Deliverable Report

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LCA result report of the different alloys and production technologies

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
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Technical References

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Summary

SALEMA's project aims at developing solutions that bring benefit for the automotive sector, in specific non-CRM dependent aluminium industrial ecosystem. SALEMA aims to demonstrate the feasibility of the proposed solutions in the automotive industry at large and the electric vehicle (EV) in particular.

This report addresses O&B#1 on the sustainability of the proposed solutions by conducting a Life Cycle Assessment (LCA) of all the different alternatives of alloys applied also to four different demonstrators: Shock Tower, Frontal Frame, B-Pillar and a Battery Housing.

General methodological aspects of LCA methodology have been applied on all demonstrators including all life cycle stages of a vehicle from cradle-to-cradle.

LCA results prove SALEMA's solutions as more beneficial solutions from an environmental point of view. Alloy production being the most dominant in environmental impact, justifies the need to search for more sustainable solutions with more recycled material content. Moreover, the use of renewable energy also plays an important role on the path to more beneficial solutions.

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Abbreviations

Abbreviation / Acronyms	Description
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
BEV	Battery Electric Vehicle

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1. Introduction and Background

In the wake of the European Green Deal[1], the transport industry faces the challenges of lightweighting while simultaneously mitigate reliance on imported advanced materials. Amidst this need, SALEMA project aims to revolutionize the aluminium industry by developing high-performance aluminium alloys that not only meet the technical requirements of lightweight automotive structures but also alleviate the sector's dependency on Critical Raw Materials (CRM).

At the core of SALEMA's project lies a fundamental commitment to also account for the environmental impact of its solutions. Through a meticulous Life Cycle Assessment (LCA) across every phase of the aluminium life cycle, from raw material extraction and alloy production to product manufacturing and eventual end-of-life disposal. These LCAs address three key life cycle stages: Manufacturing, Use-phase, and End-of-Life. All in the aims of guaranteeing that SALEMA's solutions not only make sense from a technical perspective but also uphold environmental sustainability.

SALEMA's commitment to environmental sustainability extends further with a comparative analysis against current industry benchmarks, evaluating the performance of various aluminium alloys across three key forming technologies used in automotive component production: High Pressure Die Casting (HPDC), stamping, and extrusion, giving a total of 10 LCA's.

1.1. Objectives of task and deliverable

- To assess the environmental impacts of SALEMA's solutions using established LCA standards and the tailored Product Category Rule (PCR).
- To evaluate the environmental benefits of SALEMA's sustainable solutions across key life cycle stages, within a circular economy framework.
- To compare SALEMA's aluminium alloys against industry benchmarks, providing insights to enhance environmental efficiency and sustainability in the automotive and aluminium sectors.

2. Activities

Data Collection: Comprehensive gathering of data pertaining to the entire aluminium life cycle, including raw material extraction, alloy production, manufacturing processes, and end-of-life management.

Stakeholder Collaboration: Engagement with SALEMA's partners to gather insights, data, and ensure alignment with industry practices and standards.

Environmental Impact Assessment: Quantifying environmental impacts associated with SALEMA's aluminium solutions.

Comparative Analysis: Comparing SALEMA's aluminium alloys for the different demonstrators according to their production process (HPDC, stamping or extrusion).

Reporting and documentation: Compiling and documenting LCA results, methodologies, assumptions, and findings in a comprehensive report.

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3. LCA Methodology

Life Cycle Assessment (LCA) serves as a widely accepted methodology for identifying, characterizing, and evaluating the environmental impacts of products, processes, or services across their entire life cycle. This entails compiling a comprehensive inventory of inputs and outputs associated with the product system to assess its environmental footprint. By integrating inventory analysis with impact assessment, the results are interpreted in alignment with the study's objectives.

To ensure a thorough examination of all relevant factors, the life cycle is typically segmented into stages: raw material extraction, manufacturing, use stage, and end-of-life management. International standards ISO 14040[2] and ISO 14044[3] provide the foundational framework for LCA methodology, comprising four interconnected phases: goal and scope definition, inventory analysis, impact assessment, and interpretation. Additionally, the SPE-14040-1475 standard by the CSA group outlines requirements for conducting comparative LCAs of automotive parts, which can provide guidance on the average use stage.

LCA is an iterative and holistic process, that allow to accommodate new insights, evolving study goals, and data availability. Figure 1 illustrates the interrelationships among these phases, highlighting the cyclical nature of the LCA process.

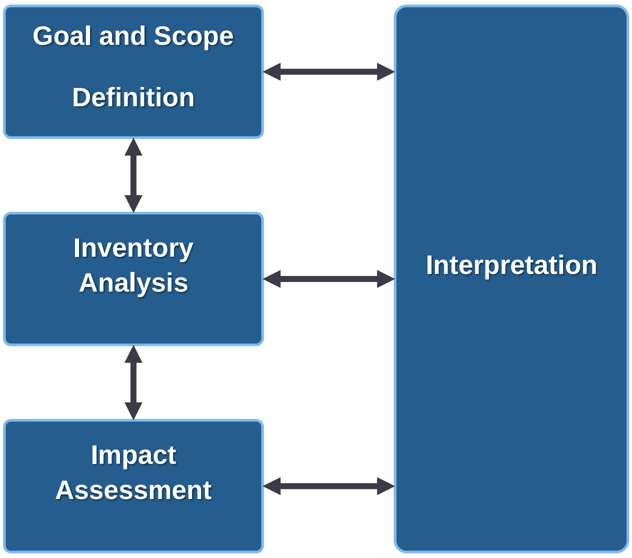

Figure 1. LCA Scope

3.1. Goal and Scope definition

The goal and scope definition phase are the first step in a Life Cycle Assessment, and it represents the core of the assessment, and its definition serves as the foundational basis guiding the entire study. While modifications can be made in later stages due to unforeseen issues or new information, starting with a well-defined goal and scope is ideal for ensuring the study's effectiveness and accuracy. The LCA scope describes the performance of the system, including the selected function(s) to be reflected by the study's goal, any limitations, allocation procedures (if necessary), data requirements and its quality, main assumptions, and impact categories to be evaluated.

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The functional unit needs to be carefully defined in relation with the objectives of the study, and it should be clearly defined and measurable. The main purpose of the functional unit is to quantify the function of the study. Its definition determines the fluxes, and after the definition of the functional unit, the reference flux is defined. The reference flux is the amount of the functional unit that is used as a reference to calculate the environmental impacts of the product system.

The system boundaries in LCA studies are crucial as they define the limits within which the analysis is conducted. System boundaries delineate the processes within the system and determine what is included in the assessment. Any exclusion of life cycle stages or process steps should be justified and explained if they do not significantly impact the results.

3.2. Inventory Analysis

In this phase, the Life Cycle Inventory (LCI) is created by collecting data on all inputs and outputs in reference to the functional unit. The LCI phase involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system, including raw materials, energy inputs, and emissions associated with each life cycle stage. The ICL phase provides a comprehensive inventory of all relevant inputs and outputs associated with the product, process or service being evaluated.

Data quality is a critical aspect of the LCI phase, with primary data obtained directly from the producer or originator used whenever possible, and secondary data used to fill in any gaps. Reasonable assumptions may be necessary in cases where reliable foreground data is not available, and trustworthy databases and scientific literature can also be utilized to supplement the study.

3.3. Impact Assessment

In the Life Cycle Impact Assessment (LCIA), the purpose is to translate the elementary flows from the life cycle inventory into their potential contributions to the environment. This phase can be divided into mandatory and optional operations. Focusing on mandatory elements those include:

- Selection of impact categories, category indicators, and characterisation models, where the environmental effects are identified, depending on different factors, such as the study's objectives and the sector being examined. For this study, selected impact categories are presented in **Table 1**
- Assignment of LCIA results (classification), the elementary flows of the inventory are assigned to the relevant selected impact categories.
- Calculation of category indicator results (characterization), which involves translating the matches found in the classification step into potential environmental impacts by applying characterization factors derived from the category indicators and the characterization model.
- Conducting data quality analysis.

Table 1 Impact Categories description

Abbreviation	IMPACT CATEGORY	UNITS	DESCRIPTION
AP	Acidification potential	kg SO_2-**eq**	Increased acidity of soil and water due to proton release from anthropogenic emissions
GWP	Global Warming Potential (GWP100a)	kg CO2-eq	Additional radiative forcing due to the increase of greenhouse gases in the atmosphere

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ADP	Abiotic depletion (elemental reserves)	kg Sb-eq	Increased extraction of resources leading to depletion of non-renewable mineral reserves
ADP (fosil)	Abiotic depletion (fossil fuels)	MJ	Indicator of the depletion of natural fossil fuel resources
FwEcotox	Fresh water aquatic ecotoxicity	kg 1,4-DB eq	Toxic effects of chemicals and biodiversity loss in fresh waters due to toxicological response of different species
MEcoTox	Marine aquatic ecotoxicity	kg 1,4-DB eq	Toxic effects of chemicals and biodiversity loss in marine waters due to toxicological response of different species
TEcoTox	Terrestrial ecotoxicity	kg 1,4-DB eq	Toxic effects of chemicals and biodiversity loss in terrestrial ecosystems due to toxicological response of different species
EP	Eutrophication	kg PO4--- eq	Increased biomass formation and loss of biodiversity due to release of nutrients
HT	Human toxicity	kg 1,4-DB eq	Impact on humans of toxic substances emitted to the environment
ODP	Ozone layer depletion (ODP)	kg CFC-11 eq	Indicator of emissions to air that cause the destruction of the stratospheric ozone layer
POC	Photochemical oxidation	kg C2H4 eq	Indicator of emissions of gases that affect the creation of photochemical ozone in the lower atmosphere (smog) catalyzed by sunlight, with effect on human health and ecosystem quality

3.4. Interpretation

The interpretation is the final phase of an LCA where the study results are considered together and analysed in light of uncertainties and assumptions made throughout the study, by considering other factors such as contribution analysis, relevance reasoning, data quality limitations, and critical review.

This stage offers a comprehensive assessment of the study's conclusions, emphasizing any limitations in the results and providing recommendations based on the findings for minimizing the negative effects of the system being studied.

