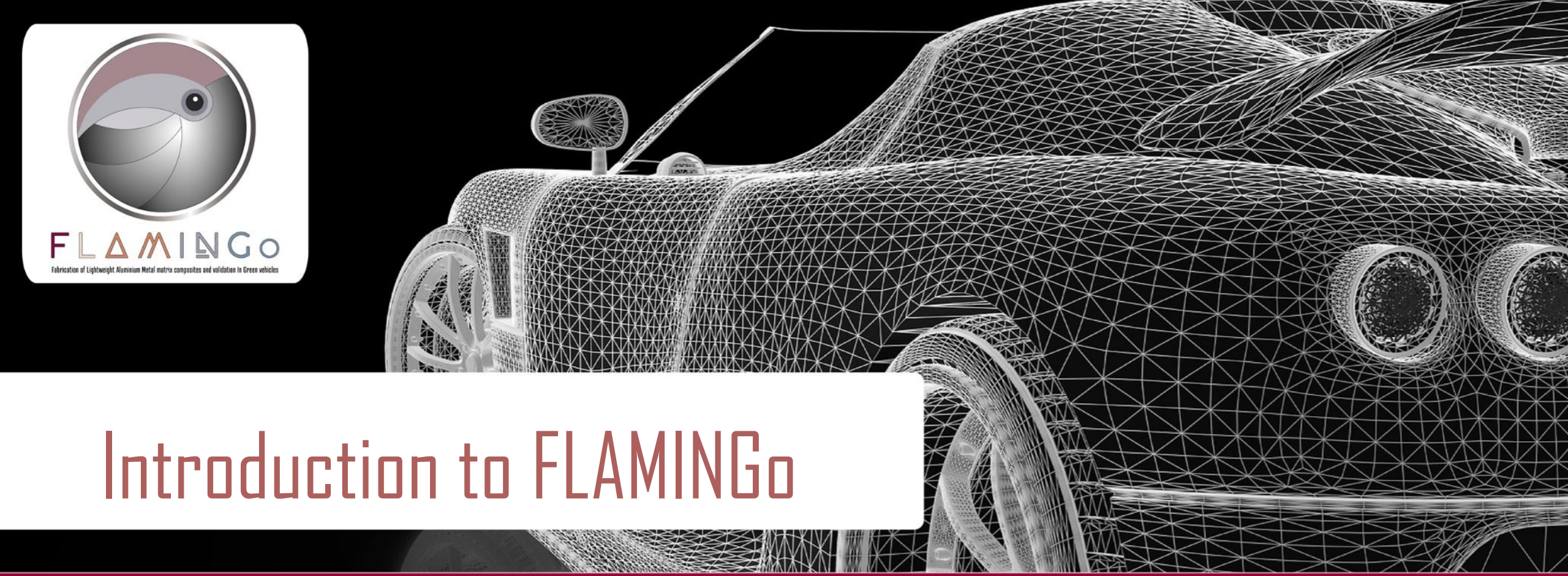

Introduction to FLAMINGo

Life Cycle Assessment (LCA) and its application to the automotive sector

Ramón García – Global Factor

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grand agreement number 101007011

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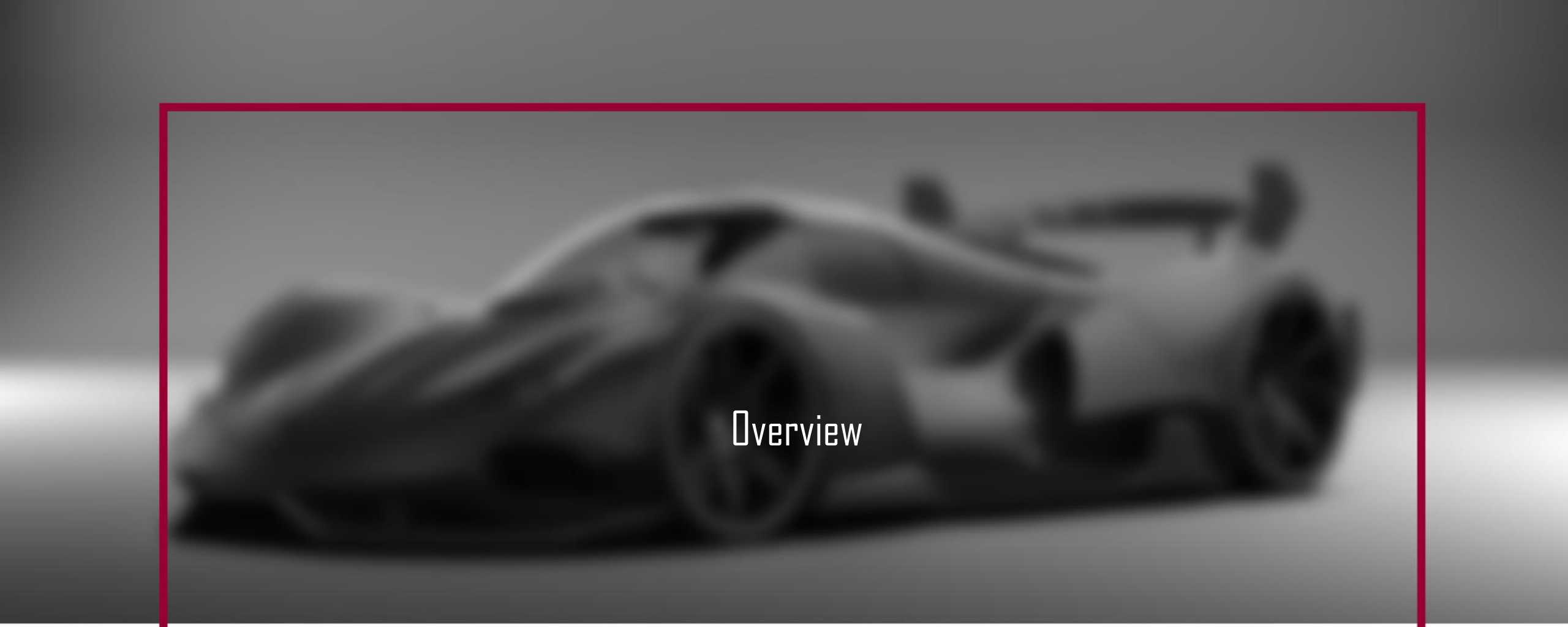


