Interreg
Greece-Bulgaria

EUROPEAN UNION

E.VE.CR.I **locale**

European Regional Development Fund

D 3.3
CHARGING STATIONS INTEROPERABILITY ACROSS EUROPE

Blagoevgrad / Thessaloniki / Sofia 2023

Alliance of the Producers of Ecological Energy (SPEE-BG)

Centre for Research and Technology Hellas - Hellenic Institute of Transport – GR (CERTH-HIT)

Bulgarian Electric Vehicles Association – BG (BAEPS)

www.local-e.eu

DELIVERABLE DOCUMENTATION SHEET

DELIVERABLE	D3.3. Charging Stations Interoperability Across Europe
WORK PACKAGE	WP3 Studies & Analysis
EDITORS	AVS EOOD (Subcontractor of SPEE-BG) and A.I. Soft (Subcontractor CERTH -HIT)
CONTRIBUTORS	TAMVAKOS Athanasios (CERTH-HIT), ZAIMOV Martin (BAEPS)
PEER REVIEW	DENKOVA Mina (SPEE-BG)
TYPE	Study
VERSION	1.0 / 28.02.2023
COPYRIGHT	© E.VE.CR.I. Project The text, figures and tables in this report can be reused under a provision of the Creative Commons Attribution 4.0 International License.
DISCLOSURE STATEMENT	While the information contained in the documents is believed to be accurate, the authors(s) make no warranty of any kind with regard to this material including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Neither the E.VE.CR.I. Beneficiaries nor any of its members, their officers, employees or sub-contractors shall be responsible or liable in negligence or otherwise howsoever in respect of any inaccuracy or omission herein. Without derogating from the generality of the foregoing neither the E.VE.CR.I. Beneficiaries nor any of its members, their officers, employees or sub-contractors shall be liable for any direct or indirect or consequential loss or damage caused by or arising from any information advice or inaccuracy or omission herein.

QUALITY MANAGEMENT

28.02.2023	☒	Approved by WP Leader [TSETSINAS Ioannis]
02.03.2023	☒	Approved by the Common Management Team
06.03.2023	☒	Approved by the Lead Beneficiary [ARSOV Ivo]

PROJECT DOCUMENTATION SHEET

PROJECT ACRONYM	E.VE.CR.I.
PROJECT FULL TITLE	Electric Vehicles and Charging Crossborders Infrastructure
SUBSIDY CONTRACT	B6.3a.01/13.04.2021
PROJECT DURATION	24 months [13 April 2021 – 12 April 2023]
PRIORITY AXIS	01: A Competitive and Innovative Cross-Border Area of the Cooperation Programme INTERREG V-A GREECE-BULGARIA 2014-2020
CALL IDENTIFIER	6th CALL for Project Proposals
PROJECT OFFICER	Jenya DINKOVA
LEAD BENEFICIARY	Alliance of The Producers of Ecological Energy – BG (SPEE-BG)
PROJECT BENEFICIARY 2	Centre for Research and Technology Hellas - Hellenic Institute of Transport – GR (CERTH-HIT)
PROJECT BENEFICIARY 2	Bulgarian Electric Vehicles Association – BG (BAEPS)
WEBSITE	https://local-e.eu
SOCIAL MEDIA	#evecri #local-e

GLOSSARY

CPO - Charge Point Operator	Legal entity responsible for physical installation and operation (e.g. safety, economic and managerial subsistence, maintenance, permanent operation and accessibility, helpline) of its charging stations. CPOs set prices for the use of their infrastructure and establish contracts with MSPs. CPOs are able to provide ad hoc charging directly to drivers.
Backend provider	Company, offering software for charging infrastructure as well as services to the CPO, such as user and tariff management.
Frontend provider	Company creating design and operation of the interface between the customer and the visual, human and software of the service provider (CPO).
API - Application Programming Interface	A set of defined rules that enable different applications to communicate with each other. It acts as an intermediary layer that processes data transfers between systems, letting companies open their application data and functionality to external third-party developers, business partners, and internal departments within their companies.
MSP -Mobility Service Provider	Legal entity with contracts with CPOs to enable its customers (EV drivers) to charge at CPOs' charging stations. The MSP charges and pays CPOs at negotiated tariffs all charging sessions. EV drivers have contracts with MSPs in order to access their network. The MSP is responsible for authentication and invoicing customers (RFID card, NFC bank card, mobile phone application).
Destination charging	Refers to charging infrastructure at places that people visit. EV drivers can charge while dining, staying at hotels, shopping or while studying.
Interoperability	Referring to electric vehicle charging infrastructure, it is the compatibility of key system components - vehicles, charging stations, charging networks, the grid and the software systems that support them, allowing all components to work seamlessly and effectively.