4. SALEMA's alternatives

4.1. SALEMA's Alloys

4.1.1. High Pressure Die Casting (HPDC) alloys

Table 2 presents the different alloy alternatives and recycled content percentages in HPDC. The baseline alloy, AlSi10MnMg, serves as a reference point with 0% recycled content, while Variant 4, Variant 6, Variant 7, and Variant 12 exhibit varying degrees of recycled content, ranging from 20% to 90%.

Table 2 HPDC variants

HPDC	Alloy	Recycled content
Baseline	AlSi10MnMg	0%
1	Variant 4	70%

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2	Variant 6	90%
3	Variant 7	75%
4	Variant 12	20%

Table 3 outlines the composition of the baseline alloy for HPDC, specifically AlSi10MgMn. It details the input quantities used in the alloy's formulation per kg of alloy, providing a comprehensive breakdown of the material composition. This foundational information sets the stage for subsequent alloy variants and their respective recycled content percentages, offering insights into both the elemental composition and sustainability profiles of SALEMA's HPDC alloys.

Table 3 Baseline alloy for HPDC – AlSi10MgMn

Input		AlSi10MgMn
Aluminium	kg	0,8898
Iron	kg	0,0016
Titanium	kg	0,0007
Copper	kg	0,0002
Magnesium	kg	0,0030
Manganese	kg	0,0056
Silicon	kg	0,0987
Zinc	kg	0,0001
Nickel	kg	0,0001
Chromium	kg	0,0001
Lead	kg	0,0001
Tin	kg	0,0001
Cobalt	kg	-

Table 4 presents a detailed breakdown of the composition of the alloy variants for HPDC. It specifies the input quantities of different elements in kilograms (kg) for the baseline alloy and the four alternative variants: Variant 4, Variant 6, Variant 7, and Variant 12. The recycled content for each is: 70% for Variant 4, 90% for Variant 6, 75% for Variant 7, and 20% for Variant 12.

Table 4 HPDC SALEMA's alloys variants

Input		Variant 4	Variant 6	Variant 7	Variant 12
Aluminium	kg	0,8869	0,8836	0,9118	0,9585
Iron	kg	0,0010	0,0025	0,0001	0,0008
Titanium	kg	0,0010	0,0010	0,0010	0,0005
Copper	kg	0,0002	0,0008	0,0002	0,0008
Magnesium	kg	0,0020	0,0020	0,0020	0,0220
Manganese	kg	0,0055	0,0070	0,0065	0,0105
Silicon	kg	0,1025	0,1025	0,0775	0,0025
Zinc	kg	0,0004	0,0004	0,0004	0,0004
Nickel	kg	0,0002	0,0000	0,0002	0,0002
Chromium	kg	0,0002	0,0000	0,0002	0,0002
Lead	kg	0,0002	0,0002	0,0002	0,0002
Tin	kg	0,0002	0,0002	0,0002	0,0002

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Cobalt	kg	-	-	-	0,0035

4.1.1. Stamping alloys

Alloy 5754 and alloy 6082, are respectively baseline alloys for cold stamping and hot stamping. In cold stamping, alloy 5754 boasts a formulation with traces of iron, titanium, copper, magnesium, manganese, silicon, zinc, and chromium. Notably, lead, tin, and cobalt are absent from this composition. Conversely, hot stamping alloy 6082 exhibits distinct elemental ratios tailored for its specific manufacturing process. With precise quantities of iron, titanium, copper, magnesium, manganese, silicon, zinc, nickel, chromium, lead, tin, and negligible cobalt content, alloy 6082 is optimized for the high-temperature conditions inherent to hot stamping applications. These baseline compositions serve as essential reference points for evaluating the material properties and suitability of alternative alloys in stamping operations. Table 5 and Table 6 present the detailed composition of the baseline stamping alloys.

Table 5 Baseline alloy for cold stamping - 5754

Input		5754
Aluminium	kg	0,9995
Iron	kg	0,0040
Titanium	kg	0,0020
Copper	kg	0,0010
Magnesium	kg	0,0310
Manganese	kg	0,0050
Silicon	kg	0,0025
Zinc	kg	0,0015
Nickel	kg	-
Chromium	kg	0,0030
Lead	kg	-
Tin	kg	-
Cobalt	kg	-

Table 6 Baseline alloy for hot stamping - 6082

Input		6082
Aluminium	kg	0,9997
Iron	kg	0,0025
Titanium	kg	0,0005
Copper	kg	0,0005
Magnesium	kg	0,0090
Manganese	kg	0,0070
Silicon	kg	0,0100
Zinc	kg	0,0001
Nickel	kg	0,0003
Chromium	kg	0,0013

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Lead	kg	0,0003
Tin	kg	0,0003
Cobalt	kg	-

Table 7 presents SALEMA's alternative alloys tailored for cold stamping applications. These variants include a recycled content of 65% for 5754 v1, 80% for 5754 v2, 70% for 6181A v3, and 85% for 6181A v4.

Table 7 Cold stamping SALEMA's alloys variants

Input	Unit	5754 v1	5754 v2	6181A v3	6181A v4
Aluminium	kg	0,9615	0,9598	0,9731	0,9709
Iron	kg	0,0031	0,0038	0,0030	0,0035
Titanium	kg	0,0003	0,0003	0,0003	0,0003
Copper	kg	0,0008	0,0007	0,0019	0,0019
Magnesium	kg	0,0288	0,0291	0,0080	0,0084
Manganese	kg	0,0021	0,0024	0,0028	0,0030
Silicon	kg	0,0029	0,0032	0,0100	0,0110
Zinc	kg	0,0002	0,0003	0,0007	0,0008
Chromium	kg	0,0300	0,0400	0,0200	0,0200

Table 8 presents SALEMA's alternative alloys tailored for hot stamping applications. These variants include a recycled content of 85% for 6111, 70% for 6181 v2, and 85% for 6181 v3.

Table 8 Hot stamping SALEMA's alloys variants

Input	Unit	6111	6181 v2	6181 v3
Aluminium	kg	0,97675	0,9731	0,9709
Iron	kg	0,002	0,003	0,0035
Titanium	kg	0,0005	0,0003	0,0003
Copper	kg	0	0,0019	0,0019
Magnesium	kg	0,0075	0,008	0,0084
Manganese	kg	0,003	0,0028	0,003
Silicon	kg	0,009	0,01	0,011
Zinc	kg	0,00075	0,0007	0,0008
Chromium	kg	0,0005	0,0002	0,0002

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4.1.1. Extrusion alloys

Table 9 delineates the elemental composition of the baseline alloy for extrusion – 6063. The absence of cobalt and the precise proportions of other elements contribute to its suitability for extrusion applications, ensuring optimal performance.

Table 9 Baseline alloy for extrusion - 6063

Input		6063
Aluminium	kg	0,9998
Iron	kg	0,0018
Titanium	kg	0,0005
Copper	kg	0,0005
Magnesium	kg	0,0060
Manganese	kg	0,0008
Silicon	kg	0,0050
Zinc	kg	0,0005
Nickel	kg	0,0003
Chromium	kg	0,0005
Lead	kg	0,0003
Tin	kg	0,0003
Cobalt	kg	-

Table 10 presents SALEMA's alternative alloys tailored for extrusion applications. These variants include a recycled content of 90% for 6111, and 70% for both 6063 and 6082.

Table 10 SALEMA's extrusion alloy alternatives

Input		6111	6063	6082
Aluminium	kg	0,9708	0,9775	0,9655
Iron	kg	0,0020	0,0040	0,0025
Titanium	kg	0,0005	0,0013	0,0013
Copper	kg	0,0080	0,0018	0,0018
Magnesium	kg	0,0060	0,0060	0,0090
Manganese	kg	0,0030	0,0023	0,0070
Silicon	kg	0,0070	0,0050	0,0100
Zinc	kg	0,0008	0,0013	0,0010
Nickel	kg	0,0005	0,0003	0,0003
Chromium	kg	0,0005	0,0005	0,0013
Lead	kg	0,0005	0,0002	0,0003
Tin	kg	0,0005	0,0002	0,0003

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4.2. SALEMA's demonstrators

4.2.1. Shock Tower

A critical component in automotive suspension systems, is produced using HPDC technology. The baseline alloy for this demonstrator is AlSi10MnMg, renowned for its lightweight and high-strength properties. The shock tower plays a pivotal role in providing structural support and absorbing impact forces, making it an essential safety feature in modern vehicles. Figure 2 depicts the shock tower system boundaries.

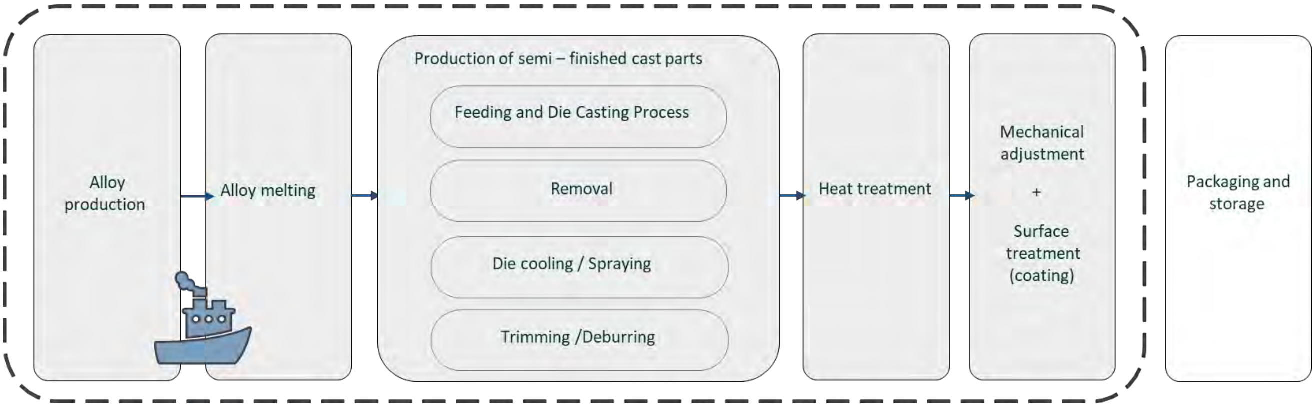

Figure 2 Shock Tower system boundaries

Table 11 presents the Life Cycle Inventory (LCI) for one shock tower demonstrator. Broken down into categories of material production, processing, and transport, the LCI quantifies various inputs and their corresponding quantities in different units. Material production encompasses the production of the baseline alloy, while processing includes energy-intensive activities such as die casting, heat treatment, surface treatment, and alloy melting and feeding, corresponding mainly to electricity and natural gas consumption. Additionally, transport factors for road transport, transport via barge, and transoceanic transport account for the weight and distance travelled.

