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CarE-Service

Circular Economy Business Models for innovative hybrid and electric mobility through advanced reuse and remanufacturing technologies and services

Editorial

Welcome to the second newsletter of the CarE-Service Project. Besides discussing some project progress on technical topics, in this newsletter we also share our position on battery legislation. Reading this newsletter, you will also have the opportunity of learning more about the new mobility services that are being developed in the framework of CarE-Service. As our project is market oriented, new potential circular business models are presented for metal parts of electric vehicles. Moreover, an important event will take place on 9th December, our Exploitation Webinar, where the preliminary results will be presented and there will be the opportunity to meet project partners virtually to provide feedback and suggestions for further developments, express interest to be involved as a “tester” or “first replicator”, as well as to start establishing relationships for future eventual partnerships.

Newsletter Contents

CarE-Service Position Paper for Legislation

Drawing on lessons learned from the CarE-Service project activities, the consortium welcomes the Commission's initiative to modernize the **EU's batteries legislation** and prepared a Position Paper calling for the modification of key provisions of the current "**Batteries Directive**" (Directive 2006/60/EC).

The released Position Paper includes the analysis of the limitations and barriers posed by the existing regulatory framework for the implementation of the most important targets regarding the End-of-Life Batteries, having impacts on the second-use applications and recycling, and hindering the promotion of a Circular Economy approach.

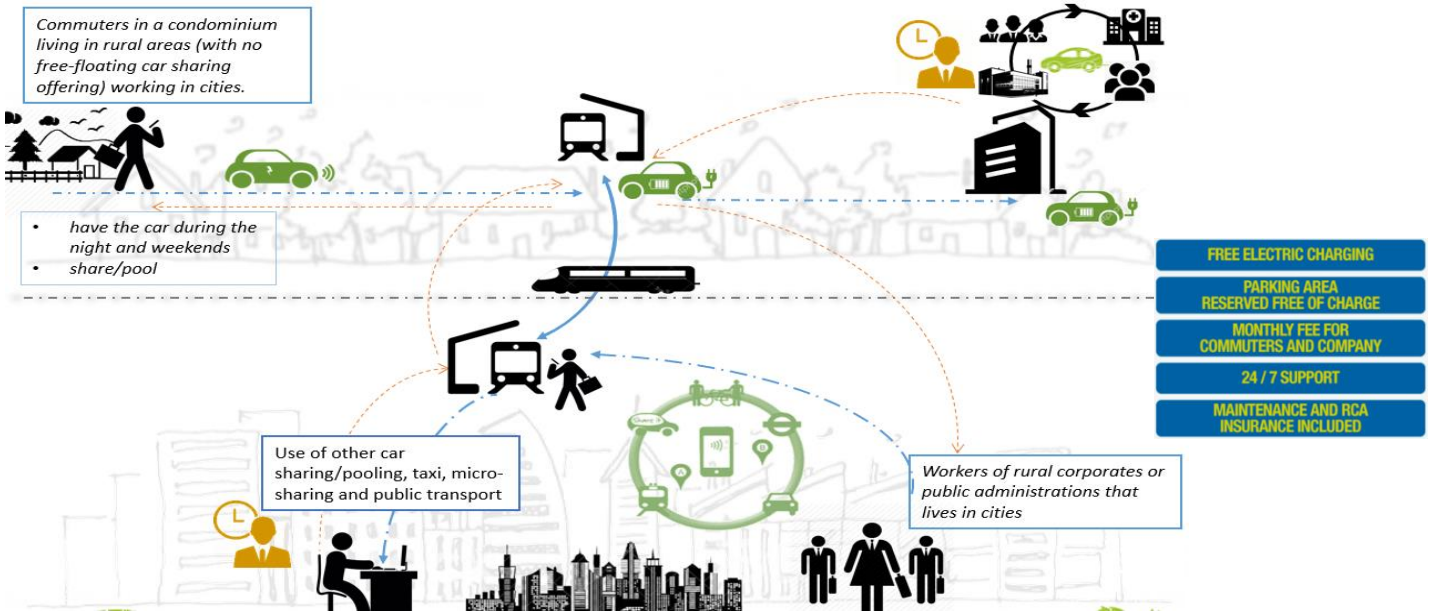
Two main frameworks were analyzed in order to propose actions to remove these obstacles, with the clear indications of the associated potential benefits for all the stakeholders in the battery value-chain.

