Circular economy business models
for innovative hybrid and electric mobility through advanced reuse and remanufacturing technologies and services

REQUIREMENTS FOR INNOVATIVE SERVICES
AND BUSINESS MODELS
(Deliverable 1.1)

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## Project Consortium

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Executive Summary

This deliverable will report the work of task T1.1 concerning the identification of stakeholder requirements, specifications and KPIs at B2B and B2C level collected through a wide consultation of consumers, service companies and industrial stakeholders.

To this aim, diverse methods of data collection were performed including:

- Detailed interviews not only with all industrial partners in the CarE-Service consortium but also with the support of the project stakeholder group and other relevant companies in the value chain.
- Comprehensive consultation with some members of the project consumer committee and additional consumer associations.
- Exploratory open-ended discussions in the form of focus groups with diverse themes of B2C requirements for future sustainable/circular business models and services.
- European Survey of consumers’ view on non-ownership and electrification in mobility services.
- Literature review on the state of the art of mobility services and car sharing business models.

Thanks to the above data collection channels, the business model and service engineering requirements and KPIs were identified and quantified, where possible, categorized in following six value chains:

- B2B business models
  - Battery reuse value chain
  - Metal reuse value chain
  - Techno-polymer reuse value chain
  - Business model of the ICT Platform
  - Business model of the SMMs
- B2C business models

List of Acronyms

B2B: Business to Business
B2C: Business to Consumer
BM: Business Model
EoL: End of Life
EV: Electric Vehicle
ICE: Internal Combustion Engine
ICT: Information Communication Technology
KPI: Key Performance Indicator
LCA: Life Cycle Analysis
OEM: Original Equipment Manufacturer
SMM: Smart Movable Module
SoH: State of Health
Introduction

Methods

B2B Requirements and KPIs

B2C Requirements and KPIs

Key Results/Messages of the Report

Conclusion

Annexes
1 INTRODUCTION

The CarE-Service project aims at demonstrating the feasibility of innovative circular business models for hybrid and electric vehicles, that will offer new highly customised and performance-based mobility services for Europeans. This will be achieved through the establishment of new circular European value chains for the reuse and remanufacturing of high added-value parts of electric/hybrid vehicles; generation of new service markets for sustainable mobility; demonstration of the economic, social and environmental sustainability and creating conditions for a wide exploitation of the results within Europe.

The ongoing transitions within the automotive industry highlighted by the transition from traditional fuel powered vehicles to electric and hybrid electric vehicles present a challenge for post-use product treatment on the one hand. On the other hand, it provides an opportunity for the creation of new circular economy-oriented business models that could affect the automotive value chain.

The aim of this task is to identify requirements for various stakeholders relevant for creation of innovative services and business models. These requirements will be defined both on a business-to-business (B2B) level through elaboration on the three main reuse chains; batteries, metals and techno polymers as well as on a business-to-customer (B2C) level through elaboration on carsharing/renting services.

1.1 Objectives

This report is aim at achieving the following:

- Identifying requirements for creation of innovative B2B business models for batteries, metals and techno polymers reuse chains
- Identifying requirements for creation of innovative B2C business models for mobility services such as carsharing and renting.
- Identifying relevant key performance indicators at B2B level
- Identifying relevant key performance indicators at B2C level
1.2 Report Structure

Due to the requirements on two different levels, this report is structured as follows:

**Introduction:** Overview of the project and deliverable scope and objectives.

**Data collection:** The different methods employed to collect data for understanding both business model requirements of B2B and B2C are presented. Design and methodology for each of the data collection methods is also provided. Particularly, description of the twenty interviews, five focus groups and the European survey are provided.

**B2B Requirements:** Data analysis of B2B interviews deriving the business model requirements of the five B2B value chains are described. The five B2B models include: three (battery, metal and techno polymer) reuse chains as well as two business models of SMMs and ICT platform.

**Results:** A list of requirements based on the results from the data analysis, implications and requirements for development and establishment of innovative B2B business models are derived and provided for the B2B level. Key performance indicators are also listed.

**B2C Requirements:** Analysis of B2C interviews, focus groups and a detailed elaboration of the survey data to derive B2C BM requirements are provided.

**Results:** A list of requirements based on results from the data analysis, implications and requirements for development and establishment of innovative B2C business models are derived and provided for the B2C level. Key performance indicators are also listed.

Conclusions are provided in the final section of the report.
2 METHODS

2.1 Data Collection

Business model requirements for the three main reuse chains; HEV/EV batteries, metals and techno polymers have been derived primarily from Interviews with industrial stakeholders within those value chains. The interviewed stakeholders include not only the consortium partners, but also external stakeholders of the value chain. Recyclers/remanufacturers and experts of circular economy solutions in automotive industries, OEMs, fleet management companies and technology providers were interviewed. As facilitators for the CarE-Service future scenario model, the stakeholders responsible for supporting the Information Communication Technology (ICT) platform and the Smart Movable Modules (SMMs) were also interviewed to derive business model requirements. At this stage of the project, the owner of the ICT platform within the consortium is not definite, hence several issues should be considered in terms of the integration level of the ICT Platform with Smart Movable Modules (SMMs). For instance, an industrialized business could act as the owner of the ICT platform and SMMs. Alternatively, two specialized businesses can act separately as owners of the ICT platform and SMMs with contractual agreements between them. These options will be decided in the future steps of the project.

Both qualitative and quantitative methods were applied to collect data. The purpose of employing both quantitative and qualitative methods was to ensure attainment of both in-depth and wide views required for construction of new BMs.

- In-depth interviews with stakeholders within the mobility services value chains: carsharing service providers; car renting service providers; charging infrastructure implementors; policy implementors and OEMs.
- A European survey administered in diverse European countries.
- Focus groups in five different European countries.
- Literature review on the state of the art of mobility services.

As this study focuses on innovative BMs within the mobility sector, we purposely turned towards mobility-as-a-service solutions such as carsharing and car renting. These services enable car users to access cars without having the responsibility of owning them.
Methodology

Both qualitative and quantitative methods have been applied to collect data.

Figure 1: Data collection methods used

2.2 Interview Design

A set of 20 in-depth interviews were conducted with industrial stakeholders from 6 different countries within Europe that are involved in various activities for the circular economy within the mobility industry. Depending on the location proximity, both virtual and physical interviews were accommodated. A set of predetermined questions covering areas about reuse chains, the envisioned model, and mobility services were prepared to guide the interviewers. Follow up questions could then be posed depending on the responses. Interviewees were contacted in advance and briefed about the project and its goals. In addition, the set of the predetermined questions was sent to the interviewees a few days prior to the interviews in order to enable preparation for a fruitful discussion. Some of the interviews were recorded with the interviewees’ permission to enable interviewers’ full attention during the course of the interviews. The interviewees for this section of the report comprised of consortium partners, mobility services providers, charging infrastructure implementers, policy makers, OEMs and members of the project stakeholder group. Due to the level of publicity of this deliverable, the names of external interviewees are anonymised in this report.
3 B2B REQUIREMENTS AND KPIs

In this section, we aim at mapping the business model requirements and KPIs for the project’s solutions that are targeting Business-to-Business supply chains. To draw the B2B requirements for the CarE-Service, we rely on the interviews with diverse supply chain stakeholders.

The project’s solutions targeting B2B supply chains are twofold:

- The CarE-Service Components’ Reuse Value Chains (Focusing on Battery, Metal and Techno-polymer parts)

- The CarE-Service Hardware/Software Solutions (Focusing on ICT platform and Smart Movable Module to be developed in the project).

Accordingly, this section is divided into following sub-sections, each focusing on a specific B2B solution of the project.

**Figure 2: Outline of B2B section**
3.1 Business Model Requirements & KPIs for Value Chain of Battery Reuse

To derive the business model requirements & KPIs for the batteries value chain, insights from the interviews with the stakeholders were merged. Interviewees include both consortium members and CarE-Service stakeholders, experts in the battery market (AVIC), in battery recycling (ENV), in battery reuse applications (JRC), in battery logistics (COBAT), in battery treatment procedures such as disassembly and testing as well as in development of solar energy solutions. Additional insights for the battery reuse value chain were drawn from interviews with OEM (FCA).

![Figure 3: Stakeholders interviewed for Battery Reuse value chain](image)
3.1.1 Business Model Requirements for Value Chain of Battery Reuse

Drawn from combined insights of the above experts and value chain members of the battery reuse value chain, the following business model requirements were defined.

**Sharing the history and status data of batteries from OEMs among the other stakeholders:** At the moment, the data of the battery (e.g. how it was used and charged) are owned by OEMs due to their extended responsibility in collection of batteries. However, the stakeholders in the battery treatment process expressed the need for knowledge on the battery historical states as a key pre-requisite for efficient and effective battery treatment. Although due to confidentiality matters of OEMs, this can be challenging, solutions can be twofold: top-down approach through an open data policy and legislative framework for battery history data among supply chain actors; bottom-up approach through application of advanced tools that enable cleaning, sorting, anonymizing the data of the battery history while respecting confidentiality rules of OEMs and still applicable for treatment facilities for carrying out efficient and effective treatment.

**Universal and/or legal handbook for dismantling, transportation and treatment of (damaged) batteries:** This requirement is drawn from the concern over the absence of a homogenous procedure on battery dismantling, transportation and treatment procedures. This is especially important for the damaged batteries as their procedures are constrained a lot by the legislative frameworks. This concern will lead to diverse adopted handbooks by different actors, which limit the large-scale cooperation among stakeholders. The establishment of a handbook on battery dismantling, transportation and treatment would ease processes and ensure specialization and economies of scale.

**Value based pricing for the diverse reuse applications of battery:** For reused applications, a critical requirement will be value-based pricing. This requirement consists of assigning a fair value to reused components compared to the new components/products. In particular, a reduction in price of the reused products/components is expected by a range of 10-20%, however it needs to be tailored for each specific reuse application based on its market.

**Address the risk of Variability in the price of batteries’ material over time:** When the battery is recycled, some of the recovered materials possess huge variability in price. This variability is seen in the past actual price trend of materials, and/or is predicted in future.
Accordingly, addressing the risk of variability in the price of batteries’ material over time is a fundamental requirement for estimation of economic sustainability of recycling strategies for batteries.

**Sustainable distribution of value (economic gain) between value chain actors:** The battery reuse process is quite an extensive multi-step process (collection, transportation, dismantling, diverse treatment, sale in various secondary and primary applications), with involvement of numerous companies. Thus, the final value that is derived from users of reused batteries or its component should be sustainably and fairly distributed among the actors. However, since yet the supply chain is not existing, a mechanism for sustainable distribution of value among actors should be designed in the project, even if quite challenging, to ensure business model sustainability of reuse applications.

**Capability to address the variability in procedures for treatment of EoL batteries in diverse car models:** The treatment and dismantling of batteries differ from one car model to the other. To this challenge, the business model behind reuse applications of batteries should be capable of addressing the variability in procedures in diverse car models to ensure the economies of scale. This requirement can be approached with either standardization of procedures or by designing tools and machines that are capable of addressing this variability.

**Optimizing the value chain network of centres for collection/disassembly/treatment in terms of sizing, vertical integration, geographically (having many fragmented centres and few big centres):** Here, the question to be answered is whether it is more reasonable and sustainable to have many fragmented small centres for collection, disassembly and treatment, or to have quite big centres in key areas of Europe. This question needs to be answered in the design of business model for battery reuse to ensure its economic sustainability and viability.

**Guarantee Continuity/stability of batteries’ input flow:** In order to make sure of the business model viability of battery reuse in both primary and secondary applications, there is a need for guarantee on continuity and stability of batteries’ input flow. Future business models, therefore, need to assess ways of providing market availability for all value chain partners.
**Assuring consumers on the reused parts (market acceptance) and Warranty for reused batteries:** From a marketing perspective, there have been concerns over market knowledge and acceptance for reused and remanufactured batteries by the end customers. Warranty on the reused parts in a mandate in this regard, but it needs to be accompanied by other assurance mechanisms for users of the reused batteries or its components.

**Maximizing the number of potential secondary applications:** This requirement is simply to ensure the economies of scale and higher economic benefit in the battery reuse applications.

**Commitment of the OEMs for engaging in EoL operations (by incentives or showing the economic sustainability):** OEMs responsible for take-back systems of used batteries need to become more engaged in post-use treatment processes and pioneer this collaboration as this may expose ways of managing the potential threat of cannibalization that arises from reduced demand for new batteries.

**Design for Circularity incorporated in the new car models:** Manufacturers need to implement battery designs that facilitate second life battery processes through ease of dismantling. For this, an incentive system for OEMs is needed.

To summarize, following Figure highlights the key requirements for batteries reuse value chain.