Overview

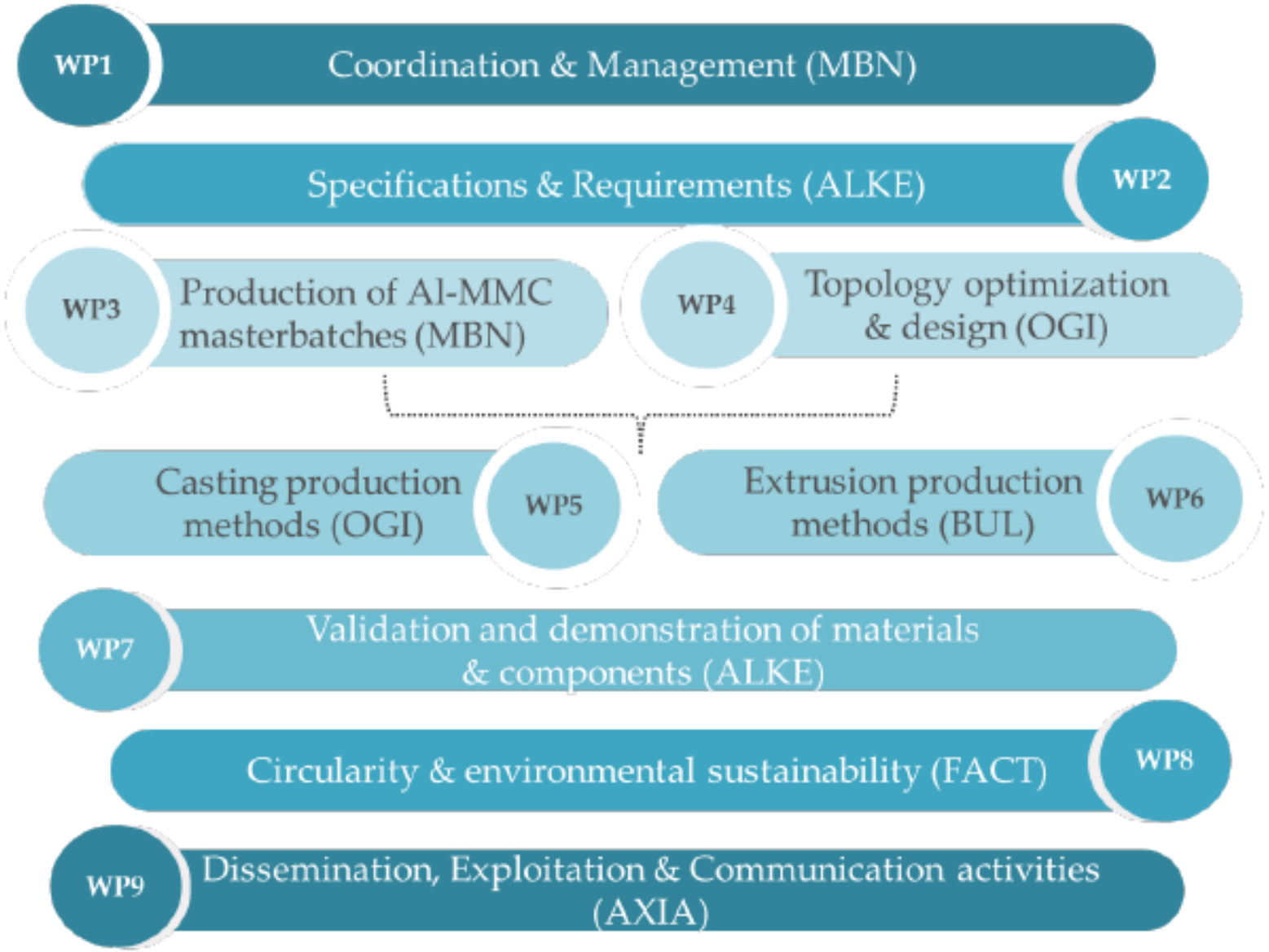
Introducting the Project

- **FLAMINGo: Fabriaction of Lightweight Aluminium Metal matrix composites and validation in Green vehicles.**
- The project aims to address the introduction of **Aluminium Metal Matrix Composites** in automotive, demonstrating cost effective processing solutions in all the steps of its circular economy from cradle to cradle.
- The project focuses on the development of an electric vehicle made of lighter materials while reducing its environmental impact. To this end, life cycle analysis and life cost analysis are being applied to choose materials that have a lower impact and can be adapted to the project's objective.
- **Partners:**
  - MBN NANOMATERIALIA SPA
  - VEREIN FUER PRAKTISCHE GIESSEREIFORSCHUNG
  - BRUNEL UNIVERSITY LONDON
  - CONSTELLIUM CRV SAS
  - INSTITUTO DE SOLADURA E QUALIDADE
  - KAMPAKAS METALLOURGIKI TECHNIKI EMPORIKI KAI VOIMICHANIKI AE
  - ALKE SRL
  - AXIA INNOVATION UG
  - EUROPEAN FEDERATION FOR WELDING JOINING AND CUTTING
  - FACTOR IDEAS INTEGRAL SERVICE SL

Partners


OGI
AXIA INNOVATION
Brunel University London
BCAST
EWF
Constellium
ISQ
Factor CO2
MBN nanomaterialia
alkè
GROUP KAMPAKAS

