eCHARGE 4DRIVERS

Easy charging, easy driving

Summary of project results

November 2024

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Discover our solutions

Foreword

Since its launch in 2020, the eCharge4Drivers project has been committed to making Electric Vehicle (EV) charging more user-friendly and accessible to all. By uniting 29 leading European electromobility stakeholders, we've focused on practical solutions that truly enhance the experience for EV drivers. This, in turn, fosters greater adoption of electromobility and supports the European Green Deal's vision for a sustainable, zero-emission transport system.

From the outset, we've prioritised understanding user needs, gathering insights through questionnaires distributed to European citizens. Our pilot projects, demonstrated in 10 key locations across Europe—including metropolitan areas and Trans-European Transport Network (TEN-T) corridors—allowed us to develop and showcase innovative services for users before, during, and after the charging process. These include smart charging services, mobile charging options, charge points at lamp posts, networks of battery-swapping stations for Light Electric Vehicles (LEVs), the implementation of the Plug & Charge technology, enhanced route planners with booking services, and real-time information during charging. The development of our EV Charging Location Tool helps ensure that all user needs are met via sustainable and efficient investments. We've also provided recommendations for legal and regulatory harmonisation, along with essential guidelines for investors and authorities to ensure the long-term sustainability of charging infrastructure and services.

Thanks to the dedication of our partners, we're not only advancing best practices but also laying the groundwork for a harmonised charging experience across Europe. The innovations we've introduced will undoubtedly shape the future of electromobility, creating a greener, more sustainable transportation landscape.

Dr. Angelos Amditis, eCharge4Drivers Project Coordinator and R&D Director of ICCS

Overview of the eCharge4Drivers solutions

eCharge4Drivers is an EU-funded Horizon 2020 project working to improve the EV charging experience in urban areas and on interurban corridors, making it more convenient for users to go green. Throughout four years, the project developed and demonstrated user-friendly and innovative charging solutions, such as battery swapping stations for light electric vehicles, smart charging stations, modular charging stations, enhanced booking and routing services, and detailed information to users before, during, and after charging. To foster the broad implementation of charging infrastructure in Europe, the project produced recommendations for standardisation, legal, and regulatory frameworks, as well as decision support tools to ensure the sustainability of the e-mobility investment recommendations and guidelines for investors and authorities to develop further sustainable charging infrastructure services.