![Figure 4: Summary of key requirements for batteries reuse value chain](image)
3.1.2 Business Model KPIs for Value Chain of Battery Reuse

According to the CarE-Service Grant Agreement, a minimum of 50 batteries will be tested for identifying the potential business model elements of the battery reuse. However, this is generally stated and in fact, in this section, a more detailed KPIs on specific demonstration cases of the battery reuse is identified. The battery reuse value chain of the CarE-Service includes three demonstration cases:

- **Stationary application reusing batteries in solar panels systems**
- **Re-use of cells in e-bikes for customers (e.g. weekend riders), and for companies (e.g. freight, distribution bikes)**
- **Use of recovered compounds from battery recycling process for other applications**

Due to the diverse market, revenue model and other business model elements of the three demonstration cases in this reuse chain, the KPIs are identified separately for each case, as following:

<table>
<thead>
<tr>
<th>KPI</th>
<th>Stationary application reusing batteries in solar panels systems</th>
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</thead>
<tbody>
<tr>
<td>Relative reliability of reused battery compared to new one</td>
<td>Same</td>
</tr>
<tr>
<td>Relative durability of reused battery compared to new one</td>
<td>80-90%</td>
</tr>
<tr>
<td>Relative design featured of the reused battery compared to new one</td>
<td>Same</td>
</tr>
<tr>
<td>Minimum number of batteries needed to be tested for identifying the business model</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Number of solar panels systems for demonstration</td>
<td>Minimum 1</td>
</tr>
<tr>
<td>Reduction percentage in price of reused battery compared to new ones</td>
<td>More than 15-20% compared to the same</td>
</tr>
<tr>
<td>Relative quality percentage of reused parts compared to new parts</td>
<td>100% the same</td>
</tr>
<tr>
<td>Customer acceptance of re-assembled batteries</td>
<td>100%, verified by IASOL in later stages (in Stakeholder group)</td>
</tr>
<tr>
<td>Chance of upgrading possibility</td>
<td>Very low &lt;5%</td>
</tr>
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*Table 1: KPIs for stationary application reusing batteries in solar panels*
### KPIs for Reuse of Cells in e-bikes for Customers and Companies

<table>
<thead>
<tr>
<th>KPI</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative Reliability of Reused Cells Compared to New One</strong></td>
<td>More</td>
</tr>
<tr>
<td><strong>Relative Durability of Reused Cells Compared to New One</strong></td>
<td>More or same depending on the case</td>
</tr>
<tr>
<td><strong>Relative Design Featured of the Reused Cells Compared to New One</strong></td>
<td>Same</td>
</tr>
<tr>
<td><strong>Minimum Number of Batteries Tested for Reuse of Cells of “Low-Demand” Batteries for Customers (e.g. Weekend Riders)</strong></td>
<td>More than 15-20% up to 2/3, even with a better quality one (to be confirmed by e-bike companies in later stages) – AVIC predictions show in 2025: the price for new battery could be 150-300 $/kwh, while 50-150 $/KWh for reuse battery.</td>
</tr>
<tr>
<td><strong>Relative Quality Percentage of Reused Cells Compared to New Cells</strong></td>
<td>More (to be verified by in later stages)</td>
</tr>
<tr>
<td><strong>Number of Demonstrated Batteries for Customers</strong></td>
<td>&gt;10 for customers</td>
</tr>
<tr>
<td><strong>Number of Training Modules to be Designed for this Demo-Case</strong></td>
<td>Minimum 1</td>
</tr>
<tr>
<td><strong>Chance of Upgrading Possibility</strong></td>
<td>Very high &gt;90%</td>
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Table 2: KPIs for Reuse of Cells in e-bikes for Customers and Companies

### KPIs for Use of Recovered Compounds from Battery Recycling Processes for Other Applications

<table>
<thead>
<tr>
<th>KPI</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative Reliability of Recycled Compounds Compared to New One</strong></td>
<td>Same</td>
</tr>
<tr>
<td><strong>Relative Durability of Recycled Compounds Compared to New One</strong></td>
<td>Same</td>
</tr>
<tr>
<td><strong>Relative Design Featured of the Recycled Compounds Compared to New One</strong></td>
<td>Same if not better</td>
</tr>
<tr>
<td><strong>Minimum Number of Batteries Tested</strong></td>
<td>Around 5</td>
</tr>
<tr>
<td><strong>Minimum Number of Recovered Compounds</strong></td>
<td>&gt;2</td>
</tr>
<tr>
<td><strong>Relative Price of Recovered Material</strong></td>
<td>If the same quality can be achieved, the price can be the same with 0% reduction. Other AVIC forecasts to be verified: buying price of old battery by recycler at a price around 8 to 10 $/kwh (1120 $ / ton) and value recovered from recycling will be in the range of 3000 to 4000 $/tons or 20-25 $/KWh.</td>
</tr>
</tbody>
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Table 3: KPIs for use of recovered compounds from battery recycling processes for other applications
3.2 Business Model Requirements & KPIs for Value Chain of Remanufacturing Metal Parts

Due to the diverse range of metal components in HEV/EVs, it is important to primarily highlight the focus of CarE-Service, when it comes to metal parts. In particular, CarE-Service aims at developing technical solutions and new business models for remanufacturing following metal parts, even if it is subject to change in later stages of project, the requirements are based on remanufacturing of the following parts:

![Figure 5: Metal Parts that are the focus of CarE-Service in terms of Remanufacturing](image)

To derive the business model requirements for the value chain that would remanufacture the metal parts of HEV/EVs for being reused, insights from the interviews with the experts of value chain from the CarE-Service Consortium were merged. In particular, experts are: Re-forming technologies and innovative joining systems (Fraunhofer); Design and implementation of reverse logistics’ services to enable circular economy business models (C-ECO); Original Equipment Manufacturer of HEV/EVs (FCA).

![Figure 6: Stakeholders interviewed for the Metals value chain](image)
3.2.1 Business Model Requirements for Value Chain of Remanufacturing Metal Parts

Drawn from combined insights of the above experts and value chain members of the value chain, the following business model requirements were defined for remanufacturing the above metal parts to be reused in new or similar car models.

**Data Sharing among supply chain actors**: The experts in the metal remanufacturing processes especially in terms of reforming technologies express the need for knowledge on the material and product composition of parts (e.g. CAD data of parts, etc). This data typically is confidential in possession of manufacturers of parts (OEMs). If data is shared with remanufacturers, special agreements on confidentiality agreement on data should be designed, considering the fact that a remanufacturer can work with multiple OEMs in competition.

**Managing the Trade-off in LCC and LCA caused by remanufacturing processes**: Due to the remanufacturing processes in this value chain, it is expected that the cost and adverse environmental impact of remanufacturing processes can lead to trade-offs in both Life Cycle Assessment in terms of the cost and environmental impacts. This trade-off should be anticipated and managed properly in business model design of the remanufacturing processes for CarE-Service metal parts.

**Production-Scale Cost Estimation vs. lab-scale**: Due to the extreme novelty of reforming technologies for the reuse of structural metal parts of one car model in another car model, the solutions are mainly at lab-scale. In CarE-Service, the solution will be developed at the Fraunhofer ISI institute, which in fact is not an industrial actor. Accordingly, the production-scale estimation of the economic sustainability of the solutions and their corresponding business model should be managed attentively, even if quite challenging.

**Value-based Pricing**: Similar to reuse application of batteries, a critical requirement for remanufactured metal parts of the project is value-based pricing (Assigning a fair value to reused components compared to the new components/products). In this regard, the value-based pricing for the remanufacturing CarE-Service metal parts, can be proposed in following categories and align with past/future legal frameworks:

- Scrap
- Non-scrap: Parts that are reused through reforming; Parts that are appropriate for remanufacturing; Recycled metal material.
**Requirement to address the variability in procedures for diverse car ages, models, types and material compositions.** Since different car ages and models possess various material compositions, the reusability level of the parts and the purity level of the materials differ which directly influence the remanufacturing process. A recommendation here is to design primary testing on materials to determine their age and reusability capacity (maybe at dismantling site) for remanufacturers or recyclers.

**Design for Circularity incorporated in the new car models:** OEMs should adopt design for circularity practices, similar to all other circular economy approaches, to ease not only the second life of components but also consequent lives of each component including the metal parts.

**Economic Sustainability Incentive for remanufacturers:** Based on value-based pricing, precise cost and revenue models should be estimated to ensure remanufacturers on adoption of the solution.

**Increase the value/scale-up for production of remanufactured parts:** As a requirement, incentives for scaling-up the reuse and remanufacturing for acceleration of more proactive circular economy approaches compared to recycling has been a priority in automotive industry. However, the remanufacturing approach is up to now adopted mainly for hard engineering parts of the vehicles such as Engines, and not structural metal parts of the cars. Accordingly, this can be considered as a radical innovation in automotive but due to its opportunity potential, the scaling up should be the target.

**Harmonizing regional regulations through common European approach:** When it comes to remanufacturing approaches in general, and in particular mainly for structural metal parts of vehicles, there are some national regulatory frameworks. However, in order to assure economic sustainability for remanufacturers and also for European-scale exploitation of the solutions, harmonizing the regional regulations through a common European approach is needed.

**Assuring consumer on the remanufactured parts (market acceptance):** Customer acceptance on reused parts is an essential element in transition of OEMs in engaging in using reused parts in new branded cars. During marketing acceptance analysis of products, psychological effects (on the terminologies such as scrap) and full transparency on reusing
processes should be considered. While, regulations should eventually influence the consumers’ perception on reused parts, the efforts from associations and OEMs to analyse and change the precise customer perception would be facilitating the process.

**Improved the supply chain cooperation attitude of/towards dismantlers:** Dismantlers are key actors in remanufacturing processes of CarE-Service metal parts (as the main actor in take-back system of products). However, the readiness of supply chain actors in extensive cooperation with dismantlers is not yet clear, thus there could be a need to improve the supply chain cooperation attitude towards dismantlers. But of course, this is a bilateral cooperation, thus, similar attitude of dismantlers is expected towards other supply chain actors.

**Need to complete the supply chain with the other secondary applications:** At the moment, due to novelty of the solution, not a clear statistical analysis exists for reusability of metal parts at the EoL or when damaged (e.g. how much percentage of damaged vehicles could have reusable metal parts of the project). On the other hand, there are quite strict measures in automotive industry on reusing and their safety consequences and responsibilities. Thus, there is a need to consider the maximum number of secondary applications for reuse of vehicles’ metal parts, and correspondingly, to complete the reuse supply chain of automotive with other related reusing supply chains.

**Recycling strategy for process waste of remanufacturing operations:** As a more obvious requirement, there would be process waste in the remanufacturing processes (same amount as in the production system of a metal part). Still the business model behind the solutions should clearly put forward complementary recycling strategies for wastes in the remanufacturing processes.

To summarize, following figure highlights the key requirements for remanufacturing and treatment of metal parts considered in the project [Please refer to Figure 5 for Metal Parts that are the focus of CarE-Service in terms of Remanufacturing].
Figure 7: Summary of key requirements for the remanufacturing of CarE-Service metal parts

3.2.2 Business Model KPIs for Value Chain of Remanufacturing Metal Parts

According to the CarE-Service Grant Agreement, the Market acceptability of re-manufactured automotive parts is assigned to 70% (to be verified by production of outer skin automotive parts (i.e. a hood or roof) of FIAT 500e out of a part disassembled from another vehicle version or model). Furthermore, in the course of T1.1, the following additional KPIs are identified for value chain of remanufacturing metal parts.

Figure 8: Summary of project KPIs for the remanufacturing of CarE-Service metal parts
3.3 Business Model Requirements & KPIs for Value Chain of Reusing Techno-Polymer Parts Mainly through Recycling

Due to the diverse range of metal components in HEV/EVs, it is important to primarily highlight the focus of CarE-Service, when it comes to techno-polymer parts. In particular, CarE-Service aims at developing technical solutions and new business models for reusing mainly through recycling following techno-polymer parts, even if it is subject to change in later stages of project, the requirements are based on following parts:

![Techno-Polymer Parts Diagram](image)

*Figure 9: Techno-Polymer Parts that are the focus of CarE-Service in terms of Reuse Mainly Recycling*

To derive the business model requirements for the value chain that would reuse techno-polymer parts of HEV/EVs mainly by recycling, insights from the interviews with the experts of value chain from CarE-Service Consortium were merged. In particular, experts are:

- Radici Group: Expert in polyamide production chain;
- National Centre for Metallurgical Research (CENIM) of the Spanish National Research Council (CSIC): Expert in valorisation and recycling of several solid materials, liquid effluents and waste and sub-products via physical-, hydro-, and pyro metallurgical techniques of different industrial sectors;
• Fiat Chrysler Automobiles and FIAT Research Centre: Original Equipment Manufacturer of HEV/EVs.

![Figure 10: Stakeholders interviewed for the Technopolymers value chain](image)

3.3.1 Business Model Requirements for Value Chain of Reusing Techno-Polymer Parts mainly through Recycling

Drawn from combined insights of the above experts and members of the value chain, the following business model requirements were defined not only for recycling for reusing of the above techno-polymer parts in the automotive industry but also in other value chains (including furniture and electronics).

**Optimized Separation processes for shredded materials:** Due to variety of the techno-polymer parts, a primary separation process is needed for shredding materials. While, this requirement can be considered as a technical, from business model point of view, this requirement impose a primary step of separation of products, affecting the cost and environmental simulation of the business model.

**Optimized Time-base processes for material composition analysis:** One key challenge in this process is that reuse processes for techno-polymers require a detailed specification of the materials, since the status of the material will determine the appropriate reuse application. This may to some extent be minimized through categorization (prior requirement),
however this too does not ensure complete correctness. Currently, there aren’t any portable devices enabling fast identification of materials and the existing lab equipment that enables accurate evaluation takes long. Therefore, a simple and fast process of material customization identification is required, with minimum variance. This can be a process in the SMMs to identify the typology and status of the components from all material perspectives such as oil, both before and after reconditioning.

**Value based pricing for the diverse applications of battery reuse:** Similar to other circular economy approaches of the project, value-based pricing by assigning a fair value to reused components compared to the new components/products. For the Techno-polymer parts, the most suitable categorization, is value-based pricing for diverse applications.

**Assuring consumer on the recycled material/parts (market acceptance) (e.g. fair-trade concepts; Winning guarantee offerings):** As a requirement, marketing processes of products with recycled materials are less affected by the market acceptance since it may not even appear in the product. However, still psychological effects of labelling recycling should be considered in the market acceptance of its business model. While fashionable designs may be attractive on the market, lower costs are also a motivating factor for buyers (value-based pricing – above requirement). Therefore, definition of processes such as fair-trade concept approach with full transparency of reuse process can be leverages on users to be more convinced. Moreover, implementation of guarantee services for recycled materials may also motivate a rise in market acceptability for the reused products.