Roaming

EV driver's ability to use and charge their electric vehicle across networks and across countries. Whether you're taking a cross-country road trip or driving across borders, EV roaming allows drivers to seamlessly charge up at stations belonging to different networks. It should be a seamless experience across all EU Member States and should not be affected by how or when the car is charged. 99% of publicly accessible charging stations in the EU are technically e-roaming capable but less than 15% provide full cross boarder roaming service in practice. Roaming has to be smooth and cost transparent and many MSPs' subscribed customers should have the option to pay the same low price for charging out-of-network as they pay for in-network charging. This flat rate approach would help EV drivers know exactly what their charging session will cost, wherever they choose to recharge.

Similar to mobile roaming networks, EV roaming is made possible through collaboration among EV charging service providers. This is enabled through Open Charge Point Interface (OCPI) protocol, custom API or roaming hubs like Hubject, Gireve and others. OCPI provides the connectivity between MSPs and CPOs.

ABSTRACT

This report provides multiple examples of current interoperability providers and solutions and some tentative recommendations as well as the mind process for identifying the best solution for this project. The main expected difficulties and risks in developing a cross-border network are listed followed by the roaming options and a few general conclusions

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

The mass adoption of electric vehicles requires a large scale and convenient network of charging point locations. EV roaming has a key role in rendering accessible and convenient the growing charging infrastructure in line with the growth of EV drivers both in Greece and Bulgaria.

This report provides multiple examples of current interoperability providers and solutions and some tentative recommendations as well as the mind process for identifying the best solution for this project.

The main expected difficulties and risks in developing a cross-border network are listed followed by the roaming options and a few general conclusions.

I. INTEROPERABILITY PROVIDERS

Here are examples of several European eRoaming platforms and large CPOs providing interoperability and roaming services that have been examined by the project team.

Hubject

Hubject is one of the largest platforms that provides interoperability solutions for charging points operators in the world. The company was started in 2012 and today it reunites more than 400,000 charging stations on one single map.

The network works with real-time automated financial flows which facilitates the different operators of charging points.

e-clearing.net

e-clearing is an interoperability platform created in 2014 aiming to reunite the different charging stations operators on the European market. They give the possibility to their partner CPOs to choose with whom they want to roam.

e-clearing are trying to attract new partners with the following benefits:

"An open market model that gives complete autonomy to connect; you choose the partners to connect with and the data you want to exchange. e-clearing.net uses the open protocol OCHP that includes all needed functionalities

An open business model for direct business relationships without intermediate parties.

Get unlimited business by only paying a fixed, yearly membership fee. So, no costs per transaction, token or chargepoint!"

Gireve

The French company Gireve created in 2013 is an e-roaming platform that plays an important role in the creation of pan-European e-mobility roaming. The platform provides different services for

charging point operators. They have access to different offers for partnership with other operators, the platform facilitates the negotiations and the contract conclusion.

The roaming services of Gireve include:

- Data flows

- Book, charge and follow op of the charging sessions

- Quality controls on the charging sessions and connectivity overview of the charging sessions

Virta

The Finnish company was created in 2013. It has been one of the fastest growing companies in Europe in the last few years and now has over 1'000 partner CPOs, mostly in Europe.

They service over 300 charging points in Greece and over 60 in Bulgaria.

ChargePoint

The company was created in 2007 and with nearly 200.000, claims to be the world's largest network of EV charging stations in North America and Europe.

In addition to being one of the largest CPOs, the company designs, develops and manufactures hardware and software solutions and offers a variety of different AC and DC charging stations.

Enel

Enel is an Italian power utility company with a large number of partnerships in different spheres of the sustainable energy fields. The company started to provide solutions to power electric vehicles back in 2010 and in the present-day Enel is the top Italian provider of interoperability solutions for the EV charging operators.

MOBI.E

MOBI.E is a Portuguese company that initially developed e-mobility and the charging stations in the country. Today, MOBI.E provides various kind of services that are connected to electric vehicles and mobility.

The enterprise controls a large interoperable platform for recharging that includes not only the operators of charging points, but also energy retailers and automakers.

Tesla

One of the main brands of electric mobility, Tesla has given access to its massive Supercharger network to owners of non-Tesla EVs.

Fortisis

The Fortisis network was the first network of electric car charging points in Greece, which started operating in 2013. Its design and development philosophy are based on the vision of an open shared charging network for electric vehicles, which contributes to the sustainability of motoring and cooperation of those who develop and invest in electrification infrastructures.

Ampeco

Ampeco is a Bulgarian company providing a platform for EV charging and Smart Load Management that is also a software provider. They offer to their client EV Roaming services that include an integration with the EV Roaming leaders GIREVE and Hubject, direct integration based on OCPI protocols, as well as an access to a Roaming partner management portal.