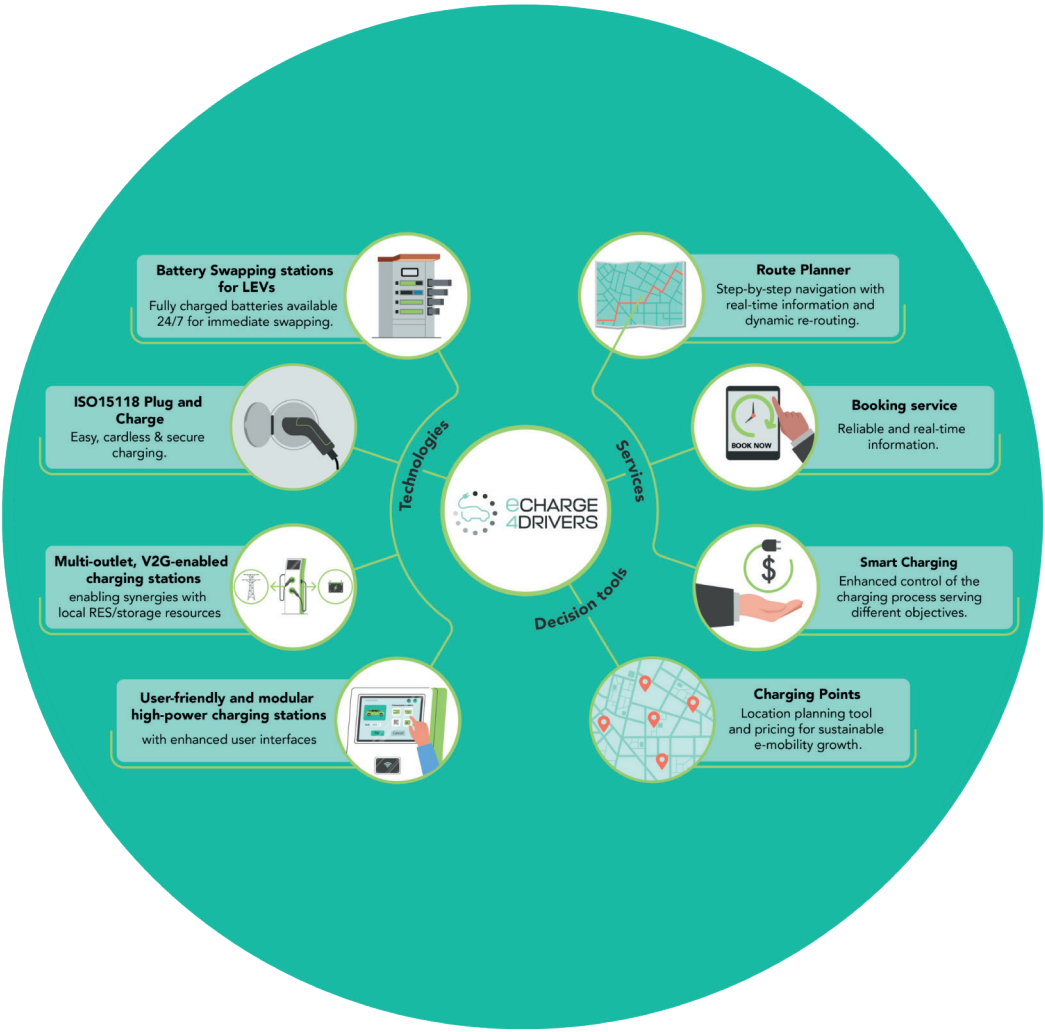
FACTS & FIGURES:

4
Years

14.4
€ million budget

29
Partners

eCharge4Drivers solutions

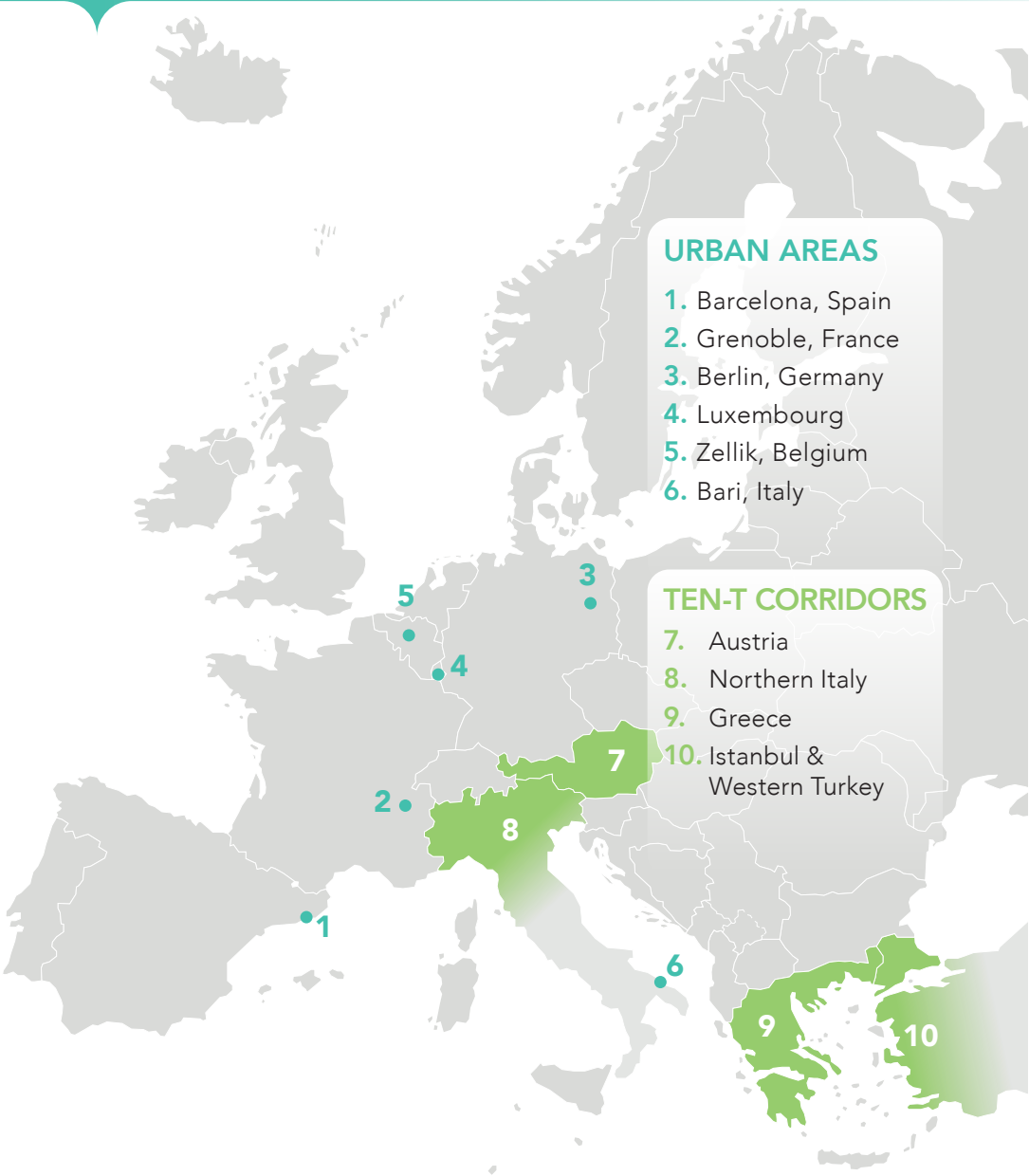


User needs

Users are at the core of eCharge4Drivers' solutions, which have been designed to enhance the charging experience and meet their evolving needs. During the first half of 2023, eCharge4Drivers conducted an a posteriori survey to assess the impact of various project charging options on user experience and acceptance. These solutions included battery swapping, smart charging, enhanced booking, route planning, and Plug & Charge. Aggregated results from the different demonstration sites indicate that the majority of the electric vehicle drivers were positive and satisfied with the tested charging options.

The survey implemented the Unified Theory of Acceptance and Use of Technology (UTAUT), where users had to indicate to which extent they agreed with different statements. Most of the respondents expressed a willingness to adopt the charging options tested during the project if they were available in the future. The majority also found the project solutions easy to use and enjoyable, and they considered that these should also be used by other people close to them. Participants were positive about having the necessary knowledge and conditions to use battery swapping and smart charging, and to a lesser extent, this also was the case for the other solutions. However, except for battery swapping, most users were reluctant to pay for their use.

Our demonstration sites



Overview of the solutions tested in the demonstration sites

		Urban Areas						TEN-T Corridors			
		Barcelona	Grenoble	Berlin	Luxembourg	Zellik	Bari	Austria	Northern Italy	Greece	Turkey
Infrastructure	User-friendly charging stations					●	●	●	●	●	●
	Multi-outlet V2G enabled stations					●					
	Battery Sharing Concept	●		●							
	Charging points on lamp post		●								
e-Mobility Services	Advanced Charging Authentication (ISO15118PnC)					●		●	●	●	●
	Enhanced Booking Service	●		●		●	●	●		●	●
	Advanced Routing Service	●					●		●	●	●
	Smart Charging Suite	●	●		●	●		●			
Decision Support Tools	CP Location Tool	●			●				●		
	Incentive Schemes and Tariff structures	●	●	●		●	●				

User-friendly charging stations for different types of vehicles

eCharge4Drivers partner ABB developed innovative, user-friendly charging stations for passenger cars and motorcycles, equipped with the Combined Charging System (CCS) (IEC 62196) fast-charge connector. The stations are designed to be modular and scalable, accommodating various charging needs. They feature an ergonomically-sized touch display and an intuitive graphical user interface. Additionally, the charging stations feature an extra-long cable with a retraction system for easy plug-in of the connector into the car's inlet, their design ensures that all operational parts are accessible for wheelchair users, promoting inclusivity and ease of use.