Work Plan


WP1
Coordination & Management (MBN)
Specifications & Requirements (ALKE)
WP2
WP3
Production of Al-MMC masterbatches (MBN)
WP4
Topology optimization & design (OGI)
Casting production methods (OGI)
WP5
Extrusion production methods (BUL)
WP6
WP7
Validation and demonstration of materials & components (ALKE)
Circularity & environmental sustainability (FACT)
WP8
WP9
Dissemination, Exploitation & Communication activities (AXIA)

Project Objectives

- FLAMINGo objectives are all targeting the innovations throughout all the supply chain, enabling the introduction of lightweight materials in a wider spectrum of components (by increased mechanical properties) and car segments (by decreased costs per kg-saved).
- The objectives are in accordance with the topic LC-GV-06-2020, targeting in the application of Aluminum Metal Matrix Composites (Al-MMCs), demonstrating cost effective processing solutions for the automotive industry as well as following the principles of the circular economy on a cradle-to-cradle approach. In the following the specific objectives of the FLAMINGo project are described together with the responsible partner for each objective, the relevant WPs in which the objectives will be achieved and KPIs.
- The project is divided in three types of objectives, each one with its specific objectives and in charge of a specific partner:
  - Objectives related to the development of technologies.
  - Objectives related to demonstration activities.
  - Objectives related to market replication.

Challenge

The main specific challenge for this Project is related to the improvement efficiency and range of electric vehicles through production and use, to recovery.

To bring effective results to mass produced vehicles FLAMINGo focus on validating cost-effective implementation of Aluminum Metal Matrix Composites throughout the vehicle life-cycle.

FLAMINGo addresses metal Aluminium reinforced with ceramic nanoparticles and develops the manufacturing chain to make it promptly adoptable by automotive sector, exploiting the existing processing capabilities of car manufacturers and OEM in the automotive sectors.

Manufacturing and assembly methods

Cradle-tocradle approach

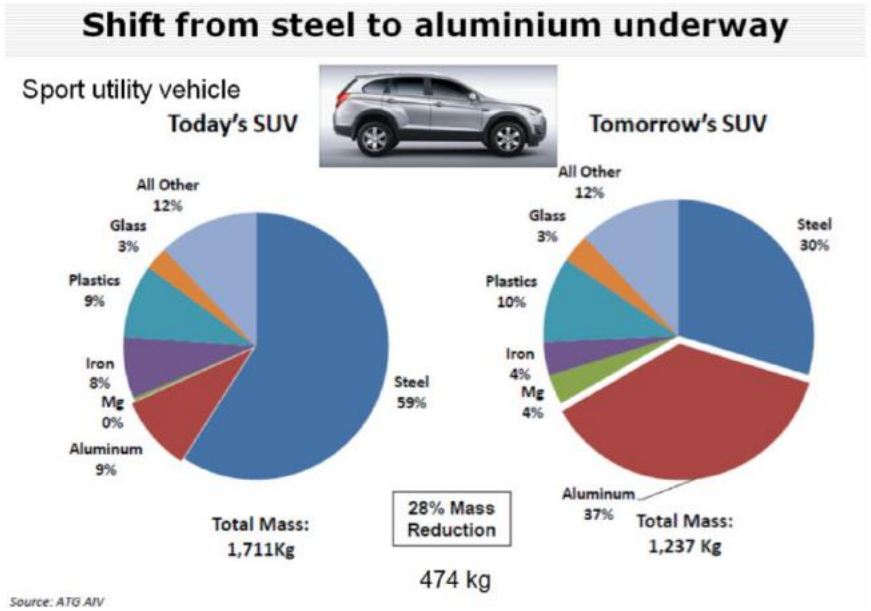
Implementation of advanced methodologies

SWOT Analysis

	Helpful to achieving the objective	*Harmful to achieving the objective*
Internal origin (attributes of the system)	**Strengths** - Strong technological and upscaling capacity for providing solutions and fast prototyping - Holistic approach to sustainability - New Al materials value chains, for product development and commercialization - Cross sectoral market approach - Resource Efficiency and Recycling Management - Regulations (e.g. emissions) are pushing for novel new material solutions for the sector - Lightweighting technologies are available like nowhere around the globe - FLAMINGo advances in topology, modelling and simulation which is highly relevant for new materials, components, manufacturing technologies.	**Weaknesses** - New concept with uncertain customer and sector acceptance - Further Investments including private funds are required - Necessity of strong IPR policy within the ecosystem and between FLAMINGo and customers -Multi-material research and development currently lacks focus especially on EoL options. - Lack of communication and openness between stakeholder in the value chain (e.g. OEMs and suppliers or design & development and testing & validation) lead to unclarities about requirements. - Slow regulation and legislation processes within the EU
External origin (attributes of the environment	**Opportunities** - Better use resources and AI throughout the lifecycle. - Cooperation with existing companies offering niche services. - Increasing research in design and optimization of multiparameter design systems - Extremely high market potential. - Scope of product line expansion. - The available infrastructure (Value Chain) offer opportunities to become leaders in affordable lightweight materials, recycling of composites and circular economy. - New emerging business models make more expensive lightweighting technologies viable.	**Threats** - Threat of new entrance of competitors in the European market - New regulations on emissions - Compliance with regulations on nanomaterials - Customer reaction to pricing policies - End users are relatively reluctant to accept new technologies - Prove commercially viable OEM components - Changing political environment/ instability (e.g. the US and China trade war, Brexit impacting the EU, and overall instability in the middle east) creates disturbances in the complex and interwoven value chain that relies heavily on partners in these regions.