**Continuity maximization in input flow of EoL/damaged products:** For viability of the business model for techno-polymer materials’ reuse, in a similar vein to batteries, considering all applications, there is a need for guarantee on continuity and stability of material input flow. Future business models, therefore, need to assess ways of providing market availability for all value chain partners.

**Defining a portfolio of recycling strategies depending on the final application:** Ensuring a multi-model strategy of recycling is required due to the fact that for each application, one recycling process (with its relative cost of process with quality of output) is appropriate. To avoid carrying on recycling for a specific application with a process that gives even excessive quality of material with higher cost, a portfolio of recycling strategies and processes can be designed, if they can compensate the investment costs (to be verified in later stages of the project).
**Design for Circularity incorporated in the new car models:** Similar to other circularity approaches in other value chains, design for circularity is required for recycling techno-polymers to be reused in diverse application in various supply chains.

**Assuring Economic sustainability:** As a more obvious requirement, assuring economic sustainability of the process is identified. However, the logic behind stating the obvious requirement, in a similar vein to other cases, is the fact that the more critical aspect of this value chain is more on the economic sustainability of the solution, in compared to technological solutions or other aspects.

To summarize, following Figure highlights the key requirements for recovery of CarE-Service techno-polymer parts mainly through their recycling [Please refer to Figure 9 for Techno-polymer Parts that are the focus of CarE-Service].

![Figure 11: Summary of key requirements for the reusing CarE-Service techno-polymer parts mainly through recycling](image)
3.3.2 Business Model KPIs for Value Chain of Remanufacturing of Techno polymers

According to the CarE-Service Grant Agreement, Market acceptability of re-manufactured parts: 70%. Verified by re-production of at least ten new parts type (dashboards structures, battery supports, office chair supports, customized design products). Furthermore, in the course of T1.1, the following additional KPIs are identified for value chain of reusing techno-polymer parts mainly through recycling.

### Relative design feature of the recycled material compared to virgin material (e.g. color)

- Same

### Time for visual inspection

- <20 minutes

### Relative selling price of recycled material compared to virgin material

- Non-predictable (To be verified by demonstration)

### Percentage of recycled materials from the input material

- Recycling Rate > 98%

### Time for Chemical disruptive technique to recognize the polymer composition in laboratory (DSC)

- <2 hours

### Chance of upgrading possibility

- 0%

### Relative durability of recycled material compared to virgin material

- Non-predictable (To be verified by demonstration)

### Relative reliability of recycled material compared to virgin material

- Non-predictable (To be verified by demonstration)

### Percentage of techno-polymer material after extrusion in each part that can be considered as the input amount to the recycling

- 100%

### Number of total components in car that are usable for techno-polymers recycling

- 5 to 20

### Percentage of techno-polymer material after dismantling of the car in each part that can be considered as the input amount to the recycling

- Non-predictable (To be verified by demonstration)

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*Figure 12: Summary of project KPIs for the reuse of CarE-Service Techno Polymer parts mainly through recycling*
3.4 Business Model Requirements & KPIs for the CarE-Service ICT Platform

To derive the business model requirements for the ICT Platform, insights from the interviews with the experts of the platform design in the project consortium were merged. In particular, the following companies were interviewed:

3.4.1 Business Model Requirements for the ICT Platform

Drawn from combined insights of the above experts, the following requirements were defined for the business model of CarE-Service ICT Platform.

Addressing the Marketplace effectively (Meeting the supply and demand): As the key element of the business model behind the CarE-Service ICT platform – its marketplace - the enlargement of the market by meeting the supply and demand on the maximum level is identified as one of the key requirements. In this regard, the key requirement would be the capability of the ICT platform to engage a comprehensive set of companies (enrolled regarding diverse components of the three reuse value chains as well as from both supply and demand perspectives. To do so, the ICT platform owner company is required to offer additional services to both supply and demand companies in order to integrate a maximum number of companies in the platform. This is especially important not only to expand its network and consequently enhance its revenue, but also to gain competitive advantage. The service and business model requirements would consider, but not be limited to the following:

Figure 13: Stakeholders interviewed for the ICT Platform
• Role-based registration options: Different subscription packages with diverse fees for members depending on the competences members possess and show in the registration (e.g. buyer or seller). In addition, to ensure the maximum satisfaction of the enrolled companies, the business model of the ICT platform is required to offer multi-model revenue models for each stakeholder.

• Allowing qualifications on involved members and certified competences: offering the qualification criteria for enrolled companies (e.g. identification of criteria for quality evaluation of the enrolled companies as well as establishing structured review processes for other companies to review the other enrolled companies upon their collaboration).

• Guaranteeing the fair participation of different stakeholders especially within competitors: The platform will make sure that the supply and demand allocation will be not in favour of anyone, but the conditions of the contract will be among the parties.

**Addressing the logistics in the value chain integration:** As part of the integration of the value chain (as stated in the Grant Agreement of the project as the KPI of the ICT platform, the platform owner should effectively address the logistics. To do so, diverse service typologies may be offered by the Platform owner depending on the needs of the enrolled companies (e.g. premium, classic and economic packages). The foreseen key challenges for transportation services would relate to the transportation of the batteries within countries considering the national/European regulation on transportation of EoL/damaged batteries.

**Fulfilling the law on data security/protection (e.g. GDPR) and security measures both on individual and company level** (More information in D1.3): A necessary requirement for the business model behind the ICT platform, would be to fulfil all the law and regulatory frameworks on the data security and protection. This means to establish procedure to respect the confidentiality of the data respecting all European/National regulations, while maximizing the availability of customized data for each stakeholder.

**Addressing traceability of product data and testing results in the certification of used products or components:** As part of the interdisciplinary requirement with Smart Movable Modules, the ICT platform will act as the platform where SMMs can show the traceability of the product and testing data for their market acceptance. This can be unified with the business
model behind the SMMs or separated depending on the exploitation plan of the project. The platform will provide supporting activities to the SMMs. Apart from the basic functionalities (book, order, etc), the platform will give the opportunity to SMMs to interact with the marketplace. When a demand from the marketplace is placed, the SMMs will receive the information in order to fulfil the demand of the marketplace (e.g. someone is looking for a door for a FIAT 500e, then the SMMs will able to target to extract a door for a 500e, etc.)

**Identifying the potential members of the platform for the future exploitation of the platform**

(not to be targeted in the design of the platform): for a thorough cost-revenue model of the ICT platform along for the future exploitation plan of the project, thorough statistic on the potential population of enrolled companies is needed for each stakeholder type (e.g. remanufacturers, recyclers, dismantlers, repair shops, car manufacturers). The analysis will support the CarE-Service to identify the minimum number of companies needed to ensure the economic sustainability of the ICT platform and the business plan behind it.

To summarize, the following Figure highlights the key requirements for Business Model behind the CarE-Service ICT platform.

*Figure 14: Summary of key requirements for the Business Model of CarE-Service ICT Platform*
3.4.2 Business Model KPIs for the ICT Platform

Furthermore, in the course of T1.1, following KPIs are identified for business model of the ICT Platform.

- **No. of membership types**
  - Minimum 2 (e.g. Gold & Silver)

- **No. of roles members can register**
  - Minimum 3 (e.g. Buyer, seller, etc.)

- **No. of registered companies in each role during the course of the project**
  - Minimum 1

**Total No. of members enrolled in the platform during the CarE-Service project**
- 20 (consortium partners and 5G companies)

**No. of members enrolled in the platform during the CarE-Service project leveraged by other H2020 projects**
- Minimum 5

*Figure 15: Summary of project KPIs for the business model of ICT Platform*
3.5 Business Model Requirements & KPIs for CarE-Service Smart Movable Modules

In CarE-Service project, two smart movable modules are planned to be demonstrated. First Module for disassembly and second module for testing and certification.

Since, both Smart Movable Modules are planned for the CarE-Service components, it is important to be reminded here the focus of CarE-Service in terms of components (Batteries, Figure 5 of metal parts, and Figure 9 of techno-polymer parts). To derive the business model requirements for the Smart Movable Modules, insights from the interviews with the experts of disassembly, testing and certification were merged both from the CarE-Service Consortium and the Stakeholder Group.

![Diagram of Smart Movable Modules](image)

**Figure 16: Two Smart Movable Modules for Disassembly, Testing and Certification**

![List of Stakeholders](image)

**Figure 17: Stakeholders interviewed for the Smart Movable Modules**
3.5.1 Business Model Requirements for Smart Movable Modules

Drawn from combined insights of the above experts, following requirements were defined for the business model of CarE-Service Smart Movable Modules.

*Optimized the routing of the two modules that could operate separately:* This requirement deals with ensuring the continuous flow of optimum number of components from the 1st module to be tested in the 2nd SMM for its economic sustainability considering the logistic optimization of the process.

*Compliance with operator safety requirements and urban movable vehicle legislation:* Generally, due to the need for an expert operator with the technologies in SMMs (e.g. in terms of interfaces’ safety with regards to the operator safety) as well as their movability (e.g. in terms of length/weight/height or frequency-level of the robotic solutions in the vehicle moving in areas), compliancy with the safety levels for both approaches will be assured. In order to specify the exact measurements during course of the project, the logistics of SMMs should be mapped accordingly.

*Fast quality control process for immediate part qualification and optimal routing in the reusing network to understand macro-strategy:* The key requirement identified, is the fast-primary quality grading of the damaged and EoL components in order to identify the qualification of parts for reusing and to identify primary and secondary applications. This tailored time-specific procedure should be designed based on the quality required for each application of each component, the time needed for the procedure and the cost of the procedure. In this regard, many components should be tested for the primary qualification test in order to build the capability to select processes based on the possible trade-off between their cost and their complexity. Accordingly, a threshold number of components to be tested will be identified in later stages of the problem, depending on the specific procedure for each component. Moreover, this requirement will impose the need for supply chain actors of all potential applications to identify different options of quality (with corresponding price) for each application of each CarE-Service component.

*Full tracking of disassembly and testing processes with full transparency:* This requirement is aimed at guaranteeing legislation for dismantlers (in terms of disassembly process) as well as guaranteeing full transparency in testing procedure for other business users. To do so,
demonstration of showcases and the real-time reassurance of users on the re-qualification of reused parts are the possible initiatives for coping with this requirement.

To summarize, the following Figure highlights the key requirements for business model of the Smart Movable Modules of the project both for disassembly and testing/certification:

- Optimized the routing of the two modules that could operate separately
- Compliance with operator safety requirements and urban movable vehicle legislation
- Fast quality control process for immediate part qualification and optimal routing in the reusing network to understand macro-strategy
- Full tracking of disassembly and testing processes with full transparency

Figure 18: Summary of key requirements for the Business Model of CarE-Service Smart Movable Modules (Containers with Disassembly and Testing/Certification Technologies)
3.5.2 Business Model KPIs for the CarE-Service Smart Movable Modules

According to the CarE-Service Grant Agreement, following KPIs for SMMs are already anticipated: disassembly time < 2 hours per car, at least 3 experiments on a car model is anticipated for all parts of CarE-Service, Acceptability of modules by human operators >95% (to be verified by means of questionnaires). Furthermore, in the course of T1.1, the following additional KPIs are identified for business model of CarE-Service SMMs.

![Image of KPIs](image.png)

**Figure 19:** Summary of project KPIs for the Business Model of CarE-Service Smart Movable Modules (Containers with Disassembly and Testing/Certification Technologies)

3.6 Summary of Business Model Requirements for B2B solutions of the project

On business-to-business logic, there are several BM and service requirements, based on interviews with twenty actors of the value chains. In particular, the B2B BM/service requirements and KPIs were identified particularly and in detail for the five value chains of the project, namely: battery, metal and techno-polymer recovery and/or reuse value chains as well as Business Model of the SMMs and ICT platform [Please refer to section 3]. In this section, we attempt to conclude by integrating all perspectives and draw the general key messages and the key requirements for CarE-Service project idea as the future innovative circular mobility system.
There are similar requirements within majority of the five business models mentioned above, as the general Business Model Requirements for B2B solutions of CarE-Service. In following, the general requirements are concluded:

**Value-based pricing:** This requirement consists of assigning a fair value to recovered products, components and materials considering its comparison with the new ones. This implies a reduction in price by a range of 10-20% -unless in few cases where the recovered material has the exact same properties of the virgin material- to ensure the market penetration of products, components or materials.

**Assuring Market Acceptance:** Marketing strategies to ensure the business users on the quality, reliability, durability of the received components, materials and services is another common requirement in the B2B solutions of CarE-Service. The marketing strategies include but are not limited to warranty/guarantee packages for reused components/materials. In addition, the marketing mechanisms and regulatory frameworks necessary for changing the customer attitude towards recovered components and materials are necessary. This is due to the fact that customers in many European countries still consider the recovered components and parts as lower quality pieces. The collaborative approaches can ensure also the market availability for all value chain partners, enabling the capacity management to deal with unexpected fluctuations in supply or demand.

**Data traceability for reuse applications:** Structured mechanisms on assurance of users on information transparency under for instance fair-trade concept approach is another common requirement for reused products. The information transparency and structured mechanisms to deliver the full activities carried out for recovery are set as a key requirement for BM and services of future circular mobility systems. Due to the complex confidentiality of information exchanged in the value chain, specific (bilateral) contracts should be taken in consideration to ensure confidentiality while maximizing the fairness of responsibility division and sharing information within the value chain partners.