Beyond these design improvements, the stations were prepared to accommodate new functionalities defined on the European or international level during the project, including compliance with the European Measurement Instruments Directive (2014/32/EU), the dispenser identification (EN 17186), and the Plug & Charge standard (ISO 15118), ensuring seamless operation as the charging ecosystem keeps evolving. ABB delivered two containers with direct current (DC) and alternating current (AC) chargers for the demonstration phase, originally intended for five demonstration sites, in Belgium, France, Italy (two locations), and Spain.

In addition, VUB designed and developed off-board chargers for LEVs with specific communication and interface circuits to cover LEV requirements. These DC charging stations are suitable for private or public use, based on the EnergyBus open standard for electric components of LEVs and the Open Charge Point Protocol (OCPP) standard communication protocol. VUB also developed an Internet of Things (IoT) architecture for cloud connectivity and edge monitoring, with the implementation of the OCPP1.6J protocol. Tests have been performed in the laboratory and at the Zellik (Belgium) demonstration site, including the communication with the Charge Point Operator (CPO) onsite and usage from real users, including Radio Frequency Identification (RFID) identification and an LED display with Human Machine Interface (HMI). Testing continued with drive and charging data collection to assess further the operation of the IoT device and charger.

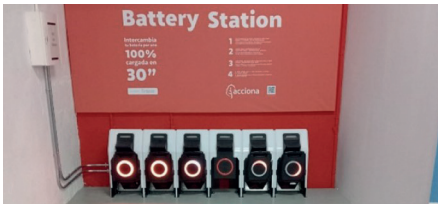
VUB charging station

ABB 180 kW Terra charger in mobile container

Battery swapping for electric two-wheeler vehicles

In Berlin, Swobbee deployed and demonstrated a battery-sharing solution for L1e electric vehicles (e-scooters). The system represents a sustainable alternative to traditional charging, allowing users to quickly swap depleted batteries for charged ones at strategically located stations. This reduces downtime and ensures a continuous flow for users, particularly in high-demand urban areas. While the deployment faced challenges related to battery standardisation, station logistics, and regulatory compliance, the adaptability of the stations to accommodate different battery technologies made them highly adaptable and responsive to market needs. Advanced inventory management systems were also implemented to ensure a steady supply of charged batteries and remote maintenance capabilities ensured operational efficiency.

Battery swapping station in Berlin



Battery swapping station in Barcelona

In Barcelona, two battery swapping stations were set up and operated in BSM parking locations near major traffic corridors: BSM Navas and BSM Cotxeres de Sarrià, each with six docks. The pilot was very successful, although the use of the service in underground parking locations presented some challenges for users, such as navigating ticketing systems and swapping batteries within the allocated time frame. Overall, the system operated smoothly without requiring additional training for users. However, obtaining local permits delayed the deployment by several months, and issues linked to floor irregularities in the parking locations extended the scope of civil works before installing the stations.

Key lessons learned include the necessity for streamlined regulatory frameworks, particularly regarding battery standardisation across vehicles, and the importance of choosing optimal station locations for greater convenience. User acceptance was positive, with many citing the time-saving and environmental benefits of the system.

Looking forward, the scalability of this model is one of its key strengths. It can be expanded regionally, nationally, and even across borders, with the potential for integration into larger public transportation networks. In Barcelona, BSM and Silence will expand the network with nine additional car parks, bringing Silence's network to over 35 locations by the end of 2024.

Charging points on lamp posts

Charging point on lamp post

Grenoble-Alpes Métropole explored the feasibility and user acceptance of installing charging points on lamp posts in residential areas, particularly near apartment blocks without parking facilities and where residents cannot recharge their vehicles at home. These charging points offer sufficient slow charging, which is suitable in these areas where cars remain parked for extended periods.