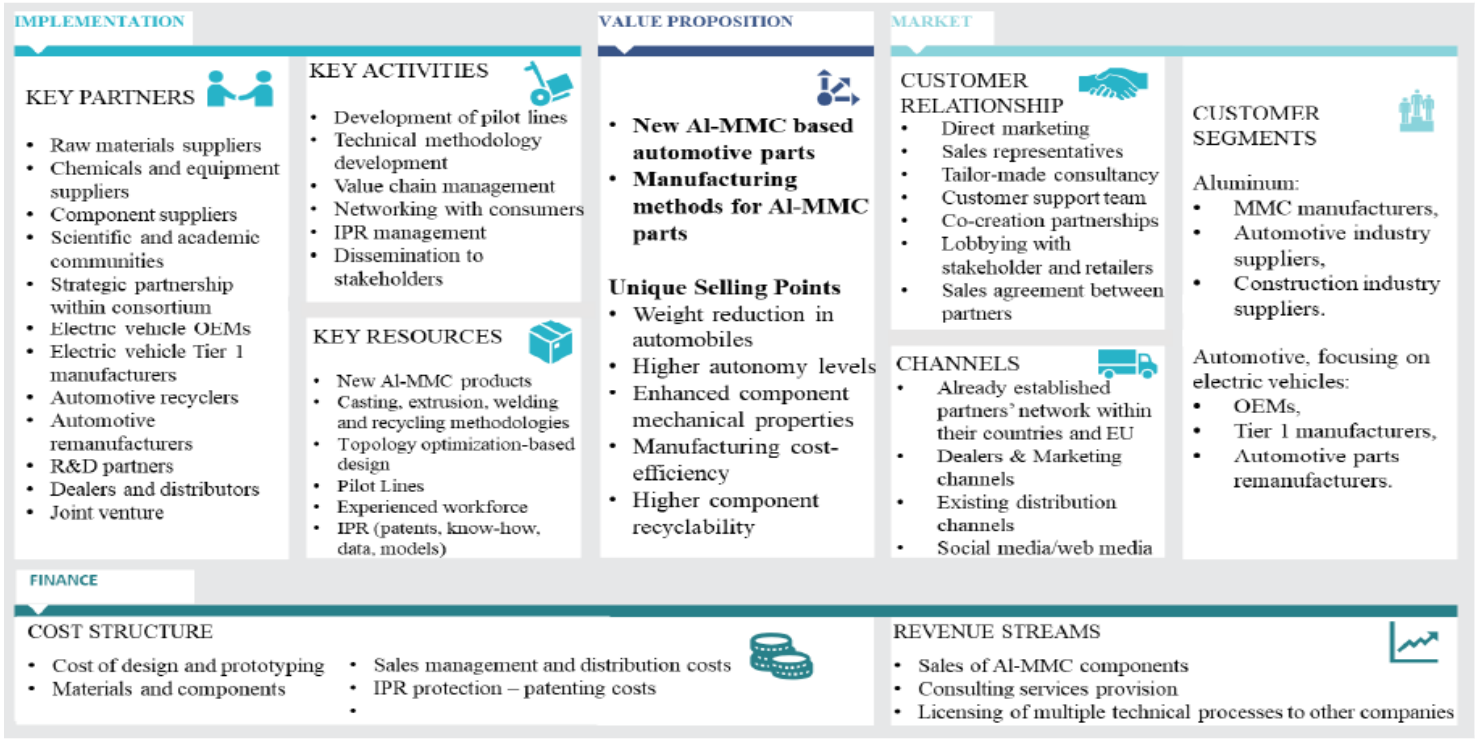
Concept of FLAMINGo Project

- Nowadays, in the automotive sector the two most widespread material classes are steels (Ultra-high strength-steels-UHSS- and mild steels) and aluminium alloys.
- Since today the current material development tendencies in the automotive industry are overviewed first of all from the point of view of weight reduction, **aluminium alloys are an engineering solution** in this scenario at expenses of mild steel but also of UHSS parts.
- FLAMINGO will contribute to this development trend **extending further the application of Aluminum** into car components thanks to a **new approach for manufacturing Al based composite** materials with elevated performance for automotive parts.



Approach and Methodology

- The FLAMINGO project will have a duration of 42 months and will comprise of the following phase:
  - **Phase 1:** Production of Al-MMCs masterbatches via solid state mechanical milling
  - **Phase 2**: Re-design of automotive parts and components via topology optimization
  - **Phase 3**: Optimization of manufacturing methods and demonstration
  - **Phase 4:** Environmental sustainability, circular economy and market issues



Introduction to the Industrial Need

Industrial Need

- Electric vehicles (EVs) were predicted to be the next disruptive market force for transportation and technology as they have a strong potential to revolutionize the way that energy is used.
- Today EVs manufacturers are well convinced that light-weighting is a major topic for the body-in-white design.
- **FLAMINGO** project aspires to develop a group of integrated technologies that will allow the wide use of Aluminum Metal Matrix Composites (Al-MMCs) in the automotive industry and more specifically on the EVs. This will involve advancements in technologies such as mechanochemical alloying and mixing, manufacturing methods such as Green Sand Casting, Low Pressure Die Casting and Welding, as well as in topology optimization and recycling processes. High expertise partners in the mentioned areas have set up the FLAMINGO consortium in order to deliver these high innovation solutions.
- According to Jerome Favero, the head of automotive steel solutions of Arcelor Mittal, ***"Even if there is energy recovery while braking, losses will occur. A lighter mass will reduce the overall amount of energy needed to move the car and improve performance parameters such as acceleration and handling. And if we reduce the mass of materials, we directly reduce the emissions that are caused by the production of these materials."***

