USER-CHI
CHARGING YOUR E-MOBILITY FUTURE

INTEROPERABILITY FRAMEWORK IMPLEMENTATION

D3.2: INFRA – Interoperability Framework Implementation

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Abstract

To enable the widespread adoption of EVs it is essential to establish an interoperable charging network that allows users to charge “anywhere, anytime” within the EU. Therefore, an interoperability framework (INFRA) has been developed considering conditions under which interoperability can be reached regarding electromobility services in general and the five technical USER-CHI products INCAR, CLICK, SMAC, INDUCAR and INSOC. It also highlights barriers still inhibiting interoperability and provides a set of guidelines with recommendations on how to reach interoperability.

Keywords

Interoperability, technical, semantic, legal, organisational, INFRA, INCAR, charging, contracts, roaming, service, barriers, operator, provider, stakeholder, actor, role scheme.

Copyright statement

Executive summary

The USER-CHI deliverable D3.2 “INFRA – Interoperability Framework Implementation” summarises the results of the corresponding task T3.2 “INFRA – Interoperability Framework implementation” whose aim it is develop the Interoperability Framework comprising of guidelines, and recommendations to support interoperability along four layers (semantic, technical, legal, organisational). INFRA is based on the results of the design and specification process performed in T3.1 and presented in D3.1 “Design and Specification of interoperability and roaming services”.

This deliverable should serve as a handbook for the USER-CHI product and demo site leaders as well as external stakeholders involved in the implementation of the five technical USER-CHI products. It should support them by giving recommendations on relevant semantic, technical, and legal aspects currently enabling or hindering interoperability of charging services and charging points. The developed guidelines also consist of general recommendations allowing transferability beyond the scope of the project and for stakeholders engaged in the field of charging services for electric vehicles.

D3.2 starts with an introduction, followed by the development process of INFRA. Then the set of guidelines and recommendations for interoperability is described in detail and finally leading to the conclusions.

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1. Introduction

1.1 Purpose of the document

The widespread adoption of Electric Vehicles (EVs) requires the establishment of cross-national conditions that allow users to charge “anytime, everywhere” within the European Union (EU). This demands to foster and establish interoperable charging infrastructure that can be accessed irrespective of vehicle brands and the operators providing and operating charging infrastructure. The purpose of this document is therefore to provide an overview of guidelines that help to enable interoperability of the novel charging solutions developed in USER-CHI to increase the user-friendliness of electromobility.

The target beneficiaries of this presented Interoperability Framework (INFRA) are product developers and further stakeholders that implement charging solutions or charging infrastructure solutions such as the five technical USER-CHI products CLICK, INCAR, SMAC, INDUCAR and INSOC.

1.2 Scope of the document

This document provides an overview of the interoperability framework (INFRA) resulting in the formulation of guidelines. This includes the description of the development process of INFRA throughout the working process and results in the formulation of a set of guidelines that help to reach interoperability within the USER-CHI project and allow for transferability, where applicable based on the status quo of information collected.

1.3 Structure of the document

The document is divided into four main chapters. Following an introduction, the connection to other USER-CHI tasks is briefly described in chapter 2. In chapter 3 the development process of INFRA is described by presenting a summary of the concept of INFRA and four main steps that have been carried out together with the USER-CHI partners (product developers and city partners). In chapter 4 the set of guidelines including recommendations for the target beneficiaries is presented. In chapter 5 the findings drawn from the previous sections are presented and discussed.

2. Connection to other tasks

This chapter describes the connection to other USER-CHI tasks. Task 3.2 has connection to T1.3, T3.1 and 3.3 as described below.

2.1 Technical and legal requirements – T1.3

T1.3 focused on collecting technical and legal requirements that USER-CHI solutions should consider when developing the products. D1.3 includes a corresponding inventory of technical and legal aspects (technical standards and normative restrictions/legislation) that USER-CHI solutions must accomplish at all 5 partner countries and a selected set of five other relevant EU countries (general requirements). It also includes requirements that not only focus on technical and legal aspects, but also on functional or development-oriented aspects that need to be fulfilled to implement the technical USER-CHI solutions in the USER-CHI demonstration sites (specific requirements). The results presented in D1.3 serve as an input for INFRA.

2.2 Design and specification of interoperability and roaming services – T3.1

T3.1 provided functionalities of INFRA grouped in different functional blocks, as well the high-level design of the services to be provided by the INCAR system and an overall description of the INFRA concept specifying the four main pillars in which both functional and non-functional requirements are classified into and benchmarked to determine interoperability. The four main pillars that have been addressed in T3.1 describing the organisational, legal, technical, and semantic layer. The description of the four-layer approach exemplified the logic of the INFRA framework and described the process to go through to reach interoperability (e.g., through using guidelines and “interoperability checks”).

2.3 INCAR – Interoperability, Charging and Parking Platform development – T3.3

T3.3 provides the development of the integrated services for EV charging of the INCAR Platform such as interoperability and roaming services, routing services to EVSE, park and charge services, real-time availability information for publicly accessible charging points. INCAR represents the product with the greatest relevance in terms of interoperability among all technical USER-CHI products. INFRA will therefore contribute to interoperability in the development process of the INCAR services by providing applicable guidelines and recommendations for several (prioritised) technical, semantic, and legal aspects.

3. Development of the Interoperability Framework (INFRA)

3.1 The concept of INFRA

The overall INFRA concept represents a framework and a product of USER-CHI that provides an overview to various stakeholders on the conditions under which interoperability can be achieved resulting in improved usability of publicly accessible charging infrastructure. It addresses different barriers that currently inhibit interoperability on various levels. As indicated in Figure 1 the Interoperability Framework consists of four layers (organisational, legal, technical, and semantic) determining interoperability regarding electromobility services in general and the five technical USER-CHI products INCAR, CLICK, SMAC, INDUCAR and INSOC. INCAR - Interoperability, Charging and Parking Platform is directly linked to INFRA in terms of the application of interoperability[1].

[1] An in-depth description of each layer has been presented in D3.1. The following paragraphs aim at representing a summarised version of the core concept of INFRA prior to its description of the implementation process (T3.2) and result representation (chapter 4).

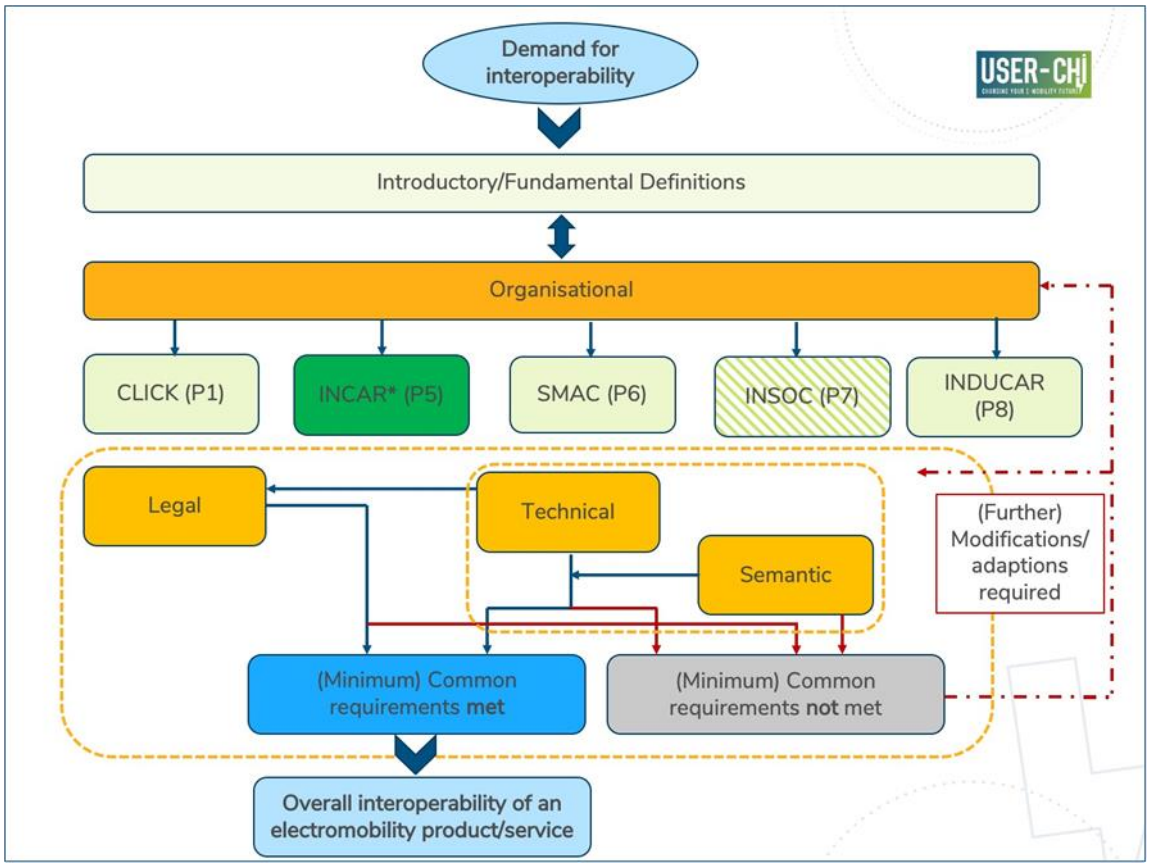

Figure 1: Overall structure of the Interoperability Framework – INFRA

Following with the structure shown in Figure 1, INFRA layers are described as follows:

- The **organisational layer** is also referred to as the global layer. It aims at creating a common understanding of goals, functions, system boundaries and responsibilities among all stakeholders involved in the development and implementation process of produces and specific use cases that enable interoperability resulting in a holistic role scheme.
- The **legal layer** is referred to as a specific layer and represents national, regional, and local legal aspects that determine interoperability in the electric mobility ecosystem.
- The **technical and semantic layer** are referred to as specific layers and focus on technical requirements for interoperability for all key aspects involved in providing charging services and infrastructure. This includes both hardware and semantic (communication technology) requirements for electric vehicle supply equipment (EVSE), payment for charging services, billing, data sharing processes and data management among charging point operators (CPOs), electromobility service providers (EMSPs) and roaming platforms as well user authentication and roaming for an extended user access to charging infrastructure.

3.1.1 Interdependencies between the semantic, technical, legal, and organisational layer

Within the four layers of INFRA there are interdependencies, which are not only reflected in the above-mentioned framework of a global layer and specific layers, but also by the dependencies of the three specific layers on each other. As shown in Figure 2 the organisational/global layer forms the general framework that surrounds the requirements of the three specific layers. The global layer is therefore particularly critical for the success as an enabler or disabler for the practical implementation of the technical USER-CHI products. In this context, the acting stakeholders, and their (established) relationships to each other are essential.

The requirements of the semantic layer are a further essential part of the technical requirements and contribute to the minimum requirements in INFRA composing of the requirements from the three specific layers[2]. The technical layer in turn primarily involves technical requirements (such as standards, technical connection rules) for the hardware and energy supply of the USER-CHI products including hardware components and a grid connection (in case of INSOC and INDUCAR) and thus become important part of the minimum requirements as well.

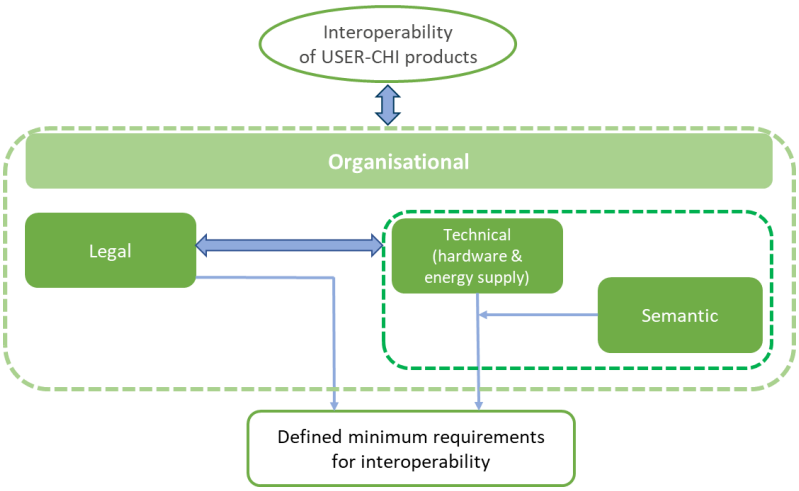

Figure 2: Interdependencies between INFRA's layers

Within the specific layers, the legal layer in turn forms the basis for the legally compliant and interoperable implementation of the USER-CHI products with their specific technical requirements and to some extent provides statutory provisions for technical implementation (e.g., charging plug specifications in the Alternative Fuel Infrastructures Directive – AFID[3]). It also provides the framework for contractual B2B agreements between the different stakeholders involved and thus connects it to the organisational layer.

[2] See paragraph on minimum requirements below.

[3] European Union 2014: Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0094

Consequently, the requirements of the technical, semantic, and legal layer form the minimum requirements defined for each product for an interoperable implementation, as described in the following chapter 3.1.2.

3.1.2 Definitions and categorisation of requirements

Requirements for the interoperability for electric vehicles´ charging infrastructure can be categorised by different means reflecting their specifics and contextualisation within the different layers of INFRA. The following section will provide definitions of the different categories of general/specific requirements and functional/non-functional requirements as well as minimum requirements for the technical USER-CHI products. It serves as an overview to provide an understanding of the role of different requirements arising for interoperability within the development and implementation of the USER-CHI products.

General and specific requirements

Requirements can be categorised by their scope of application and nature in the context of the implementation of a product referring to the four layers. Within INFRA **general requirements** (mainly) refer to the organisational or global layer, which provides the overall framework for each product that is intended to be interoperable implemented. **Specific requirements** refer to the specific layers reflecting the legal, technical, and semantic requirements for interoperability.[4]

In the context of this deliverable and of INFRA, only the first conceptual understanding of general and specific requirements is used.

Functional and non-functional requirements

A further classification used within INFRA is the distinction in functional and non-functional requirements.[5]

Functional requirements in INFRA are related to the specific technical functionality of the five technical products concerning the technical (e.g., hardware standards) and semantic dimension (e.g., communication protocols for platforms, interfaces). In contrast, **non-functional requirements** are related to the feasibility of the USER-CHI products, emphasising their importance for the actual/practical implementation. They refer to the organisational and legal dimension of INFRA. During the implementation phase technical products or solutions can face challenges with existing organisational structures such as locally established role schemes or stakeholders for providing publicly accessible charging infrastructure. Furthermore, local, or national legislation can hinder the product's local implementation due to additional requirements it must comply with (e.g., regulation of measuring instruments, tariff models, provisioning of dynamic data). Non-functional requirements are therefore of high practical relevance for successfully implementing the USER-CHI products.

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[4] See D1.3 Technical and legal requirements for USER-CHI solutions (chapter 4)

[5] Cf. for example Camara/Dupas/Ducq 2017: Validation and Verification of Interoperability Requirements; https://hal.inria.fr/hal-01438406

With respect to the previously explained categorisation of general and specific requirements, functional and non-functional requirements in INFRA can be linked to these. Functional requirements can also be categorised as specific requirements, while organisational requirements can also be categorised as general requirements.