**Design for Circularity:** As a requirement, design for circularity including design for easy disassembly, treatment and recycling is another key requirement which is a pre-requisite for effective and efficient circularity approaches in the value chains.
Win-win situations for all actors involved in the value chain by maximizing the horizontal and vertical cooperation: The added-value created by the circular mobility systems should be optimally distributed in the value chain. The bargaining power balance can be achieved as a result of collaboration between companies, which in fact encourages the continuity of value chain collaboration. To this aim, a fair distribution of the economic value of the final product; appropriate contractual agreements; fair distribution of the extended responsibility can be exemplified as solutions coping with this requirement. This collaboration should not be subject only to horizontal cooperation (with diverse actor types of the value chain), but also within each tier of the value chain (called as coopeetition or cooperation while competition as vertical associations among one tier of the supply chain). To name an example of the vertical collaborations, the contractual agreements between remanufacturers with diverse competences are required to derive a sharing economy and resources. More open platforms that can involve more value chain actors are required to enable the successful implementation of fair, transparent but confidential cooperation and coopeetition. The sharing economy and resources between the value chain should go beyond the differentiation of B2B from B2C business models and shall try to maximize the integration of the B2B and B2C models. In order to make sure the collaboration and fair distribution of resources will happen in the future innovative business models; a structured incentive mechanism is needed for all value chain actors.

Single-EU Market: The current market of HEV/EVs is not large enough at both local and at national level in most cases for reusing value chains. This results in lack of saturation and accordingly jeopardizing economic sustainability of the remanufacturing and recycling firms. This requirement can be coped with in a twofold approach: from one hand, the mechanisms supporting the Single-EU market should be enforcing; from the other hand, it is necessary then to scout business opportunities not only inside the automotive sector but also maximizing the secondary applications for recovered components and materials.

Addressing innovative logistic systems for damaged/EoL components of EV/HEV: Drawn from the data collected in this report, there seems to be caveats regarding the development of the logistics mechanisms for EoL/damaged HEV/EVs. The most critical is the battery, which must be removed from the vehicle prior to successive treatment operations. Special safety measures and diverse national regulations for transportation of such components heavily influence transportation logistics, and therefore logistics costs. On the other hand, there
could is a trade-off between adverse environmental and economic impact of logistics with single-EU market. Thus, innovative logistics then must be tailored for each of these cases in order to optimize the associated costs for transportation.

Assuring Economic Sustainability for Manufacturers by incentives for Mitigating cannibalization risk and for Treatment facilities: In principle, as a general and kind trivial requirement, we need to ensure the economic sustainability for manufacturing and treatment facilities both. Regarding manufacturers, in marketing strategy, cannibalization refers to a reduction in sales volume, sales revenue, or market share of one product as a result of the introduction of a new product by the same producer. Cannibalization is present particularly when bringing to the loop of second life components that may reduce the sales volume of the new components marketing. An important requirement of the future circular mobility is to mitigate the cannibalization by several means, including but not limited to: ensuring the economic sustainability of second life engagement for OEMs by guaranteeing the sufficient and growing market of both demand and supply of recovered components; expanding and targeting the specific market segment of customers who are oriented towards more environmental products or cheaper components; introduction of advanced servitization in mobility vehicles’ sale in order to boost the market for recovered components; increasing the uniqueness of recovered components for that’s attuned to the needs in the market; mapping the value of the parts and components with the higher value added, and also the value of their closest substitutes. On the other hand, for remanufacturers, the assurance of economic sustainability is to ensure big production, continuous flow of input and output as well as detailed estimation of Cost/Revenue Model.

Capability to address the variability in procedure for diverse car models: The combined insights of the experts and members of the value chain show the dependence of almost all procedure on the car models. To cope with this requirement, the technological solutions should include either standardized processes or should be adaptable to diverse algorithms corresponding to various car/product models.

Tuning quality ratio of cost for recovering processes based on the needs of applications: Tuning the quality of a component to a level not exceeding the specific needs of a given application is another requirement set thanks to the data collected in this report. The logic behind is the fact that recovery processes can be quite costly, jeopardizing the economic
sustainability of the recovery business models, if less quality of the output is demanded. This will result in additional benefit and competitive advantage for the users of the products/components/materials since they will not pay more for an overqualified component. In order to meet such requirement, preliminary tests are needed on each damaged or EoL part to determine the optimal reuse application channel depending on the health status of the part as well as the available market of the secondary applications. To this aim, there is a need of establishment of clear regulations and incentives for circularity in multi-sectorial approach, respecting the country level standardization and national market for each secondary application. The general Requirements are summarized in the following Figure.

Figure 20: Summary of common requirement for the Business Model of CarE-Service B2B solutions
4 B2C REQUIREMENTS AND KPIs

This section of the deliverable explores the business model requirements on the B2C section. These were derived from a combination of interviews with industry stakeholders, focus groups and a consumer survey. The figure below shows an outline of the B2C section.

Figure 21: Outline of the B2C section

4.1 Business Model Requirements derived from the Combined Interviews.

The interviewed stakeholders include mobility services providers, OEMs, regional policy makers and charging infrastructure implementers as shown in the figure below.

Figure 22: stakeholders interviewed for the B2C section.
4.1.1 Mobility Services Providers

The mobility service providers interviewed include both short and long-term mobility service companies, car-sharing service providers and car renting service providers. With the rapid changes in the industry, OEMs are finding it difficult to identify a precise framework for the future of electric mobility especially regarding end of life treatments. They have had to revise their business models to accommodate changing market demands, which strategy has seen many OEM venture into provision of mobility services. The following business model requirements have been derived as a result of combined insights from the interviews.

**Wider implementation of charging infrastructure:** Range anxiety is a prevailing barrier for adoption of electric vehicles. Interviewees expressed that customers tend to choose combustion engine vehicles over electric vehicles even when presented with both options at the same price because customers unaccustomed to using electric vehicles are often doubtful of the electric vehicle’s battery capacity to get them to their desired destination. Efforts should thus be focused on wider implementation of charging infrastructure. A further requirement for this challenge is investment into technologies for prolonging battery lives. These factors are important for electric vehicle adoption as they will encourage increased use of electric vehicles on longer journeys and serve to reduce range anxiety.

**Standardisation of payment methods for charging infrastructure:** Absence of a standardised payment form for public charging of electric vehicles is one of the factors posing a challenge to mobility service providers’ adoption of electric cars. Users of electric vehicles often need different charging cards to enable them access to charging infrastructure from the various implementers. Since many of the carsharing and car renting service users are often one-time users, this serves as an inconvenience. Alignment of payment methods at charging stations is thus recommended to ease payment processes for customers.

**Implementation of a multi-mobility approach:** Many customers are primarily driven by price and convenience in their choice of mobility service providers. To increase customer satisfaction, car utilization and profits, a multi mobility approach integrating both B2B and B2C business models is encouraged since B2B opportunities may give the critical mass needed by the sheer volume of transportation and hence the number of cars. B2B and B2C customers often have different usage patterns; daily working hours for the B2B market while the B2C
market may prefer to use the cars in the evenings, weekends and holidays, thereby maximising the utilisation rate. Hereby, market segmentation and targeting customers with different needs, based for example on the type of trip, and user profile is encouraged to create better services for each customer segment.

**Use of automatic vehicle monitoring systems:** As carsharing services blossom and operators’ vehicle fleets continue to enlarge, it becomes increasingly difficult for service providers to monitor and schedule vehicle repairs, services and washes. It is thus essential that carsharing business models facilitate automatic vehicle monitoring systems to enable them keep up to date with required fleet services such as vehicle services, washes, etc in order to satisfy their users and hence create a professional impression on users.

**Government intervention:** In addition, rapid advancement in electric vehicle technology for example battery manufacturing technologies renders fast extinction of existing technology, thereby discouraging mobility services providers from heavy investment in electric vehicles. As a requirement for circular economy approaches, there is need for regulation bodies to get involved through lobbying for tax reductions and carpool recognition at parking lots to reduce costs.

![Figure 23: Summary of requirements for mobility services providers](image)
4.1.2 Charging Infrastructure Implementers

As a facilitator for adoption, charging infrastructure is an inevitable component of the electric and hybrid electric vehicle value chains. Almost all interviewed stakeholders mentioned importance of charging infrastructure as a requirement for market advancement of electric vehicles. The following requirements for charging infrastructure implementation were derived to facilitate development of innovative business models in the sector.

*Development of an umbrella power grid network:* The main challenge facing charging infrastructure implementers currently is the threat of weak power grids. With increase in electric vehicles comes an increase in charging infrastructure requirements, which may not be accommodated by the current power grids in most cities especially at peak hours. Reinforcement of the grids will require heavy capital investments, for which it is still unclear who would foot the bill. A related challenge comes with the installation requirements for private housing companies where cable changes needed to accommodate capacity requirements may come with heavy extra costs. These costs are burdensome for the companies who may not be prepared for them. The stakeholders are thus currently faced with the challenge of finding solutions to this major threat. An alternative to this problem may be the development of an umbrella system with even smarter charging systems capable of balancing current distribution within a grid according to the requirements at peak hours.

*Availing charging infrastructure in residential areas to enable overnight charging:* Limited charging opportunities in apartment building residential areas is a prevailing hurdle hindering electric car ownership as overnight charging becomes challenging. Efforts to convince landlords about the need for installation of charging infrastructure in residential areas have in the past not been successful as electric vehicles have not been greatly considered. With increased demand, however, landlords are beginning to realise the need for charging infrastructure and embracing the idea. Additionally, by offering subsidies on the purchase of electric vehicle charging equipment for private individuals governments help to enable affordable overnight charging at home thereby boosting a steady increase in the demand for electric vehicles.

*Standardisation of payment systems for public charging infrastructure within Europe:* There are different companies working with the installation of charging infrastructure, each with
their own charging cards required for identification at the charging stations. Electric vehicle owners require at least 3 different cards that identify them at different charging stations within one country. If one were to take their car abroad, they would require even more charging cards to access charging infrastructure, which is an inconveniencing factor for electric vehicle users.

**Mobile platforms that enable location of available charging infrastructure:** The possibility for electric vehicle drivers to map their journeys according to the available charging stations is a vital requirement for convenience. Unified mobile platforms that enable drivers to locate available charging stations are required. So far, this has been facilitated through online apps showing drivers the locations of charging stations, what kind of chargers there are and their availability in real time.

**Summary of Key challenges and requirements for mobility services expressed by charging infrastructure implementers.**

A. Development of an umbrella power grid network
B. Availing charging infrastructure in residential areas
C. Standardisation of payment systems for public charging within Europe
D. Mobile platforms that enable location of available charging infrastructure.

*Figure 24: Summary of requirements expressed by charging infrastructure implementers*
4.1.3 Policy Makers/Implementers

As part of the group that sets regulations governing the mobility sector, policy makers and implementers have the ability to influence electric vehicle adoption and use of mobility services. Regional/municipal bodies have a duty to implement targets set by governments on the progress of circular economy practices within the transport sector and renewable energy goals, which include electrification of fleets. The following requirements to foster business model innovation within the mobility services sector were derived from interviews with some policy makers.

Clear goal setting: Clear goals on adoption of environmentally sustainable solutions such as use of mobility services and adoption of electric vehicles need to be set at national and municipal levels to influence decisions at lower state-owned organisations. This could be in form of projects aimed at encouraging circular economy solutions in the transport sector and use of electric vehicles. Fleet managers could be encouraged to opt for more renting and leasing solutions instead of car ownership which is costly especially when the cars are redundant. This can be done through tracking the cars and mapping their journeys to show distances covered and redundancy rates.

Initiation of partnership projects between municipalities and car dealers: Since use of electric vehicles is still considered a relatively new venture, there is still lack of trust for the technology and capacity of the vehicles among both fleet managers and car drivers. Besides early adopters, most people tend to have a negative attitude towards new technology. Partnership projects between municipalities and car dealers are relevant to enable of testing periods for electric cars in order to facilitate cultivation of trust required to boost electric vehicle adoption. This will give vehicle users an opportunity to test the technology without committing to owning it, and consequently eliminate the barrier of using new technology.

Introduction of incentives for EV owners: Incentives such as free parking or access to bus lanes, may also be necessary to show cost efficiency in terms of numbers achieved from use of electric vehicles in comparison to ICE vehicles.

Facilitation of charging infrastructure implementation: An additional requirement for boosting electric vehicle adoption is the availability of charging infrastructure, where
regions/municipalities may also need to take an active role in facilitating its implementation. Moreover, state owned organisations need to set the example for car users by being the first to adopt these environmentally sustainable mobility services and use of electric vehicles.

**Summary of business model requirements from policy implementers**

<table>
<thead>
<tr>
<th>Setting clear goals on environmentally sustainable solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment of partnerships with car dealers to avail testing opportunities for new EV technology</td>
</tr>
<tr>
<td>Incentives such as free parking for EV users</td>
</tr>
<tr>
<td>Taking a front row in facilitation of charging infrastructure</td>
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*Figure 25: Summary of Requirements from Policy Implementers*
4.2 Business Model Requirements Derived from the Consumer Survey

The consumer was mainly targeted towards users of various car-sharing services, including rental services with an aim to understand users who rely on electric and/or hybrid electric vehicles. The overall purpose was twofold: first, to collect information relevant for the project on mobility usage patterns, drivers and barriers as well as needs of the users and second, to act as an informative source on innovative and sustainable mobility solutions such as carsharing, short term car renting and use of electric vehicles. The survey was further purposed to capture limitations of current electric and hybrid electric vehicle offerings and acceptance criteria from various customer groups within Europe. With the results, both qualitative and quantitative techniques were used to present an in-depth analysis of customer experience, drivers and barriers of carsharing and short-term renting, as well as relevant key performance indicators to users.

Considering our central premise, the following research questions were formulated (Totten, Panacek and Price, 1999):

**Research Question 1.** Which factors influence (positively or negatively) customers’ choice of non-ownership mobility services (such as car-sharing, renting, leasing, pooling, etc.)?

**Research Question 2.** Which factors influence (positively or negatively) customers to choose electric/hybrid electric vehicles in non-ownership-based mobility?