After addressing and overcoming several technical constraints, six charging points were installed across five stations located in the municipalities of Varces-Allières-et-Risset and Claix, two towns in the Grenoble urban area. Out of these six charging points, five operate only when public lighting is on. So far, their use has been limited, as most users prefer charging points that work both day and night. This demonstration highlighted the crucial importance of political support and the involvement of city technicians who can dedicate time to the project. Additionally, the limited availability of charging points during the day is not convenient for EV users, as reflected in the significantly higher usage of the charging point operating both day and night compared to the charging points available only at night.


Charging point on lamp post

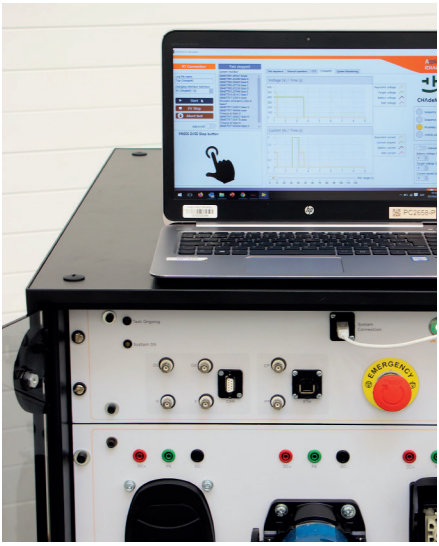
Plug and Charge (PnC) service, defined by ISO 15118-2, revolutionises the electric vehicle (EV) charging experience by enabling seamless communication between EVs and charging stations. With PnC, drivers simply connect their vehicles to a compatible charging point, and the authentication, authorisation, and billing processes occur automatically, eliminating the need for RFID cards or mobile apps. In eCharge4Drivers, partners implemented this standard to support the Plug and Charge use case, making EV adoption easier through enhanced user convenience, reduced waiting times, and improved security.

A key objective was to develop a methodology and associated tools to evaluate the interoperability of end-to-end communication systems, encompassing various stakeholders, including charging station manufacturers, vehicle manufacturers, backend systems of CPOs, roaming platforms, and eMobility Service Providers (eMSPs). PnC scenarios were created for testing purposes and to evaluate the conformity of end-to-end communication with ISO15118 and Open Charge Point Protocol (OCPP) standards.

Testing included conformity testing of the CCS technology for charger and EV manufacturers, and interoperability testing. These assessments were designed to verify that the charging technology specifications of EVs and Electric Vehicle Supply Equipment (EVSEs) adhere to the established technical norms using IDIADA's simulator. Hubject played a pivotal role by providing the infrastructure for effective PnC deployment and handled the necessary certificates. Route220 (EVWay) CPO backend was certified by Hubject to be compliant with ISO 15118-2. In total, Route220 performed 7,409 sessions with 3,090 unique users, a number that increased as vehicle manufacturers registered more PnC-enabled vehicles.

During the implementation and testing, partners overcame challenges related to combining different topics and fields of expertise and resolving errors in communication interface implementation. One challenge included the lack of public infrastructure and commercially available EVs enabling PnC for the tests, which limited the wider deployment of PnC services by eMSPs. The PnC protypes designed and developed within the project were demonstrated in different cities against different commercial PnC enabled products (EV/EVSEs/CPOs), providing valuable experience in terms of interoperability and deployment challenges.

Validation scenarios were executed with industry project partners, including VOLVO, BMW, ABB, Route220, SMATRICS, BFS, Hubject, and EVWay, resulting in a comprehensive assessment of the systems involved and valuable technical recommendations for CPOs, EV manufacturers, and EVSE manufacturers.