* **Legal and administrative framework**. The main issues are: the lack of the Extended Producer Responsibility (EPR) transferability; the impossibility to apply the End-of-Waste Regulation for End-of-Life batteries; lack of coherence between different regulatory instruments, to ensure smooth functioning of the internal market for batteries, waste batteries and materials obtained from recycled batteries and how to facilitate the use of batteries in second-life applications.
* **Technical framework**. Several aspects have been analyzed, such as: the safety issues related to the batteries' transportation, storage and handling; the need of a standardization of the batteries' design; and also, the need for requirements to improve recycling efficiency and the development of second-life applications.

The released CarE-Service Position Paper is a living and dynamic document due to the upcoming Battery Directive revision, planned for December 9th. Thus, it will be upgraded in the following months. Watch the presentation video and read our Position Paper!

Innovative green multi-modality mobility services

Within the CarE-Service project, a new business model that supports the multi-modality services in sharing mobility has been developed by E-Vai, with contributions from STIIMA-CNR, to be widely accessible through the mobility markets. An innovative mobility value proposition exploiting multi-modality and electric cars fleets maintained and upgraded through re-used, remanufactures and recycled parts, will respond to daily mobility needs of B2C customers (commuters from rural areas to the city and vice versa) and B2B customers (companies' employees in both cities and rural areas with an access to the railway stations). Different customers' journeys are represented in the following figure: from rural areas to the office in the city center, from the city to the office in a rural area as well as local trips of company employees during the day.



The car sharing company E-Vai is testing this innovative mobility value proposition in cooperation with a multi-utility company in Italy, that is located in a rural area. The relationship between E-Vai, the company and its employees is as following:

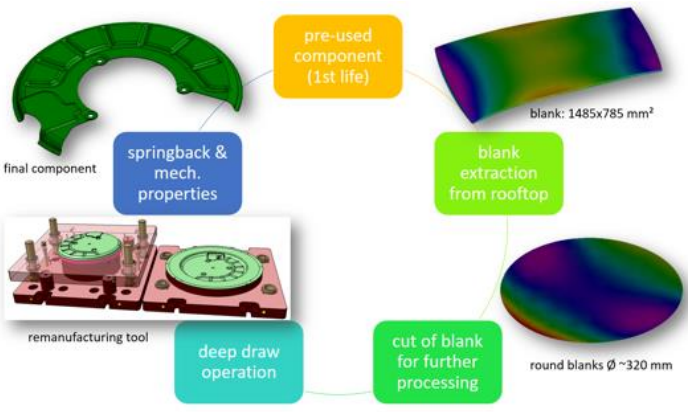
- The company is the exclusive user of the Electric Vehicles (EVs) provided by E-Vai.
- Company employees living in the city can use E-Vai cars to cover the last mile from the station closest to the company site, up to the office. At the end of the working day, they will reach the station with the car and leave it parked there to continue their trip home by train and other urban transportation types.
- An integrated multi-modality service such as e-scooters, e-bikes and all kinds of public transportation will also enable the commuters to easily reach their destination in the city (the station in the morning and their home at the end of the day) with a unique reservation and payment method for the whole journey.
- During the day, night, in the weekend and holidays, the EVs are available to be shared among the citizens in the rural area or other local communities indicated by the company (such as schools, cooperatives, etc.). In this case, revenues are transferred to the company.
- Parking slot availability is guaranteed at the pick-up and return station in the rural area.

In order to test the market acceptance and potential of the new value proposition, in the following months E-Vai is going to offer this integrated mobility service in its E-Vai website to other interested customers, in the frame of the CarE-Service final demonstration activities.

Remanufacturing Business Models for car metal parts

Every year, end-of-life vehicles (ELV) generate between 7 and 8 million tons of waste in the European Union. According to the current Directive for End-of-Life vehicles, 85-95% of the ELV should be recovered or recycled safely. When vehicles reach their EoL, re-usable parts are disassembled, dangerous parts removed, and the remaining metals are scrapped and delivered to steel workshops for melting. However, multiple metal parts could have a second life before melting (an energy-intensive process), leading to potential economic and environmental benefits.

Enabled by new technologies developed by Fraunhofer_IWU, within the CarE-Service project, alternative circular business models are being designed and assessed for metal parts by National Research Council of Italy, Linkoping University, FCA and other project partners. Concerning exterior metals (such as car roof, hood, door panels, etc.), cold reforming technologies and processes allow the re-use of metal sheets of old vehicles for the production of other metal parts with similar or different shapes for application in automotive or in other industries. Within the project, for example, the production of brake disk covers out of car roofs is addressed. New joining and disjoining technologies (patent pending) will also allow the re-use of structural metals for the same or different models of cars.



Metal sheet reforming process

In this scenario, a car-sharing fleet could be maintained using remanufactured metal parts and also periodically updated in the aesthetics with the most recent design without the need of totally substituting car fleets. In a futuristic business model scenario, car makers can produce new cars or new segments of refurbished cars including remanufactured metals.