Table 11 Shock Tower LCI

Description	Units	Qty
Material		
Baseline Alloy production	kg	6,8
Processing		
Die casting machine	kWh	2,628
Die casting peripherals	kWh	2,020
Heat Treatment	kWh	4,700
Surface treatment	kWh	1,224
Alloy melting and feeding	m3	1,640
Transport		
Road transport	tkm	0,680

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Transport Barge	tkm	0,453
Transport Transoceanic	tkm	12,513

4.2.2. Frontal frame

Key structural element in vehicle chassis, is manufactured using a combination of HPDC plus extrusion. This demonstrator uses AlSi10MnMg as baseline alloy. Figure 3 depicts the system boundaries for the frontal frame.

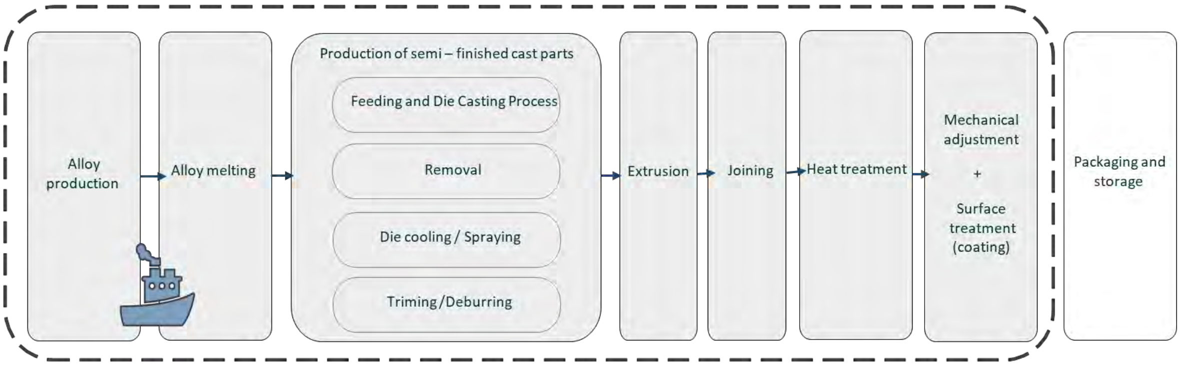

Figure 3 Frontal frame system boundaries

Table 12 presents the inventory to produce a Frontal Frame. LCI is divided into material production, processing, and transport categories. Material production encompasses the production of the baseline alloy, while processing includes alloy holding, melting, die casting, heat treatment, and shot blasting, quantified as electricity and natural gas consumptions. Additionally, transport by road or water is accounted in tkm.

Table 12 Frontal frame LCI

Description	Units	Qty
Material		
Baseline Alloy production	kg	19,000
Processing		
Alloy holding	m3	0,595
Alloy melting	m3	1,200
Alloy melting and holding	m3	1,795
Die casting machine including peripherals	kWh	9,600
Heat Treatment	kWh	4,700
Shot blasting (die casting part)	-	-
Transport		
Transport Barge	tkm	0,453
Transport Road	tkm	1,900

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Transport Transoceanic	tkm	12,513

4.2.3. B-Pillar foot

The B-Pillar is critical structural component in vehicle body frames. Manufactured using hot stamped sheet metal technology. The alloy 6082 is considered the baseline. The hot stamping technique allows for the creation of intricate shapes with superior strength-to-weight ratios, enhancing the structural integrity and safety performance of the vehicle. Figure 4 depicts the system boundaries for the B-Pillar demonstrator.

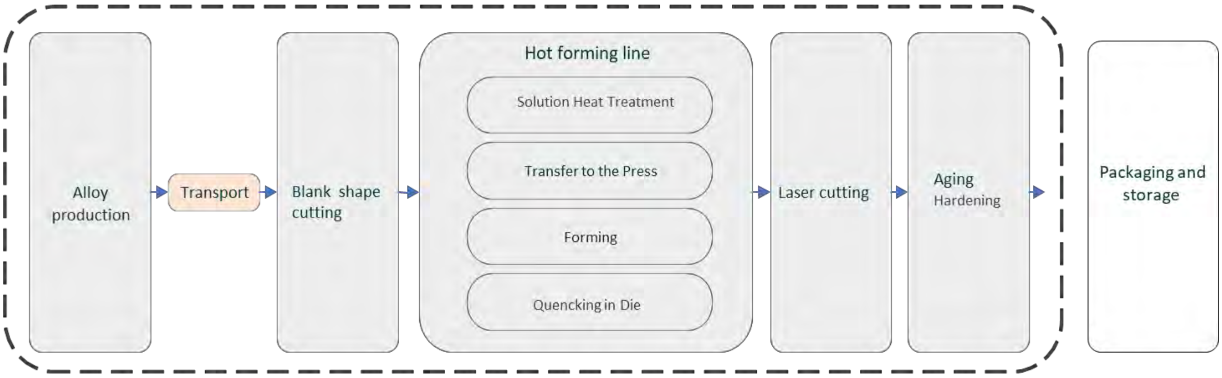

Figure 4 B-Pillar system boundaries

Table 13 presents the inventory associated with the production of a B-Pillar. Table is structured in Material production, Processing and Transport categories, where material production includes the production of the baseline alloy, while processing activities such as aging hardening, blank shape cutting, hot forming line operations, and laser cutting consider the electricity consumed to produce the B-Pillar. Transport accounts for the weight and distance travelled in tkm.

Table 13 B-Pillar LCI

Description	Units	Qty
Material		
Baseline Alloy production	kg	2,286
Processing		
Aging Hardening	kWh	0,289
Blank shape cutting	kWh	0,047
Hot forming line	kWh	0,967
Laser cutting	kWh	0,267
Scrap	kg	0,786
Transport		

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Transport road	tkm	0,307
Transport train	tkm	5,511

4.2.4. Battery box housing

Designed to accommodate the vehicle's battery pack, is produced by extrusion process. Baseline alloy considered in SALEMA is 6063. The extruded profiles provide a lightweight yet robust housing solution, ensuring the secure placement and protection of the vehicle's battery system while optimizing energy efficiency and performance.

Table 14 presents the inventory associated with the production of a Battery Housing. Table is structured in Material production, Processing and Transport categories, where material production includes the production of the baseline alloy, while processing activities such as electricity consumption for casting and extrusion, as well as natural gas consumption for extrusion and casting are accounted. Transport accounts for the weight and distance travelled in tkm.

Table 14 Battery housing LCI

Description	Units	Qty
Material		
Baseline Alloy production	kg	146,395
Processing		
Electricity casting	kWh	1,323
Electricity extrusion	kWh	86,657
Natural gas extrusion	m3	42,257
Natural gas for casting	m3	12,025
Transport		
Road transport	tkm	31,165
Transport train	tkm	379,749
Transport Transoceanic	tkm	1.605,529

5. Life Cycle Assessment

Environmental Assessment of the different demonstrators has been performed following the ISO 14040[2], ISO 14044[3] and Deliverable 8.3 on the PCR for Al components in passenger cars in Europe.

Functional Unit for all the assessments has been defined as 1 kg of component in a Battery Electric Vehicle (BEV).

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Use stage considers a lifetime driving distance of 180.000km according to the EEA Report [4] in conjunction with energy consumption depicted on Table 15, also based the same Report. Average energy consumption is then considered as 20,09 kWh/kg.

Table 15 Use stage energy consumption per kg

Type	Typical battery weight (kg)	Typical vehicle weight (kg)	Energy consumption (kWh/100km)	Lifetime driving distance (km)	Energy consumption per kg of EV (kWh/100km kg)	Energy consumed during lifetime (kWh/vehicle)	Energy consumed during lifetime per kg of vehicle (kWh/kg)
Luxury car	553	2100	21	180000	0,010	37800	18,00
Large car	393	1750	19	180000	0,011	34200	19,54
Medium car	253	1500	17	180000	0,011	30600	20,40
Mini car	177	1100	15	180000	0,014	27000	24,55

End-of-life considerations were based on the European Aluminium Association Report from 2022 [5] that estimates that in today's modern plants 95% of the aluminium in an end-of-life vehicle is successfully and profitably reused or recycled into new aluminium products substituting primary aluminium.

5.1. SALEMA's Alloys LCA Results

HPDC Results are presented in Table 16, considering a recycled content of 0% for AlSi10MgMn, 70% for variant 4, 90% for variant 6, 75% for variant 7 and 20% for variant 12.