Plug & Charge testing

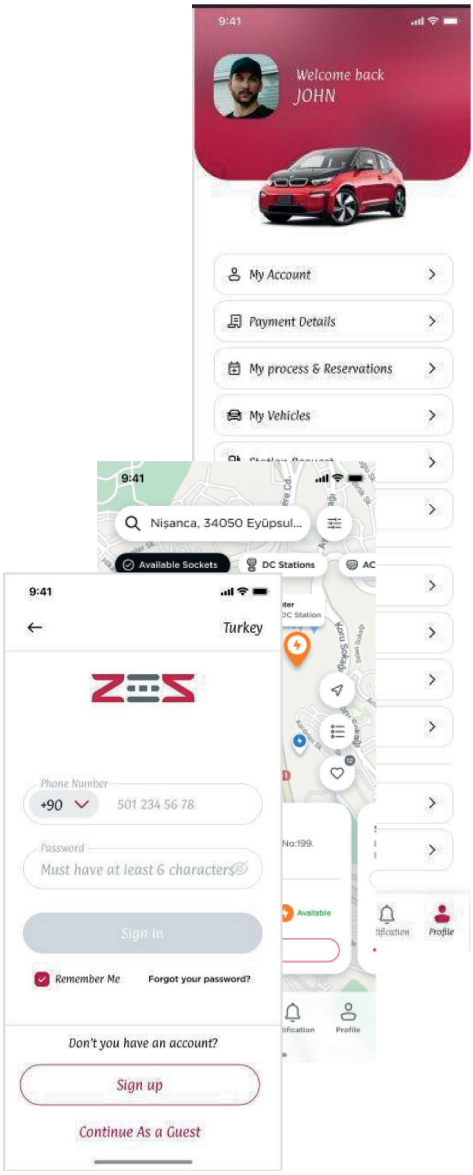
Seamless booking service

A new booking service was developed as part of eCharge4Drivers, offering users greater convenience with the ability to pre-book charging slots. The booking service improves the user experience by providing certainty and reducing waiting times at charging stations. Increased usage and positive user feedback highlighted the successful integration of the service into the public charging network. The impact assessment also demonstrated a reduction in wait times and an increase in successful bookings.

While developing the reservation system, eCharge4Drivers partner ZES adapted existing station commands and added business rules. For example, users can make reservations by linking to their calendars, while automated reminders and cancellation notifications are seamlessly delivered through the mobile app for a better user experience.

Operationally, one challenge involved penalties and automatic cancellations when another customer began charging on a reserved socket but did not finish. ZES addressed this by checking whether the reserved socket was occupied and by sending notifications to the charging customer, informing them of the upcoming reservation. Additionally, SMS notifications were sent to customers, even if their app notifications were turned off.

From a regulatory perspective, the enhanced booking services significantly improve the experience for EV users, with ZES reporting no challenges or obstacles related to the demonstration.



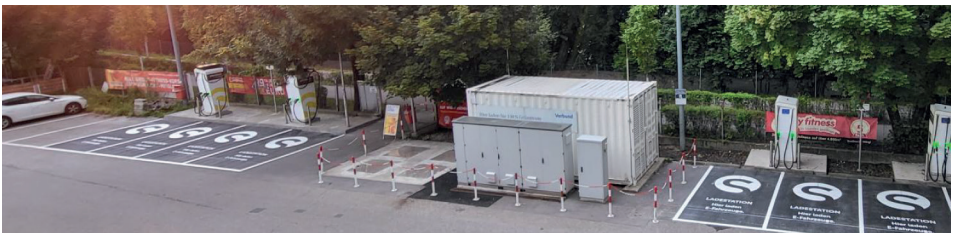
Enhanced booking app

Five Smart Charging Energy Management System (EMS) solutions were deployed in the eCharge4Drivers demonstration sites in Barcelona, Chambéry, Luxembourg, Austria and Zellik.

The CEA team, as a Smart Charging Service Provider (SCSP), developed an EMS that optimises charging profiles based on user preference, local grid constraints, cost minimisation for CPO, and maximising renewable electricity use. The EMS was fully implemented in two EV charging infrastructures: the Porta de Sarrià public car park in Barcelona and the CEA-INES R&D centre at Chambéry, France. More than 6000 smart charging sessions were recorded with 30 EV users between December 2022 and June 2024, with a self-production ratio increased to 56% on average and to 95% in some cases.