**Research Question 3.** What is missing in the current market offering of mobility services with respect to customers’ needs?

**Research Question 4.** Can a greener approach to the life cycle of electric vehicles incentivise customers to increase the recourse to non-ownership mobility services?
4.2.1 Survey Design

Questions on frequency and purpose of use of carsharing/short term renting services were asked at the beginning of the survey to determine relevance of the follow up questions to the respondents. Following these were questions purposed to determine drivers and barriers of carsharing/short term renting among respondents. A review of past literature in the field of carsharing services, including prior surveys among consumers, (Hawlitschek et al., 2016; Tuan, 2000; Hartl et al., 2018; Schaefers, 2013) enabled categorisation of the survey into eleven major constructs, to which relevant attributes were formulated in the form of statements. These constructs were purposed to determine the level of influence, on both choice of electric vehicles during carsharing as well as choice and continued use of carsharing/short term renting services in general.

For purposes of relevance, the survey had a skip logic, meaning that depending on the group of respondents, different and/or additional questions were asked. For example, if one group of respondents had experience of using electric vehicle offerings, additional questions not only about their attitudes towards such offerings but also about the actual customer experience were asked. Hence, not all questions in this survey were necessarily asked to all consumers.

Specific to the drivers for choice of electric vehicles were questions on shared values aimed at analysing reasons why people choose to use electric vehicles over Internal Combustion Engine (ICE) vehicles during carsharing/short term renting. Human beings are said to have a conditional preference for their actions that is dependent on what they and the society around them believes is the right thing to do (Bicchieri and Xiao, 2009). With the attributes under this construct, the survey aimed at measuring how to what extent conditional preference influences respondents’ choice of vehicle. In addition, respondents’ perceived convenience when using electric vehicles in carsharing was measured with questions aimed at assessing the extent to which customers considered electric vehicles to be readily available, their ease of use and ways in which they make users’ lives easier (Kleinaltenkamp et al., 2018). The level of convenience may influence both sharing tendency and choice of electric vehicle (Schaefer, 2013; Lindloff et al., 2014).
Following convenience are questions on trust, which aim at measuring the level of trust users have in the electric vehicles available to them during carsharing/short term renting services. This may influence both sharing tendency and choice of electric vehicle (Garbarino and Johnson, 1999).

Other constructs aimed at carsharing/short term renting in general include:

Sustainability orientation (Alsmadi 2007) and environmental perception (Kleinaltenkamp et al., 2018) of carsharing/short term renting services, both of which may influence users’ sharing tendency. Questions were also asked to determine users’ level of frugality, which is believed to influence their price perception of carsharing/short term renting services (Akbar et al., 2016), (Kleinaltenkamp et al., 2018). This was followed by questions measuring users’ level of appreciation for the social nature of carsharing services. With this, the aim was to assess the extent to which customer’s perception of their carsharing social experience influences their sharing tendency (Akbar et al., 2016).

Questions on general satisfaction with carsharing/renting services are also asked towards the end and were followed by questions on customers’ intention to start/continue using carsharing/short term renting services in the future (Garbarino and Johnson, 1999).

It was deemed important to know who the respondents were, and this was achieved through questions on demographics which came at the end of the survey (Totten, Panacek and Price, 1999), enabling building of respondents’ profiles. These included questions on car/other vehicle ownership, gender, age, household size, income level, education level and country of residence.

4.2.2 Survey Dissemination

With the help of the consortium partners, the survey was translated to five European languages, besides English: French, German, Italian, Portuguese and Spanish. This was to enable its administration within at least six different European countries. The distribution channels were as follows: Project website and Twitter account, Partners’ institutional channel such as distribution in colleagues and on partners’ website/platform (e.g. E-vai platform), Consumer associations e.g. Altroconsumo and Assoutenti Lombardia, Public administrative bodies such as Citta Metropolitan Milano, Personal social media channels of consortium
partners e.g. LinkedIn, Facebook and Tweeter accounts of individuals, Around 80 mobility-related Facebook Groups.

Consumer associations e.g. Aтроconsumo and Aсsoutenti Lombardia. Public administrative bodies such as Citta Metropolitan Milano.

Survey distribution channels

- Mobility related Facebook groups
- Consortium partners’ LinkedIn accounts
- Consortium partners’ emails and websites
- CarE-Service website

**Figure 26: Survey distribution channels**

4.2.3 Analysis of Survey Results

The survey was filled out by 144 respondents across more than 6 countries. Below is a descriptive analysis of the results. As the survey was disseminated in six countries, the distribution of respondents according to country of residence is as shown in figure below.

Spain had the highest response rate at 29.2%, followed by Germany at 26.4% while Sweden and France had the lowest at 5.6% and 2.1% respectively. Respondents from other countries included: Switzerland, England, Finland, Poland and Belgium.

**Figure 27: Survey respondents by country of residence**
4.2.3.1 *Income and education level*

25.7% of respondents have an income above €4000 after tax, which is the highest categorization based on income. Only 3.5% of respondents earn below €1000 a month after tax. Majority of the respondents, 81.7% are graduates with a university degree or higher qualification while 16.7% have a high school certificate. The table below shows the survey respondents by income group.

<table>
<thead>
<tr>
<th>Income Group (€)</th>
<th>Total Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1000</td>
<td>5</td>
<td>3.5%</td>
</tr>
<tr>
<td>1001-2000</td>
<td>32</td>
<td>22.4%</td>
</tr>
<tr>
<td>2001-3000</td>
<td>25</td>
<td>17.5%</td>
</tr>
<tr>
<td>3001-4000</td>
<td>23</td>
<td>16.1%</td>
</tr>
<tr>
<td>Above 4000</td>
<td>37</td>
<td>25.9%</td>
</tr>
<tr>
<td>Not mentioned</td>
<td>21</td>
<td>14.7%</td>
</tr>
</tbody>
</table>

*Table 4: Survey respondents by income group*

Most respondents are not frequent users of carsharing/renting services as only 0.7% responded to have used carsharing/renting services on a daily basis, 4.9% on a weekly basis and 16.7% on a monthly basis. 39.6% of respondents reported that they have never used carsharing/renting services. Since the survey was designed with a skip logic, most of the questions specific to experience of carsharing/renting services were not relevant to the group that had not used carsharing services, leaving missing data in majority of the cases. The table below shows the frequency of use of carsharing/renting services by respondents.

<table>
<thead>
<tr>
<th>Frequency of use</th>
<th>Total Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>1</td>
<td>0.7%</td>
</tr>
<tr>
<td>Weekly</td>
<td>7</td>
<td>4.9%</td>
</tr>
<tr>
<td>Monthly</td>
<td>24</td>
<td>16.7%</td>
</tr>
<tr>
<td>Yearly</td>
<td>55</td>
<td>38.2%</td>
</tr>
<tr>
<td>Never</td>
<td>57</td>
<td>39.6%</td>
</tr>
</tbody>
</table>

*Table 5: Frequency of use of carsharing/renting services by respondents*
4.2.3.2 Factors motivating use of carsharing/renting

Respondents who have used carsharing/renting services were asked to rate their reasons for using carsharing services over alternative transport means on a scale of 1-5, 1 being the lowest score and 5 being the highest score. As shown in the figure, most respondents were motivated to use carsharing services due to the fact that they do not need to assume any responsibilities for car maintenance costs. More than 70% of the respondents on this question rated this factor with either 4 or 5 which are at the higher end of the scale. Other reasons motivating their choice were cheap services and no initial investment required. Availability of diverse car models was valued as the least influential factor in the choice of carsharing services by respondents and having a mean score of 2.06 which is below the scale average of 3. Respondents state other aspects motivating them to use carsharing/renting services as: possibility of making one-way trips in point-to-point business models; extra advantages of using carsharing services within the city such as easier access to parking; is an alternative to public transport when travelling abroad, carsharing is convenient as it is easier and faster; social nature of carpooling and ride sharing models since one always has company during the trip. The figure below shows the mean rating of reasons for using carsharing/renting services by respondents.

![Figure 28: Mean rating of reasons for using carsharing/renting services by respondents](image)

4.2.3.3 Factors preventing use of carsharing/renting

Respondents were similarly asked to score the reasons preventing them from using carsharing services on a scale of 1-5, with 1 being the lowest and 5 the highest. As highlighted in figure
2, the limited number of pickup points is the main barrier for use of carsharing/renting services. Other factors preventing the use of carsharing/renting services include unsuitability of the services to the users’ needs as some respondents state that using carsharing/renting services may not be well suited for certain family situations, for example if one has children that need to be transported to several activities frequently. Additionally, lack of control over unexpected issues that may hinder users from reaching their destinations is another factor limiting the use of carsharing services. A revelation was the low influence of price as a barrier for using carsharing services as the respondents scored it below the average mean score of the scale. Other factors mentioned by respondents in the survey that made them reluctant to use carsharing/renting services include:

a. Many offerings have round-trip business models which are unsuitable for users who may only need to travel from one point to another.

b. Often carsharing/renting services have a specific limit to the number of hours that one can use the cars, or else it quickly becomes expensive. This limits customers who may want to take the cars for longer trips, for example overnight or weekend trips.

c. The services are mostly available in the larger cities. Most smaller size cities have very few offerings, since low overall population and low population density makes it challenging to have a high number of pickup points in smaller cities hence limiting use of carsharing. The figure below shows the mean rating of factors preventing use of carsharing/renting services by respondents.

![Figure 29: Mean rating of factors preventing use of carsharing/renting services by respondents](image-url)
4.2.3.4 Type of car used during carsharing/renting services

Of the total respondents who use carsharing/renting services, a significant majority of 73.8% answered that they mostly use ICE cars, while 22.6% use electric vehicles and only 3.6% use hybrid electric vehicles. The figure below shows the choice of vehicle by respondents during carsharing/renting.

![Figure 30: Choice of vehicle by respondents during carsharing/renting]

4.2.3.5 Reasons for choice of ICE vehicles

Respondents who use ICE vehicles answered that their decision was mainly influenced by the provisions of their service providers who in most cases only offered ICE vehicles. Limited charging infrastructure was the next factor influencing respondents’ choice of electric vehicles. Similar to reasons for choosing to use carsharing services, the price is not seen as a very influential factor for the choice of ICE vehicles over electric vehicles. The figure below shows the mean score of factors influencing use of ICE vehicles by respondents.

![Figure 31: Mean score of factors influencing use of ICE vehicles by respondents]
4.2.3.6 Reasons for choice of electric vehicles

On a scale of 1-5, respondents who use electric vehicles rated low emissions as the highest influencing factor for their choice, followed by the extra advantages attained from using electric vehicles such as free parking, access to driving in the bus lanes and exemption from congestion charges in some cities. Some consumers also mentioned curiosity and the need to get the driving experience of an electric car as reasons for their choice of using electric cars. The better driving experience and perception of electric vehicles as a prestigious choice were the least influential factors in the respondents’ choice of electric vehicles. It can also be noted here that price was not a major motivating factor for the choice of electric cars over ICE vehicles in carsharing/renting. While the purchasing price for electric vehicles is significantly higher than equivalent ICE vehicles, overall the study finds that carsharing service providers with a mixed fleet tend to have identical/similar prices on their ICE and electric/hybrid options. The actual usage costs may be influenced by public stakeholders subsidising electric/hybrid options (e.g., free parking, no tolls, tax deductions), which lowers the operating costs. Hence, the survey results would confirm results from the qualitative parts of the study, which finds that carsharing providers may not use pricing as a differentiator between ICE and electric/hybrid options. The figure below shows the mean score of factors influencing use of electric vehicles by respondents.

![Figure 32: Mean score of factors influencing use of electric vehicles by respondents](image)

4.2.4 Business Model Requirements derived from the Consumer Survey

Before deriving requirements for the business models, we need to recap and take a look at our research questions for the survey. From the results of the survey, we were able to identify several factors that influence, both positively and negatively, customers’ choice of non-
ownership mobility services such as carsharing/short-term renting. We similarly identified several factors responsible for both positive and negative influence of customers’ choice of electric vehicles during carsharing/renting services. We can thus identify factors that may be missing in the current market offering of mobility services with respect to customer needs. A significant percentage of the respondents (39.6%) stated that they have never used carsharing/renting services. This shows that there is a need to design more attractive business models that will encourage more users to engage in the services. The following requirements for future business models within the mobility services sectors have been derived:

*Adoption of multi-model approaches:* To encourage more users and cover a wider market, carsharing/renting business models need to explore opportunities of multi-model approaches where point-to-point business models can be integrated with round-trip business models. While users who may only need to make one-way trips appreciate the point-to-point models also for their convenience in finding parking space, operating round-trip models minimizes car redundancy. Therefore, integrating the two business models may be a way to capture a larger market. Similarly, carsharing/renting services providers should consider integrating the needs of other market segments such as families with children and provide car models and pricing solutions that suit these segments. An example could be the provision of car seats for children as an extra facility to encourage more users.

*Use of a green marketing approach will attract more users:* A revelation was seen that price is not the main driving factor responsible for the dominant use of ICE vehicles over electric vehicles. The survey results show that it is the limited availability of offerings driving the use of ICE vehicles and environmental aspects such as low emissions that drive the use of electric vehicles. As this shows an appreciation for electric vehicles by users for their low emissions, it can thus be considered to validate a response to our fourth research question and, therefore, state that a greener approach to the lifecycle of electric vehicles may serve to incentivize customers to increase the resources to non-ownership mobility services.

