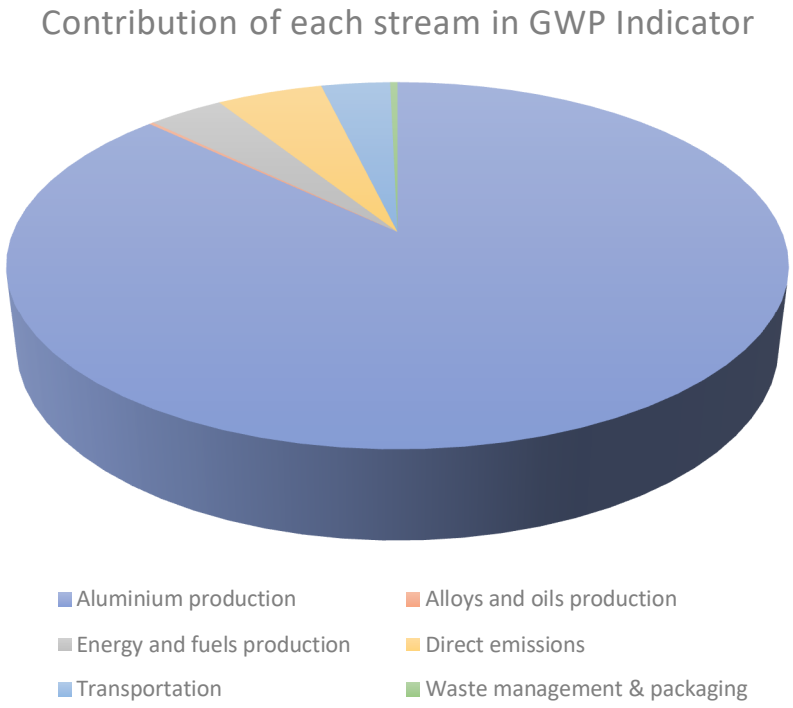
RESOURCE USE	Unit	Upstream	Core	Total
PERE	MJ	4,25E+01	8,50E-01	4,33E+01
PERM	MJ	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	4,25E+01	8,50E-01	4,33E+01
PENRE	MJ	1,18E+02	4,48E-01	1,19E+02
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,18E+02	4,48E-01	1,19E+02
SM	kg	4,54E-02	0,00E+00	4,54E-02
RSF	MJ	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00
FW	m3	2,98E-01	4,50E-04	2,98E-01

Use of renewable primary energy excluding resources used as raw materials (**PERE**),Use of renewable primary energy resources used as raw materials **(PERM**), Total use of renewable primary energy resources (**PERT**), Use of non-renewable primary energy excluding resources used as raw materials (**PENRE**), Use of non-renewable primary energy resources used as raw materials (**PENRM**), Total use of non-renewable primary energy resources (**PENRT**), Use of secondary material (**SM**), Use of renewable secondary fuels (**RSF**), Use of non-renewable secondary fuels (**NRSF**), Use of net fresh water (**FW**).

3.10 Sensitivity analysis

Figure 1 shows that the main contributor in the production of slugs and discs is aluminium production. Thus, sensitivity analysis based on the recycled content in aluminium input is conducted. Also, sensitivity analysis on the amount of electricity consumed is conducted, to ensure the assertion that the two products (slugs and discs) can be modelled as one, since the differentiation is in the energy used in cutting process.

Figure 1



As it seems in figure below, aluminium production contributes the most for the production of slugs and discs, accounting for about 87%, while the production of auxiliary materials such as alloys and oils account for 0,22%. Impacts from energy sources production and transmission (diesel, LNG and electricity) contributes 3,74% while on site emissions from diesel and natural gas combustion contribute 5,25%. Transportation of raw materials contributes about 3,5% of total GWP indicator. Other factors such as packaging and waste management are of minor significance, not exceeding 0,5%.

The critical review of Life Cycle Assessment (LCA) was assigned to Mr. Evangelos Symsaris by the LCA commissioner, being a person independent of the Life Cycle Assessment (LCA) conduction and an internal expert with extended technical knowledge and experience on the company's Environmental Management System and Principles and being familiar with ISO 14040 and ISO 14044. The project under review is the LCA of the company's aluminium profiles and the reporting period was 01/01/2021-31/12/2021. The critical review was conducted concurrently with the LCA study, according to the requirements of ISO 14044:2006, ISO 14044:2006 and ISO/TS 14071, including an assessment of the LCI model and the analysis of individual data sets.