Nexxtlab developed a Smart Charging system that synchronises charging with local photovoltaic production, allowing sourcing cheaper and greener electricity while avoiding grid constraints. The smart charging demonstration in Luxembourg was a great success: 901 users performed 3648 charging sessions between April 2022 and June 2024 with no reported loss of comfort, as charging sessions were planned based on user preferences for range and duration, aligning with the availability of locally produced solar power.

Demonstration of smart charging at Porta de Sarrià public car park in Barcelona



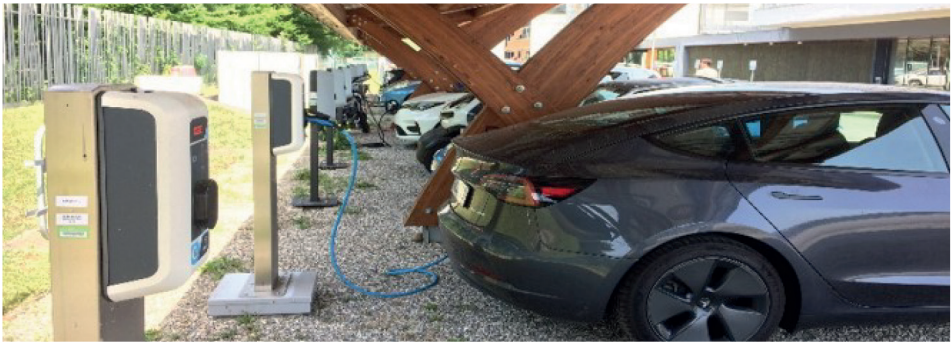
Demonstration of smart charging at micro grid system in Innsbruck, Austria

Smart charging

VERBUND tested an upgraded Micro Grid Management System (MGMS) at different High-Performance Charger (ABB & Alpitronic) locations of SMATRICS in Innsbruck, Austria. It was shown that a stationary Battery Energy Storage System (BESS) can supply extra power at the charging station, beyond the grid's capacity, complementing an operational peak-shaving service that contributes to lowering the operational expenditures of the location by lowering the peak powers.

VUB enhanced an EMS to optimise the Micro Grid system, maximising the use of renewable energy for better integration of fast charging. As demonstrated at Zellik, the EMS service can significantly reduce the daily peak powers and the operation energy costs and increase the self-production ratio from 52 % (without smart charging) to 93% (with smart charging service).

Key lessons include the importance of user preference, interoperability, security and reliability in the communication between operators for real-time data exchange and optimal charging set-points. Standard equipment (charge point with OCPP 1.6) and protocols such as the Open Charge Point Interface (OCPI 2.2 version) are therefore recommended.

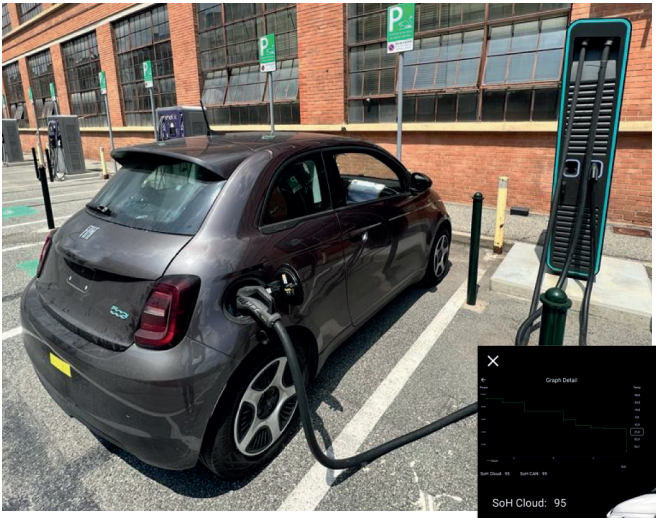


Demonstration of smart charging at CEA-INES EV charging infrastructure in Chambéry-France