Minimum requirements

Minimum requirements form the basis for achieving overall interoperability of the technical USER-CHI products within the four-layer approach. Within INFRA minimum requirements refer to a combination of different requirement aspects, related to each technical USER-CHI product and the specific layers of interoperability. The most relevant individual requirements of all specific layers form the minimum requirements.

Therefore, users of INFRA – in USER-CHI the responsible product leaders and demo site partners – should define minimum interoperability requirements for the legal, technical, and semantic layer they aim to achieve for their products or solutions.

The minimum requirements are thus narrowed down and based on the product leaders´ and demo site leaders´ prioritisations of the relevance of the different technical, semantic, and legal aspects for interoperability[6]. Aspects with high relevance, such as compatible charging plugs or uniform charging protocols, should always be considered or strived for when implementing the USER-CHI products or charging solutions to ensure basic interoperable functionality and feasibility.

The USER-CHI products CLICK, INCAR and SMAC are platform solutions and therefore differ from INSOC and INDUCAR. With focus on minimum requirements, they do not only include platform (software, ICT) components but also hardware components. Therefore, further hardware (technical) requirements must be part of the minimum requirements.

3.2 Development of INFRA guidelines in USER-CHI

This sub-chapter describes the **development process** of INFRA within USER-CHI. In an **iterative approach** the **five steps** explained in detail below were executed, also incorporating the results drawn from T1.3 and T3.1. Throughout the development process of INFRA the product leaders of the five USER-CHI products CLICK, INCAR, INDUCAR, INSOC and SMAC as well as the city partners from the cities of Barcelona, Berlin, Budapest, Rome, and Turku have been involved in workshops.

[6] See chapter 3.2.4 (Prioritisation of legal and technical requirements)

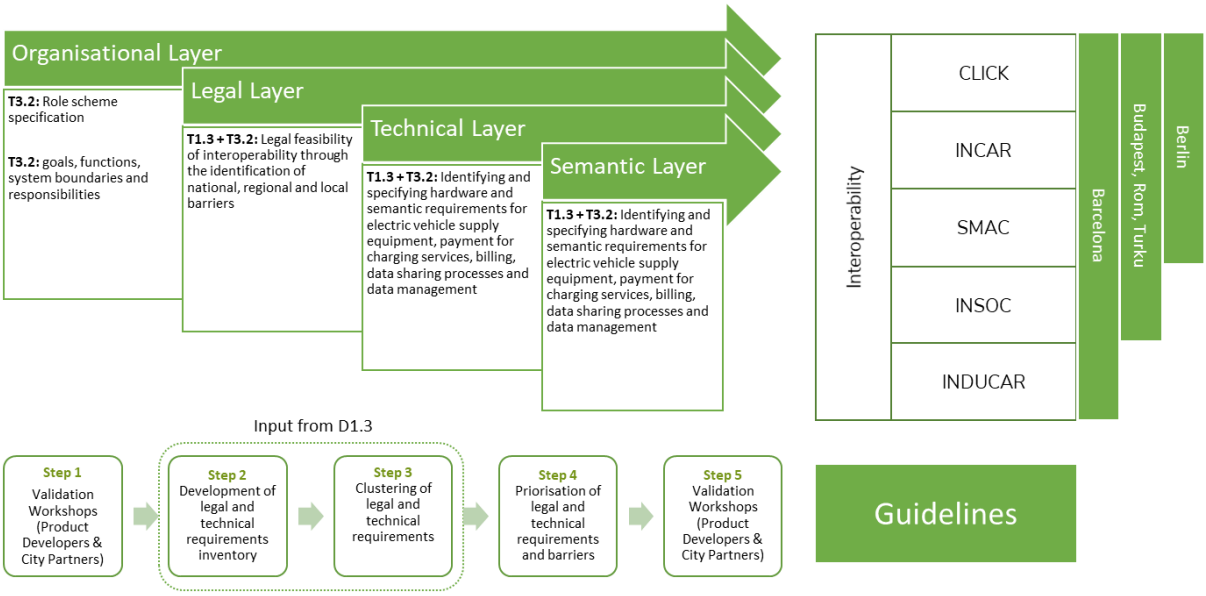

Figure 3: Development process of INFRA guidelines

3.2.1 Validation workshops (product developers and city partners)

In a **first step** the organisational layer has been addressed resulting in the specification of role schemes and the consolidation of different understandings of goals, functions, system boundaries and responsibilities by means of enabling interoperability through the implementation of CLICK, INCAR, INDUCAR, INSOC and SMAC. Therefore, one validation workshop for each USER-CHI demonstration city has been organised and completed between December 14th and 18th 2020.

To reach a common understanding among all relevant parties involved in the development process of INFRA, all USER-CHI partners have been asked to complete a table prior to the workshops indicating an overall role scheme. The role scheme consists of information of project partners and external parties that are relevant for the implementation of the five technical USER-CHI products in each demonstration city. The main preparation tasks included:

- To check if any role is missing in the table provided and give an indication of different (potential) users of the technical USER-CHI products that will be applied in each USER-CHI demonstration city
- To specify the roles by providing the names of the stakeholders involved in each USER-CHI demonstration city
- To indicate a definition/task of each stakeholder for the application of the products in each USER-CHI demonstration city
- To indicate how each role relates to other roles within the applications of the respective product in each USER-CHI demonstration city

The relevant instruction and template sent out to the relevant USER-CHI partners prior to the workshops is attached in Annex 1.

3.2.2 Development of legal and technical requirements inventory[7]

The **second step** of the development of INFRA focused on the development of legal and technical requirements resulting in a set of legal and technical requirements inventory determining interoperability. This step has been approached through the work carried out within T1.3. A detailed description of the methodological approach is presented in chapter 3 of D1.3. A summary of relevant legal and technical requirements inventory is attached in Annex 2.

3.2.3 Clustering of legal and technical requirements

In a **third step**, the collected legal and technical requirements have been clustered. Therefore, the requirements inventory developed in T1.3 served as the main input. The technical and legal requirements presented in D1.3 have been selected and sorted according to USER-CHI demonstration cities and distinguished between general and specific requirements as described in the sections 3.1.1 and 3.1.2.

3.2.4 Prioritisation of legal and technical requirements and validation workshops (product developers and city partners)

In a **fourth and fifth step** the core legal and technical aspects have been prioritised by the developers of INFRA based on the results drawn from D1.3 and resulted in a preliminary list of prioritised aspects. Following that a validation workshop for each USER-CHI demonstration city has been organised between March 15th – 19th 2021. These workshops aimed at prioritising legal and technical aspects that either support or inhibit interoperability the most considering both the development and the implementation of the technical USER-CHI products. The prioritisation of the technical and legal aspects by the USER-CHI product leaders and USER-CHI city partners was essential to determine, which aspects presented in D1.3 acted as enablers and/or barriers for interoperability. Therefore, a qualitative 4-point rating scheme[8] has been applied to indicate the relevance of a technical or legal aspect. The rating scheme ranged from low (+/-) to high (+++). After the prioritisation of the technical and legal aspects the partners were also asked to comment on existing barriers for interoperability within their scope of demonstration.

The relevant instruction and template sent out to the relevant USER-CHI partners prior to the workshops is attached in Annex 3.

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[7] The following steps (including the second step) addressed work carried out of the three specific layers.

[8] The relevance for interoperability can be indicated as low (+/-), moderate (+), medium (++) or high (+++).

3.2.5 Guidelines´ presentation

Following the five steps, the results have been consolidated to a selected set of semantic, technical, and legal aspects determining interoperability. The selection of the aspects has been based on the results of the prioritisation activity. Those aspects rated of high (+++) and medium (++) priority/ relevance for interoperability or explicitly mentioned as important for interoperability by the involved project partners are presented in chapter 4.

The presentation of the guidelines is based on a structured text box, which highlights the following information (Figure 4):

- **Guideline for technical/legal requirement**

The guidelines presented can be defined as a general statement or advice that helps to reach interoperability in the scope of USER-CHI and also beyond the scope of the project. Within INFRA a guideline is interpreted as the overall result drawn from the development process.

- **Relevance for interoperability**

The section « relevance for interoperability » indicates the priority of the semantic, technical, and legal aspects for interoperability based on the assessment of the USER-CHI product leaders and the USER-CHI city partners.

- **Information on existing technical standards/ regulation**

The section « information on existing technical standards/ regulation » shows the link to existing general rules and/or principles that are affected by means of technical standards and legislation.

- **Main barriers for interoperability/ need for action**

This section captures the barriers that inhibit interoperability and have been identified by the USER-CHI product leaders and USER-CHI city partners indicating the need for action to reach interoperability.

- **Recommendations**

This final section « recommendations » provides solutions on how to diminish the main barriers for interoperability pre-dominantly in the scope of USER-CHI for the semantic and technical layer. A more general proposition of solutions on how to tackle the barriers for interoperability is formulated in the scope of the legal layer.

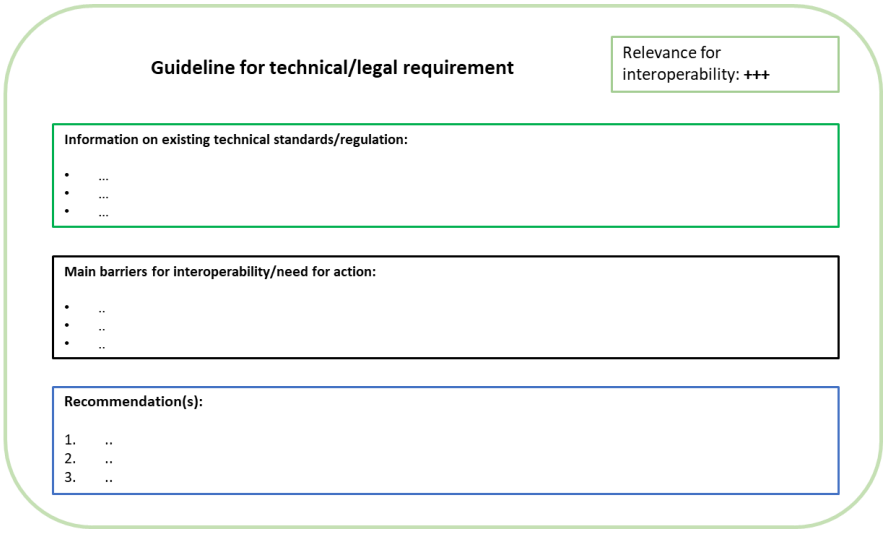
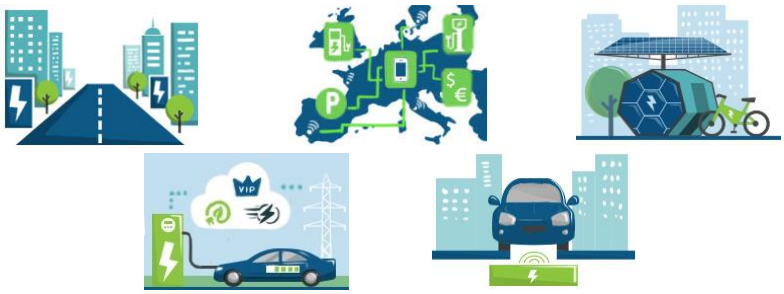


Figure 4: structured text box format for guidelines

4. Role schemes and guidelines for interoperability

In this chapter, the results of the work carried out presented throughout chapter 3 are shown.[9] After presenting the developed **role schemes** for the organisational layer, the results concerning the semantic, technical, and legal layer are formulated as **guidelines and recommendations that help to enable interoperability** in the scope of USER-CHI through the implementation of the technical products CLICK, INCAR, INDUCAR, INSOC and SMAC. The guidelines presented also provide general recommendations to some extend that allow for transferability beyond the scope of the USER-CHI project based on an indication of future developments. This particularly addresses legal barriers and concerns and is specifically outlined in section 4.3.

4.1 Organisational layer



The organisational layer forms the general framework for the semantic, technical, and legal layer and applies to all technical USER-CHI products. In this context an overall/general role scheme as well as five city-specific role schemes have been elaborated including the acting project partners and external (local) stakeholders involved in the intended practical implementation of the products. All role schemes are based on the results of the validation workshops described in chapter 3.2.1.

4.1.1 Overall roles scheme

The overall role scheme for the implementation of the technical USER-CHI products reflects the actors that are generally involved in providing charging services and infrastructure as well as the results of the validation workshops including additional roles provided by the city partners and product leaders. Additional roles include project partners and external stakeholders involved in providing technology and data (e.g., ETRA, VMZ), public lighting, academia, or marketing activities such as AMB and Eurocities (EUR).

[9] The results of the workshops are attached in Annex 4 and Annex 5.

The overview consists of 21 different roles (see Figure 5) and illustrates that in basically all demonstration cities the same established and new stakeholders of the energy, transport sector and public authorities take responsibility for implementing EV charging services, infrastructure and ensuring their interoperability. In the following chapter 4.1.2 it becomes apparent that not all roles are represented in all demonstration cities, although certain roles are found in all five cities. The specific roles and responsibilities are explained more in detail in section 4.1.3.

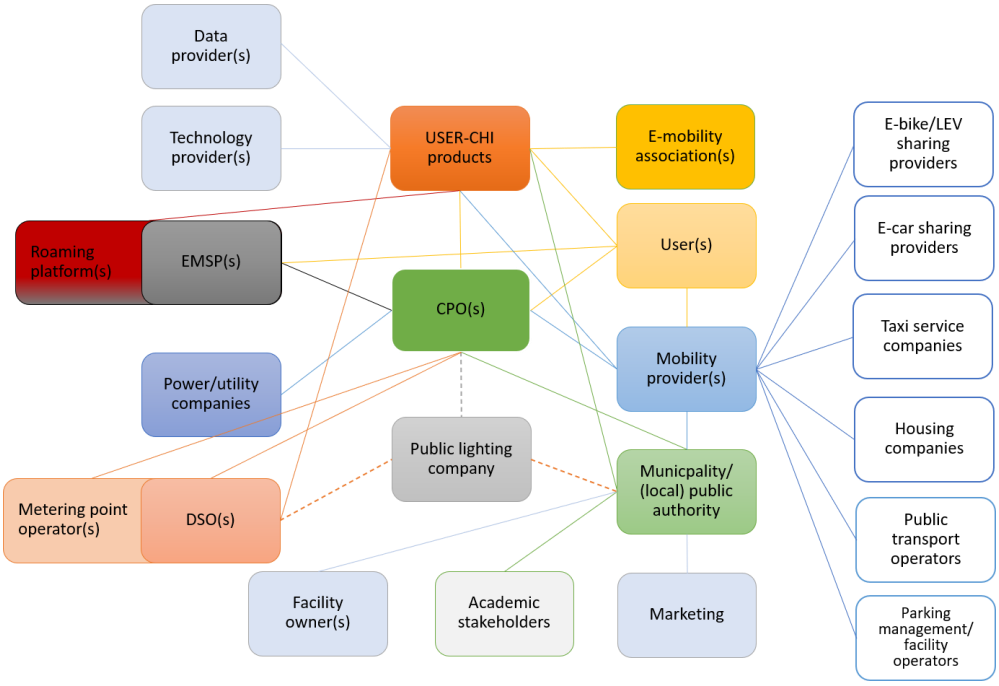


Figure 5: Overall role scheme – implementation of technical USER-CHI products in demostration cities

There are both advantages and disadvantages associated with the bundling or simultaneous performance of several roles by a single actor. The reduced number of local actors involved and therefore necessary communication as well as the possibility of integrated (“in house”) implementation approaches and processes have a potentially positive effect on interoperability. On the other hand, the overlapping of several roles at one actor can have a negative impact due to a lack of communicative accessibility for external actors and providers of charging solutions, thus opposing the goal of location- and operator-independent interoperability.