Table 16 LCA for HPDC alloys

Impact category	Unit	AlSi10MgMn	Variant 4	Variant 6	Variant 7	Variant 12
ADP	kg Sb eq	5,49E-04	2,13E-05	8,21E-06	1,83E-05	1,03E-04
ADP (fosil)	MJ	1,28E+03	2,42E+01	1,23E+01	2,09E+01	5,55E+01
GWP	kg CO2 eq	1,28E+02	2,43E+00	1,18E+00	2,09E+00	5,59E+00
ODP	kg CFC-11 eq	2,24E-06	3,08E-08	1,58E-08	2,64E-08	7,71E-08
HT	kg 1,4-DB eq	1,11E+02	1,84E+00	8,81E-01	1,59E+00	5,30E+00
FwEcotox	kg 1,4-DB eq	8,06E+01	7,47E+00	2,74E+00	6,44E+00	2,13E+01
MEcoTox	kg 1,4-DB eq	3,69E+05	7,58E+03	3,14E+03	6,41E+03	1,87E+04
TEcoTox	kg 1,4-DB eq	4,17E-01	8,28E-03	4,10E-03	7,19E-03	1,25E-01
POC	kg C2H4 eq	4,78E-02	7,57E-04	3,22E-04	6,36E-04	1,84E-03
AP	kg SO2 eq	6,09E-01	1,25E-02	5,73E-03	1,07E-02	3,01E-02
EP	kg PO4--- eq	1,91E-01	4,44E-03	2,64E-03	3,94E-03	9,30E-03

Graphic results are presented in Figure 5, where GWP impacts are depicted, showing the favourable effect of the recycled content in each of the SALEMA alternatives.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

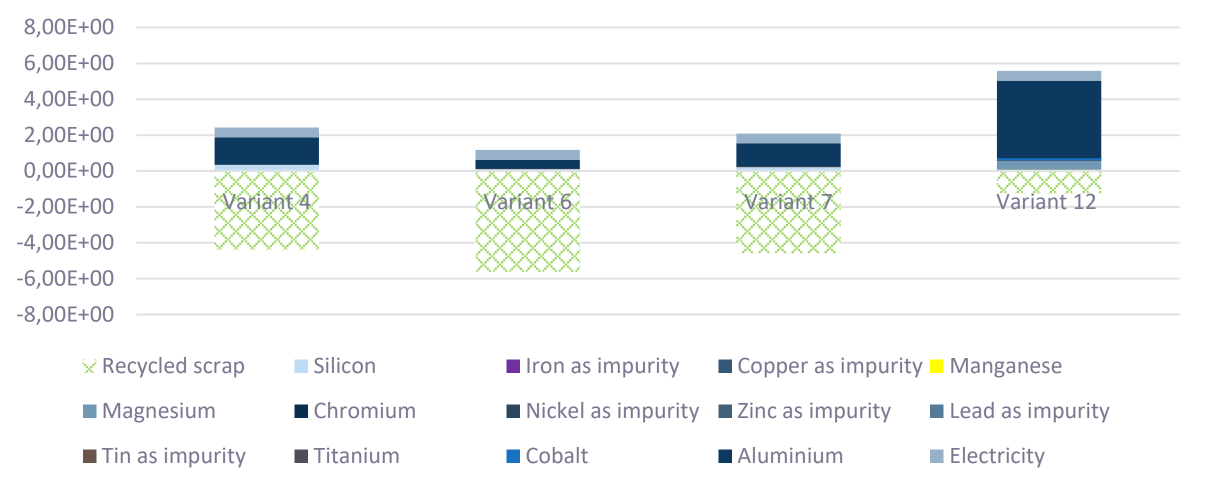

Figure 5 GWP for HPDC alloys

LCA results for cold stamping alloys are presented in Table 17, considering a recycled content of 0% for the baseline alloy, 65% for 5754 v1, 80% for 5754 v2, 70% for 6181A v3 and 85% for 6181A v4

Table 17 LCA for cold stamping alloys

Impact category	Unit	Baseline 5754	5754 v1	5754 v2	6181A v3	6181A v4
ADP	kg Sb eq	7,97E-05	3,24E-05	2,00E-05	2,88E-05	1,50E-05
ADP (fosil)	MJ	7,11E+01	3,08E+01	2,09E+01	2,48E+01	1,56E+01
GWP	kg CO2 eq	7,21E+00	3,04E+00	2,03E+00	2,48E+00	1,52E+00
ODP	kg CFC-11 eq	1,09E-07	4,23E-08	2,84E-08	3,06E-08	1,95E-08
HT	kg 1,4-DB eq	6,51E+00	3,38E+00	2,27E+00	2,76E+00	1,55E+00
FwEcotox	kg 1,4-DB eq	2,74E+01	9,52E+00	5,62E+00	8,28E+00	4,31E+00
MEcoTox	kg 1,4-DB eq	2,38E+04	8,89E+03	5,55E+03	7,69E+03	4,30E+03
TEcoTox	kg 1,4-DB eq	2,42E-02	4,27E-02	3,16E-02	2,77E-02	1,49E-02
POC	kg C2H4 eq	2,41E-03	9,16E-04	5,80E-04	7,46E-04	4,26E-04
AP	kg SO2 eq	3,76E-02	1,52E-02	9,89E-03	1,28E-02	7,60E-03
EP	kg PO4--- eq	1,16E-02	5,38E-03	3,90E-03	4,58E-03	3,16E-03

Figure 6 depicts GWP impacts for SALEMA's cold stamping alloys

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

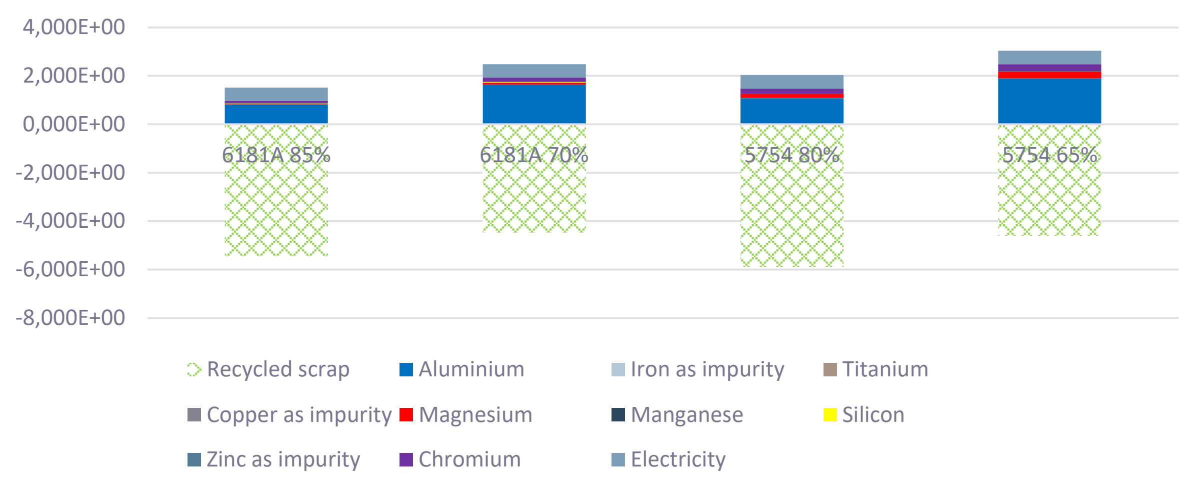

Figure 6 GWP for cold stamping alloys

Hot stamping alloy LCA results are presented in Table 18

Table 18 LCA for hot stamping alloys

Impact category	Unit	Baseline 6082	6111	6181A v1	6181A v2
ADP	kg Sb eq	8,12E-05	1,03E-05	2,46E-05	1,23E-05
ADP (fosil)	MJ	6,44E+01	9,30E+00	1,86E+01	9,33E+00
GWP	kg CO2 eq	6,66E+00	9,63E-01	1,93E+00	9,65E-01
ODP	kg CFC-11 eq	8,04E-08	1,15E-08	2,29E-08	1,15E-08
HT	kg 1,4-DB eq	5,80E+00	7,71E-01	1,92E+00	9,61E-01
FwEcotox	kg 1,4-DB eq	2,69E+01	3,90E+00	7,92E+00	3,95E+00
MEcoTox	kg 1,4-DB eq	2,30E+04	3,32E+03	6,79E+03	3,40E+03
TEcoTox	kg 1,4-DB eq	2,78E-02	3,30E-03	7,36E-03	3,69E-03
POC	kg C2H4 eq	2,20E-03	3,15E-04	6,39E-04	3,20E-04
AP	kg SO2 eq	3,61E-02	5,14E-03	1,05E-02	5,27E-03
EP	kg PO4--- eq	1,06E-02	1,53E-03	3,13E-03	1,57E-03

Figure 7 depicts GWP for hot stamping alloys, including the graphic representation of the recycled content benefits in environmental impacts.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

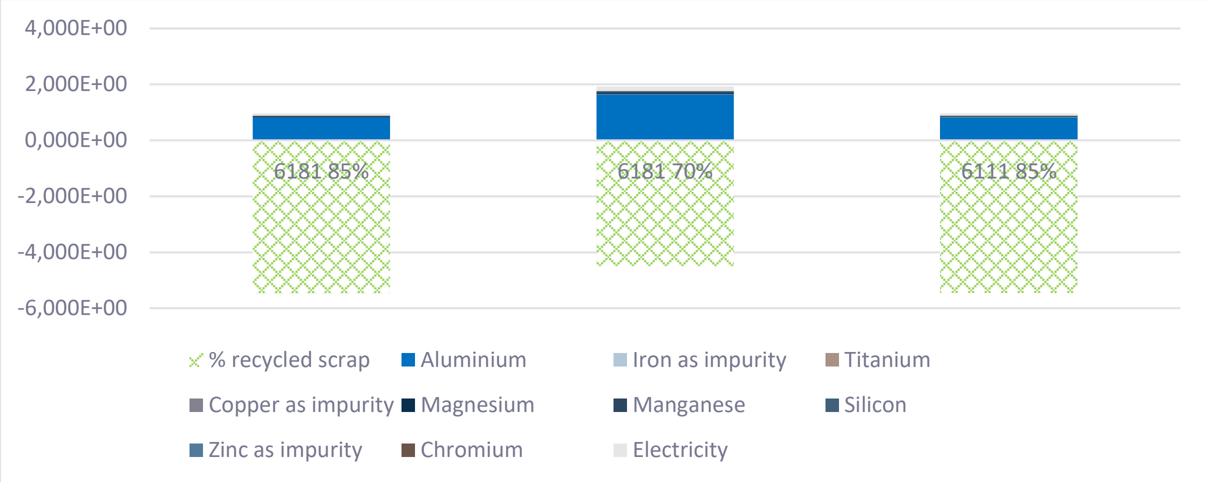

Figure 7 GWP for hot stamping alloys

Extrusion alloy LCA results are presented in Table 19 and Figure 8 depicts the GWP for SALEMA's alternatives.