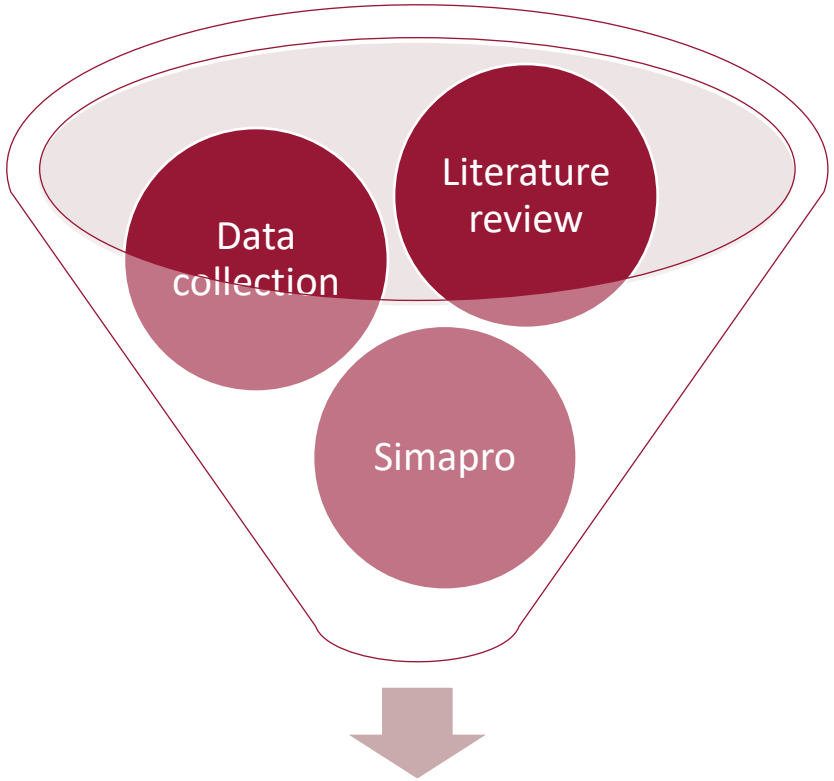
ALKE's Electric Utility Vehicle model ATX

Life Cycle Analysis and Life Cycle Cost Analysis Approach

Life Cycle Analysis and Life Cycle Cost Analysis

Life Cycle Analysis:

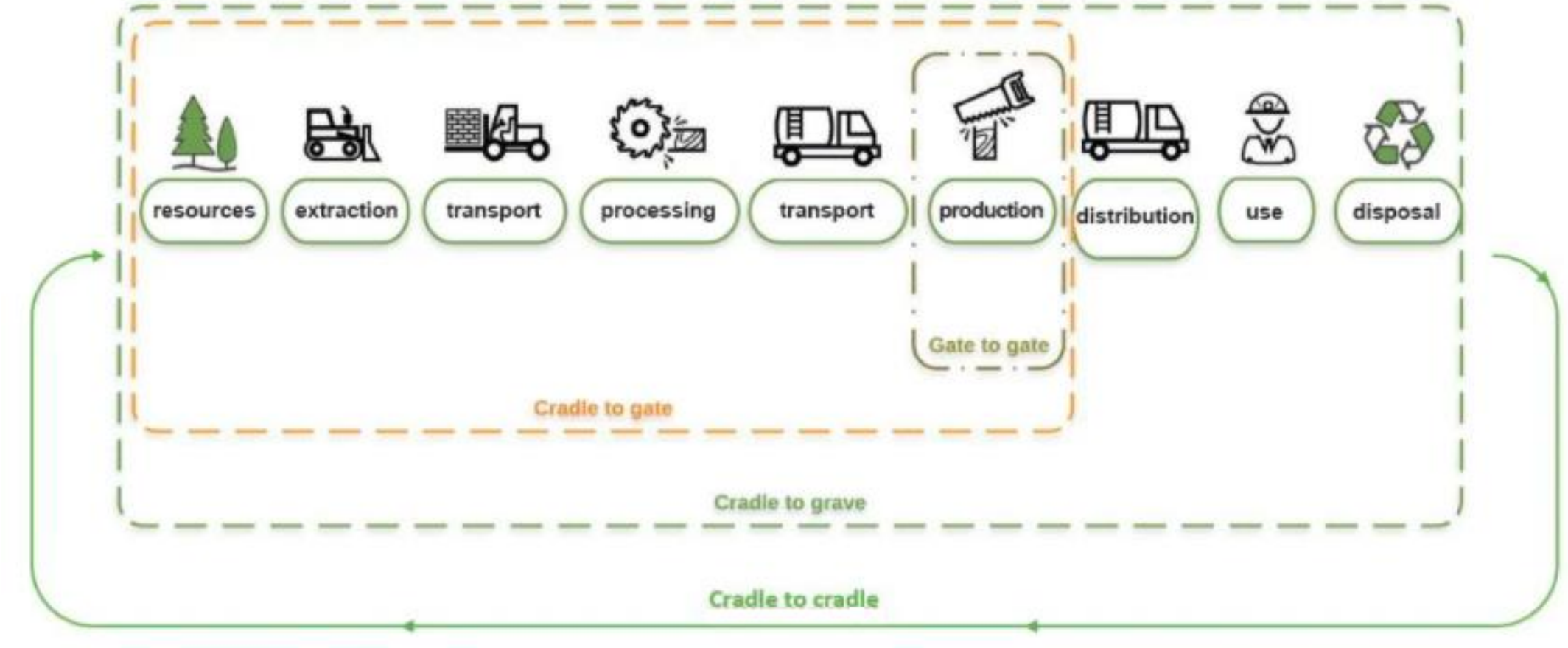
- LCA is a technique for determining the environmental aspects and potential impacts associated with a product.
- Compiles an inventory of the relevant inputs and outputs of the system.
- LCA consists of four phases:
    - Definition of objectives and scope
    - Inventory analysis
    - Impact assessment
    - Interpretation of results