In this context all USER-CHI demo site leaders and product leaders are recommended to use their established relationships and collaborations for implementing the technical USER-CHI products. Furthermore, the often internally and externally complex organisational processes of the implementation of public charging points and services should be further streamlined. Therefore, all actors and their roles should be involved in the coordination and implementation processes of the USER-CHI products at an early stage in order to avoid later changes in the implementation phase, which are often cause a high level of effort.

Finally, the demo site leaders (municipal actors) are advised to work hand in hand with providers of charging points and charging solutions in the implementation process to ensure a prompt and efficient implementation of the products.

4.1.2 Specific role schemes per USER-CHI city

4.1.2.1 Barcelona

In Barcelona there will be all five technical USER-CHI products implemented currently comprising of a total of 16 different roles for its city-specific role scheme (see Figure 6). Some roles are taken on by the same actors at once, such as Endesa as power/utility company and electricity distribution system operator in Barcelona. UTE ETRA-GIC is taking responsibility as EMSP and roaming platform operator for EV charging on behalf of AMB. Moreover, AMB Electrolineres acts simultaneously as CPO and metering point operator for its charging points.

AMB itself is responsible as local authority for Barcelona as well as facility owner, user of the USER-CHI products (e.g., INCAR Platform, CLICK Platform), actor for marketing and data provider for the planning charging points. Further Barcelona roles also include AMB as provider of e-car sharing (AMB Mobilitat) and e-bike/LEV sharing services (AMB e-Bicibox). Besides taxi companies with EVs involved as well as the e-mobility association Taxi Ecologic and technology providers for INSOC (provider for PV panels) and INDUCAR (IPT for providing inductive chargers, company for retrofitting of AMB's EVs to be decided).

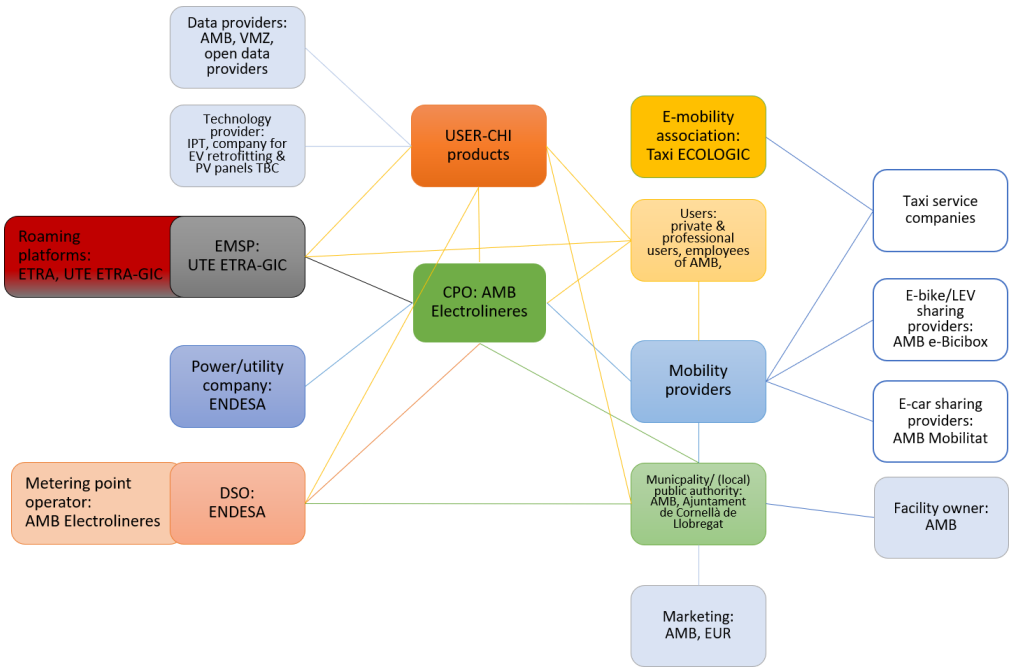


Figure 6: Specific role scheme – implementation of CLICK, INCAR, SMAC, INSOC, INDUCAR in Barcelona

4.1.2.2 Berlin

Within the Berlin demonstration sites there will CLICK, INCAR and SMAC implemented, at present including 14 different roles for the city-specific role scheme (see Figure 7). Some roles are also taken on by the same actors simultaneously, e.g., QWI as CPO and EMSP or Stromnetz Berlin as electricity distribution system operator and metering point operator on the grid side. The power/utility company to provide the electric energy for charging points has not yet been decided. ETRA is taking responsibility as roaming platform operator for EV charging in Berlin as well and acts as technology provider (backend system) for the INCAR Platform together with VMZ (frontend system).

GEW acts simultaneously as housing company and operator of its own parking facilities (parking spots and charging points in semi-public space for tenants and external users). A parking management operator for GEW's facilities has not yet been chosen.

On the mobility provider side there are several potential e-car sharing providers that can be taken into consideration such as WeShare, ShareNow, Sixt Share and Mobileeee. SenUVK is responsible as the city's authority regulating all on-street charging points and operating the "Berlin Model" for charging infrastructure. In addition, the eMO (Berlin Agency for Electromobility) as a local e-mobility association can be involved by the local project partners for dissemination and marketing activities if required.

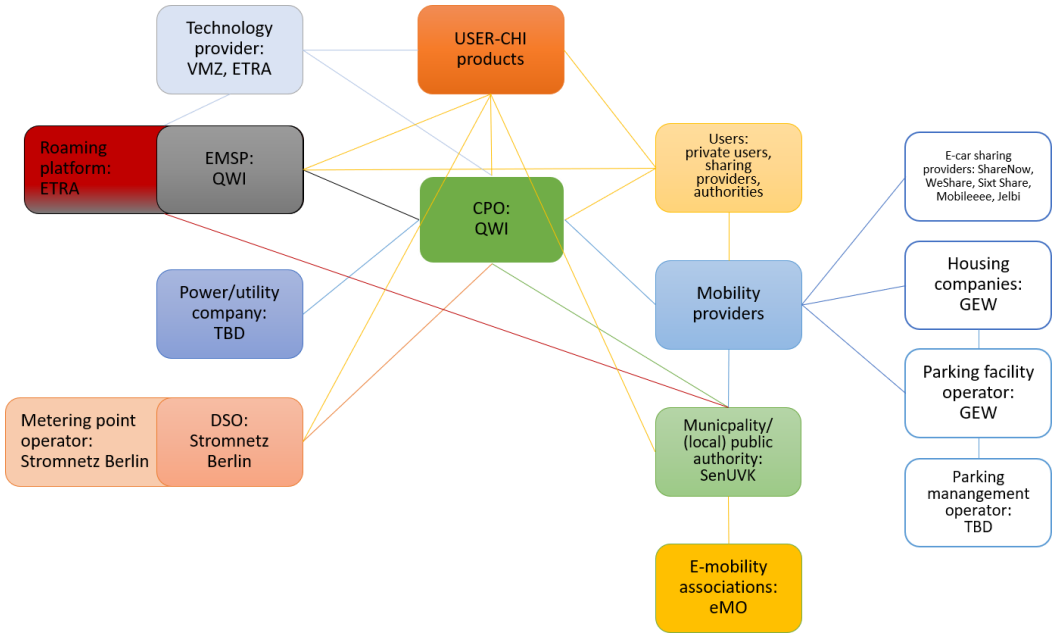


Figure 7: Specific role scheme – implementation of CLICK, INCAR, SMAC in Berlin

4.1.2.3 Budapest

Budapest's demonstration activities will incorporate implementing four technical USER-CHI products, at present including 15 different roles within the city's role scheme (see Figure 8). Multiple roles are also taken on by the same actors at once, such as BUD or BKK as CPO and EMSP (to be decided for the USER-CHI demonstrations), BUD as public authority and BKK as public transport operator in Budapest. Further CPOs and EMSPs active in Budapest include NKM Mobiliti (both roles) and GreenGo (EMSP). ETRA is once more taking responsibility as roaming platform operator (INCAR Platform) for EV charging in Budapest.

ELMÜ will act simultaneously as electricity distribution system operator and metering point operator on the grid side and besides that, is also active as CPO and EMSP. The potential power/utility companies to provide the electric energy for charging points are E.ON and MVM, but have not yet been decided.

Beside BUD the district governments of Budapest are also involved as local public authorities regarding the implementation of on-street charging infrastructure and services. Related to the municipality, there are further roles such as the e-mobility association Jedlik Ányos Klaszter, the Óbuda University for Technology and Economy (academic stakeholders) and the public lighting company BDK that is operating smart lamp posts.

Other than the public transport operator BKK, there are also providers of e-car sharing services (ShareNow, Mol Limo, GreenGo) and LEV sharing services (Lime, Blinkee.City) in Budapest, who could potentially be involved in the demonstrations.

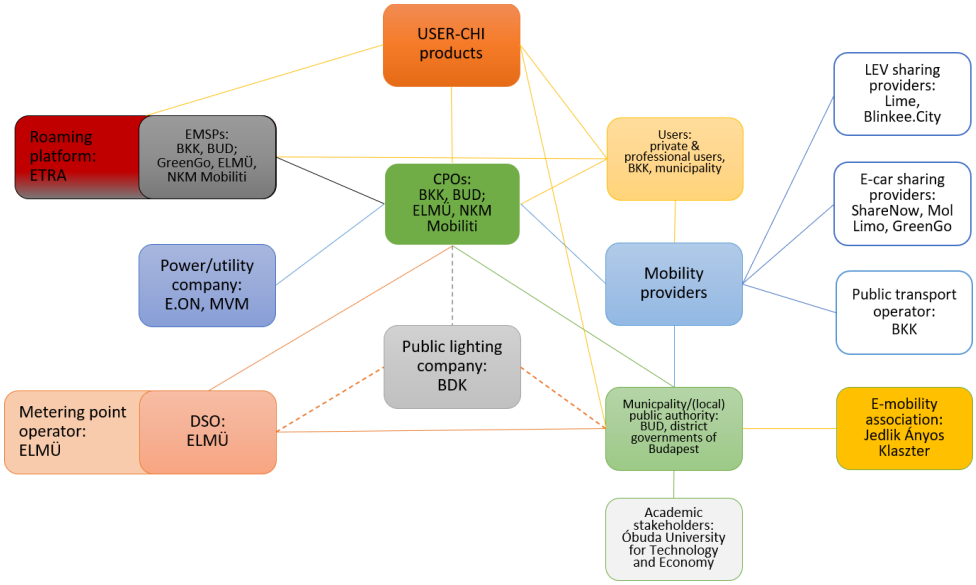


Figure 8: Specific role scheme – implementation of CLICK, INCAR, SMAC, INSOC in Budapest

4.1.2.4 Rome

In Rome there will be four technical USER-CHI products implemented currently comprising of 13 different roles within the city-specific role scheme. As Figure 9 shows, some roles are taken on as well by the same actors at once, such as ENEL X being CPO and EMSP. Moreover, ACEA acts simultaneously as power/utility company, electricity distribution system operator and metering point operator on the grid side. ETRA is taking responsibility as roaming platform operator (INCAR Platform) for EV charging in Rome.

Together with the municipality, RSM is responsible as local authority for Rome for the implementation of public charging points and services as well as user of the USER-CHI products (e.g., INCAR Platform, CLICK Tool).

Other roles that will potentially be involved in the Rome demonstration activities include different providers of mobility services: e-car sharing (RSM, Enjoy, ShareNow) and e-bike/LEV sharing services (Helbitz, Lime, Dott, Wind), taxi companies with EVs as well as the public transport operator ATAC. With e-mobility associations (i.a., MOTUS E) related to the municipality, there is another role to be foreseeably involved in the demonstration activities.

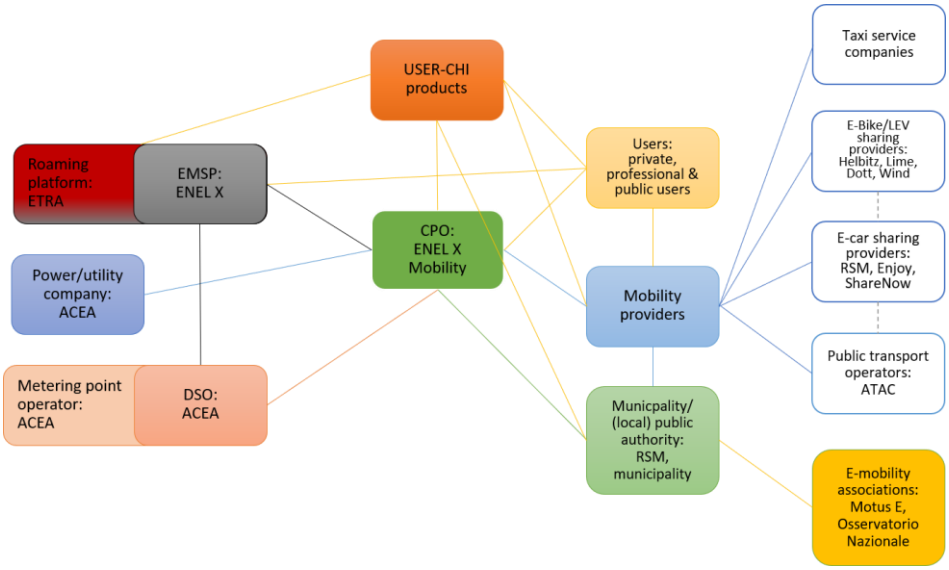


Figure 9: Specific role scheme – implementation of CLICK, INCAR, SMAC, INSOC in Rome

4.1.2.5 Turku

Similarly to Budapest and Rome, within the Turku demonstration sites there will be CLICK, INCAR, SMAC and INSOC implemented, at present including 15 different roles in the city's role scheme. As illustrated in Figure 10, multiple roles are also taken on by the same actors at once. Turku Energia (ENER) acts as CPO (in cooperation with VASO), power/utility company for providing electric energy for the charging points, electricity distribution system operator and metering point operator on the grid side.