PlugShare and ChargeHub

These are the two most popular charging points location mapping services. They allow users search for stations across all major charging networks. Both allow users to plan trips and filter search results by connector type, charger power, network, and other features such as highest user ratings or locations with amenities like restrooms and Wi-Fi.

For CPOs in our region joining international interoperability platforms remains inefficient because of the limited number of electric vehicles driving from afar to the Balkans contrary to the growing Greece-Bulgaria electric vehicles traffic. The first are in the tens per month while costs for joining an international platform are between 10 and 20'000 not including interface development costs.

II. GREEK BULGARIAN INTEROPERABILITY OPTIONS

For many years now, CPOs have struggled to determine their operational and commercial choices.

1. Creation of a new platform

Many operators have chosen to create their own application. This solution has not been very effective because charging at only one operator is a serious constraint for customers. They prefer to have access to a larger network of EV charging stations, as most regions are not yet very well covered even by a multitude of operators, let alone by one of them.

Thus, it has been more difficult for them to attract new customers. In locations where there aren't a lot of operators developing a shared application has allowed to achieve interoperability, as well as facilitate the users and attract new customers.

In general, EV users have become accustomed to using many different platforms and applications in order to cover their needs.

2. Integration with a large international platform

By joining a large platform, an operator can present its charging points along with those of its competitors. This can be beneficial because of attaining a larger pool of clients and can be also beneficial for the clients since they can charge their vehicles at a much larger network of charging points.

Joining an international platform as Hubject is the easiest way to achieve interoperability between different operators. The main benefit for the operators is that their charging points become visible for more users and they can attract foreigners that would not have an easy access to their

networks. On the negative side is the cost of using large platforms could be prohibitive, particularly for small CPOs.

3. Interoperability via direct agreements among CPOs

Interoperability could be achieved by direct agreements between the operators of the different networks. Once an agreement is concluded, the operators can integrate the charging points of their partners in their own systems. Thus, operators use the platforms of their partners and vice versa. The large number of different and separate agreements is a serious drawback. In consequence, the management of such partnerships has proven to be quite difficult, particularly for small operators.

Certain countries, like the Netherlands, have rendered it compulsory for CPOs to provide interoperability and roaming capabilities. In Greece and in Bulgaria it is not yet the case, so we have had five options:

- an international "front end" MSP platform to which our partner CPOs would have to provide access or would have already given access;
- an international "back end" MSP platform, which our partner CPOs would have to join or would have already joined;
- a payment app operator with whom our partner CPOs would sign a payment roaming agreements;
- an MSP providing RFID or NFC cards that each one of our partner CPOs would allow to be used for payment;
- a dedicated mobile platform that would provide map localization and links to each of the partner CPOs service and payment apps.

Following lengthy negotiations with many CPOs we have chosen the last option for budget, simplicity, speed and effectiveness reasons. The first main obstacle for the development of a proprietary platform turned out to be time. It was estimated that it takes at least 9 to 12 months for the elaboration of a charge point service and payment application.

Furthermore, in order to simplify the charging experience, the e-mobility industry is currently further simplifying the charging process by eliminating the hassle of using an external device to authorize the use of a charging station. The act of paying with a bank (NFC) or RFID card, using an app, scanning a QR code is likely to be greatly reduced.

More and more often CPO customers are automatically authorized to use their charging stations and settling the billing process after charging. The main such protocol is named Autocharge. It requires an initial registration on the CPO's platform after which any of the CPO's charging stations automatically recognizes and interfaces with the vehicle. Autocharge is now available at all our partner CPOs in Greece and Bulgaria..

III. MAIN DIFFICULTIES AND RISKS EXPECTED IN DEVELOPING THE PLATFORM

a.   Legal and tax constraints to international interoperability and across the Greek-Bulgarian border in particular.

b.   Physical Charging Interface

Charging stations provide a variety of DC fast charging and AC charging connectors. Standards vary across countries and continents as shown in the following diagram.

Figure 1: Types of EV charging connectors

Supporting multiple formats adds equipment complexity and cost and may increase the footprint required to serve a given number of vehicles.

Considering the evolution of the charging infrastructure in Greece and Bulgaria we have decided to support the Mennekes (AC charging) and CCS2 (DC charging) standards.

c.   Agreements with CPOs

Most complex is the agreement on the transactions and billing processes as well as the access to the books and all relevant data. Real time money flow requires integration of additional software.

d.   Agreement with software engineers

The networks will have to be integrated in different ways to achieve interoperability. The platform might offer integration with GRIEVE and Hubject networks and direct P2P integration with other operators of EV charging points requiring access to CPO APIs.

e.   Technical requirements and constraints for joining any of the platforms.

CPOs use a variety of API protocols and standards for roaming integration, depending on their specific needs and the needs of their partners. Here are some of the most commonly used protocols and standards:

- OCPP (Open Charge Point Protocol): OCPP is an open standard protocol that is widely used for communication between EV charging stations and central management systems. It is used by many EV charging network operators for roaming integration.