Challenges for such business models that are being investigated are:

* the cost of the new remanufacturing technologies: it should not be higher than the cost of new parts and spares. A high-volume approach, with high automation content, is needed for that.
* the quality of remanufactured parts: it should be acceptable for customers and correctly priced through value-pricing approaches. Currently, the quality is suitable for the production of non-aesthetic parts but it should be improved for exterior design body components.
* uncertainty of the conditions of parts recovered from old vehicles, which affects both quality and costs.
* The potential decrease of metal scraps available for secondary metal production, due to their longer use time in multiple life periods.

How to decide what to do with End-of-Life Batteries?

CarE-Service developed a Decision Support System (DSS) to decide what is the most convenient batteries EOL strategy -reuse, remanufacturing or recycling-, according to their residual properties. It has two main objectives:

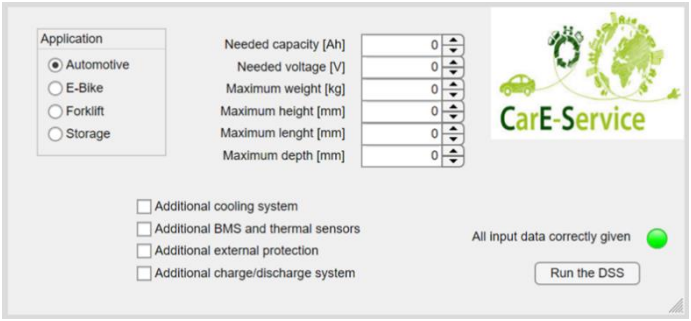
* to classify post-use products sold in the ICT CarE-Service platform through data obtained from tests carried out by CarE-Service Smart Movable Modules;
* to support remanufacturing activities, suggesting the best modules configuration strategy in order to fulfill requirements for the selected secondary application.

To achieve the first mentioned objective, C-ECO, PROD and ENV are working on the implementation

of a process for the classification of the selected end-of-life batteries. The implementation is based on C-ECO's service brand, CoremanNet, and its software solutions for cores from conventional combustion engine vehicles. In the CarE-Service project, CoremanNet is extended to support the selection of batteries from end-of-life electric vehicles. The application is a guided process that supports operators and testers to identify, visually inspect and perform tests on battery packs, modules and cells, with all the necessary safety measures. Based on tested performance, every part can be classified, sorted accordingly and uploaded into the marketplace, followed by the corresponding documentation. The tests and the different classes of each part based on its test results were defined by ENV, while PROD supports the integration of the application with the Marketplace, the central component of the ICT-Platform.

The second objective has been fulfilled by STIIMA-CNR and ENV, creating an ad-hoc software tool for battery remanufacturers (Figure), able to match their current modules availability with specific end-user's requirements. Exploiting data on product residual State of Health and considering all technical features to be compliant with, the DSS optimization algorithm calculates all the possible combinations of available battery modules which can be remanufactured into a second life pack, listing the alternative solutions by cost. Additional information on connections configuration or materials recyclability is also present, to support remanufacturers' choice.

The evident value of the CarE-Service DSS tool is represented by the chance to unlock the remanufacturing for post-use automotive batteries, which nowadays is technically and economically uncertain, providing concrete support to the different activities of value-chain stakeholders.



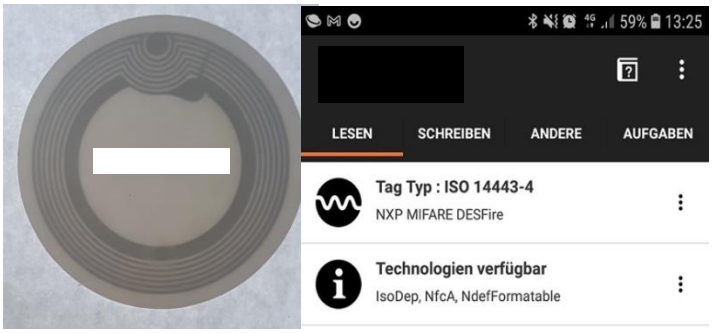
Remanufacturer's DSS user interface

RFID Data Storage for metals

The quality of metal remanufacturing process is deeply affected by uncertainty of the type and conditions of metals recovered from EoL cars. A solution to reduce uncertainty might be to include a data storage device into metal parts, in which original metal characteristics are registered, together with other information coming from the use phase.

Within the project CarE-Service, the Fraunhofer IWU Department STEX leads the definition, testing and documentation for a fitting data storage concept. The result of this research is a low cost, open source, smart and very small storage chip with RFID technology.