As in all other USER-CHI demonstration cities ETRA is taking the role as roaming platform operator for EV charging in Turku. Furthermore, IGL and Virta are both also active as roaming platform providers as well as EMSPs. VASO acts simultaneously as housing company and CPO (in cooperation with ENER). Further housing companies involved in the demonstrations include TVT and Teknologiakiinteistöt oy.

TUR is responsible as the city's authority regulating all on-street charging points and services as well as user of the USER-CHI products (e.g., INCAR Platform, CLICK Tool).

On the mobility provider side e-car sharing and e-bike or LEV sharing providers can be taken into consideration but have not yet been decided. Further roles that will potentially be involved in the demonstration activities include taxi companies with EV fleets, the public transport operators VR, Föli and Matkahuolto as well as e-mobility associations (i.a., Sähköautoilijat ry).

Additionally, technology providers will be involved by the Turku project partners to enable implementing SMAC and INSOC. Huippuenergia will provide the smart metering system for the SMAC Tool, as well as PV panels, stationary batteries, and production of renewable energy. Regarding INSOC the technology provider for the PV panels and battery packs has not yet been decided.

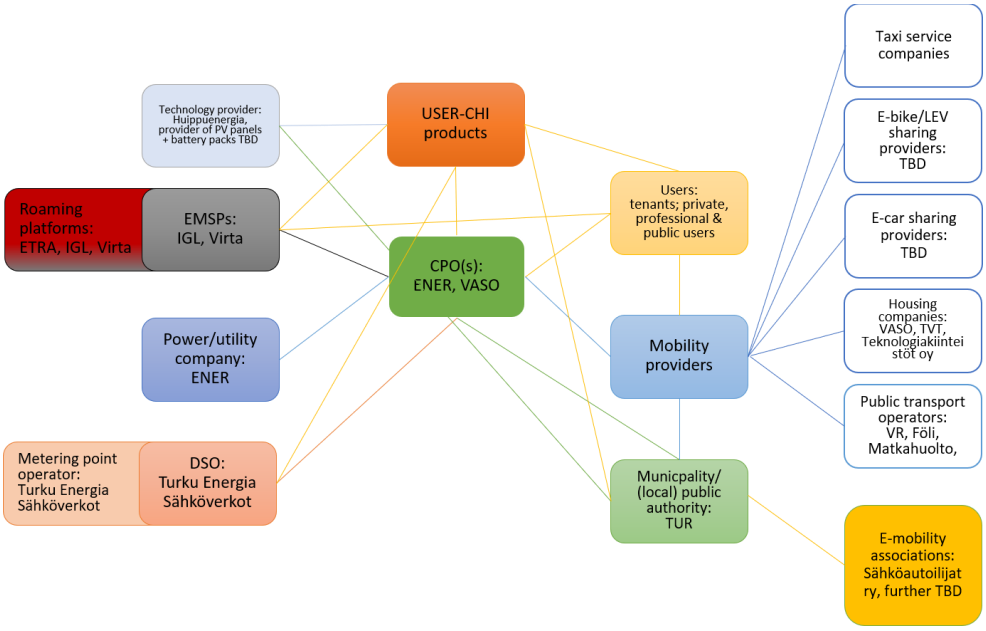


Figure 10: Specific role scheme – implementation of CLICK, INCAR, SMAC, INSOC in Turku

4.1.3 Specific roles and responsibilities/tasks

The various project partners and stakeholders that are involved in the interoperable implementation of the technical USER-CHI products are taking different roles illustrated in the following Table 1. The individual responsibilities and tasks of a role are related to the technical USER-CHI products and may differ depending on the specific actor and its demonstration

city/location. In practice, individual actors sometimes take on multiple roles, for example, power/utility companies are often also CPO and EMSP. Municipalities also often take over the operation of public charging points and act therefore as a CPO. Moreover, EMSPs can also be roaming platforms at once. Power/utility companies can also be responsible for the electricity distribution grid as well as the operation of metering points on the grid side.

Role	Responsibilities/tasks
CPO	• installation, operation, and maintenance of charging points • responsibility to ensure the electric power supply for its charging points (with power/utility company) • interaction between backend system and own charging points (data exchange via OCPP) • concluding contracts with EMSPs and roaming platforms to provide them access to charging points for their users • provisioning of charging points to EV users of respective EMSPs with access agreements • metering of energy consumption as a part of the charging points (→storage and transfer of measuring values) • generation of billing data for charging transactions • transfer of billing data to the respective EMSPs, roaming platforms • invoicing of access charges for granting access to charging points and costs for charging transactions with the respective EMSPs, roaming platforms
DSO/metering point operator	• connection of charging points to the electricity distribution grid • transmission of electrical energy to the charging points • operation of metering points on the grid-side • operation of the (low voltage) electricity distribution grid in a certain area or city
E-mobility asso-ciations	• promotion of electric vehicles and charging infrastructure • disseminating information/knowledge about EVs and charging infrastructure to the public and professional stakeholders
EMSP	• concluding contracts with EV users and providing authentication options/media (e.g., RFID cards, smartphone apps) • provisioning of tariff model for charging transactions • provisioning of authentication and payment services to EV users • billing of charging transactions with EV users

Mobility provider	• provisioning of various mobility and transport services:
	  ○ e-car sharing, e-bike, and LEV sharing
	  ○ public transport services
	  ○ taxi services
	  ○ parking services
	  ○ mobility services for tenants (of housing companies)

Table 1: Roles and responsibilities/tasks in providing charging services and infrastructure[10]

Role	Responsibilities/tasks
Municipality/(local) public authority	• provisioning of public space for on-street charging points • issuing of permits for on-street charging points • charging of fees for the use of public space by charging infrastructure (to CPO) • provision of funds for and tendering of charging points and charging services • ensuring compliance charging points and services with the respective legal requirements, such as non-discriminatory access • definition of rules or minimum requirements for interoperability of public charging points and services
Power/utility company	• supply of electric energy for charging points (to CPO)

Roaming platform	• provisioning of authentication services (to users):
	  ○ EV users´ app (frontend system)
	• provisioning of interoperability and roaming services:
	  ○ centralising and facilitating of connections between EMSPs and CPOs
	  ○ static and real-time information of EVSEs
	  ○ parking and charging services (reservation of parking spots/EVSEs)
	  ○ management and monitoring of charging transactions
	  ○ controlling and recording of energy consumption of charging transactions (charge detail records)
	• provisioning of accounting services:
	  ○ centralising and redirecting of information between EMSPs and CPOs
	• provisioning of routing services
	• provisioning of electromobility dashboards

[10] Nationale Plattform Zukunft der Mobilität 2020: Roadmap zur Implementierung der ISO 15118, Standardisierte Kommunikation zwischen Fahrzeug und Ladepunkt, p. 6ff., https://www.plattform-zukunft-mobilitaet.de/wp-content/uploads/2020/12/NPM_AG5_AG6_2020_Q4_ISO15518.pdf; has.to.be GmbH 2015: Die Welt hinter der Ladestation, Leitfaden für die Errichtung von vernetzten Lade-Infrastrukturen, p. 16ff.; https://beenergised.azureedge.net/2016/10/DE-Beyound-the-station.pdf; The Mobility House GmbH 2021: Lexikon der Elektromobilität, https://www.mobilityhouse.com/de_de/ratgeber/gsm-ocpp-plc-the-mobility-house-klaert-auf.

User	• usage of charging points and services through private, professional users and tenants (INCAR, SMAC, INDUCAR) • usage of e-bike and LEV sharing services (INSOC) • usage of e-car sharing services (INSOC) • usage of location planning tool for new charging points (CLICK)
Additional roles: technology & data provider, facility owner, marketing, academia, public lighting company	• provisioning of hardware and software for the demo site-specific implementation of the USER-CHI products (esp. INCAR, INSOC, INDUCAR) • provisioning of local facilities for charging infrastructure and parking spots • conduction of local and project-wide marketing activities for the USER-CHI products • conduction of local research activities

Table 2: Roles and responsibilities/tasks in providing charging services and infrastructure[11]

4.2 Semantic layer

In the following chapter, **seven guidelines for interoperability** concerning the semantic layer of INFRA are presented.

4.2.1 Interoperability of roaming platforms, EMSPs, and CPOs


The interoperability between roaming platforms, EMSPs, CPOs and possible further third parties is determined by the usage of specific communication protocols such as the Open Charging Protocol Interface (OCPI). Currently, there are four major communication protocols (OICP, OCHP, eMIP and OCPI), applied/ in use to offer roaming services to EV drivers across the EU. However, the different roaming platforms use different proprietary protocols (OICP, OCHP, eMIP) or customised interfaces, so communication amongst them including data exchange activities is not uniformly provided. This is identified as a main barrier to enable interoperability on a local/regional, national, and European level.

[11] C.f. ibd.

The most crucial recommendation is therefore to use open charging protocols such as OCPI for data exchange between roaming platforms, EMSPs, CPOs and other stakeholders involved in providing charging services to enable interoperability. Furthermore, for interoperable communication between charging points and backend systems of CPOs it is recommended to use the open standard OCPP.

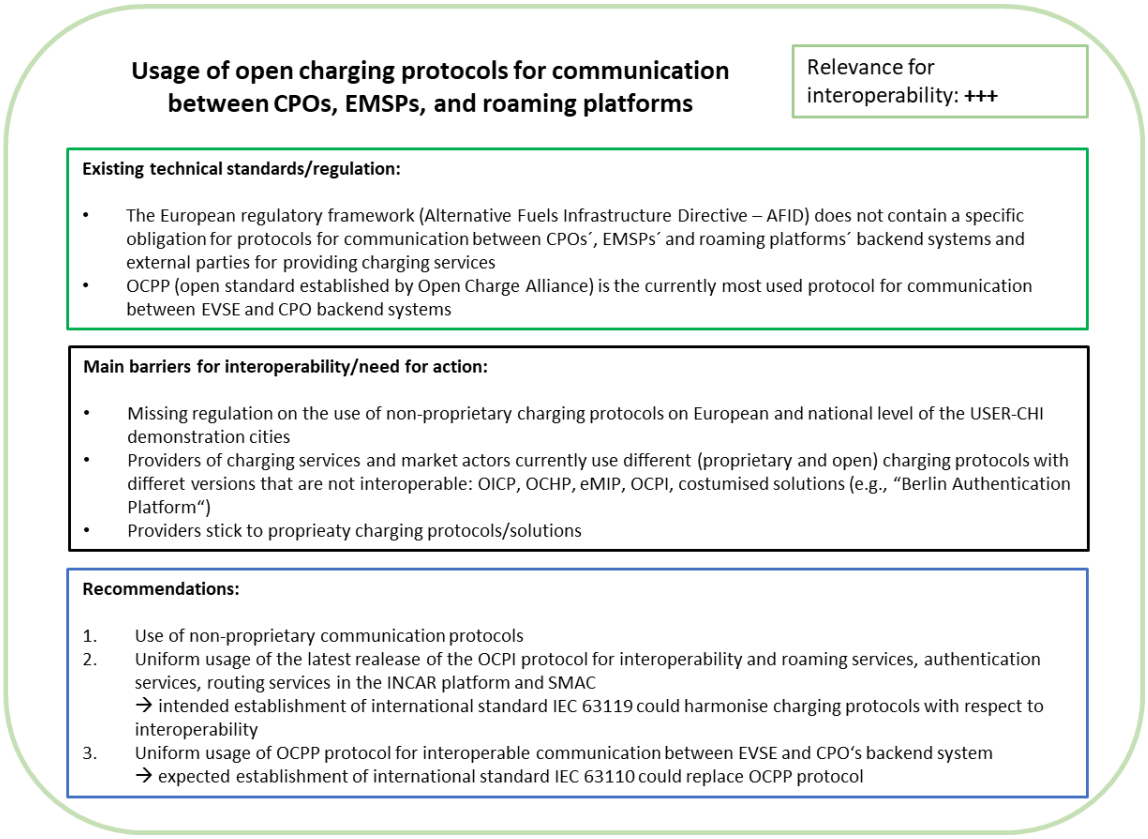


Figure 11: Usage of open charging protocols for communication between CPOs, EMSPs, and roaming platform[12]

4.2.2 Authorisation and authentication methods

[12] Nationale Plattform Zukunft der Mobilität 2020: Roadmap zur Implementierung der ISO 15118, Standardisierte Kommunikation zwischen Fahrzeug und Ladepunkt, p. 9; The Mobility House GmbH 2020: Zukunftssichere Ladeinfrastruktur: Warum der OCPP-Standard fürs Laden von Elektroautos so wichtig ist.

At most publicly accessible charging points, EV users aiming for charging need to authenticate themselves via various authentication media in order to start a charging transaction. These include e.g., RFID cards or tokens, smartphone apps, NFC connections to mobile devices or quick response codes. Currently CPOs use different solutions established in the market, so that there is no uniform way of user authentication across different providers and at different locations of charging points. Users need to have different types of authentication media available to charge their EVs. It is therefore recommended for CPOs to offer multiple authentication solutions that are widely established such as RFID cards and smartphone apps.

Authorisation and authentication methods

Relevance for interoperability: **+ to +++**

Existing technical standards/regulation:

- Different authorisation and authentication methods established in the market, e.g.:
  Radio frequency identification (RFID) card/token
  Near-field communication (NFC)
  Smartphone app
  Quick response (QR) code

Main barriers for interoperability/need for action:

- Different solutions established in the market that are not always interoperable
- Users need to register at various CPOs and EMSPs and carry different authentication media to have extensive access to charging infrastructure at different locations, regions, countries

Recommendations:

1. Use of a uniform authentication method for all charging points
2. Provision of multiple authentication methods that are widely used such as RFID, smartphone app

Figure 12: Authorisation and authentication methods for charging infrastructure

4.2.3 Online payment services

Online payment services are an essential part of the payment and accounting processes of charging transactions between CPOs, EMSPs, roaming platforms and the user itself. There are various providers of online payment services established in the market offering their services for general and specific applications such as EV charging. In in the case of roaming the complexity of payment and accounting processes with exchange of transaction data between the backend

systems of different CPOs, EMSPs, roaming platforms and other stakeholders involved hinders interoperability (e.g., through specific protocols that are not compliant with the GDPR). To enable interoperable online payment processes for EV charging services it is recommended to use operator-independent (independent of proprietary solutions of specific providers of charging services) and uniform payment services.