Table 19 LCA for extrusion alloys

Impact category	Unit	Baseline 6063	6111	6063	6082
ADP	kg Sb eq	8,11E-05	1,06E-05	3,47E-05	3,30E-05
ADP (fosil)	MJ	6,23E+01	6,14E+00	2,85E+01	2,53E+01
GWP	kg CO2 eq	6,46E+00	6,37E-01	2,89E+00	2,61E+00
ODP	kg CFC-11 eq	7,60E-08	7,38E-09	3,64E-08	3,35E-08
HT	kg 1,4-DB eq	5,56E+00	8,66E-01	2,82E+00	2,65E+00
FwEcotox	kg 1,4-DB eq	2,67E+01	2,74E+00	1,09E+01	1,06E+01
MEcoTox	kg 1,4-DB eq	2,26E+04	2,36E+03	9,68E+03	9,18E+03
TEcoTox	kg 1,4-DB eq	2,49E-02	3,00E-03	1,16E-02	1,09E-02
POC	kg C2H4 eq	2,14E-03	2,17E-04	9,21E-04	8,76E-04
AP	kg SO2 eq	3,53E-02	3,66E-03	1,56E-02	1,43E-02
EP	kg PO4--- eq	1,03E-02	1,08E-03	5,22E-03	4,26E-03

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

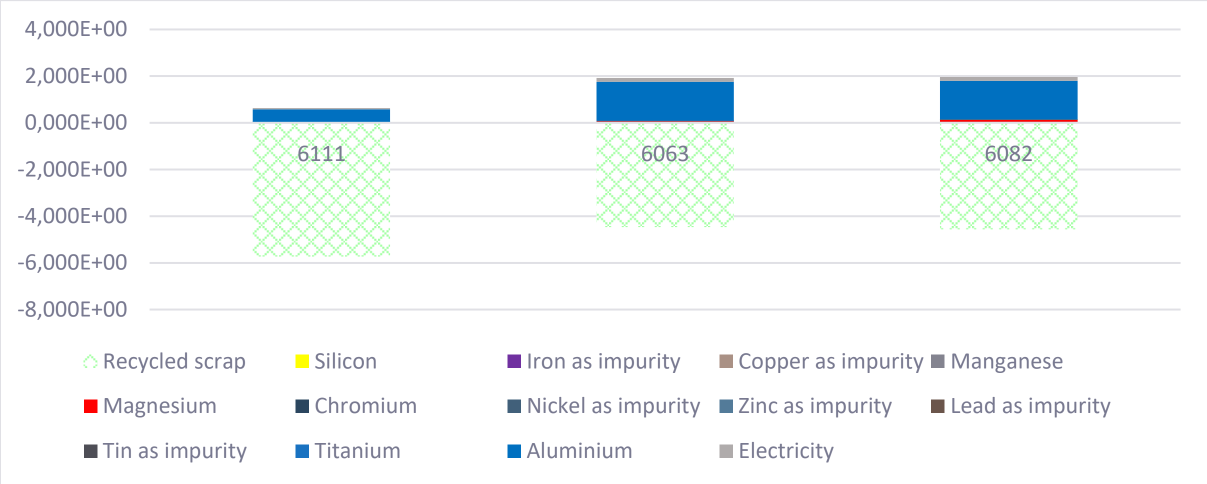

Figure 8 GWP for extrusion alloys.

Alloy LCA results clearly show the benefits of including recycled material in the production of more sustainable alloys in general and in specific in the automotive industry.

5.2. Shock Tower

LCA results for the different SALEMA alloy solutions are presented in Table 20, Table 21, Table 22, Table 23, and Table 24.

Table 20 LCA Baseline Shock Tower

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	5,49E-04	1,28E+02	2,24E-06	1,11E+02	4,17E-01	6,09E-01
processing	7,02E-07	5,70E-01	3,19E-08	1,94E-01	2,24E-03	1,95E-03
transport	8,23E-08	4,03E-02	6,13E-10	1,82E-02	2,20E-04	4,98E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	2,61E-05	6,10E+00	1,07E-07	5,28E+00	2,00E-02	2,90E-02
TOTAL	5,76E-04	1,35E+02	2,38E-06	1,16E+02	4,41E-01	6,42E-01

Table 21 LCA Variant 4 Shock Tower

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	2,13E-05	2,43E+00	3,08E-08	1,84E+00	8,28E-03	1,25E-02
processing	7,02E-07	5,70E-01	3,19E-08	1,94E-01	2,24E-03	1,95E-03
transport	8,23E-08	4,03E-02	6,13E-10	1,82E-02	2,20E-04	4,98E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	1,06E-06	1,38E-01	1,96E-09	1,06E-01	5,40E-04	7,26E-04
TOTAL	2,38E-05	3,53E+00	7,06E-08	2,38E+00	1,26E-02	1,72E-02

Table 22 LCA Variant 6 Shock Tower

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	8,21E-06	1,18E+00	1,58E-08	8,81E-01	4,10E-03	5,73E-03

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processing	7,02E-07	5,70E-01	3,19E-08	1,94E-01	2,24E-03	1,95E-03
transport	8,23E-08	4,03E-02	6,13E-10	1,82E-02	2,20E-04	4,98E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	4,44E-07	7,83E-02	1,24E-09	6,05E-02	3,41E-04	4,04E-04
TOTAL	1,01E-05	2,22E+00	5,49E-08	1,37E+00	8,20E-03	1,01E-02

Table 23 LCA Variant 7 Shock Tower

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,83E-05	2,09E+00	2,64E-08	1,59E+00	7,19E-03	1,07E-02
processing	7,02E-07	5,70E-01	3,19E-08	1,94E-01	2,24E-03	1,95E-03
transport	8,23E-08	4,03E-02	6,13E-10	1,82E-02	2,20E-04	4,98E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	9,22E-07	1,21E-01	1,75E-09	9,40E-02	4,88E-04	6,40E-04
TOTAL	2,07E-05	3,17E+00	6,60E-08	2,11E+00	1,14E-02	1,53E-02

Table 24 LCA Variant 12 Shock Tower

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,03E-04	5,59E+00	7,71E-08	5,30E+00	1,25E-01	3,01E-02
processing	7,02E-07	5,70E-01	3,19E-08	1,94E-01	2,24E-03	1,95E-03
transport	8,23E-08	4,03E-02	6,13E-10	1,82E-02	2,20E-04	4,98E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	4,92E-06	2,88E-01	4,16E-09	2,71E-01	6,09E-03	1,56E-03
TOTAL	1,09E-04	6,83E+00	1,19E-07	6,00E+00	1,35E-01	3,56E-02

From the results, we can identify that aluminium alloy production has the greatest contribution in the LCA, accounting up to 95 % in the case of the baseline with no reycled content. For SALEMA's alloys is closely related to the amount of recyled material in the composition and it ranges from 53% in the case of variant 6 with 95% recycled content, passing through variants 4 and 7 with 70% recycled content and reaching up to variant 12 with only 20% of recycled content and a contribution of 82% from the aluminium production.

Figure 9 depicts the comparison of results for GWP category.

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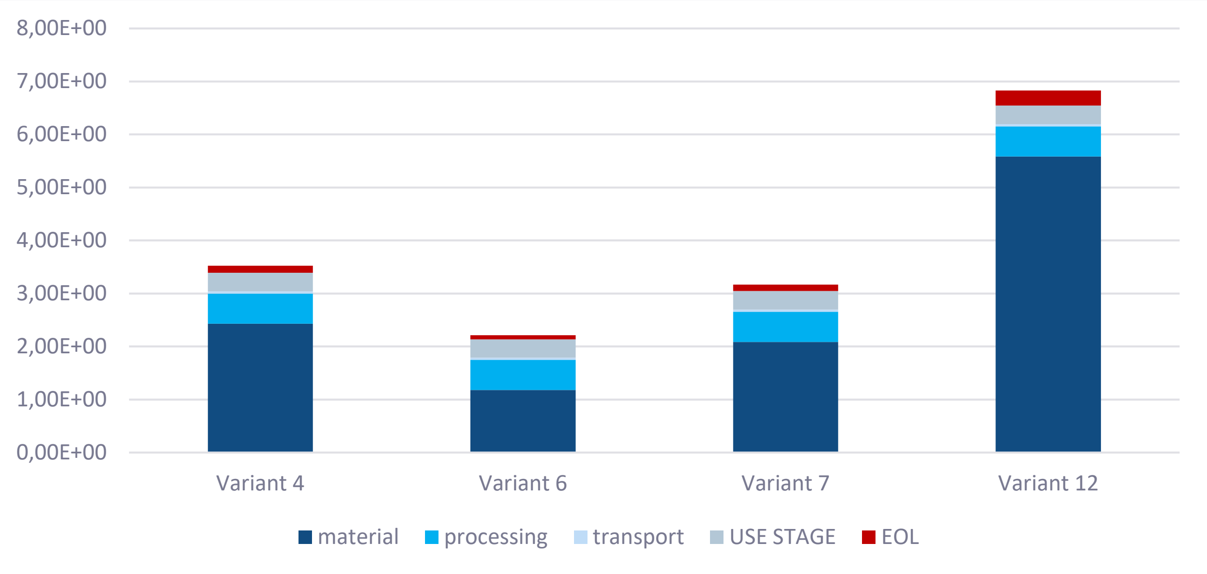

Figure 9 GWP Shock Tower comparison.

5.3. Frontal frame

LCA results for the different SALEMA alloy solutions for the Frontal Frame are presented per kg of demonstrator in Table 25, Table 26, Table 27, Table 28, and Table 29.