Demonstration of smart charging at micro grid system in Zellik

Demonstration of smart charging at Park & Ride car park in Luxembourg

Preventive diagnostic and charging optimisation service



Demonstration of smart charging and battery predictive maintenance services at Stellantis battery lab © Centro Ricerche Fiat S.C.p.A

Demonstration of smart charging and battery predictive maintenance services at Stellantis battery lab © Centro Ricerche Fiat S.C.p.A

eCharge4Drivers partner CRF Stellantis focused on developing smart charging and battery predictive maintenance services for electric and hybrid vehicles, based on advanced connectivity and applying the concept of "extended vehicle". A model-based algorithm, developed by the University of Pisa, predicts battery degradation, using the historical battery data sent by the vehicle to the cloud during normal driving. The optimal charging profile is then calculated based on the predicted battery degradation curve and sent back to the vehicle the following day. The evaluation of the decay curve can also be used to provide an early alert of abnormal battery degradation. The Company cloud also shares the optimal charging profile with the Charging Point Operator to anticipate the energy needs and to regulate the next charging profile.

The demonstrator underwent two phases of testing, each lasting four months, in a WLTC circuit. The vehicle batteries were tested in the Stellantis battery lab at the beginning and end of each phase to compare the results with those obtained by the model-based algorithm. In addition, the University of Pisa developed a battery ageing simulation platform that has been used to evaluate the optimal charging profile and project KPIs. This project exemplifies interoperability between electric vehicles, cloud, and CPOs, as well as effective collaboration between industry and academia.

Tool for optimal deployment of charging infrastructure

Presentation of the EV location planning tool during a workshop in Differdange, Luxembourg

The EV Charging Location Planning Tool includes socio-demographic data, mobility flows, and charging session data from existing charging stations to predict future needs for charging points, both slow and fast, according to scenarios that include the anticipated adoption of electric vehicles. The tool was presented to target group users, mainly communes and authorities interested in the effective and efficient placement of charging points. Their feedback has been positive, especially as they seek to determine which sites to prioritise first and where to deploy additional chargers.

Users see several main benefits from the tool's demonstration. It facilitates informed decision-making by allowing users to make data-backed decisions when planning charging infrastructure, which is a clear improvement over the traditional, intuition-based methods. The tool also ensures efficiency in resource allocation by focusing on the most promising locations for new charging points and estimating utilisation rates and profitability. It also enhances EV driver satisfaction by increasing the availability of charging points in the most needed areas. Lastly, the tool supports long-term planning by simulating scenarios for three to five years, providing confidence for future developments.

Website front-end of the CP Location Planning Tool

Nudging users through pricing and incentives

In February 2021, the BSM charging station network in Barcelona introduced new tariff schemes, after having offered free charging to incentivise the EV market. With the increasing EV fleet in the city and the need to give value to both the electricity provided and the infrastructure, the new tariff system was designed to ensure fair pricing and meet user needs. The tariffs were tailored to various parameters, such as vehicle type (motorbike or car), personal or professional use, frequency of use, and time of day. Existing and new users were informed of the changes in advance, and a calculator was developed to help users determine the best option based on their charging habits.

Initially, the new tariff led to a noticeable drop in charging station usage. However, after an adjustment period, usage patterns returned to previous levels. Despite this temporary decline, the new tariffs brought positive changes in behaviour. For example, the time spent at fast-charging stations decreased from over two hours to 25 minutes. Overall, the new tariffs contributed to a more efficient, reliable, and accessible service, benefitting all users.

Similarly, Grenoble-Alpes Métropole (GAM) introduced new pricing in April 2022 based on kWh consumption and space occupation time, consistent with parking policies. This allowed GAM to reach a budget balance, maintain vehicle rotation, and keep only "active" subscribers (around 200) using the network. While some users initially resisted the tariff change, and combustion-engine vehicles or EVs not plugged in were still using the parking spaces, overall, the pricing changes resulted in high social acceptance. The usage of charging stations continued to increase, leading to new EV users and the installation of new charging stations.

BSM charging station in Barcelona

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