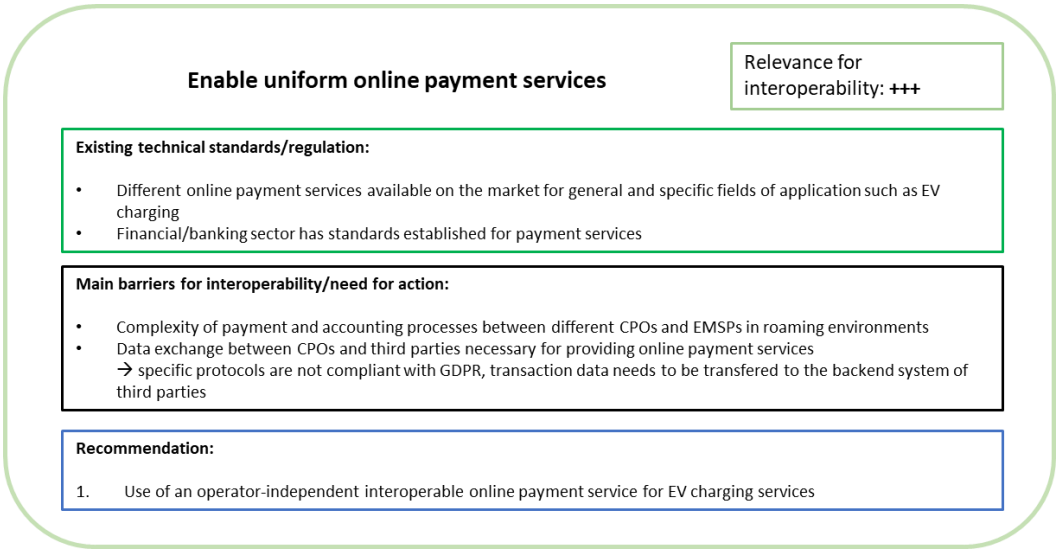


Figure 13: Enable uniform online payment services

4.2.4 Security and transparency in accounting services (application of blockchain technology)


One way to increase the security and transparency in accounting services for users of charging services is to apply processes based on blockchain technology. Currently the European and national legal frameworks on blockchain technology are not fully established and harmonised[13], so it is vital for providers of roaming services for EV charging to continuously monitor changes in the respective legislation.

Regarding interoperability in accounting processes of roaming platforms the lack of security, transparency, and automation can be overcome by application of blockchain technology to

[13] See also chapter 4.4.10.

involve the contractors exchanging transaction data. For this reason, providers of roaming services are advised to apply blockchain-based technology for their accounting services to enable interoperable and secure accounting processes among CPOs, EMSPs and involved external parties. Another recommendation focuses on the continuous monitoring of development of blockchain technology within the scope of accounting processes for EV charging across different providers.

Provision of secure and transparent accounting services (application of blockchain technology)

Relevance for interoperability: **++ to +++**

Existing technical standards/regulation:

- Two of the major use cases for blockchain technology are crypto currencies and smart contracts
- European and national regulation on blockchain and its technology options is not fully harmonised yet

Main barriers for interoperability/need for action:

- Lack of automation, transparency, and security in the accounting processes of roaming platforms
  → blockchain technology necessary for involving contractors exchanging data in roaming platforms
- There is a lack regulatory harmonisation on the European level for blockchain technology

Recommendations:

1. Application of blockchain technology for accouting services for charging services to contribute to interoperable accouting processes of CPOs, EMSPs, roaming platforms, and external parties
2. Continuous monitoring of the developments in the establishment of blockchain technology in the field of accounting processes of EV charging

Figure 14: Provision of secure and transparent accounting services

4.2.5 Planning data, provision of data for planning aspects

The availability of utilisation data from existing charging points is vital for the purpose of location planning to extend existing charging infrastructure networks in public and semi-public space of municipalities. Since there is no common legal obligation for providers of charging points in the USER-CHI demonstration cities to provide utilisation data for charging infrastructure planning, it is not reflected in their data flows. Furthermore, historic and/or online utilisation data should be provided in a GDPR-compliant way which is not yet specified.

This results in a number of recommendations for municipalities and CPOs to be followed. Municipalities should consider utilisation data for location planning of publicly accessible charging points prior to the implementation process. Municipalities should therefore consider introducing rules at municipal level obligating CPOs to provide historic and/or online utilisation data of charging points for planning aspects. Another recommendation aims at defining minimum

requirements for data provision to be fulfilled by CPOs within public tenders for charging infrastructure. In addition, it is recommended for municipalities to consider initiating municipal policy initiatives to introduce legal foundations regarding the data provision by CPOs for location planning.

Consideration of planning data / provision of data for planning aspects

Relevance for interoperability: +++

Existing technical standards/regulation:

- No common legal obligation for providers of charging services in the USER-CHI demonstration cities existing to provide e.g. historic and online utilisation data for the purpose of charging infrastructure location planning

Main barriers for interoperability/need for action:

- Planning aspects not reflected in the data flows of providing charging services
- No legal obligation yet given in the USER-CHI demonstration cities to provide historic data for planning purpose to the municipality
- GDPR-compliant provision of data for planning purposes not yet specified and mandatory

Recommendations:

1. Consideration of planning data by the municipality before implementing publicly accessible charging infrastructure
2. Introduction of own rules at the municipal level that obligate all CPOs to to provide (GDPR-compliant) historic and online utilisation data of existing charging infrastructure for planning purpose
3. Definition of minimum requirements for CPOs to provide data in the context of public tenders for charging infrastructure
4. Initiate municipal policy initiatives at regional or national level for the introduction of legal foundations for data provision for planning purpose

Figure 15: Planning data, provision of data for planning aspects

4.2.6 Parking data standards

The interoperable integration of parking services requires uniform communication protocols for data exchange between operators of parking facilities and platforms as well. The availability of parking data is an essential requirement in providing these combined services for EV charging and parking such as reserving parking spots at charging points.

Currently there are multiple (proprietary) solutions for parking data standards (e.g., IPIPS, IPI-DataEx) available, but no common international standard has been widely established yet. Moreover, the lack of access to parking data hinders interoperability of integrated digital park and charge services for EV users since it is required to be combined with charging data.

Therefore, it is recommended to use existing solutions for open data standards, such as from the Alliance for Parking Data Standards (APDS)[14]. The APDS develops and publishes specifications for parking data aiming at different use cases of on-street and of-street parking and has proposed them to the International Organisation for Standardisation (ISO) [15]. The latest version (release 2.1) of the standard includes data domains for location, and occupancy of parking spots, parking rates, rights, sessions, and observation (parking space monitoring)[16].

In general, developers and providers of roaming/charging platforms, such as the INCAR platform, that offer combined parking and charging services are recommended to integrate parking data interfaces at an early stage of platform development to enable interoperability from scratch.

[14] The APDS is an international organisation aiming at establishing a global standard for data elements related to providing various parking services.
[15] Alliance for Parking Data Standards 2021: About APDS.
[16] Alliance for Parking Data Standards 2020: Parking Data Specification, Technical Documentation, Information Model, Release 2.1, Status: Final, p. 10ff.

Consideration of parking data standards

Relevance for interoperability: +++

Existing technical standards/regulation:

- Different standards for data elements for (on-street and off-street) parking services available on the market, i.a.:
  IPIPS data standard (International Parking Industry Payment Standards)
  IPI-DataEx data standard
  ADPS data standard

Main barriers for interoperability/need for action:

- Different data standards for parking services available, but no common international standard that covers most/all use cases and data domains established yet
  →lack of standardisation
- Lack off access to parking data
- Combination of parking and charging data necessary

Recommendations:

1. No use of proprietary solutions for data exchange between operators of parking facilities (especially off-street) and platforms
2. Use of existing solutions/approaches for data standards, that integrate most functionalities and data domains, e.g., APDS data standard
3. Integration of parking data for combined parking and charging services into roaming/charging platforms at an early stage of platform/service development

Figure 16: Parking data standards[17]

4.2.7 Routing services

Routing services to EVSE locations as well as integrated parking and charging services are an important feature of roaming/charging platforms to enable EV users an easy and convenient routing to such locations. Version 2.2 of the open charging protocol OCPI incorporates information of EVSE locations that is necessary to provide routing services to EV users, so there are no relevant barriers to interoperability regarding the INCAR Platform. For developers and providers of roaming/charging platforms aiming to provide routing services it is thus recommended to uniformly use open charging protocols such as OCPI including information of EVSE locations.

[17] International Parking Institute 2017: IPI-DataEx – Data Exchange Standard, June 2017; European Parking Association 2016: Summary: The Function and benefits of the International Parking Industry Payments Standards IPIPS (powered by IFSF) for the parking industry.

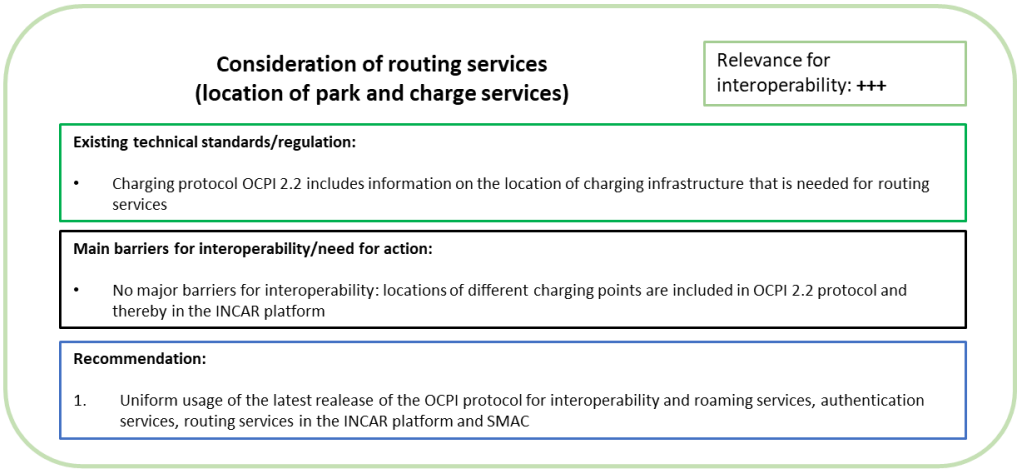
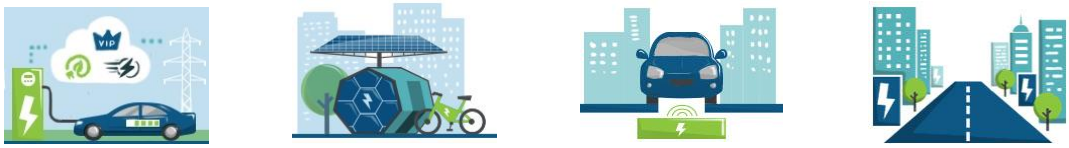


Figure 17: Routing services for EV charging

4.3 Technical layer

The technical requirements that need to be considered when implementing interoperable charging infrastructure in the context of USER-CHI and beyond the scope of the project are mainly related to existing technical standards for charging infrastructure/ charging points, grid connection and electro-magnetic compatibility. In the following chapter, three guidelines are shown in the technical layer of INFRA.

4.3.1 Technical requirements of the grid operator and metering device operator



The supply of electric energy for charging infrastructure is provided through the physical connection to the electricity distribution grid. Therefore, different technical requirements of the local grid operators and metering point operators arise for CPOs. With focus on the grid connection there are international standards established as well as national standards or technical connection rules (TCR) in the USER-CHI countries. Moreover, there are national or local standards for the electricity meter location.

Due to the different national or local requirements for the connection of EVSE to the distribution grids a uniform approach of implementation across various countries is difficult to realise. The requirements for the electricity meter location are in the same way depending on the requirements of the respective local distribution system operator.

As a result, it is recommended to CPOs to consider the national or local requirements for the grid connection and electricity meter location at an early stage of the planning and implementation phase of new charging points. Users of CLICK as well as planners of new charging points are besides recommended to take the grid connection as well as the grid's capacity into account during the process of location planning to identify possibly necessary grid extensions at an early stage.

Consideration of technical requirements of the grid operator and metering device operator

Relevance for interoperability: **+/- to +++**

Existing technical standards/regulation:

- International standard IEC 60364-7-722 specifies the grid connection of charging infrastructure (low voltage)
- Different national standards or technical connection rules (TCR) for the grid connection of charging infrastructure
- Different national standards for electricity meter location
- In many cities only one operator (DSO) responsible for the public electricity distribution grid, usually also responsibility for operating metering points

Main barriers for interoperability/need for action:

- Uniform implementation of the grid connection of charging infrastructure in different cities can face barriers for interoperability → e.g., transnational interoperable implementation in different cities
- Different technical connection rules in different cities/distribution grids
- Different requirements for electricity/smart meter location depending on the DSO

Recommendations:

1. Consideration of the local/regional differences with respect to the grid connection of charging points during the planning and implementation phase of charging infrastructure
2. Consideration of the grid connection and the grid's capacity in the planning phase of new EVSE in order to identify any necessary grid extensions in an early stage of planning process

Figure 18: Technical requirements of the grid operator and metering device operator[18]

4.3.2 Charging plug components for electromobility (charging plugs standards – conductive charging)

Plug components for the conductive charging of electric vehicles are standardised on international and European level comprising of three different plug configurations for AC and DC charging (Type 2, Combo 2 CHAdeMO). Within in the European regulation the first two plug types are furthermore specified by the Alternative Fuels Infrastructure Directive, which has to be implemented or is in process of implementation into national law of the USER-CHI countries.

Due to the established standardisation and European regulation no barriers to the interoperability of plug components for conductive EV charging arise. CPOs are required to uniformly employ Type 2 sockets or cables for AC charging points and Combo 2 sockets or cables for DC charging points.

[18] See also D1.3 Technical and legal requirements for USER-CHI solutions, chapter 4.1.1.1 – 4.1.1.3.

Using uniform charging plug components for electromobility (charging plugs standards – conductive charging)

Relevance for interoperability: +++

Existing technical standards/regulation:

- Different charging plug standards established on the market: CCS (Combo 2), Type 2 (Mennekes), CHAdeMO
- International and European standards established for charging plug configurations: IEC 62196-2 + EN 62196-2 (Type 2); IEC 62196-3 + EN 62196-3 (Combo 2); ISO/IEC 61851-23 + ISO/IEC 61851-24 + IEC 62196 (CHAdeMO)
- The European regulatory framework (AFID) contains a specific obligation for AC and DC charging plug configurations: Type 2 for AC charging, Combo 2 for DC charging

Main barriers for interoperability/need for action:

- No barriers for interoperability due to international and European standards and European regulation

Recommendation:

1. Uniform usage of Type 2 and Combo 2 charging plugs for AC and DC charging points

Figure 19: Charging plug components for electromobility

4.3.3 Charging plug components for LEV's charging

In contrast to the standardisation and regulation of plug components in the field of conductive EV charging, there are no international or European standards for plug components for LEVs established yet. Currently, manufacturers of LEVs such as e-bikes and kick e-scooters typically use proprietary plug components (as a part of proprietary charging devices) on the battery side of the vehicles and thereby hinder interoperability.

It is therefore highly relevant for interoperability that providers of LEVs in sharing fleets, such as in INSOC, uniformly use only one connector type on the battery side within all implementations of such services and vehicles.