*Maximise the use of online platforms to provide additional services to users:* This insight was derived from the revelation that carsharing/renting users appreciate use of online platforms as a facilitator for their experience. This can thus be used as a validation for recommending the need to harness the role of online platforms that ease booking and payments processes when designing business models for carsharing/renting services.
4.3 Business Model Requirements from the Focus Groups

4.3.1 Focus Groups Design

Complimentary to the survey, focus groups were carried out in Sweden, Italy, Spain, Germany and Portugal. The purpose of the focus groups was to gain in-depth and qualitative perspectives from end users that may not easily have been attained through the survey’s quantitative nature (Totten, Panacek and Price, 1999). These may complement the survey data through posing open-ended, exploratory questions. For each focus group, a set of predetermined questions were prepared to which follow up questions were asked during the discussions. The table below shows the focus groups conducted and the main take-aways from each focus group.

<table>
<thead>
<tr>
<th>Discussion Topics</th>
<th>Main Requirements Derived</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td></td>
</tr>
<tr>
<td>Drivers and barriers of carsharing/renting services.</td>
<td>Capacity management due to demand fluctuation</td>
</tr>
<tr>
<td>Drivers and barriers of EV ownership.</td>
<td>Multi-stakeholder collaboration to improve convenience</td>
</tr>
<tr>
<td>Engagement in non-ownership mobility services.</td>
<td>Collaboration with public transport providers.</td>
</tr>
<tr>
<td>Mobility needs of employees related to work trips.</td>
<td>Competitive pricing</td>
</tr>
<tr>
<td>Improvement path of corporate renting/sharing services towards more sustainable mobility system.</td>
<td>Differentiated marketing (versus conventional cars)</td>
</tr>
<tr>
<td>Mobility needs of commuters.</td>
<td>Low cost parking</td>
</tr>
<tr>
<td>Potential multi-model transportation services capable of meeting their needs.</td>
<td>Customized offers.</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
</tr>
<tr>
<td>Benefits and barriers of non-ownership business models.</td>
<td>Integrated payment systems</td>
</tr>
<tr>
<td>Peculiarity of electric and hybrid electric vehicles.</td>
<td>Harness the use of online platforms</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diversified provisions</td>
</tr>
<tr>
<td></td>
<td>Synchrony with public transport</td>
</tr>
<tr>
<td></td>
<td>Uniformity in provisions</td>
</tr>
<tr>
<td></td>
<td>Reduced overlapping with public transport</td>
</tr>
<tr>
<td></td>
<td>Variety of car capacity</td>
</tr>
<tr>
<td></td>
<td>Tools for enhancing socialization</td>
</tr>
<tr>
<td></td>
<td>Green marketing approach</td>
</tr>
<tr>
<td></td>
<td>Dedicated parking slots</td>
</tr>
<tr>
<td></td>
<td>Accelerate cultural support and EV awareness.</td>
</tr>
<tr>
<td></td>
<td>Access to integrated ICT platforms for EV owners.</td>
</tr>
</tbody>
</table>

*Table 6: Focus groups conducted and the main take-away from each focus group*

4.3.2 Swedish Focus Group

The focus group in Sweden was conducted at Linköping University. Recruitment of participants was through emails sent out to different student groups inviting participants who have experience with carsharing services. Five participants were recruited based on their diverse experiences with different carsharing and car renting services that included both peer-to-peer models and business-to-customer models. The main focus of the discussion were the drivers and barriers of carsharing and renting services, as well as drivers and barriers of using electric vehicles.
4.3.2.1 Reasons for use of carsharing/short term renting services

**Price:** All the participants mentioned price as the main motivating factor for their choice of carsharing services, stating that the carsharing services they used, offered a better price than other alternatives means of transport.

**Convenience:** This was also a uniform factor mentioned by the participants who stated that they chose to use carsharing services due to the level of convenience they got from the services in comparison to alternative transport means. A participant using car sharing in their business operations mentioned that use of carsharing services also significantly reduces the amount of paperwork involved, which is an added advantage as it saves time.

**Sustainability orientation:** This factor was mentioned by the participant who used carsharing services for business since the company has a policy to use transport means that have the least effects on the environment. As a company, they often consider the type of car and type of fuel used and are willing to pay extra for renewable energy sources. They often choose to use electric vehicles as a first priority for all distances that can be covered by the electric vehicle range and plug-in hybrid electric cars for longer distances. When asked about their personal experience while driving electric cars, the participant mentioned that using electric cars gives a good conscience as a better option than a combustion engine car, especially since the company has contacted the service provider to ensure that the electricity is from a green source.

**Curiosity:** Some of the participants mentioned that they tried out car sharing and ridesharing services out of curiosity after recommendations from friends.

4.3.2.2 Barriers to carsharing/short term renting services

**Limited availability:** The users mentioned the limited offerings of carsharing services as the main barrier for using the services. Carsharing services are only available in the larger cities and even then, there aren’t enough carpools in all locations. Whenever the car is not available or only available in a location far away from the user, this acts as a demotivating factor limiting the user from utilising the services. Specific to electric cars is the limited availability of charging infrastructure as well as the time required to charge the car. For this reason, users opt to use plug-in hybrid electric cars for longer distances rather than using pure electric cars.
**Technical aspects:** Short-term renting and carsharing often involves routine checks to be performed by the user both before and after their trip. These are often perceived as inconvenient and time consuming, especially when one is in a hurry.

**Minimised spontaneity:** There is a tendency for reduced spontaneity as a negative effect of reliance on carsharing/short term renting as opposed to car ownership. Since trips must be planned and booked in advance due to the limited offerings, there is no room left for spontaneity, which is sometimes appreciated by the users.

**Extra costs involved with carsharing:** The users also mention that a lot of extra costs are involved with carsharing such as subscription fees. Considering that many offerings use a pay as you go system, charging either by the minute or by the hour, it becomes more expensive to use the services on a long-term basis.

<table>
<thead>
<tr>
<th>Reasons for use of carsharing</th>
<th>Barriers to carsharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>Limited availability</td>
</tr>
<tr>
<td>Convenience</td>
<td>Technical aspects</td>
</tr>
<tr>
<td>Sustainability orientation</td>
<td>Minimized spontaneity</td>
</tr>
<tr>
<td>Curiosity</td>
<td>Extra costs involved</td>
</tr>
<tr>
<td></td>
<td>with charging</td>
</tr>
</tbody>
</table>

**Figure 33: Insights from the Swedish focus group**

**4.3.3 German Focus Group**

In Germany, the focus group was carried out at the Fraunhofer institute in Dresden. Five participants were chosen. It entailed open-ended interactive discussions with the aim of gaining multi-perspective insights on the mobility needs of employees during work-related trips. Results from the focus group were used to discuss and suggest requirements for improvement of corporate renting/sharing services towards more sustainable and circular mobility business models.

**4.3.3.1 Advantages of carsharing/renting**

Participants viewed the advantages for using carsharing/renting services in comparison to use of public transport or one’s own vehicle. Regarding the former, convenience is appreciated since users are allowed the luxury to travel at their own convenience without needing to adjust to the public transport timetables, which may require tedious waiting periods.
Moreover, carsharing/renting may turn out to be a cheaper option depending on the distance to be covered. Regarding the latter, using carsharing/renting services during work related trips was appreciated as it prevents wear and tear on one's own vehicle.

4.3.3.2 Barriers of carsharing/renting

The limited number and scarcity of pick up points was seen as a significant factor that prevents customers from using carsharing services. Some participants stated that they would consider selling their car to rely on carsharing and public transport entirely if the system was more flexible and the cars more easily accessible. Roundtrip models that require picking up the cars and returning them to specific locations are perceived as inconvenient for users. Familiarity is another important factor for users of carsharing services. As sharing/renting services tend to offer different car models, having to adjust to different car models’ buttons and mechanisms during each trip is perceived as inconveniencing and thus hinders the use of carsharing/renting services.

4.3.3.3 Use of electric cars

Electric cars are appreciated by the users, and constantly chosen for inner-city and other short-term trips. Participants liked the experience and appreciated the atmosphere perceived when driving electric cars, which was described as nice and enjoyable. Moreover, electric cars are smaller and thus easier to park, compared to the other company cars. However, short battery life is a problem as it causes range anxiety especially when the battery cannot handle the frequent journeys made. This is intensified by limited access to fast charging infrastructure, thereby making electric cars a less suitable choice.

4.3.3.4 Perception on remanufactured parts

Participants who viewed cars as simply a mode of transport and not a status symbol had no objections and appreciated the use of cars embedded with remanufactured parts as long as they are fully functioning and not more expensive than the cars with new parts.

Figure 34: Discussion points from the German focus group
4.3.4  Portuguese Focus Group

The Portuguese focus group was organised by Prodigentia with the support of the Electric Vehicle Users Association (UVE) in Portugal. Five participants, who were owners and experienced users of electric vehicles during carsharing were chosen to participate. The main aim of the discussion was to understand major factors influencing purchase and use of electric and hybrid electric vehicles as well as the factors preventing their purchase and use. The topics covered included: Drivers and barriers towards usage of EV sharing services in comparison to EV ownership; expected characteristics of non-ownership mobility services for offering highly customized services or leasing services to be substituted instead of EV ownership; coping with public transport challenges; users’ perception and acceptance criteria on vehicles embedded with remanufactured parts; users’ perception and acceptance criteria on multi-model mobility systems where diverse public-private and mobility systems are integrated uniquely. The following insights were drawn from the discussions of the focus group.

Coping with public transport challenges especially for long-trips and alignment with the cultural shift in users on reluctance of ownership and more consumer acceptance of leasing offers were the main reasons motivating the use of carsharing services discussed.

As a barrier of carsharing services the main factor discussed was limited geographical coverage of existing offers since the offerings are mainly in big cities, resulting into limited application of the services in long-distance travels between diverse cities.

4.3.4.1  Drivers of using electric vehicles

The discussion on using electric vehicles was based on experiences with either car ownership or carsharing services. Tax benefits are a main driving factor for both ownership and sharing services of electric vehicles. Due to the tax exemptions of at least 25-35% a year, carsharing providers are able to offer competitive prices to their users (25 to 35% a year). In addition, there is a special tax benefit for corporate mobility systems which puts carsharing firms at an advantage.

Electric vehicles are perceived by owners and carsharing users as a reliable, more durable and damage-free option compared to combustion vehicles. Participants also mentioned that they value the reusability of the high value-added parts in electric vehicles such as the batteries.
4.3.4.2 **Barriers of using electric vehicles**

The problems with electric vehicles are mainly related to challenges experienced when charging the cars. Compared to refilling combustion engine cars, electric vehicles require a much higher charging time, which is not efficient for the users. Since one is not able to rest in the car while it is charging, this can be an inconvenience for drivers on long trips especially during cold or rainy days. On a positive note, however, access to the charging stations, which has previously been a major barrier for electric vehicle use has, however, been simplified by the creation of online platforms such as [http://www.eafo.eu/eu](http://www.eafo.eu/eu) that have been set up to create awareness of accessible charging locations for electric vehicles.

![Diagram showing Discussion points during the Portuguese focus group](image)

**Figure 35: Discussion points from the Portuguese focus group**

4.3.5 **Spanish Focus Group**

In Spain, the focus group was organized by CSIC in Madrid, with support from the consumer association AUVE and moderation from CNR-STIIMA. Participants were contacted by email and phone calls and a total of eight were recruited for the discussion. They included electric and hybrid electric car owners, representatives from electric car users associations and representatives from public bodies with focus on environmental matters. For this discussion, the main aim was to get participants’ perspectives on carsharing, ownership and use of electric vehicles. Additional questions were asked about participants’ perspectives on use of cars with remanufactured parts.
4.3.5.1 **Mobility choices**

In Spain, a high percentage of the population lives in metropolitan areas. For people in rural areas, the main choice for mobility is car ownership. Generally, a car is a status symbol, therefore, ownership is a widespread choice even in urban areas. When one owns a car, finding available parking slots may be more challenging in some cities than in others. Whereas using public transport is perceived as an economic choice, it is more challenging to use during peak hours.

During the discussion, an assessment was carried out to determine whether participants were in a position to compare the costs associated to owning a car versus a non-ownership alternative such as short-term renting. All users of electric and hybrid cars said they had a good understanding on the matter and while accepting that the initial investment is higher (without considering eventual government incentives), they considered maintenance costs to be much lower if compared to ICE cars. Electric car owners said that they are very careful in investigating costs throughout the lifecycle of the vehicle; thus, they were convinced that an electric car in the end costs less than its ICE equivalent. Electric car users found ownership a convenient choice in terms of availability because the car is always ready for them to use in any eventuality. Still, depending on how intensively they used the car, convenience in terms of price may vary, being more convenient as intensity of use increases.

It became clear that cost was a main driver for the participants’ transport choices. The participants considered short-term renting as a viable alternative for users that would want to change their car after 5 years or less. For electric cars, this is an attractive alternative considering the fear towards the fast-technological obsolescence perceived.

4.3.5.2 **Perceptions on carsharing**

Carsharing is perceived as a good complement for public transportation, and according to one of the participants, this has helped in reducing the use of private vehicles by between 45 to 60 percent in Madrid, making it a good practice example at a European level. For each vehicle made available for carsharing, there can be a reduction of six to nine vehicles in the city. Moreover, in some cities there are privileged parking areas reserved for carsharing vehicles, either at low cost or even completely free. Another participant also argued that carsharing is not considered competition but a complementary service, the main difference being inclusion
of a driver in the service price. However, for long-distance trips, carsharing using electric cars is problematic due to lack of proper charging infrastructure in between cities. All participants agreed that there should be an integration within the payment systems to ease use of charging infrastructure.

When asked under what conditions they would move towards carsharing only, the participants were sceptic, arguing that after a few years of “ownership” their car was already amortized and even a yearly fee of one hundred euros for carsharing would not seem convenient, depending on the intensity of use. They mentioned that they would consider engaging in carsharing in parallel to ownership in some cases, for example if another family member also needed transportation and was unable to use the same car they own, or when they feared that they would have difficulties finding available parking slots in urban areas or charging stations for their trip. Apart from specific uses in rural areas for reaching far destinations where owners would also consider using carsharing, most of the participants consider that this service is more viable in urban centres, and in particular among young people that are more open to technological changes.