RFID tags can be sorted by frequency. Most tags communicate either in ultra-high frequency (UHF) at 433 MHz or between 860 MHz and 960 MHz or in high frequency (HF) at 13,56 MHz. UHF tags are commonly used in logistics, part management and distribution. In a logistics scenario where many parts have to be read in a short timeframe and often simultaneously, high reading range is crucial for the application and tags are built to maximise it. UHF tags are read by special reading devices, which are hand carried, attached to doorframes or set up as a gate. The tags store a unique Part ID and often have a storage capacity of 100 bytes to 500 bytes. More uncommon UHF tags with storage capacity of 4 kbytes to 8 kbytes are used on expensive airplane parts, such as passenger seeds. These tags cost between 20 € to 30 € and are therefore not economic in our use-case on metal parts in the automobile industry.



Picture of an ISO 14443-4 Storage Chip and an open-source android tool for writing/reading

For further development, ISO 14443-4 Storage Chip 8k tags with a storage capacity of 8 kbytes were selected. The tags were bought as a sticker or smart card. Smart cards have the advantage of integrating multiple security features from payment cards depending on the needs of OEMs. The tags are glued on metal parts together with a special "On metal shield" adhesive.

Pre-treatments on the End-of-Life Techno-polymers components

RadiciGroup High-Performance Polymers, thanks to the opportunity offered from the CarE-Service European Project, studied the approach of recycling the polymer components disassembled from end-of-life vehicles. The method developed in this project focuses on components made of polyamides engineering polymer, which is a thermoplastic material. The developed procedure is exportable to all the engineering polymers of the same family and the total recyclable quantity of the EoL components could be significantly increased.

The proposed method has been developed considering the mechanical recycling approach, where the environmental impact is lower than the chemical approach. In this phase, the focus is on the disassembly and pre-treatments of the EoL components, necessary to guarantee good quality of the recycled materials.

The quantitative analysis of parts disassembly and preliminary separation was possible thanks to the car dismantler Pollini, involved by FCA.

This first phase, with successive sorting, was fundamental to select which components to use to perform the feasibility study of the mechanical recovery, its refining, and the final validation. This operation considers three important variables: engineering polymers quantity in the dismantled components, purity and the disassembly easiness. The screening was performed on many components dismantled from the EoL cars, radiator tanks, exploded airbags, gearbox supports, cooling fans, wheel covers, fan shrouds, engine covers, valve covers, external door handles, and rear wipers. All these components, collected in quantity equal to 30 kg per type, have been processed in two phases: the first one was the engineering polymer selection by visual control of the components, the second one was the separation of the materials not adapt to the recycling phase (metals and other pollutants). These two phases have been carried out considering the efforts into selection and separation. It was possible to select the most adapted components to set-up and validate the successive recycle phases. The resultant components were wheel covers, airbags, external door handles, and rear wipers. The first two, made of polyamide 6.6, have been used to set-up the recycling process, the second two, made of polyesters (PBT and PET), thermoplastics ones, have been used to validate the recycling methodology.

Pieces selection

The wheel covers have been washed using a degreasing detergent and high-pressure hot water at 60°C. The airbags, external door handles, and rear wipers, observing the level of acceptable dirt, the washing phase was not necessary. The last operation, to complete the preparation of the raw material, was the grinding phase, necessary to reduce the components in small chips of 6 – 10mm of dimension for use in the following phases of formulation tuning, and then the scale-up.

At this point of the project, it is possible to summarize a significant result. An important

"change of thinking" to introduce a massive Design for recycling of the components, is urgently required. It is necessary to promote mono-materials components and the disassembly easiness of them. In this way, it will be possible to increase substantially the recyclable quantity of engineering polymers present in the vehicles. This could be an invitation to all the car makers and to all the manufacturers, whose products want to be concretely recycled and recyclable.

Exploitation Webinar

The first CarE-Service exploitation event will be held on **December 9th 2020**. This event will be a big opportunity to discuss and share the first outcomes of the project with interested stakeholders.

There will be the opportunity to virtually meet project partners in order to provide feedback and suggestions for further developments, express interest to be involved as a "tester" or "first replicator", as well as to start establishing relationships for future eventual partnerships.
The webinar will constitute an excellent opportunity for networking and for entering the CarE-Service community. For more information and registration please visit the following link: https://www.careserviceproject.eu/events/first-care-service-exploitation-event-on-9th-december-2020/

Project Coordinator Contact:
Giacomo Copani
giacomo.copani@stiima.cnr.it
STIIMA-CNR National Research Council of Italy

Dissemination and Communication:
Olga Rodriguez
olga.rodriguez@csic.es
CSIC-Spanish National Research Council

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