Using uniform charging plug components for LEV charging

Relevance for interoperability: +++

Existing technical standards/regulation:

- No internatioanl or European standard for LEV charging plugs established yet
- Manufacturers of kick e-scooters, e-scooters, e-bikes use proprietary charging plugs on the battery side

Main barriers for interoperability/need for action:

- Lack of existing standards for charging plugs for kick e-scooters/e-scooters/e-bikes (battery side)
- LEVs often use Schuko plugs and own charging devices

Recommendation:

1. Uniform usage of one plug type within all implementations of INSOC in USER-CHI

Figure 20: Charging plug components for LEV charging

4.4 Legal layer

The following chapter describes 11 guidelines including recommendations for interoperability in the legal layer of INFRA.

4.4.1 National implementation of the Alternative Fuels Infrastructure Directive


The Alternative Fuels Infrastructure Directive (AFID) of the European Union currently forms the most relevant European legal foundation for the implementation of infrastructure for alternative fuels including charging infrastructure for EVs. It regulates the non-discriminatory access of users and providers of services and electricity to public charging points as well as ad hoc charging. It furthermore defines the responsibilities and roles of CPOs, EMSPs, and DSOs and obligates minimum standards for technical interoperability of AC and DC charging plugs. The widespread national implementation of the AFID in the EU member states is therefore crucial to enable harmonised and interoperable charging for EV users across the EU.

In the five USER-CHI countries the AFID is partially or fully implemented (e.g., Germany, Hungary) into national law or in process of implementation (e.g., Finland, Italy). Due to national differences in the implementation and the implementation process, which has not yet been completed, legal uniformity regarding interoperability among the countries is so far not fully given. Within the framework of AFID, the topics of roaming for EV charging and charging protocols have not yet been addressed, thus hindering interoperability, as no specifications arise.

Consequently, it is recommended to all stakeholders (esp. CPOs, EMSPs and roaming platforms) involved in providing charging services and public charging points to continuously monitor the AFID and its national implementations for regulatory changes in the aforementioned aspects. Additionally, municipalities are advised to consider defining stronger minimum requirements for interoperability in the context of public tenders for charging infrastructure than required by their respective national legal frameworks.

Widespread national implementation of the Alternative Fuels Infrastructure Directive – AFID (2014/94/EU)

Relevance for interoperability: **++ to +++**

Existing technical standards/regulation:

- The AFID includes obligations for non-discriminatory access to public charging infrastructure (users, service and electricity providers), ad hoc charging (without contract), technical interoperability standards for AC and DC charging plugs, definition of roles and responsibilities of CPOs, EMSPs and DSOs
- AFID is (partially) implemented or in progress of implementation into the national legal frameworks of the five USER-CHI countries

Main barriers for interoperability/need for action:

- Process of implementation into the national legal frameworks not completed yet in the five USER-CHI countries
- Some national implementations differ from the obligations of the AFID: weaker or stronger minimum requirements for interoperability
- The AFID does not contain obligation for charging protocols (communication between CPOs´, EMSPs´ and roaming platforms´ backend systems and external parties) → see guidelines for semantic interoperability
- The issue of roaming for EV charging is not addressed in the AFID, therefore no specific obligations arise

Recommendations:

1. Continuous monitoring of legislative changes at national and European level regarding obligations for non-discriminatory access to public charging infrastructure, regulation of ad hoc charging, requirements for interoperability
2. Definition of stronger minimum requirements for interoperability than required by national law in the context of public tenders for charging infrastructure

Figure 21: National implementation of the AFID (2014/94/EU)

4.4.2 National regulation of interoperability of charging infrastructure operated by different CPOs


Beside the AFID and its national implementations further national regulations aiming at interoperability of charging infrastructure can contribute to enabling interoperability charging for EV users. Such regulations are not yet widely established or in process of implementation in the USER-CHI countries. There is a general lack of legal obligations regarding interoperability requirements for charging points that are operated by different CPOs. Further barriers could e.g., arise in the field of DC charging.

Municipalities are recommended to consider initiating policy initiatives at national level to introduce legally binding minimum requirements for the interoperability of charging points operated by different CPOs. As well, municipalities are recommended to consider defining minimum requirements for interoperability in the context of public tenders for charging infrastructure in case they are not required by respective national laws.

Introduction of national regulation of interoperability of charging infrastructure operated by different CPOs

Relevance for interoperability: **++ to +++**

Existing technical standards/regulation:

- National laws to enable interoperability are not yet widely established or are in progress of implementation into the national legal frameworks of the five USER-CHI countries

Main barriers for interoperability/need for action:

- There is a general lack of regulation in the national legal frameworks of the five USER-CHI countries in terms of interoperability requirements for charging infrastructure operated by different CPOs
- Further barriers could arise, e.g. in terms of DC charging

Recommendations:

1. Initiation of municipal policy initiatives at national level to introduce legal foundations for mimimum requirements for interoperability of charging infrastructure operated by different CPOs
2. Definition of minimum requirements for interoperability in the context of public tenders for charging infrastructure if they are not required by national law

Figure 22: National regulation of interoperability of charging infrastructure operated by different CPOs

4.4.3 Administrative approval of the installation of public charging points

In the USER-CHI cities the responsibility for the administrative approval of charging points in public space falls to the respective municipalities with the local regulation being most relevant for their deployment. The process of approval is handled differently in each municipality hindering a uniform administrative approach at national and European level. This has a particularly negative impact on CPOs that install and operate charging points across countries or the European Union. Further barriers arise from the time-consuming and resource-intensive administrative process for both, local authorities and CPOs aiming to deploy public charging points.

To simplify and streamline the administrative approval of public charging points, municipalities are recommended to optimise their existing processes to reduce its complexity, number of necessary of administrative steps and necessary human resources. Moreover, municipalities should consider introducing initiatives in regional or national city alliances to establish uniform processes of administrative approval of public charging points across different municipalities.

Existence of appropriate administrative approval of the Installation of public charging points

Relevance for interoperability: **+/- to +++**

Existing technical standards/regulation:

- The administrative approval of the installation of public charging points is in the responsibility of the respective municipalities
- Local regulation is most relevant when it comes to the deployment of public charging points

Main barriers for interoperability/need for action:

- The administrative approval process of public charging points is handled differently in each municipality
  → A uniform approach to approval is therefore hardly possible at both national and European level
- Administrative approval process is a resource-intensive and time-consuming process for the respective authorities and providers of charging infrastructure

Recommendations:

1. Optimisation of existing local processes for administrative approval of public charging points to reduce complexity and administrative efforts for involved authorities and providers
2. Conduction of municipal initiatives, e.g., in regional or national city alliances, to establish uniform and streamlined procedures for administrative approval of public charging points across different municipalities

Figure 23: Administrative approval of the installation of public charging points

4.4.4 Booking of parking spots on public roads for charging


Reserving on-street or off-street parking spots supports a predictable and thus more user-friendly charging of EVs at higher frequented charging points in public and semi-public space and is also part of the services of the INCAR platform. Crucial for the booking of on-street parking spaces is a corresponding legal foundation enabling it, which is not yet widely established in the regulation of the USER-CHI cities. Currently, some municipalities (e.g., Berlin) are waiving parking fees at on-street charging points for EV charging, but not allowing reservations of the corresponding parking spots.

Municipalities should therefore check their local and national legal frameworks for possibilities of introducing the booking of on-street parking spots with charging points. Besides that, municipalities, CPOs, and providers of off-street parking facilities are recommended to consider focussing their activities on semi-public space to implement the reservation of parking spots.

Enable booking/reservation of parking spots on public roads for charging

Relevance for interoperability: **+/- to +++**

Existing technical standards/regulation:

- The booking/reservation of on-street parking spots for charging is not yet widely implemented or established in the regulatory frameworks of the USER-CHI cities
- Some municipalities waive parking fees at on-street charging points to facilitate charging of EVs

Main barriers for interoperability/need for action:

- Lack of legal foundation or legal exclusion of the booking/reservation of on-street parking spots for charging
- Some municpalities do not allow on-street parking spots at charging points to be booked/reserved

Recommendations:

1. Consideration of legal possibilities at local and national level to legally-compliant implement the booking of on-street parking spots for EV charging
2. Authorities and providers of charging points and parking facilities may focus on the semi-public space to implement the booking of parking spots for charging

Figure 24: Booking/reservation of parking spots on public roads for charging

4.4.5 Regulation of measuring instruments (i.a., Measuring Instruments Directive)

Measuring instruments are an essential technical component of publicly accessible charging points ensuring the reliable and accurate measuring of the charged energy, which is required for the billing of charging transactions. The European Measuring Instruments Directive – MID (Directive 2014/32/EU) regulates such devices and has been partially or fully implemented into the national legal frameworks of the USER-CHI countries or is in the process of implementation. Further legal obligations for measuring devices (electricity meters) in charging points can arise from national measuring and calibration laws such as in Germany (e.g., Mess- und Eichgesetz). Aside, in most of the USER-CHI countries there are technical standards for measuring devices established.

Nationally varying regulations for measuring devices (e.g., in the form of measuring and calibration laws) currently hinder a uniform implementation of hardware as well as storage and transfer of measured data from charging transactions for billing across different European countries. Within the field of DC charging, moreover, not all issues have yet been solved with measuring devices that comply with the respective regulations.

As a result, it is recommended to CPOs, EMSPs, and roaming platforms in cross-country EV charging use cases to comply with the highest of the national minimum requirements for

measuring devices, storage and transfer of measured data from charging transaction of the countries involved.

Regulation of measuring instruments (i.a., Measuring Instruments Directive)

Relevance for interoperability: **+/- to +++**

Existing technical standards/regulation:

- The European regulatory framework (Measuring Instruments Directive (2014/32/EU)) has been (partially) implemented or is in progress of implementation into the national legal frameworks of the USER-CHI countries
- There are technical standards for measuring devices in charging points established in most of the USER-CHI countries (e.g., Finland, Germany)
- Further legal obligations for CPOs and EMSPs arise in some of the USER-CHI countries from national measurement and calibration laws (e.g., Germany)

Main barriers for interoperability/need for action:

- Nationally varying regulations from measurement and calibration laws can pose a barrier for uniform cross-country implementation of hardware (measuring instruments) as well as storage and transfer of measured data from charging transactions forming the basis for billing processes
- Issue with compliant measuring devices in DC charging points/segment not yet fully solved

Recommendation:

1. In case of cross-country EV charging environments, the implementation of measuring instruments, the storage and transfer of measured data from charging transactions for the billing processes should meet the highest minimum requirements of all respective countries involved

Figure 25: Regulation of measuring instruments (i.a., Measuring Instruments Directive)

4.4.6 Regulation on data protection for personal data generated using charging points (General Data Protection Regulation)

When EV drivers use publicly accessible charging infrastructure there usually is personal data involved e.g., for the booking, authentication, accounting, and billing services of the charging (and parking) transactions. The EU's General Data Protection Regulation (GDPR) directly applies in all USER-CHI countries laying the ground for the processing of personal data and providing the rules for the free movement of personal data. Its obligations therefore also apply to all personal data in relation to the use of charging points. The national data protection laws (e.g., Bundesdatenschutzgesetz in Germany) of the USER-CHI countries may impose further obligations regarding the protection of personal data.

Since the GDPR applies equally to all providers of charging points and charging services, it does not result in any barriers to interoperability regarding the data protection of users. CPOs, EMSPs, roaming platforms and further third parties are required to design and implement all charging services in compliance with the General Data Protection Regulation as well as the national data protection regulations of the USER-CHI countries.

Regulation on data protection for personal data generated using CPs (General Data Protection Regulation)

Relevance for interoperability: **+/- to +++**

Existing technical standards/regulation:

- The European legal framework (General Data Protection Regulation - GDPR (2016/679/EU)) applies in all USER-CHI countries regulating the processing of personal data and providing rules on the free movement of personal data
- The national data protection laws in the five USER-CHI countries can include further obligations

Main barriers for interoperability/need for action:

- There are no relevant barriers to interoperability in terms of regulating data protection in the use of charging points, as all actors involved in the provision of charging infrastructure and services must comply with the uniform obligations under the GDPR

Recommendation:

1. All charging services to be provided should be designed and practically implemented in compliance with the GDPR and the respective national data protection laws of the USER-CHI countries

Figure 26: Regulation on data protection for personal data generated using CPs (General Data Protection Regulation)

4.4.7 Provisions for data sharing processes among CPOs, EMSPs and other stakeholders (i.a., real time availability data)

Data sharing processes between CPOs, EMSPs, roaming platforms and other parties are an essential requirement of enabling provider-independent interoperable booking, authentication, accounting, and billing services for EV users. In order to also provide users with the widest possible range of information on real time availability of charging points, e.g., in the smartphone app if the INCAR Platform, provider-independent data sharing processes are equally important. Many CPOs, EMSPs and roaming platforms currently offer only proprietary or partially interoperable charging services.

To date there are no legally binding obligations established for data sharing processes or open access to data across providers of charging services in the EU or in the national legal frameworks of the USER-CHI countries. The AFID does not include or specify any requirements for data sharing among stakeholders involved in providing charging services. Similarly, there is a fundamental lack of obligations in national legal frameworks for operator-independent data sharing contributing to interoperable charging services.

Municipalities are therefore advised to consider defining minimum requirements for CPOs regarding the provision of data to other parties involved in providing charging services in the context of public tenders or concessions for charging points. Municipalities can also consider

introducing own local rules that oblige all CPOs of charging points in public space to share data with other stakeholders. Another recommendation aims at initiating policy initiatives at the national level to introduce legal obligations for data sharing processes among providers of charging services enabling interoperability.

Provisions for data sharing processes among CPOs, EMSPs and other stakeholders (i.a., real time availability data)

Relevance for interoperability: **++ to +++**

Existing technical standards/regulation:

- There are no legal provisions yet established on European level or national level in the USER-CHI countries for data sharing processes/open access to data among providers of charging services to ensure a minimum level of interoperability

Main barriers for interoperability/need for action:

- The European regulatory framework (AFID) does not contain any obligations for data sharing processes among CPOs, EMSPs and further stakeholders involved in the provision of charging services
- There is a general lack of regulation in the national legal frameworks of the USER-CHI countries to obligate CPOs to share data openly with other stakeholders involved in the provision of charging services to foster interoperability

Recommendations:

1. Definition of minimum requirements for CPOs in the context of public tenders/concessions for charging infrastructure/services to provide data openly to other stakeholders involved in the provision of charging services
2. Introduction of own rules at the municipal level that obligate all CPOs to provide data to other stakeholders involved in the provision of charging services
3. Initiate municipal policy initiative at national level to make data sharing among providers of charging services in terms of interoperability obligatory by law, e.g., in the context of national implementations of the AFID

Figure 27: Provisions for data sharing processes among CPOs, EMSPs and other stakeholders (i.a., real time availability data)

4.4.8 Regulation of roaming for EV charging/regulation of roaming platforms

Data sharing processes among providers as described in the previous section are also a vital part of enabling interoperable roaming platforms. Currently, there are no legal obligations established for the roaming of EV charging or roaming platforms in the EU or in the national legal frameworks of the USER-CHI countries hindering to achieve basic interoperability among all parties involved in providing such services. Meaning that providers are e.g., not obliged to cooperate in general or to coordinate their tariff models.