**4.3.5.3 Market test for novel sharing services**

Asked about characteristics that would make a carsharing service highly customized to their specific needs, some pointed to the possibility of having personnel ready to take care of driving the cars towards charging stations and then bringing them back to the user, or to the carsharing base. Another desired characteristic is being able to replace the battery as it is currently done in scooter sharing. Otherwise, it should be easy to charge at almost any street.

**4.3.5.4 Perceptions on use of cars embedded with remanufactured parts**

Most participants indicated that they had no objection towards using cars embedded with remanufactured parts as long as the parts were certified. Yet, when a participant brought up the topic of safety or structural parts, they adjusted their position stating that even if certified, they would feel uneasy with driving a car with certain remanufactured parts such as the ABS system or the airbag. Regarding the price of the service, even if the parts were certified and equivalent to new ones, some considered that they would expect a discounted price since the parts are not new. A minority said that if price and expected performance are reasonable,
they would prefer the service with remanufactured parts because they know this is a choice helping to protect the environment.

4.3.6 Italian Focus Group

The Italian focus group was organized and moderated by CNR-STIIMA-MBM at their offices in Milan. The aim was to understand the customer side regarding mobility services such as carsharing. For this discussion, potential participants from various commuter associations as well as consumer associations were contacted through electronic mail, phone calls and physical meetings. Six participants were recruited, and they included potential customers who were commuters, with or without previous carsharing experience provided interesting insights on the mobility challenges faced by citizens. The participants were asked questions related to the survey topics.

4.3.6.1 Mobility challenges

The most critical challenges perceived in public transport are the continuous delays, old vehicles, inefficient installations and lack of transparency in management. There are a variety of ticket types to keep note of, and trains are sometimes replaced by buses, which increases the travelling time, causing inconvenience for travellers. Moreover, there is limited capacity during peak hours. An additional challenge with using public transport is the insecurity felt by users during late hours.

One of the positive aspects of public transport, however, is that it is not necessary to drive around looking for available parking slots, especially in urban areas. The possibility to socialize
during the trip is another added advantage. Moreover, in some far away areas there are positive initiatives for connecting the final stops of subway with special buses that drive passengers to shopping malls in some cases at no cost.

4.3.6.2 Proposals for novel carsharing services

It is important for participants that carsharing is economic and satisfies the necessity of reaching isolated places, where usually there is little or no presence of buses or other public transport. However, for specific needs such as trips to the supermarket or to the airport, participants would prefer to use their own car.

In the case of urban areas, in particular close to train stations, it is frequent to find an overlapping of service offerings; public transport and carsharing. In such cases, commuters tend to use public transport, unless carsharing reduces the duration of the trip. The situation changes at train stations far from the city centre, and train stations connected to the subway, for which it is desirable to have carsharing payable with the same system/subscription for train use. In addition, it is desirable to have parking slots reserved for carsharing.

Variety of car models is not particularly relevant for car sharing but luggage capacity may be an issue for current offers where most of the vehicles are rather small. A desirable case would be availability of vans in sharing, for transportation of goods after a shopping trip. In order to engage in carsharing, it is fundamental to have integration with other transportation services, and the possibility to reduce the trip time.

4.3.6.3 Multi-model mobility

Participants are strongly convinced on the necessity of integration of transportation means and mentioned some examples of initiatives already going in that direction in the most important cities, which should be extended at least to all provincial capitals. They view carsharing as a good alternative in rural areas for reaching places with very limited public service and also in slot times where the service frequency is severely reduced, which may also apply to some urban areas. In other urban areas, they assume the use of other transport means such as bicycles or even e-wheels more viable depending on the city’s accessibility.

In the case of integration of public transport specifically with carsharing involving electric vehicles, there is agreement that environmental consciousness is not well developed in the
country. Yet, some may be disposed to pay ten percent extra for a service perceived as green, other factors remaining constant.

Regarding performance of electric vehicles, the participants appreciated the ease of driving, quick acceleration and absence of combustible smells. However, they expect more autonomy, availability of charging points and ease of charging procedures through standardising the charging plugs.

### 4.3.6.4 Perceptions on use of cars embedded with remanufactured parts

Participants had no objection to the use of remanufactured parts or components in vehicles if these were certified and secure. Moreover, some mentioned that they would perceive a favourable business image from a carsharing company advertising a green approach. All concurred that price of the service does not need to change due to use of remanufactured parts.

![Perception on use of cars embedded with remanufactured parts](image)

**Figure 37: Discussion points from the Italian focus group**

### 4.3.7 Requirements derived from the combined focus group discussions

The following requirements have been derived for future business models within the mobility services sector.

*Capacity management* is an important factor to be considered by mobility services providers. As there is constant fluctuation in demand due to peak hours and off-peak hours, a requirement for increased use of carsharing services is for service providers to try to match supply to the demand levels in order to minimise the negative effects of limited availability. Hereby, efforts to tap into various market segments may be appreciated by both clients and the service providers since it helps to maximize usage capacity of the cars.
Collaboration with other stakeholders such as housing companies to implement carpools in residential areas may help to solve the problem of limited access to cars, which hinders people from using the services. Availability of carpools in the residential areas improves convenience and accessibility to the cars by users.

Collaboration with public transport providers is an important opportunity for service providers to improve the price perception of car users towards sharing/renting services. Functioning public transport systems are a major influencing facilitator for carsharing services. Users appreciate a carsharing/renting system that is synchronized to the available public transport such as train stations to connect them to their final destinations. Carsharing/renting services should work at developing business models that offer maximum alignment to the public transport systems in order to maximize customer satisfaction. With the availability of functioning public transport for commuting and regular journeys, car users realize that they do not need to own a car if they have access to carsharing services for occasions where public transport may not be convenient, such as weekend trips. By relying entirely on public transport and carsharing/renting, users perceive carsharing/renting as a lower cost alternative to car ownership as they realize a decline in their transport costs. This is because they do not need to consider car purchase costs, service costs, tax, insurance and other costs that come with car ownership. In areas where the public transport system is not regular, however, it becomes harder to convince people of the irrelevance of car ownership, which serves as a barrier to use of carsharing/renting services since that only raises transport costs if one combines car ownership with carsharing.

More advanced online systems that facilitate activities such as booking and planning the journey are appreciated by customers. Rather than having travel management personnel handling the booking services, employees prefer to have access to an online platform where they can reserve and book the car models they prefer according to their availability. Users would appreciate easy to use online platforms that map their journey for them with the most convenient transport mode so that they do not have to spend too much time on these tasks. In addition, use of online platforms limits the amount of required paperwork involved in using the services, which is not appreciated by users.

Improved convenience and accessibility are highly important to users, who would essentially appreciate possibility to use the vehicles on the same day that they are booked and not have
to endure long waiting periods. Moreover, a more digitized method of access to the cars would also be preferred, such as using a QR code to open the cars instead of having to carry a physical key.

**Varied assortment of car capacities** is an important factor for corporate clients. Some of the car models availed may not be suitable for all trips, for example, users may prefer smaller cars for inner-city short-term trips and bigger cars that can load extra levels of baggage for other trips depending on their travel needs and destinations. Service providers for B2B customers should aim at incorporating an assortment of car sizes and models into their fleets to provide a wide variety for customers to choose from for different purposes.

**Uniformity:** To harness the concept of familiarity that is appreciated by car users, carsharing/renting service providers should try to ensure uniformity within the extra features and facilities available for all cars within their pools, such as parking assistance.

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**Figure 38: Summary of requirements derived from the combined Focus groups**
4.4 General Business Model Requirements at the B2c Level

On a B2C logic, there are several business model requirements identified based on a combination of the interviews with stakeholders, focus groups and the survey. Similarly, a comprehensive set of KPIs are identified for the B2C business models. The results point towards a need to develop new and attractive business models that will encourage more users to:

1. Start using short term mobility services such as carsharing and car renting.
2. Continue using short term mobility services instead of or complimentary to owning a car.
3. Switch from using ICE vehicles to electric vehicles.

Marketing efforts need to be targeted to the general population but especially to the early adopters, millennials and the generation Z (Kumar et al., 2018), who are more accustomed to technology changes and are less interested in car ownership. To achieve this, the following implications and requirements for establishment of innovative business models are suggested.

**Mobility services providers should aim at market segmentation:** Carsharing service providers need to visualise business models that are able to target various segments of the market according to their needs. A key area of focus for these business models could be a multi-model approach through integration of offers for both private individuals and corporate clients or a combination of point-to-point and round-trip business models. Hence, current challenges such as capacity management that occur as a result of fluctuation in demand may be managed since private individuals would mostly need to access the cars during weekends and on holidays while corporate clients would use them during working hours, thereby maximising vehicle utilisation.

**Achieving a wider market and ensuring customer satisfaction through multi-stakeholder collaboration** between carsharing companies, charging infrastructure implementers, OEMs and even policy implementers can be explored in these solutions. An example could be through collaborations with housing companies to establish carpools and charging infrastructure in residential areas, thereby bringing services closer to the users. This would minimise the current challenge of access expressed by users and potential users who are reluctant to use carsharing services because carpools are normally located in areas far away from them and are thus perceived as inconvenient. Multi-stakeholder collaboration may also
be extended to payment systems where carsharing companies may envision forming associations at national or European level, that would integrate payment methods and enable users to access different service providers with one single subscription. Whereas each carsharing company may have its own fidelity card, the payment would be as easy as getting money from an ATM with different cards. Further, through private-public agreements, business models could be envisioned where a single mobility card would allow users to access both carsharing services and public transport.

**Competitive Pricing to meet a wide range of needs for users of carsharing services:** Carsharing service providers should aim at setting prices capable of favourably competing with existing alternative mobility options such as car ownership. In this effort, requirements from governmental bodies to subsidise taxes on such services that are sustainability oriented are needed. Additionally, recognition of carpools and provision of designated parking areas at subsidised prices in the cities is required.

**Multi-modality through integration of public transport and private carsharing:** To maximise the level of service provided to users of mobility services, business models synchronising carsharing service provisions with public transport provisions need to be considered. In many cases, availability of public transport acts as an enabler for use of mobility services such as carsharing, hence it would attract a wider market if carsharing service providers were able to work together with other mobility services providers such as bike sharing and public transport service providers such as train services operators in order to offer a synchronised mobility service to users.

**Minimizing waiting time for customers in terms of booking, accessing and parking the cars:** Efforts to ensure convenience for customers are important for both customer attraction and retention. These can be through reduction of trip time, which may be achieved by eliminating waiting time and delays typical of public transport. Customers do not like to wait for a car to become available, thus carsharing should provide an experience that mirrors the benefits of owning a car. The number of cars available need to be adapted to the situation, for example high numbers during peak hours close to main train or subway stations and lower numbers during off-peak hours but ensuring carsharing presence also in slots where public transport severely reduces service frequency. Further, to minimize the hurdle of finding parking space, dedicated parking slots at a low cost could be reserved for car sharing users through
arrangements with local authorities, where carsharing with EV would get a discount on parking fees.

Specific to electric vehicles, efforts are required from stakeholders at various levels to improve the experience of electric vehicle users and make them attractive to an even larger market. **OEMs should work together with regional policy makers to influence wider installation of charging infrastructure:** Currently, there aren’t sufficient charging stations in most cities, a factor which causes range anxiety for electric car drivers. As battery manufacturers work towards finding solutions of improving battery capacity in the electric vehicles, efforts need to go into wider installation of charging infrastructure and making it more accessible to users. In this area, efforts from both OEMs and regional policy implementers are required to facilitate processes of setting up charging infrastructure. Charging stations need to be strategically placed such as at airports and main transport hubs to serve diverse customer groups including carsharing companies which could have their pools based there. At national level, subsidies for setting up private charging infrastructure could go a long way in facilitating electric vehicle adoption by private individuals. Moreover, payment methods for charging of electric vehicles need to be aligned at a European level to make it more convenient for electric vehicle users to access charging stations.

**Offering additional services for the location of charging infrastructure:** An appreciated service for users of electric vehicles has been the possibility to access available charging stations in real time while on the go through mobile apps, which makes mapping of their journeys with electric vehicles an easier task. The role of ICT Platforms should not be underestimated in these business models. Mobility service providers should make use of ICT platforms as enablers to provide this additional information and improved services to users and potential users.

**Reduction of total cost of investment for electric vehicle ownership:** There are varied perceptions, on the total costs associated during the lifecycle of the vehicle since many people tend to focus on the high-level investment required for EV purchase. For some, the perception is that EVs have a lower total cost of ownership than combustion engine vehicles, while others perceive them as costlier. What is common between these two profiles is that even if they have a strong environmental consciousness, costs matter the most. In this regard, in addition to governments lowering investment costs for EV purchase through offering subsidies, OEMs should also implement special loan schemes that enable more people to afford electric
vehicles. Further, through the use of remanufactured and reused parts and components such as batteries, metal parts and techno polymers in electric vehicle production, a more competitive TCO will be achieved.

**Use of a green marketing approach to encourage both carsharing services and adoption of electric vehicles:** The role of a green marketing approach should not be underestimated in the efforts to increase use of carsharing services and adoption of electric vehicles. Many current and potential users of these services are concerned about the environment and how their consumption choices affect it (Hartl et al., 2018). Much as it may not always be the primary driving factor for each individual’s choice of mobility service, the concern for environment-related topics is growing (Barnes and Mattson, 2016) and many users consider mobility services that are directed towards sustainability as beneficial and would thus be willing to use them considering that other factors such as price, accessibility and convenience are favourable. Moreover, in cases where car parts have been reused, clear information on origin and certification will attract customers concerned about the environmental impacts of processes involved in making available any given part or component of the EV.