Table 25 LCA Baseline Frontal Frame

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	5,49E-04	1,28E+02	2,24E-06	1,11E+02	4,17E-01	6,09E-01
processing	7,25E-07	4,28E-01	2,48E-08	1,21E-01	1,27E-03	1,08E-03
transport	6,82E-08	2,62E-02	4,32E-10	1,22E-02	1,19E-04	1,99E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	2,61E-05	6,10E+00	1,07E-07	5,28E+00	2,00E-02	2,90E-02
TOTAL	5,76E-04	1,35E+02	2,37E-06	1,16E+02	4,40E-01	6,41E-01

Table 26 LCA Variant 4 Frontal Frame

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	2,13E-05	2,43E+00	3,08E-08	1,84E+00	8,28E-03	1,25E-02
processing	7,25E-07	4,28E-01	2,48E-08	1,21E-01	1,27E-03	1,08E-03
transport	6,82E-08	2,62E-02	4,32E-10	1,22E-02	1,19E-04	1,99E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	1,06E-06	1,38E-01	1,96E-09	1,06E-01	5,40E-04	7,26E-04
TOTAL	2,38E-05	3,37E+00	6,33E-08	2,30E+00	1,15E-02	1,60E-02

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Table 27 LCA Variant 6 Frontal Frame

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	8,21E-06	1,18E+00	1,58E-08	8,81E-01	4,10E-03	5,73E-03
processing	7,25E-07	4,28E-01	2,48E-08	1,21E-01	1,27E-03	1,08E-03
transport	6,82E-08	2,62E-02	4,32E-10	1,22E-02	1,19E-04	1,99E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	4,44E-07	7,83E-02	1,24E-09	6,05E-02	3,41E-04	4,04E-04
TOTAL	1,01E-05	2,06E+00	4,76E-08	1,29E+00	7,12E-03	8,89E-03

Table 28 LCA Variant 7 Frontal Frame

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,83E-05	2,09E+00	2,64E-08	1,59E+00	7,19E-03	1,07E-02
processing	7,25E-07	4,28E-01	2,48E-08	1,21E-01	1,27E-03	1,08E-03
transport	6,82E-08	2,62E-02	4,32E-10	1,22E-02	1,19E-04	1,99E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	9,22E-07	1,21E-01	1,75E-09	9,40E-02	4,88E-04	6,40E-04
TOTAL	2,07E-05	3,01E+00	5,87E-08	2,03E+00	1,04E-02	1,41E-02

Table 29 LCA Variant 12 Frontal Frame

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,03E-04	5,59E+00	7,71E-08	5,30E+00	1,25E-01	3,01E-02
processing	7,25E-07	4,28E-01	2,48E-08	1,21E-01	1,27E-03	1,08E-03
transport	6,82E-08	2,62E-02	4,32E-10	1,22E-02	1,19E-04	1,99E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	4,92E-06	2,88E-01	4,16E-09	2,71E-01	6,09E-03	1,56E-03
TOTAL	1,09E-04	6,68E+00	1,12E-07	5,92E+00	1,34E-01	3,44E-02

From this results, we identify that aluminium alloy production has the greatest contribution in the Frontal Frame LCA, accounting up to 95% in the case of the baseline with no reycled content. For SALEMA's alloys is closely related to the amount of recyled material in the composition and it ranges from 57% in the case of variant 6 with 95% recycled content, passing through variants 4 and 7 with 70% recycled content and around 70% contribution from the material, and reaching up to variant 12 with only 20% of recycled content and a contribution of 84% from the aluminium production.

Figure 10 depicts the comparison of results for GWP category of the four SALEMA alternatives.

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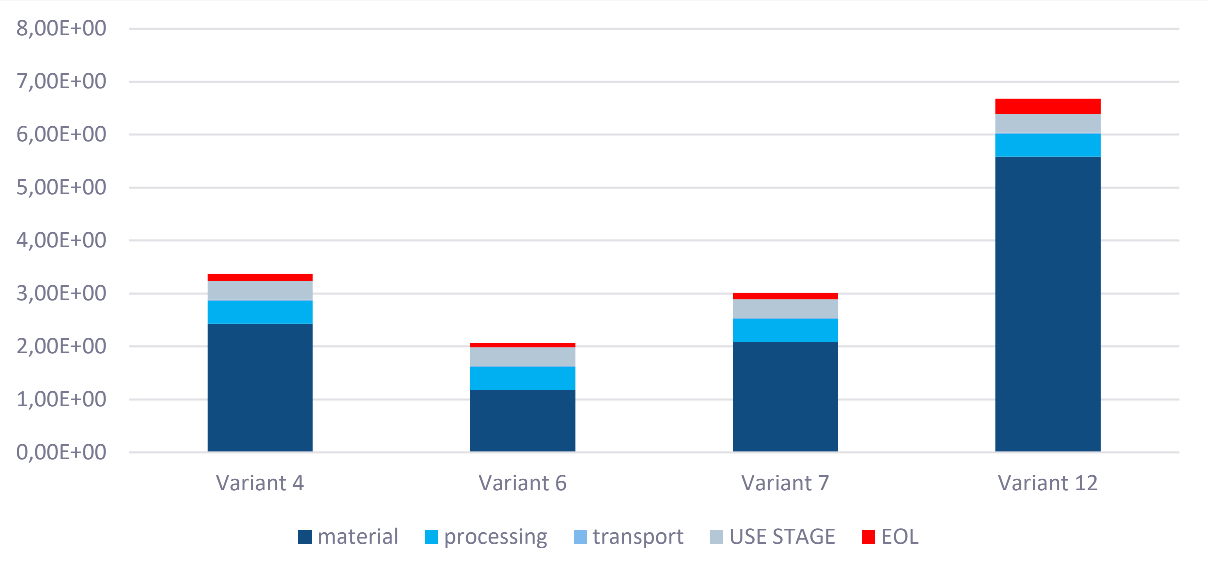

Figure 10 GWP Frontal Frame comparison

From this illustrative representation of the results, the material contribution is made evident, along with the beneficial effect of the recycled content on each of the variants.

5.4. B-Pillar foot

LCA results for the different SALEMA alloy solutions for the B-Pillar are presented per kg of demonstrator in Table 30, Table 31, Table 32, and Table 33.

Table 30 LCA Baseline 5754 B-Pillar

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	8,12E-05	6,66E+00	8,04E-08	5,80E+00	2,78E-02	3,61E-02
processing	1,86E-08	7,65E-03	1,69E-10	6,41E-03	5,04E-05	4,53E-05
transport	4,13E-07	1,14E-01	1,71E-09	8,30E-02	5,06E-04	4,48E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	3,91E-06	3,38E-01	4,31E-09	2,94E-01	1,47E-03	1,85E-03
TOTAL	8,62E-05	7,46E+00	9,18E-08	6,40E+00	3,11E-02	3,99E-02

Table 31 LCA 6111 B-Pillar

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,03E-05	9,63E-01	1,15E-08	7,71E-01	3,30E-03	5,14E-03
processing	1,86E-08	7,65E-03	1,69E-10	6,41E-03	5,04E-05	4,53E-05
transport	4,13E-07	1,14E-01	1,71E-09	8,30E-02	5,06E-04	4,48E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	5,45E-07	6,80E-02	1,04E-09	5,53E-02	3,03E-04	3,76E-04
TOTAL	1,20E-05	1,50E+00	1,97E-08	1,13E+00	5,45E-03	7,49E-03

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Table 32 LCA 6181Av1 B-Pillar

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	2,46E-05	1,93E+00	2,29E-08	1,92E+00	7,36E-03	1,05E-02
processing	1,86E-08	7,65E-03	1,69E-10	6,41E-03	5,04E-05	4,53E-05
transport	4,13E-07	1,14E-01	1,71E-09	8,30E-02	5,06E-04	4,48E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	1,22E-06	1,14E-01	1,58E-09	1,10E-01	4,96E-04	6,32E-04
TOTAL	2,70E-05	2,51E+00	3,17E-08	2,33E+00	9,70E-03	1,31E-02

Table 33 LCA 6181Av2 B-Pillar

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,23E-05	9,65E-01	1,15E-08	9,61E-01	3,69E-03	5,27E-03
processing	1,86E-08	7,65E-03	1,69E-10	6,41E-03	5,04E-05	4,53E-05
transport	4,13E-07	1,14E-01	1,71E-09	8,30E-02	5,06E-04	4,48E-04
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	6,39E-07	6,81E-02	1,04E-09	6,43E-02	3,22E-04	3,82E-04
TOTAL	1,41E-05	1,50E+00	1,97E-08	1,33E+00	5,85E-03	7,62E-03

From these results, we can clearly identify the use of 100% renewable energy in the processing stage for all different alternatives. In addition to that, alloy 6111 and 6181Av2 contain a 85% of recycled material, which explains a reduction in all impact categories, in specific, for GWP, the impact is reduced in 80% in the life cycle. Also for 6181Av1 with 70% recycled content, impact is reduced in 66% in comparison with the baseline.

Figure 11 depicts the comparison of results for GWP category for the Baseline alloy and three SALEMA alternatives for the B-Pillar.

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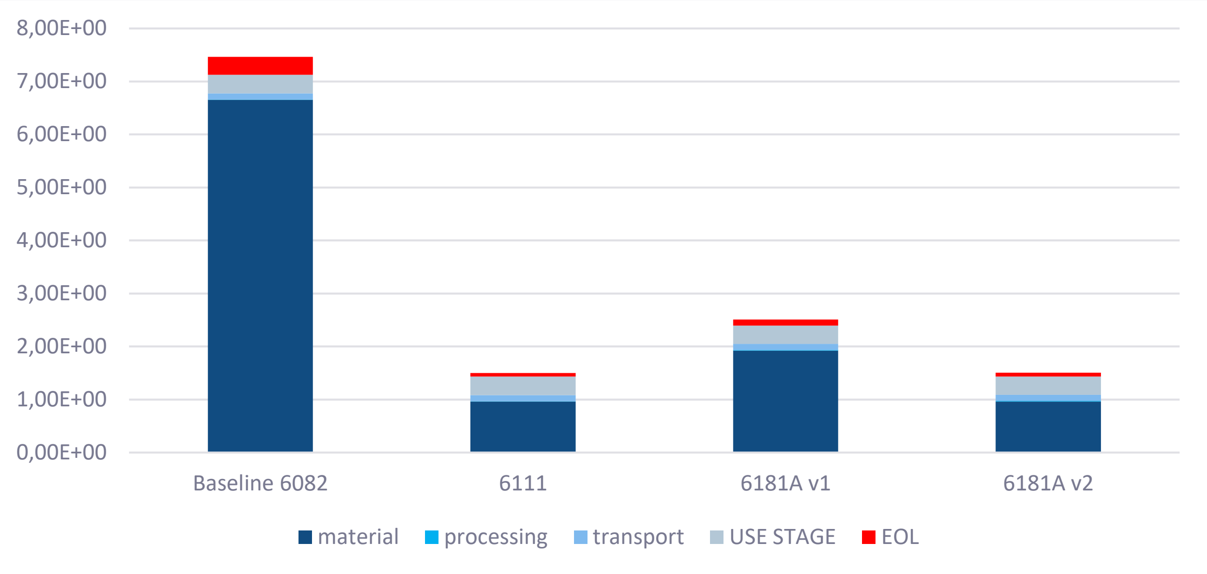

Figure 11 GWP B-Pillar comparison

In the case of the baseline, material extraction and production accounts for 89% of GWP, due to almost no contribution from the processing and transport. Contribution adjusts with the recycled content alternatives, in these cases GWP from material production only accounts for 64%-77%, while USE stage contributes to 14%-23%.