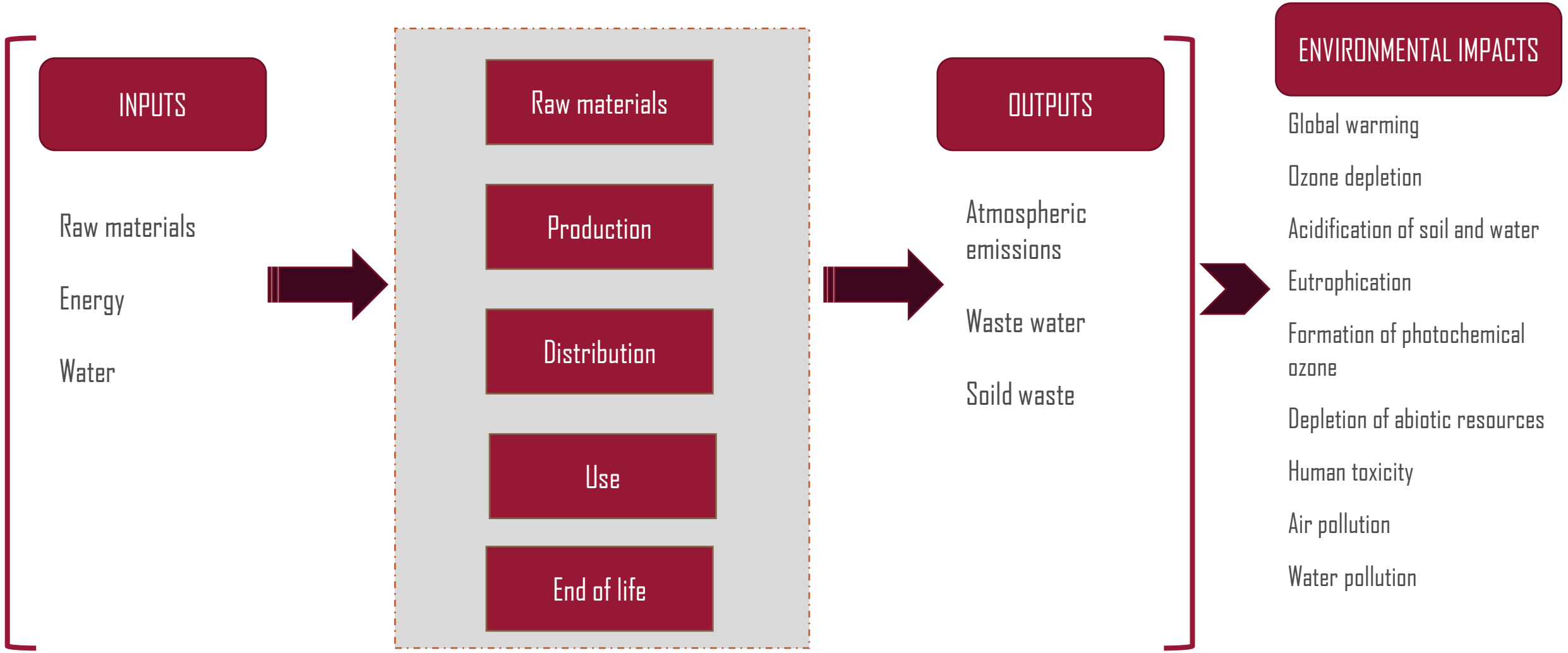
Data for LCA/LCC analysis

Life Cycle Analysis

Objective: Analize the environtmental impact of a process/product during its life cycle.