![Figure 39: Summary of general B2C requirements](image)
4.5 Key Performance Indicators for the B2c Level

The following performance indicators for adoption of carsharing/renting services and electric vehicles have been derived. It is important to note that the target set may not be representative of the entire EV and carsharing population for Europe. There are wide variations in business models, locations and even local and national government regulations, hence each KPI shown in the table below is explained according to a specific demonstration case.

**Vehicle utilisation rate:** An average privately owned car is parked for around 90% of its lifetime. For many car sharing service providers, the challenge is to find the balance required to meet demand at peak hours while at the same time minimising redundancy at off-peak hours. To maximise profitability, carsharing companies should aim at maximum vehicle utilisation. However, this may be a toll order for them to achieve, hence through employing a multi-model approach, they can gradually work towards maximum utilisation by ensuring that the cars in their service are in use at least 60% of their total lifetime.

**Charging stations at main transport hubs:** The future of electric vehicle mobility is highly dependent on access to charging infrastructure and flexibility for customers to switch between transport modes. To ease synchronisation of carsharing services and public transport so that users can easily switch between the different transport modes, at least one charging station with multiple charging points needs to be accessible at each transport hub. The number of charging points can further be adjusted depending on the level of activity taking place at each hub.

**Percentage discount versus regular parking payment:** Affordable parking space is a vital requirement for carsharing service providers engaging in both free floating and round-trip business models. As a service that promotes both decongestion in cities and positive impact on the environment, at least 10% discount on regular parking charges is a desirable incentive to support carsharing companies and promote their services to the public.

**Car models provided:** Car models with different capacities are required for different occasions. To attract more customers, carsharing companies should ideally boast of ability to provide a wide range of vehicles to suit customers’ various needs. For each carpool, at least two different sizes ranging from small to large capacity cars should be available.
**EV composition in fleets:** As improvements in battery capacity and access to charging infrastructure continue, carsharing companies should aim at making a steady shift towards fleet electrification. Considering that some governments have made declarations on reduced vehicle emissions by 2030 and proposed ICE access restrictions in some cities such as Paris and Stockholm (iea.org, 2018), carsharing service providers in these cities should gradually increase their EV fleet composition with an aim of approaching 100% electric vehicle composition by 2030.

*Figure 40: Summary of B2C KPIs*
5 KEY RESULTS OF THE REPORT

The following figures have been used to show the key requirements for business model innovation on both B2B and B2C levels.

![Diagram showing key requirements of the Business Model of B2B CarE-Service Solutions]

**B2B REQUIREMENTS**

- **Metal Core Remanufacturing**
  - Batteries’ Data Sharing among supply chain actors (at the moment they are owned by OEMs and ...)
  - Managing the Trade-off between LCC and LCA.
  - Production Scale Cost Estimation vs. lab-scale.
  - Value-based Pricing for Scrap and not-scrap (secondary raw material (after recycling), part can be reused/refurbished etc.; part can be appropriate for remanufacturing) with legal framework to be updated to this direction.
  - Capability to address the variability in procedures for diverse car ages, models, types and material compositions.
  - Design for Circularity incorporated in the new car models.
  - Economic Sustainability Incentive for remanufacturers.
  - Increase the value/return-up for bigger production of remanufactured parts.
  - Harmonizing Regional regulations through common European approach.
  - Assuring consumer on the remanufactured parts (market acceptance).
  - Improved the supply chain cooperation attitude (forward and backward). Not necessarily clarified.
  - Need to complete the supply chain with the other secondary application.
  - Recycling strategy for process waste of remanufacturing operations.

- **B2B REQUIREMENTS**
  - **Optimized Separation processes for shredded materials.**
  - **Assuring consumer on the recycled materials (market acceptance)** (e.g. fair trade concepts, winning guarantee offerings).
  - Continuity maximization in input flow of End-of-Damaged products.
  - **Optimized Time-base processes for material composition analysis.**
  - **Defining a portfolio of recycling strategies depending on the final application.**
  - **Design for Circularity incorporated in the new car models.**
  - **Value based pricing for the diverse applications of battery reuse.**
  - **Economic sustainability.**

- **SMMs:**
  - Fast quality control process for immediate part qualification and optimal routing in the networking platform to understand macro-strategy.
  - Compliance with operator safety requirements and urban movable vehicle legislation.
  - Full disassembly process tracking and transparency for guaranteeing legislation for dismantlers and other business users (e.g. through demonstration of show-cases and maximizing transparency level with business users). Compliance with the dismantle regulations.
  - Optimized the routing the two modules that could operate separately (Ensuring the continuous flow of optimum number of components to be tested in 2nd SMM for its economic sustainability considering the logistic optimization of the process).

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![Diagram showing summary of key requirements on B2C level]

**B2C REQUIREMENTS**

- **Mobility services providers**
  - Clear goal setting
  - wider implementation of charging infrastructure.
  - Standardization of payment methods.
  - Implementation of multi-mobility approach
  - Use of automatic vehicle monitoring systems
  - Government intervention

- **Charging infrastructure implementers**
  - Development of an umbrella power grid network.
  - Allowing charging infrastructure in residential areas.
  - Standardization of payment systems for public charging within Europe
  - Mobile platform that enable location of available charging infrastructure

- **Survey**
  - Adoption of multi-model approaches
  - Use of a green marketing approach
  - Maximizing the use of online platforms to provide additional services to users.

- **Focus groups**
  - Capacity management
  - Multi-stakeholder collaboration
  - Collaboration with public transport providers
  - More advanced online systems that facilitate activities
  - Improved convenience and accessibility
  - Varied assortment of car capacities
  - Uniformity

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**Figure 41: Summary of key requirements for the Business Model of B2B CarE-Service Solutions**

**Figure 42: Summary of requirements on B2C level**

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6 Conclusion

In this section, we conclude by integrating all perspectives and drawing the key message and requirements for the CarE-Service project idea as the future innovative circular mobility system. The aim of this task has been to identify requirements for various stakeholders relevant for the creation of innovative services and business models. These requirements have been defined both on a B2B level, through elaboration on the three main reuse chains (batteries, metals and techno polymers), as well as on a B2C level, through elaboration on carsharing/rental services.

Based on several qualitative (interviews and focus groups in Europe) and quantitative (European survey of non-ownership mobility users) methods, business model and service requirements and KPIs have been identified. The requirements and KPIs provided have been differentiated between B2B and B2C business models based on circular economy principles. The aims of defining the requirements and KPIs are manifold: to guarantee the economic viability and sustainability of business models for all involved stakeholders in the value chains; to ensure the viability of business models for private citizens and final users of the mobility systems; and to guarantee that the appropriate targets of the CarE-Service project are identified for designing and engineering of circular and sustainable mobility systems. The aim is to successfully reach the CarE-Service goals and to also provide relevance for typical circular mobility services providers. The requirements identified will be used to design circular business models for the three main reuse chains in the next work package.
References


Annexes

Review of the Deliverable
D 1.1 – Deliverable Title

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This project has received funding from the European Horizon 2020 research and innovation programme under the grant agreement No 776851
Overall Assessment of the deliverable

- The required level of quality is met and the deliverable put forward additional insights which can be beneficial for the progress of the project.
- The required level of quality is met perfectly and no major improvement is needed. I suggested some minor improvements.
- The required level of quality is met but there are major improvements to be made before submission of the deliverable.
- In order to meet the required level of quality of the deliverable, I have major concerns that may delay the submission of the deliverable.

Review assessment

1. Is the information contained in the deliverable technically sound and complete?

- Yes
- Can be improved

Comments/suggestion/specifications:

2. Is any critical information missing in the content of the deliverable?

- No
- Yes

Comments/suggestion/specifications:

3. Does the deliverable compliant with the relevant project objectives, targets and KPIs related to its topic?

- Clearly stated and compliant
- Clearly stated but compliancy can be improved
- Not clearly stated but compliant
- Not clearly stated and compliancy can be improved
- Other responses, please state:

Comments/suggestion/specifications:

4. Does the objective of the deliverable is clearly stated and compliant with the relevant project objectives, targets and KPIs related to its topic?

- Clearly stated and compliant
- Clearly stated but compliancy can be improved
5. Does the method of the deliverable is clearly stated and appropriate for the scope and objective of the deliverable?

- Clearly stated and appropriate
- Clearly stated but can be improved
- Not clearly stated but appropriate
- Not clearly stated and can be improved
- Other responses, please state:

Comments/suggestion/specifications:

6. Does the key messages and results of the deliverable are clearly stated and compliant with the relevant project objectives, targets and KPIs related to its topic?

- Clearly stated and compliant
- Clearly stated but compliancy can be improved
- Not clearly stated but compliant
- Not clearly stated and compliancy can be improved
- Other responses, please state:

Comments/suggestion/specifications:

7. Does the layout of the deliverable is compliant with the project template?

- Compliant
- Can be improved

Comments/suggestion/specifications:

8. Does the language style of the deliverable meet the required quality level?

- Yes
- Can be improved

Comments/suggestion/specifications:

9. Can the deliverable benefit from additional stakeholder expectations (consortium or external stakeholder expectations such e.g. consumers or other value chain stakeholders)?

- The deliverable is completely aligned with both consortium and external expectations

- Not clearly stated but compliant
- Not clearly stated and compliancy can be improved
- Other responses, please state:

Comments/suggestion/specifications:
The relevance of additional expectations can be added to the deliverable.

Comments/suggestion/specifications:

10. Does the illustrations, drawing and tables of the deliverable clear and comprehensive?

   ❌ Yes  ○ Can be improved

   Comments/suggestion/specifications:

11. Does the abbreviations, references and/or formulas of the deliverable clear and comprehensive?

   ❌ Yes  ○ Can be improved

   Comments/suggestion/specifications:

Additional comments/suggestions: e.g.

- P 2, page numbers are missing
- P 14: demonstration cases: “Use of recovered compounds from battery recycling process for other applications”: recovered metals (cobalt, Lithium, Nickel, copper) could also be used to make again material for batteries; compounds (metals) recovered from the recycling process will be as good as metals coming from mining.
- P14: price reduction between a reuse battery compare to a new one: for me, the difference will be more than 15 to 20%:
  - reuse battery will be at least 2 times less expensive than new battery (in 2025: 150-300 $/kWh for new battery, 50-150 $/kWh for reuse battery)
  - recycler will buy old battery for recycling at a price around 8 to 10 $/kWh (1200 $ / ton)
  - value recovered from recycling will be in the range of 3000 to 4000 $/tons or 20-25 $/kWh.
- P 24: figure number missing
- P 25 replace “the Smart Movable Modules” by ICT platform at the beginning
- We really need a Company Expert in disassembly and testing of damaged batteries in our stakeholder group.
- I just learn that often, in case of accident, the first thing to do is to put the car in “quarantine” for a while (several weeks) before doing anything, to be sure that the battery is safe. Big issue for our project concept.
- I will send you a contact at BOLLORE that could help us to improve and may become a stakeholder; they are making batteries and in charge of different EV car sharing services in Europe, US, Singapore.
Review of the Deliverable
D 1.1 – Requirements for innovative services and business models

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<th>Konstantinos Georgopoulos</th>
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**Review assessment**

1. Is the information contained in the deliverable technically sound and complete?
   
   ● Yes
   ○ Can be improved

   Comments/suggestion/specifications: Very minor changes are suggested.

2. Is any critical information missing in the content of the deliverable?
   
   ● No
   ○ Yes

   Comments/suggestion/specifications: Suggestions for describing in more detail some topics.

3. Does the deliverable compliant with the relevant project objectives, targets and KPIs related to its topic?
   
   ● Clearly stated and compliant
   ○ Clearly stated but compliancy can be improved
   ○ Not clearly stated but compliant
   ○ Not clearly stated and compliancy can be improved
   ○ Other responses, please state:

   Comments/suggestion/specifications: No

4. Does the objective of the deliverable is clearly stated and compliant with the relevant project objectives, targets and KPIs related to its topic?
   
   ● Clearly stated and compliant
   ○ Clearly stated but compliancy can be improved
   ○ Not clearly stated but compliant
5. Does the method of the deliverable is clearly stated and appropriate for the scope and objective of the deliverable?

- Clearly stated and appropriate
- Clearly stated but can be improved
- Not clearly stated but appropriate
- Not clearly stated and can be improved
- Other responses, please state:

Comments/suggestion/specifications: No

6. Does the key messages and results of the deliverable are clearly stated and compliant with the relevant project objectives, targets and KPIs related to its topic?

- Clearly stated and compliant
- Clearly stated but compliancy can be improved
- Not clearly stated but compliant
- Not clearly stated and compliancy can be improved
- Other responses, please state:

Comments/suggestion/specifications: No

7. Does the layout of the deliverable is compliant with the project template?

- Compliant
- Can be improved

Comments/suggestion/specifications: No

8. Does the language style of the deliverable meet the required quality level?

- Yes
- Can be improved

Comments/suggestion/specifications: No

9. Can the deliverable benefit from additional stakeholder expectations (consortium or external stakeholder expectations such e.g. consumers or other value chain stakeholders)?

- The deliverable is completely aligned with both consortium and external expectations
- The relevance of additional expectations can be added to the deliverable

Comments/suggestion/specifications: -

10. Does the illustrations, drawing and tables of the deliverable clear and comprehensive?
● Yes
○ Can be improved

Comments/suggestion/specifications: Some minor changes are required.

11. Does the abbreviations, references and/or formulas of the deliverable clear and comprehensive?

● Yes
○ Can be improved

Comments/suggestion/specifications: -

Additional comments:

For the “Business model requirements for ICT Platform”, the focus is mainly in the marketplace. Same attention has to be paid also to the platform from the SMM point of view which is also important. The comparative advantage is not only on the technical support of the platform to the SMM but also the interaction between the SMMs and the marketplace.