5.5. Battery box housing

Table 34 LCA Baseline 6063 Battery Housing

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	8,11E-05	6,46E+00	7,60E-08	5,56E+00	2,49E-02	3,53E-02
processing	7,50E-07	6,05E-01	3,96E-08	2,60E-01	1,60E-03	2,49E-03
transport	5,93E-07	2,47E-01	3,44E-09	1,46E-01	1,48E-03	3,15E-03
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	3,91E-06	3,29E-01	4,10E-09	2,83E-01	1,33E-03	1,81E-03
TOTAL	8,71E-05	7,99E+00	1,28E-07	6,46E+00	3,06E-02	4,43E-02

Table 35 LCA 6111 Battery Housing

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	1,06E-05	6,37E-01	7,38E-09	8,66E-01	3,00E-03	3,66E-03
processing	7,50E-07	6,05E-01	3,96E-08	2,60E-01	1,60E-03	2,49E-03
transport	5,93E-07	2,47E-01	3,44E-09	1,46E-01	1,48E-03	3,15E-03
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03

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EOL	5,56E-07	5,25E-02	8,43E-10	5,98E-02	2,89E-04	3,05E-04
TOTAL	1,32E-05	1,89E+00	5,65E-08	1,55E+00	7,66E-03	1,11E-02

Table 36 LCA 6063 Battery Housing

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	3,47E-05	2,89E+00	3,64E-08	2,82E+00	1,16E-02	1,56E-02
processing	7,50E-07	6,05E-01	3,96E-08	2,60E-01	1,60E-03	2,49E-03
transport	5,93E-07	2,47E-01	3,44E-09	1,46E-01	1,48E-03	3,15E-03
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	1,70E-06	1,59E-01	2,22E-09	1,52E-01	6,97E-04	8,70E-04
TOTAL	3,85E-05	4,25E+00	8,70E-08	3,59E+00	1,67E-02	2,35E-02

Table 37 LCA 6082 Battery Housing

Impact Category	ADP	GWP	ODP	HT	TEcoTox	AP
material	3,30E-05	2,61E+00	3,35E-08	2,65E+00	1,09E-02	1,43E-02
processing	7,50E-07	6,05E-01	3,96E-08	2,60E-01	1,60E-03	2,49E-03
transport	5,93E-07	2,47E-01	3,44E-09	1,46E-01	1,48E-03	3,15E-03
USE STAGE	7,02E-07	3,49E-01	5,27E-09	2,15E-01	1,29E-03	1,48E-03
EOL	1,62E-06	1,46E-01	2,09E-09	1,45E-01	6,66E-04	8,11E-04
TOTAL	3,67E-05	3,96E+00	8,39E-08	3,42E+00	1,60E-02	2,22E-02

Figure 12 presents the comparison between the different alloy alternatives for the battery housing in terms of GWP, expressed in kg of CO2 equivalent.

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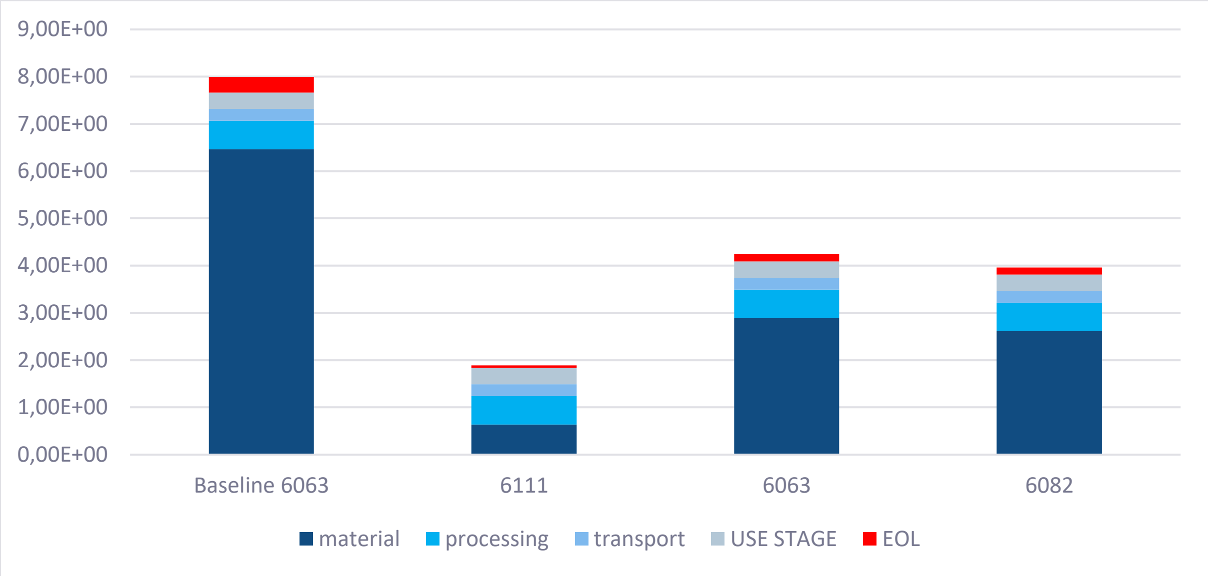

Figure 12 GWP Battery Housing comparison

From these results, the effect of the recyled content in the contribution of the different life cycle stages. GWP of the Baseline with no recycled content has an 81% contribution from the material extraction and production, while alternatives 6063 and 6082 with 60% recycled content have a contribution of 68% and 66% respectively from alloy production, around 15% of the GWP comes from the processing step, and almost 10% takes place during the USE stage.

6. Conclusions

Across all demonstrators (Shock Tower, Frontal Frame, B-Pillar, and Battery Box Housing), the material production phase consistently stands out as the primary contributor to environmental impact, particularly in terms of GWP. The baseline scenarios without recycled content show a higher impact, indicating the significance of material choice.

Variants with higher content of recycled material exhibit lower environmental impacts. This reduction is observed across all demonstrators. Additionally, the processing step also plays a significant role, especially in scenarios with higher recycled content.

The use of renewable energy in the processing stage contributes to a significant reduction in environmental impact.

In general, adopting a lifecycle perspective allows a comprehensive understanding of environmental impacts across all lifecycle stages, enabling targeted interventions to enhance sustainability from material extraction and processing, use stage to end-of-life considerations.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

7. Bibliography

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The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

8. ANNEX

Full LCA result tables are presented in this section.

Table 38 Shock Tower Baseline LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline Alloy production	5,49E-04	1,28E+03	1,28E+02	2,24E-06	1,11E+02	8,06E+01	3,69E+05	4,17E-01	4,78E-02	6,09E-01	1,91E-01
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and feeding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Die casting peripherals	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Heat Treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Surface treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04

Table 39 Shock Tower Variant 4 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 4	2,13E-05	2,42E+01	2,43E+00	3,08E-08	1,84E+00	7,47E+00	7,58E+03	8,28E-03	7,57E-04	1,25E-02	4,44E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and feeding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Die casting peripherals	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Heat Treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Surface treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Table 40 Shock Tower Variant 6 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 6	8,21E-06	1,23E+01	1,18E+00	1,58E-08	8,81E-01	2,74E+00	3,14E+03	4,10E-03	3,22E-04	5,73E-03	2,64E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and feeding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Die casting peripherals	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Heat Treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Surface treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04

Table 41 Shock Tower Variant 7 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 7	1,83E-05	2,09E+01	2,09E+00	2,64E-08	1,59E+00	6,44E+00	6,41E+03	7,19E-03	6,36E-04	1,07E-02	3,94E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and feeding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Die casting peripherals	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Heat Treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Surface treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04

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Table 42 Shock Tower Variant 12 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 12	1,03E-04	5,55E+01	5,59E+00	7,71E-08	5,30E+00	2,13E+01	1,87E+04	1,25E-01	1,84E-03	3,01E-02	9,30E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and feeding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Die casting peripherals	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Heat Treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04
Surface treatment	2,94E-07	3,32E+00	2,60E-01	4,79E-09	1,01E-01	6,61E-02	2,13E+02	1,12E-03	4,78E-05	1,10E-03	2,51E-04

Table 43 Frontal Frame Baseline LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline Alloy production	5,49E-04	1,28E+03	1,28E+02	2,24E-06	1,11E+02	8,06E+01	3,69E+05	4,17E-01	4,78E-02	6,09E-01	1,91E-01
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Transport Road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy melting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine including peripherals	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04
Heat Treatment	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04

Table 44 Frontal Frame Variant 4 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 4	2,13E-05	2,42E+01	2,43E+00	3,08E-08	1,84E+00	7,47E+00	7,58E+03	8,28E-03	7,57E-04	1,25E-02	4,44E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05

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Transport Road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy melting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine including peripherals	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04
Heat Treatment	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04

Table 45 Frontal Frame Variant 6 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 6	8,21E-06	1,23E+01	1,18E+00	1,58E-08	8,81E-01	2,74E+00	3,14E+03	4,10E-03	3,22E-04	5,73E-03	2,64E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Transport Road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy melting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine including peripherals	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04
Heat Treatment	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04º