This results in a set of recommendations for municipalities and charging service providers aimed at achieving a minimum level of interoperability in roaming of EV charging.

Municipalities should consider defining minimum requirements for roaming in the course of public tenders or concessions for charging services in general and for charging points in particular that are operated by the municipality. All providers involved in roaming for EV charging are advised to continuously monitor the developments of the regulation of roaming platforms. Finally, municipalities should consider introducing policy initiatives at the national or European level to propose obligations for the roaming of EV charging regulating cooperation and data sharing among roaming platforms and other parties involved in roaming to ensure interoperability.

Regulation of roaming for EV charging/ regulation of roaming platforms

Relevance for interoperability: **+ to +++**

Existing technical standards/regulation:

- There are no legal obligations yet established on European level (e.g., AFID) or national level in the USER-CHI countries for the roaming of EV charging or roaming platforms to ensure a minimum level of interoperability among them and other stakeholders involved in the provision of charging services

Main barriers for interoperability/need for action:

- There is general lack of regulation on European and national level with focus on roaming platforms
  →Stakeholders are not required to cooperate in general (i.a., contractual relations, data sharing processes) or to coordinate their tariff models

Recommendations:

1. Definition of minimum requirements for the roaming of EV charging in the context of public tenders/concessions for charging infrastructure/services or charging points that are operated by the municipality
2. Continuous monitoring of the developments in the legal framework of the regulation of roaming for EV charging
3. Initiate policy initiatives at national or European level to introduce legal obligations for the roaming of EV charging or roaming platforms in terms of cooperation and data sharing processes to ensure interoperability among roaming platforms and other stakeholders involved in the provision of charging services

Figure 28: Regulation of roaming for EV charging/regulation of roaming platforms

4.4.9 Regulation on vehicle to grid charging/reverse charging (national)

Current national legislation in the five USER-CHI countries does not include regulative aspects on vehicle to grid charging or reverse charging. However, international technical standards exist that provide an orientation for technical implementation of vehicle to grid charging/ connection. One technical standard is defined by the ISO 15118 series that define an international communication standard between EVs and the charging infrastructure. Another technical standard that has been referred to is the standard IEC 6080-5-104. It defines the international communication standard between EVs and the charging infrastructure. The application of vehicle

to grid or reversed charging technology is currently in its research and development phase, that includes piloting and field tests.

Because of the current state of the vehicle to grid or reversed charging technology the lack of a general national legal regulation in the USER-CHI countries has not been reported as a direct barrier. On a national level of the USER-CHI countries it has been noted that it is either possible that the vehicle to grid technology may be incorporated in pending updates of relevant legislation (i.e. Spain - the update of Law 24/2013) or minor steps have been taken to regulate vehicle to grid aspects (i.e. in Germany – 3 No. 25 EnWG defines charging points as 'final users'; § 14 a EnWG includes EVs into the category of controllable consumer devices) However, it is necessary to consider establishing uniform legal frameworks, so the technological feasibility for implementation among different countries is given.

Based on the current situation of vehicle to grid technology it is recommended to constantly monitor both the technological development in research and development, as well as the development of national legislation. Another recommendation focuses on initiating policy initiatives at the national level to accelerate the introduction of legal obligations concerning vehicle to grid charging.

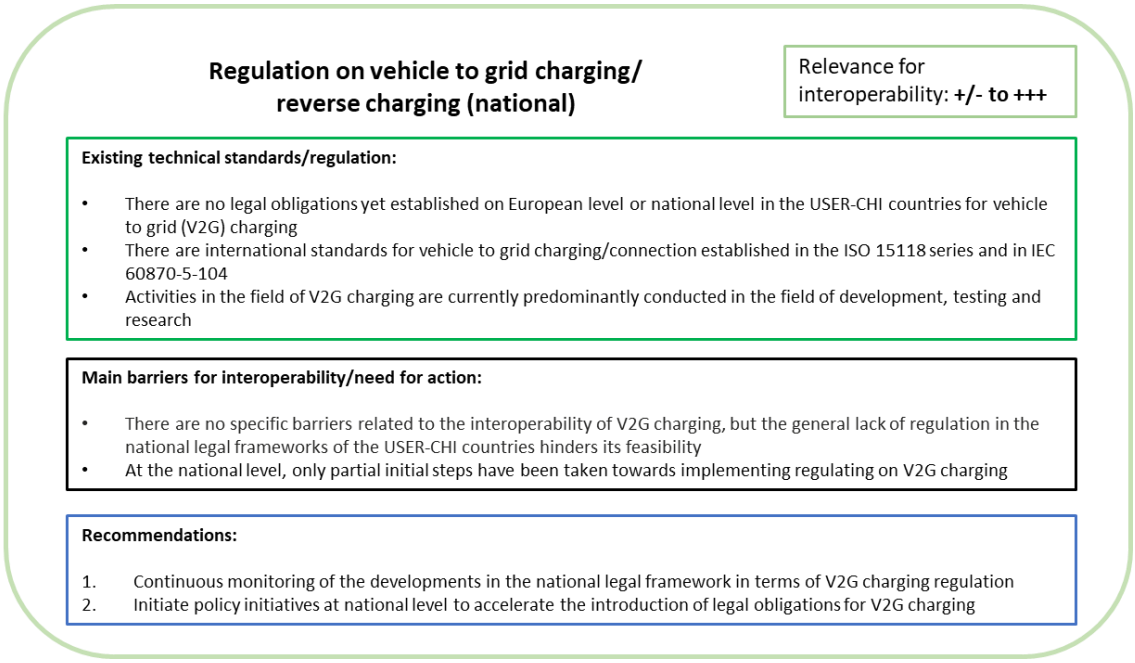


Figure 29: Regulation on vehicle to grid charging/reverse charging (national)

4.4.10 B2B smart contracts (access to charging networks)

As mentioned in the guideline on security and transparency in accounting services, one of the two main use cases for Blockchain technology are so called smart contracts.[19]

The technological term smart contract describes a software (not an actual contract) that controls and/or documents or can even cause a legally relevant activity that depends on the occurrence or non-occurrence of an actual event that can be measured and thus documented.[20] As far as smart contracts have already been successfully implemented in individual cases, they are suitable for increasing the efficiency and security of digital transactions.[21]

With smart contracts, performance, and consideration are recorded in software, whereby the software can automatically check whether a party has performed its obligations under a contract.[22] The conditions for concluding a contract are stored in a Blockchain. Only if the conditions of both parties comply ("pre-check"), then a contract is automatically concluded, e.g., when a charging point meets the contractual conditions for charging. The Blockchain then stores information about energy consumption, contracting parties, etc of a charging transaction.

4.4.10.1 Different options of smart contracts applications

Smart contracts themselves can be used in various ways. Blockchain technology is applied for tokenization in the context of cryptocurrencies and other digital assets.[23]

The benefits of the application of smart contracts are that the contracts are executed automatically, when a required event occurs. Simultaneously, all contract partners will get real time information about any status changes. [24]

This may offer increased reliability and trust by the parties involved in the process, as well as cost reduction and efficiency. Similarly, smart contracts can be used to hard code business agreements, which involve all types of asset transfer. The hard coding of business agreements renders them very transparent. Since they are executed automatically, the conditions are

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[19] Schrey, Joachim/Thalhofer, Thomas: Rechtliche Aspekte der Blockchain, NJW 2017.
[20] C.f. p.1431.
[21] Kipker, Dennis-Kenji/Birreck, Piet/Niewöhner, Mario/Schnorr, Timm: Rechtliche und technische Rahmenbedingungen des „Smart contracts", MMR 2020, p.513.
[22] Schrey, Joachim/Thalhofer, Thomas: Rechtliche Aspekte der Blockchain, NJW 2017, p.1431.
[23] The European Union Blockchain Observatory Forum, Legal and regulatory framework of blockchains and smart contracts, 2019, p.22.
[24] Schiller, Kai (Blockchainwelt) 2018: What are smart contracts?

predetermined, making it hard or even impossible for involved business parties to cancel relations.[25]

One of the disadvantages of applying smart contracts is, that the information provided cannot be adapted or changed in a later stage. Information stored in a blockchain is immutable, which renders incorrect codes severe.[26] Moreover, even with a view to the existing technical infrastructure, considerable conceptual work will still be needed for widespread application.[27]

4.4.10.2 Regulation on smart contracts

In regard of smart contracts, there is a difference between smart legal contracts, which represent legal contracts (predefined conditions for concluding a contract stored in a blockchain), as well as smart contracts based on smart technology, which merely cause legal implications.[28]

As regulation on blockchain as such is not yet harmonised on a European level, the regulation on smart contracts is not either.[29] Therefore, the legal questions deriving from the use of smart contracts will be at least partially dependent on national legal frameworks.

4.4.10.3 Smart legal contracts

Some of the legal issues, which follow the use of smart legal contracts are formal requirements, signing requirements, immutability, audits, as well as the general enforceability.

The legal issue of immutability of smart contracts shows, that the risks, that come along with the use of smart contracts are generally more suitable for B2B relations. This is shown in situations, where the automatic execution of smart contracts, which its major characteristic, are in conflict with other existing obligations. Whereas the parties involved in B2B relations might be able to waive arising settlements deriving out of the additional breaches, this is not a suitable solution for consumers.[30]

4.4.10.4 Smart contracts with legal implications

Moreover, there are three main use cases for smart contracts with legal implications:

- Smart contracts representing assets in digital form

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[25] The European Union Blockchain Observatory Forum, Legal and regulatory framework of blockchains and smart contracts, 2019, p.22.

[26] Schiller, Kai (Blockchainwelt) 2018: What are smart contracts?

[27] Kipker, Dennis-Kenji/Birreck, Piet/Niewöhner, Mario/Schnorr, Timm: Rechtliche und technische Rahmenbedingungen des „Smart conctracts“, MMR 2020, p.513.

[28] The European Union Blockchain Observatory Forum, Legal and regulatory framework of blockchains and smart contracts, 2019, p.23.

[29] C.f. p.34.

[30] The European Union Blockchain Observatory Forum, Legal and regulatory framework of blockchains and smart contracts, 2019, p.23-25.

- Smart contracts used to create decentralised autonomous organisations (DAOs)
- Smart contracts that become autonomous agent.[31]

4.4.10.5 Application of smart contracts to simplify interoperability

Smart contracts could be applied in B2B relations between different EMSPs and CPOs to improve the transparency, security, and effectivity between these contractual relations. The contractual relation between EMSPs and CPOs could use smart legal contracts for the automatic execution in the event of a charging process.

This could lead to the possibility of fostering ad-hoc charging for EV drivers. As ad-hoc charging (without specific smartphone apps or charging cards) is not always possible for e-mobility users right now, the expansions of the service would foster interoperability from a user perspective.

The use of crypto currency by end-users for the payment of a charging transaction is another possibility, which should be analysed further. Moreover, the use of smart legal contracts for B2C is also possible but offer disadvantages when it comes to questions of consumer protection (see above). However, the advantages of security and efficiency of transactions are also beneficial for B2C relations.

The use of smart contracts in B2B relations between EMSPs and CPOs might reduce the heterogeneity and complexity for the access of charging networks, as smart legal contracts may boost efficiency, security, and transparency. As smart legal contracts are executed automatically, they can reduce contractual complexity on the execution level (see above).

4.4.11 "Interoperability checks" for legal barriers

Based on the guidelines for interoperability of the legal layer the following table provides a brief overview of the interoperability checks´ results for legal barriers in the five USER-CHI demonstration cities. By means of three different symbols it is indicated whether a regulatory aspect currently poses substantial, moderate, or no legal barriers for interoperability[32]. Moderate barriers e.g., include ongoing implementation processes of European legislation into national law, local regulation that varies within the USER-CHI countries or insufficient regulation.

[31] C.f. ibd.

[32] The results of interoperability checks are indicated as follows: no legal barriers (✔), moderate legal barriers (~), substantial legal barriers (**X**).

Legal aspect	Barcelona	Berlin	Budapest	Rome	Turku
National implementation of the AFID (2014/94/EU)	✔	✔	✔	~	~
National regulation of interoperability of charging infrastructure operated by different CPOs	X	X	~	X	X
Administrative approval of the installation of public charging points	~	~	✔	~	✔
Booking/reservation of parking spots on public roads for charging	X	X	X	X	X
Regulation of measuring instruments (i.a., Measuring Instruments Directive – MID)	✔	~	~	✔	✔
Regulation on data protection for personal data generated using CPs (General Data Protection Regulation)	✔	✔	✔	✔	✔
Provisions for data sharing processes among CPOs, EMSPs and other stakeholders (i.a., real time availability data)	X	X	X	X	X
Regulation of roaming for EV charging/regulation of roaming platforms	X	X	X	X	X
Regulation on vehicle to grid charging/reverse charging (national)	~	~	✔	✔	✔

Table 3: Overview – interoperability checks for legal barriers of the most relevant regulatory aspects

The results illustrate that only very few regulatory aspects have no or moderate barriers to interoperability across all USER-CHI demonstration cities. These aspects include the national implementation of the AFID, the regulation on protection of personal data from users of charging

points (GDPR) or the regulation of measuring instruments of charging points. Regulatory barriers to interoperability exist across all cities, particularly in the fields of roaming for EV charging, data sharing processes among charging services providers and booking of on-street parking spots at charging points. The main reasons for this are a lack of or contradictory regulation in the respective USER-CHI cities.

5. Conclusions

As a summary, in this document has been presented the development process of the Interoperability Framework (INFRA) and its guidelines and recommendations for an interoperable implementation of CLICK, INCAR, SMAC, INSOC and INDUCAR in the USER-CHI demonstration cities.

INFRA provides a framework and guidelines to support interoperable charging services in the European Union with focus on the requirements for interoperability elaborated in D1.3 ("Technical and legal requirements for USER-CHI solutions"). It serves as a handbook assisting the USER-CHI project partners and electromobility stakeholders in general in implementing non-proprietary charging infrastructure and services in Europe.

As a general conclusion, the four layers considered during the development of INFRA play a crucial role for enabling interoperability within the electromobility ecosystem: the organisational, legal, technical, and semantic layer. While the organisational layer is deemed as a general framework ("global layer"), the semantic, technical, and legal layer are seen as specific layers. The organisational layer surrounds the requirements of the three specific layers and is therefore particularly critical for the success as an enabler or disabler for the practical implementation of the technical USER-CHI products. In this context, the acting stakeholders, and their established relationships to each other play an essential role.

Essentially, all cities share the same established and new stakeholders from the energy, transport and technology sectors, local governments, mobility providers and housing companies. They take responsibility for the implementation of charging points and services. This indicates that only with the involvement of all main actors it will be possible to achieve an improved implementation in terms of interoperability and thus overcome the existing, often proprietary charging services for EV users.

The semantic layer incorporates some of the most vital aspects for interoperability by addressing i.a. uniform use of open charging protocols (data exchange between roaming platforms, EMSPs, CPOs and other stakeholders), uniform authentication methods for EV users, improved security, and transparency in accounting services, provisioning of charging data for location planning and parking data standards. Communication and data exchange between providers of charging services is not uniformly given constituting a main barrier to interoperability on a local, national, and European level.