- ISO 15118: ISO 15118 is a standard for bidirectional communication between EVs and charging infrastructure. It enables secure communication for a wide range of applications, including authentication and billing.

- OCPI (Open Charge Point Interface): OCPI is an open API protocol developed by the Open Charge Alliance for roaming between EV charging network operators. It provides a standardized interface for communication between charging networks, including location and availability data, pricing information, and transaction data.

- eRoaming Intercharge: Intercharge is an eRoaming platform developed by Hubject, a company that provides an interoperability platform for EV charging. It enables EV drivers to access multiple charging networks using a single registration and payment system.

- NMI (National Mobility Infrastructure): NMI is a UK-specific standard developed by the Office for Zero Emission Vehicles (OZEV). It enables EV drivers to access multiple charging networks using a single registration and payment system, similar to the Intercharge platform.

Overall, the choice of API protocols and standards for roaming integration depends on the specific needs of the EV charging operator and their partners. Many operators use a combination of these protocols and standards to ensure maximum interoperability with other networks.

f. Charging customers' experiences and business cases.

Design of customer experience

g. Cost and other obstacles to developing a proprietary platform.

IV.   ROAMING SOLUTIONS

 Demand for electric vehicle infrastructure continues to grow both in size and complexity. As the number of EV drivers grow, service providers are being forced to adapt to the demands of their customers. Given that the market is still relatively new, service providers are experimenting with multiple roaming strategies.

In many ways, the current structure of EV charging is one of the barriers preventing the mass adoption of electric vehicles. Intense competition and lack of common regulations are maintaining price uncertainty and contravene trust. This is in contradiction with customers' need for a

seamless charging experience. Just like their mobile counterparts before them, EV charging service providers should pay attention to customer expectations.

There are a variety of ways to pay for charging services:

- through the CPO managing the given charging station with an RFID or NFC card or through a payment app;

- through a subscription to an MSP (currently 95% of payments) with the platform's app, with a card or with Plug & Charge (vehicle recognizable by the charging station).

EV roaming networks could be categorized in three broad groups each allowing any of the above payment options:

- Internal EV charging network: A management system providing the connections between the CPOs' charging stations and the MSPs using the network. This opens up the network to a wider number of drivers who can view, book charging stations and pay for the service.

- External charging network: Outside of any CPO platform is a large chain of MSPs, each with its own network of drivers.

  Many MSPs choose to enter into bilateral peer to peer (P2P) agreements, allowing their drivers to use each other's networks. This lets the service providers expand their networks while increasing revenue from new users. This presents a major inconvenience to drivers as they constantly have to monitor trends in the industry. Even worse, drivers are still limited in the number of charging points they can use.

- Charging management platform: The centralized platform acts as the link between a large number of CPO and MSP platforms and the wide market of EV drivers.

- Charging Management Platforms, tackle the issue of constant change in infrastructure, charging points, platforms and standards and corresponding range and autonomy anxiety through providing drivers with a selection of charging stations in a centralized app. By centralizing charging station networks under a single customer account, charging hubs provide the convenience and flexibility demanded by drivers while avoiding the costs and complexity of operating bilateral, peer to peer agreements while still accomplishing the goal of providing more options for their users.

Users' preferences are multitude. Here are a few. To be able to view multiple charging locations through the touch of a button. With just a click, to see prices and availability. No guessing or unpleasant surprises. From selecting a charging station, to charging, to payment, everything in one system. No need to surf through multiple apps. And most valuable, all customers would like to be able to use any charging stations without having to change networks.

CONCLUSIONS

Electric mobility is the perfect enabler for sustainable tourism, especially for countries like Greece and Bulgaria, whose heritage and economies relies on tourism. Each year, millions of Europeans drive through the two countries to visit palaces, museums, or restaurants. Travel is an experience full of opportunities to make guests feel welcomed and 'at home'. When EV drivers arrive in Greece and Bulgaria they should be able to rely on their preferred MSP, the one they trust and enables them to travel effortlessly all over Europe. That's the essence of sustainable tourism with an EV - feeling free to drive anywhere with zero impact, feeling at ease, knowing that your MSP will enable all your recharging sessions.

With more and more electric vehicles hitting the road each day, now is the time to optimize customer experience. In our case, we should design for Greeks and Bulgarians and visitors to both countries that drive electric a solution providing the flexibility to charge up anywhere with EV roaming allowing an effortless charging experience. Such a solution would permit CPO service providers and our partner SMEs to attract new customers and expand their revenue streams.

Effortlessly optimizing connections between Greek and Bulgarian MSPs and CPOs, managing charging station networks and maximizing the user experience would be a very good result of our project. The platform should provide paths for the future flexibility to add charging stations, create payment transaction systems and monitor charging station status.