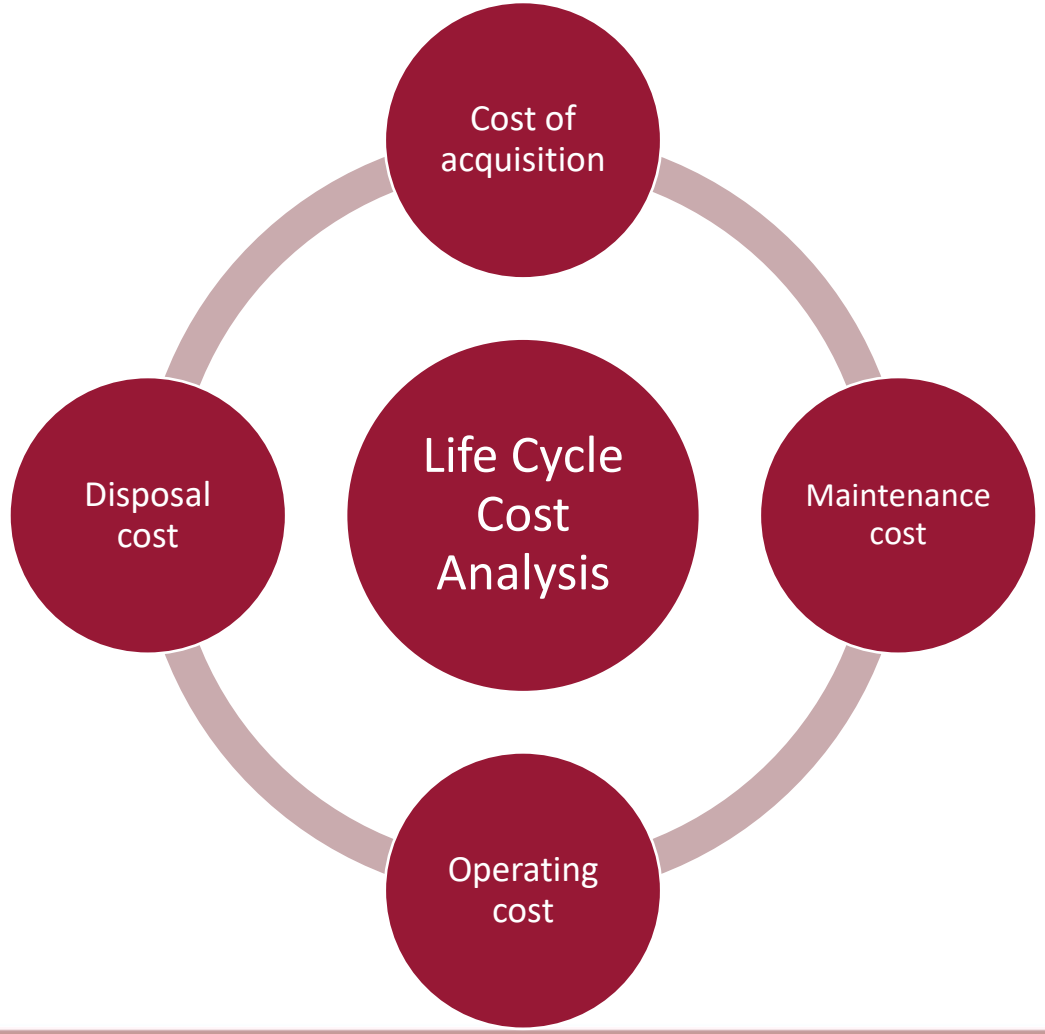


Life Cycle Analysis



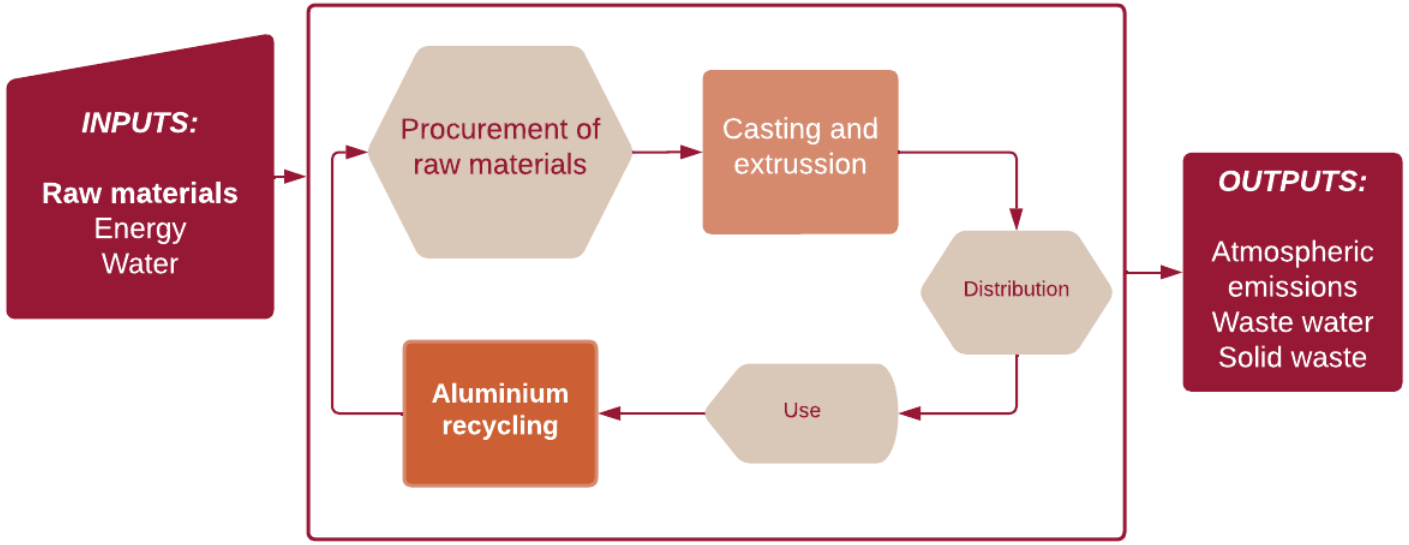
Life Cycle Cost Analysis

Objective: estimate the overall costs of project alternatives and to select the materials that ensures the parts will provide the lowest overall cost of manufacture consistent with its quality and function.



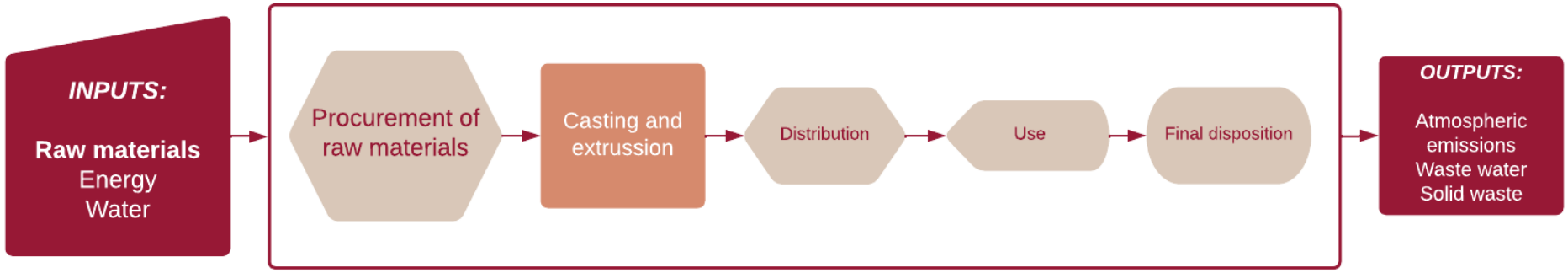
Life Cycle Analysis

LCA/LCC Flow Diagram:

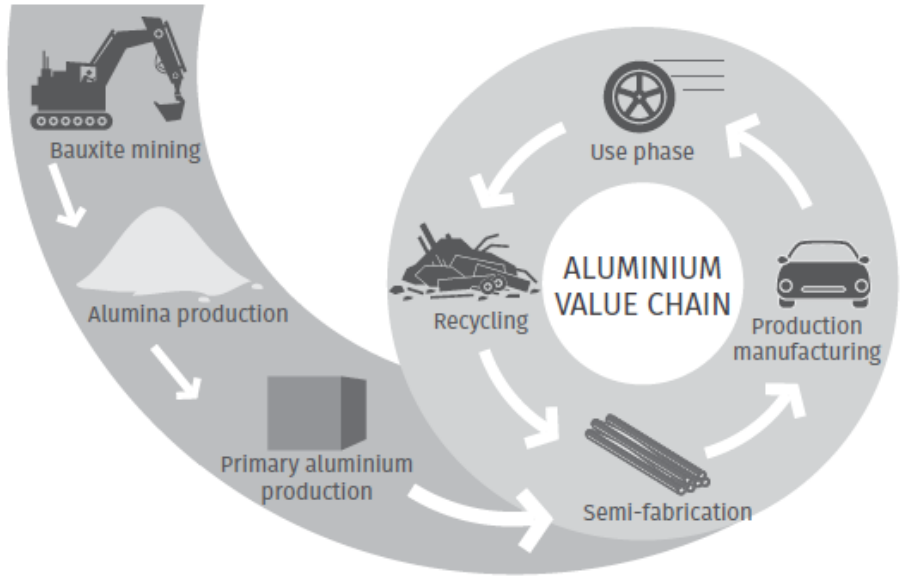


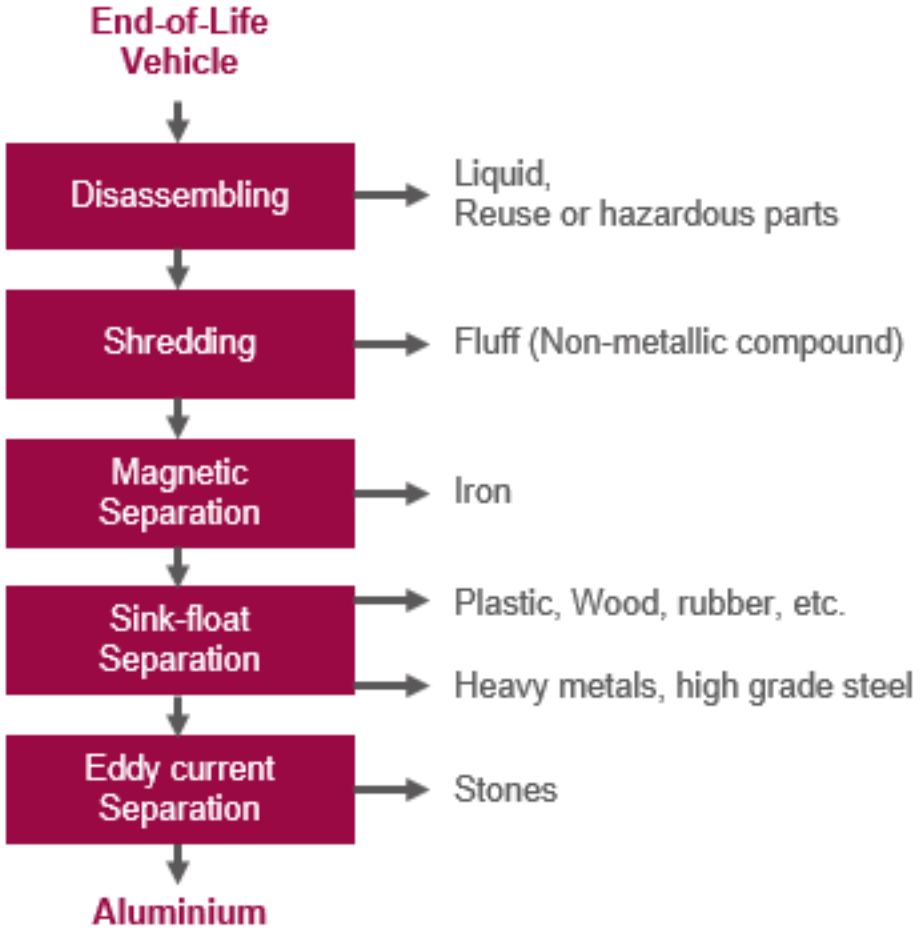
FLAMINGo

Baseline



LCA: Alumminum recycling





Process

- To reach these goals the project considers all the steps from cradle to cradle, at lab and full scale:

Component design optimization

Production of nanoparticles concentrated masterbatches of Al-MMC via solid state mechanical alloying

Casting of Al-MMC components by inoculating the masterbatch in an Al melt and homogenized by ultrasonication and electromagnetic stirring systems

Casting of Al-MMC in billets and from these the extrusion of profiles for the body frame, to assess the use of Al-MMC also in the growing automotive share of Aluminum parts from extrusion

Identification of the welding techniques for joining Al-MMC components, and assessment of the application via TIG, GTAW and RSW

Use of these components for substitution of steels and aluminum parts in electric vehicles.

Conclusions and Challenges

This preliminary analys of the LCA set the ground for the main environmental topics to focus on, and further underlines the importance of validating the recycling of Al-MMnC as the main way to ensure environmental and cost sustainability.

Conclusions and Challenges

The project is still under development.

There is still no data available from the partners about the production process that would allow us to complete the life cycle analysis. The process of data collection continues, and the improvement of the data is ongoing.

The lack of data allows us to analyze more scenarios about what was already thought not only to think about weight reduction or the use of recycled aluminum but other materials such as recycled steel which was not contemplated but can be a new option.

It is a matter of interest for the project to identify the environmental impact of the project. There are no other companies or consortiums that publish this data of the life cycle analysis of electric vehicles, so it is an opportunity of transparency for the general public.

The preliminarily analysis of the LCA set the ground for the main environmental topics to focus on, and further underlines the importance of validating the recycling of Al-MMnC as the main way to ensure environmental and cost sustainability.

Life Cycle Cost Analysis is still pending.

THANK YOU!

QUESTIONS?

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