Table 46 Frontal Frame Variant 7 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 7	1,83E-05	2,09E+01	2,09E+00	2,64E-08	1,59E+00	6,44E+00	6,41E+03	7,19E-03	6,36E-04	1,07E-02	3,94E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Transport Road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy melting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine including peripherals	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04
Heat Treatment	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Table 47 Frontal Frame Variant 12 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Variant 12	1,03E-04	5,55E+01	5,59E+00	7,71E-08	5,30E+00	2,13E+01	1,87E+04	1,25E-01	1,84E-03	3,01E-02	9,30E-03
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport Barge	5,68E-08	5,86E-01	4,98E-02	7,78E-10	1,38E-02	1,06E-02	1,88E+01	1,30E-04	6,95E-06	3,14E-04	8,43E-05
Transport Road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Alloy melting and holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy melting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Alloy holding	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Die casting machine including peripherals	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04
Heat Treatment	7,07E-07	5,29E+00	3,98E-01	7,54E-09	1,22E-01	9,54E-02	2,17E+02	1,16E-03	7,20E-05	1,18E-03	2,92E-04

Table 48 B-Pillar baseline LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline Alloy production	8,12E-05	6,44E+01	6,66E+00	8,04E-08	5,80E+00	2,69E+01	2,30E+04	2,78E-02	2,20E-03	3,61E-02	1,06E-02
Scrap	5,40E-08	3,61E-01	2,22E-02	4,92E-10	1,86E-02	2,92E-02	2,36E+01	1,46E-04	6,70E-06	1,32E-04	4,06E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05
Transport road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Blank shape cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Hot forming line	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Laser cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Aging Hardening	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table 49 B-Pillar 6111 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6111	1,03E-05	9,30E+00	9,63E-01	1,15E-08	7,71E-01	3,90E+00	3,32E+03	3,30E-03	3,15E-04	5,14E-03	1,53E-03
Scrap	5,40E-08	3,61E-01	2,22E-02	4,92E-10	1,86E-02	2,92E-02	2,36E+01	1,46E-04	6,70E-06	1,32E-04	4,06E-05

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05
Transport road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Blank shape cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Hot forming line	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Laser cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Aging Hardening	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table 50 B-Pillar 6181A v1 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6181A v1	2,46E-05	1,86E+01	1,93E+00	2,29E-08	1,92E+00	7,92E+00	6,79E+03	7,36E-03	6,39E-04	1,05E-02	3,13E-03
Scrap	5,40E-08	3,61E-01	2,22E-02	4,92E-10	1,86E-02	2,92E-02	2,36E+01	1,46E-04	6,70E-06	1,32E-04	4,06E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05
Transport road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Blank shape cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Hot forming line	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Laser cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Aging Hardening	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table 51 Pillar 6181A v2 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6181A v2	1,23E-05	9,33E+00	9,65E-01	1,15E-08	9,61E-01	3,95E+00	3,40E+03	3,69E-03	3,20E-04	5,27E-03	1,57E-03
Scrap	5,40E-08	3,61E-01	2,22E-02	4,92E-10	1,86E-02	2,92E-02	2,36E+01	1,46E-04	6,70E-06	1,32E-04	4,06E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05
Transport road	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Blank shape cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

The project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101003785

Hot forming line	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Laser cutting	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Aging Hardening	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table 52 Battery Housing baseline LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Baseline 6063	8,11E-05	6,23E+01	6,46E+00	7,60E-08	5,56E+00	2,67E+01	2,26E+04	2,49E-02	2,14E-03	3,53E-02	1,03E-02
Natural gas for casting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity casting	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Natural gas extrusion	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity extrusion	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05

Table 53 Battery Housing 6111 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003785

6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
6111	1,06E-05	6,14E+00	6,37E-01	7,38E-09	8,66E-01	2,74E+00	2,36E+03	3,00E-03	2,17E-04	3,66E-03	1,08E-03
Natural gas for casting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity casting	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Natural gas extrusion	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity extrusion	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05

Table 54 Battery Housing 6063 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
6063	3,47E-05	2,85E+01	2,89E+00	3,64E-08	2,82E+00	1,09E+01	9,68E+03	1,16E-02	9,21E-04	1,56E-02	5,22E-03
Natural gas for casting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity casting	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Natural gas extrusion	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity extrusion	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05

Table 55 Battery Housing 6082 LCA full results

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03

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6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
6082	3,30E-05	2,53E+01	2,61E+00	3,35E-08	2,65E+00	1,06E+01	9,18E+03	1,09E-02	8,76E-04	1,43E-02	4,26E-03
Natural gas for casting	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity casting	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Natural gas extrusion	1,02E-06	4,02E+01	6,84E-01	1,01E-07	1,55E-01	1,40E-01	2,05E+02	2,07E-03	2,27E-04	1,00E-03	2,79E-04
Electricity extrusion	6,20E-07	5,96E+00	5,85E-01	3,30E-09	3,37E-01	4,20E-01	1,20E+03	1,39E-03	1,30E-04	3,52E-03	2,27E-03
Road transport	6,04E-07	2,57E+00	1,84E-01	3,30E-09	8,87E-02	3,72E-02	7,14E+01	6,19E-04	2,70E-05	3,25E-04	8,24E-05
Transport Transoceanic	9,82E-09	1,23E-01	1,01E-02	1,26E-10	4,58E-03	1,42E-03	3,04E+00	8,14E-05	6,57E-06	2,42E-04	2,70E-05
Transport train	1,37E-07	4,16E-01	3,72E-02	5,24E-10	2,95E-02	2,84E-02	5,75E+01	1,75E-04	8,79E-06	1,68E-04	8,63E-05

Table 56 USE stage full LCA

Description	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
USE STAGE (Electricity consumption	7,02E-07	4,00E+00	3,49E-01	5,27E-09	2,15E-01	2,28E-01	5,69E+02	1,29E-03	6,60E-05	1,48E-03	1,09E-03

Table 57 Full EOL results for HPDC alloys

Impact category	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
AlSi10MgMn	2,61E-05	6,11E+01	6,10E+00	1,07E-07	5,28E+00	3,86E+00	1,76E+04	2,00E-02	2,28E-03	2,90E-02	9,11E-03
Variant 4	1,06E-06	1,51E+00	1,38E-01	1,96E-09	1,06E-01	3,84E-01	3,84E+02	5,40E-04	4,27E-05	7,26E-04	2,51E-04
Variant 6	4,44E-07	9,45E-01	7,83E-02	1,24E-09	6,05E-02	1,59E-01	1,73E+02	3,41E-04	2,20E-05	4,04E-04	1,66E-04
Variant 7	9,22E-07	1,35E+00	1,21E-01	1,75E-09	9,40E-02	3,35E-01	3,28E+02	4,88E-04	3,69E-05	6,40E-04	2,28E-04
Variant 12	4,92E-06	2,99E+00	2,88E-01	4,16E-09	2,71E-01	1,04E+00	9,14E+02	6,09E-03	9,40E-05	1,56E-03	4,82E-04

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Table 58 Full EOL results for cold stamping alloys

Impact category	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline 5754	3,84E-06	3,74E+00	3,65E-01	5,66E-09	3,28E-01	1,33E+00	1,15E+03	1,29E-03	1,21E-04	1,92E-03	5,92E-04
5754 v1	1,59E-06	1,82E+00	1,67E-01	2,50E-09	1,79E-01	4,82E-01	4,46E+02	2,18E-03	5,02E-05	8,52E-04	2,96E-04
5754 v2	1,00E-06	1,36E+00	1,19E-01	1,84E-09	1,26E-01	2,96E-01	2,87E+02	1,65E-03	3,42E-05	6,01E-04	2,26E-04
6181A v3	1,42E-06	1,54E+00	1,40E-01	1,94E-09	1,50E-01	4,22E-01	3,89E+02	1,46E-03	4,21E-05	7,42E-04	2,58E-04
6181A v4	7,65E-07	1,10E+00	9,43E-02	1,42E-09	9,25E-02	2,34E-01	2,28E+02	8,55E-04	2,69E-05	4,93E-04	1,91E-04

Table 59 Full EOL results for hot stamping alloys

Impact category	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline 6082	3,91E-06	3,42E+00	3,38E-01	4,31E-09	2,94E-01	1,31E+00	1,12E+03	1,47E-03	1,11E-04	1,85E-03	5,46E-04
6111	5,45E-07	8,02E-01	6,80E-02	1,04E-09	5,53E-02	2,14E-01	1,81E+02	3,03E-04	2,17E-05	3,76E-04	1,13E-04
6181A v1	1,22E-06	1,24E+00	1,14E-01	1,58E-09	1,10E-01	4,05E-01	3,46E+02	4,96E-04	3,70E-05	6,32E-04	1,89E-04
6181A v2	6,39E-07	8,04E-01	6,81E-02	1,04E-09	6,43E-02	2,17E-01	1,85E+02	3,22E-04	2,19E-05	3,82E-04	1,15E-04

Table 60 Full EOL results for extrusion alloys

Impact category	ADP	ADP (fosil)	GWP	ODP	HT	FwEcotox	MEcoTox	TEcoTox	POC	AP	EP
Baseline 6063	3,91E-06	3,32E+00	3,29E-01	4,10E-09	2,83E-01	1,30E+00	1,10E+03	1,33E-03	1,08E-04	1,81E-03	5,32E-04
6111	5,56E-07	6,52E-01	5,25E-02	8,43E-10	5,98E-02	1,59E-01	1,36E+02	2,89E-04	1,70E-05	3,05E-04	9,20E-05
6063	1,70E-06	1,71E+00	1,59E-01	2,22E-09	1,52E-01	5,47E-01	4,83E+02	6,97E-04	5,04E-05	8,70E-04	2,88E-04
6082	1,62E-06	1,56E+00	1,46E-01	2,09E-09	1,45E-01	5,34E-01	4,60E+02	6,66E-04	4,83E-05	8,11E-04	2,43E-04

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