Technical requirements for hardware and energy supply of EV charging points form the technical layer, which is based on comprehensive standardisation that fosters interoperability. The technical layer is equally relevant for interoperability as the semantic layer, but there are no general barriers arising as in the semantic layer. Barriers arise primarily regarding the local grid connection of charging points and the lack of standardisation for LEV charging plug components.

The legal layer provides an important contribution to interoperability but also substantial barriers in terms of missing or inconsistent national regulations or restrictive regulation. The regulatory

landscapes of the involved USER-CHI countries overall show very similar gaps posing barriers to interoperable charging infrastructure and services. While the EU legal framework provides basic obligations in some fields (e.g., AFID, GDPR, MID), the further developments in electromobility ecosystem in recent years are not yet extensively reflected. There is a basic lack of regulation and therefore inconsistency regarding the roaming of EV charging, the provisioning and sharing of data among electromobility stakeholders, vehicle to grid charging and reserving of on-street charging points.

In contrast, the international, European, and national standardisation landscapes of EV charging (especially on the hardware-side) is widely progressed. However, it still lacks a uniform specification for charging protocols (data exchange between roaming platforms, EMSPs, CPOs and other parties), which should preferably be stipulated by European and national law.

To sum up, INFRA provides a foundation for the intended interoperable implementation of the five technical USER-CHI products in Barcelona, Berlin, Budapest, Rome, and Turku. The main conclusion is that to achieve a more user-friendly charging infrastructure, it is necessary to focus on the semantic and legal aspects when promoting interoperability, thereby engaging all relevant stakeholders and roles.

Acronyms

Acronym	Meaning
AC	Alternating Current
ACEA	Azienda Comunale Energia e Ambiente (Italian utility company)
AFID	Alternative Fuels Infrastructure Directive
AMB	Area Metropolitana Barcelona (project partner)
APDS	Alliance for Parking Data Standards
ATAC	Azienda per i Trasporti Autoferrotranviari del Comune di Roma (public transport operator in Rome)
BUD	City of Budapest (project partner)
BKK	Budapesti Közlekedési Központ Zrt. (project partner)
CLICK	Charging infrastructure Locatlon and HolistiC Planning Kit (product of the project)
CP	Charging Point
CPO	Charge Point Operator
D	Deliverable
DC	Direct Current
DoA	Description of Action
EC	European Commission
eMIP	E-Mobility Inter-Operation Protocol
eMO	Berliner Agentur für Elektromobilität
ENEL	Enel X (project partner)
ENER	Turku Energia (project partner)
ETRA	ETRA I+D (project partner)
EUR	Eurocities (project partner)
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GA	Grant Agreement
GDPR	General Data Protection Regulation
GEW	Gewobag (project partner)
i.a.	inter alia
IGL	IGL Technologies (Finnish provider of parking and charging services)

Acronym	Meaning
IKEM	Institut für Klimaschutz, Energie und Mobilität (project partner)
INFRA	Interoperability Framework (product of the project)
INCAR	Interoperability, Charging and Parking Platform (product of the project)
INDUCAR	Inductive Charging for e-Cars (product of the project)
INSOC	Integrated Solar DC-Charging for LEVs (product of the project)
ICT	Information and Communication Technology
IPT	IPT Technology (project partner)
LEV	Light Electric Vehicle
MID	Measuring Instruments Directive
MVM	Magyar Villamos Művek (Hungarian power/utility company)
O	Objective
OCHP	Open Clearing House Protocol
OICP	Open Intercharge Protocol
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
P	Product
QWI	Qwello (project partner)
RSM	Roma Mobilita Service (project partner)
SenUVK	Senate Department for the Environment, Transport and Climate Protection (Berlin)
SMAC	Smart Charging Tool (product of the project)
T	Task
TUR	City of Turku (project partner)
TVT	TVT Asunnot Oy (project partner)
USER-CHI	Project Title: innovative solution for USER centric CHarging Infrastructure
WP	Work Package
VASO	Varsinais-Suomen Asumisoikeus Oy (project partner)
VMZ	VMZ Berlin Betreibergesellschaft (project partner)

References

Alliance for Parking Data Standards 2020: Parking Data Specification, Technical Documentation, Information Model, Release 2.1, Status: Final, p. 10ff.; https://media.wix.com/ugd/ece286_2d21a97419464a6db05be64d8d73b350.pdf.

Alliance for Parking Data Standards 2021: About APDS, https://www.allianceforparkingdatastandards.org/about.

European Parking Association 2016: Summary: The Function and benefits of the International Parking Industry Payments Standards IPIPS (powered by IFSF) for the parking industry; https://www.europeanparking.eu/media/1317/the-benefits-of-ipips-final.pdf.

The European Union Blockchain Observatory Forum, Legal and regulatory framework of blockchains and smart contracts, 2019.

International Parking Institute 2017: IPI-DataEx – Data Exchange Standard, June 2017; https://www.parking.org/wp-content/uploads/2017/06/IPI-Data-Ex-Introductory-Documents.pdf.

Kipker, Dennis-Kenji/Birreck, Piet/Niewöhner, Mario/Schnorr, Timm: Rechtliche und technische Rahmenbedingungen des „Smart contracts“, MMR 2020.

The Mobility House GmbH 2020: Zukunftssichere Ladeinfrastruktur: Warum der OCPP-Standard fürs Laden von Elektroautos so wichtig ist, https://www.mobilityhouse.com/de_de/magazin/e-mobility/was-bedeuted-ocpp-fuers-laden-von-elektroautos.html/.

Nationale Plattform Zukunft der Mobilität 2020: Roadmap zur Implementierung der ISO 15118, Standardisierte Kommunikation zwischen Fahrzeug und Ladepunkt, https://www.plattform-zukunft-mobilitaet.de/wp-content/uploads/2020/12/NPM_AG5_AG6_2020_Q4_ISO15518.pdf.

Schiller, Kai (Blockchainwelt) 2018: What are smart contracts?, https://blockchainwelt.de/smart-contracts-vertrag-blockchain/.

Schrey, Joachim/Thalhofer, Thomas: Rechtliche Aspekte der Blockchain, NJW 2017.

Annexes

Annex 1

INFRA – Organisational Layer

The overall INFRA concept represents a framework and a product of USER CHI that provides an overview to various stakeholders under which conditions interoperability can be reached resulting in improved usability of charging infrastructure by addressing different barriers that currently do not allow for interoperability.

The organisational layer of INFRA is the first layer to be described within INFRA. The aim of this layer is to find a common understanding and common grounds among all stakeholders that are involved in the implementation process of electromobility services within the electromobility "ecosystem" aiming for interoperability. This result is the specification of role schemes and the different understandings of goals, functions, system boundaries and responsibilities of the implementation of an electromobility product that may arise.

Therefore, the organisational layer includes identifying and approaching the relevant stakeholders for each product to perform a process of communicative validation.

How to fill in the table:

The following table comprises of a set of predefined roles, and three blank columns to be filled in the with the stakeholder specification and definition/task of the roles for all USER-CHI products which will be applied in your city and their relation to other roles.

Please fill in the table in preparation for the upcoming mini workshops. The aim is to capture the **role schemes for the application of all technical USER-CHI products** (CLICK, INCAR, SMAC, INDUCAR, INSOC).

The following instructions may help you to fill in the table:

- Please check if any role is missing in the table and provide the different (potential) **users** of the technical USER-CHI products which will be applied in your city.
- Please specify the roles by providing the names of the **stakeholders** in your city.
- Please indicate the **definition/task** of each stakeholder for the application of the products in your city.
- Please indicate how each **role relates to other roles** within the applications of the respective product in your city.

The table serves as an overall role scheme indication of internal and external stakeholders that are relevant for the implementation of the technical USER-CHI products.

The results will be discussed during mini workshops that will be held per USER-CHI city (Barcelona, Berlin, Rome, Budapest, and Turku). Role	**Stakeholder Specification (Names)**	**Definition/Task**	**Relation**
Your role: **……**			
Other roles involved within the implementation in your demo site:			
CPOs			
EMSPs			
E-roaming platform operators			
Public authorities			
Distribution system operators (DSOs)			
Metering point operators			
Power supply companies			
Car/bike sharing operators			
Housing companies			
Public transport operators			
E-mobility associations			

Users (private, tenants, professional, public authorities, …): **…….**			
Other roles: **…….**			

Annex 2

Technical requirements software / platforms
Location of park and charge services (routing services)
Communication protocols [(open) charging protocols: communication CPO – EMSP]
Accounting services
Authentications services
Authorization and authentication methods
(Online) payment services
OCPI token (user ID) – authentication/roaming/billing
Blockchain (smart contracts)
Parking data standards

Table 4: Relevant requirements/aspects for semantic interoperability

Technical requirements hardware
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • DSM
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements
Technical connection rules – TCR
Charging plug components for electromobility (charging plugs standards – conductive charging)
Product standards and electrical safety • equipment and conductive charging • data security
Hardware requirements for installed charging points (communication unit, IT security)
Testing of hardware/charging infrastructure
Safety and standard-compliant design of the mounting system
Technical records and documentation
Inductive charging • electro-magnetic compatibility • magnetic field emissions)
Energy storage (INSOC)
Charging plug components for LEV's charging
Energy supply for LEVs charging box (PV system)

Table 5: Relevant requirements/aspects for hardware interoperability

Legal requirements – charging infrastructure regulation
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)
National regulation of interoperability of charging infrastructure operated by different CPOs
Regulation on construction permits for the installation of charging points in public space
Involvement of public authorities and public bodies
Administrative approval of the installation of public charging points
Regulation of the installation and operation of charging points
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)
Booking of parking spots on public roads for charging
Enforcement of administrative offenses for parking
Regulation of measuring instruments (i.a., measuring instruments directive) • Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure
Regulation of tariff models regarding payment for the use of public CPs
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)
Provision of real time availability data/dynamic data by CPOs to other stakeholders
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability
Regulation of roaming for EV charging/regulation of roaming platforms
Regulation on V2G charging/reverse charging (national)
Regulation of inductive charging (national)

Table 6: Relevant requirements/aspects of charging infrastructure regulation – legal interoperability

Annex 3

Mini Workshop: INFRA – Technical and Legal Layer

The overall INFRA concept represents a framework and a product of USER CHI that provides guidelines to various stakeholders under which conditions interoperability can be reached resulting in improved usability of charging infrastructure by addressing different barriers that currently do not allow for interoperability.

Both the technical and legal layer are described within INFRA. The aim within the scope of work of the legal layer is to identify national, regional, and local barriers for legal interoperability addressing various fields of law affected by EVs, charging services and infrastructure on European and national level.
The technical (including semantic) layer aims at identifying and specifying relevant technical requirements for interoperability for various aspects involved in providing charging services and infrastructure. This includes both hardware and semantic (communication technology) requirements for EVSE, payment for charging services, billing, data sharing processes and data management among CPOs, EMSPs and roaming platforms as well user authentication and roaming for an extended user access to charging infrastructure.

The aim of the workshop is to **prioritise legal and technical aspects** that either **support or hinder interoperability** the most considering both the development and the implementation of the **technical USER-CHI products** (CLICK, INCAR, SMAC, INDUCAR, INSOC). That is why it is important to include the different perspectives and the expertise of the product leaders and the city partners for their demo sites.

The prioritisation is essential to determine which of the aspects that are available in ***D1.3 Technical and legal requirements for USER-CHI solutions*** are most relevant for the respective cities to identify enablers and barriers for interoperability.

Agenda:

1) Welcome and brief explanation of the workshop goals (IKEM)
2) Discussion on technical requirements and barriers for interoperability regarding the products to be implemented
3) Discussion on legal requirements and barriers for interoperability regarding the products to be implemented
4) Wrap up and outlook (IKEM)

The following instructions may help you to prepare for the workshop:

- Below you will find **short inventories of relevant aspects** identified for interoperable charging regarding the **regulatory and technical framework of EV charging**, which will be the basis of the discussion during the workshop.
- Both inventories are based on chapter 4 (*General Technical and Legal Requirements*, p. 53) of ***D1.3 Technical and legal requirements for USER-CHI solutions***.
    - Chapter 4.1 includes the cross-cutting technical and legal requirements for the technical USER-CHI products.
    - Chapters 4.2 – 4.6 include the product-specific general requirements for the technical USER-CHI products.
    - Please **check the paragraphs of the above-mentioned sections in D1.3** that are relevant to the product(s) you are implementing or developing.
    - The document is available on **Alfresco**: https://tecbox.etra-id.com/share/s/z5PxQnhrSkGpvIykPxCOgA
- Please **review** the technical and legal aspects summarised in **the inventories** with particular attention to their relevance and existing barriers for interoperability.
- **Take yourself notes** on the **relevance** of the aspects listed in the inventories and **existing barriers** so they can be prioritised and discussed during the workshop.
    - *What are the main barriers for interoperability?*

2) Discussion on technical requirements and barriers for interoperability

- By means of a simple **rating system**, it will be indicated whether the **relevance of a technical aspect/requirement** is low, moderate, medium, or high for interoperability: **low (+-), moderate (+), medium (++), high (+++)**
- After rating the different aspects according to their relevance, **existing barriers for interoperability** can be noted in the right column of the table

Technical requirements hardware	Specific relevance/prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)		
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements		
Technical connection rules – TCR		
Charging plug components for electromobility (charging plugs standards – conductive charging)		
Product standards and electrical safety • equipment and conductive charging • data security		
Hardware requirements for installed charging points (communication unit, IT security)		
Testing of hardware/charging infrastructure		
Safety and standard-compliant design of the mounting system		
Technical records and documentation		
Inductive charging • electro-magnetic compatibility • magnetic field emissions)		

Energy storage (INSOC)
Charging plug components for LEV's charging
Energy supply for LEVs charging box (PV system)

Technical requirements platforms/services	Specific relevance/prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]		
Accounting services		
Authentications services [e.g., OCPI token (USER ID)]		
Authorization and authentication methods		
(Online) payment services		
Application of blockchain technology (e.g., for smart contract solutions)		
Parking data standards		
Routing services (location of park and charge services)		

3) Discussion on legal requirements and barriers for interoperability

- By means of a simple **rating system**, it will be indicated whether the **relevance of a regulatory aspect/requirement** is low, moderate, medium, or high for interoperability: **low (+-), moderate (+), medium (++), high (+++)**
- After rating the different aspects according to their relevance, **existing barriers for interoperability** can be noted in right the column of the table

Important aspects of charging infrastructure regulation	Specific relevance/prioritisation	Existing barriers for interoperability
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)		
National regulation of interoperability of charging infrastructure operated by different CPOs		
Regulation on construction permits for the installation of charging points in public space		
Involvement of public authorities and public bodies		
Administrative approval of the installation of public charging points		
Regulation of the installation and operation of charging points		
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)		
Booking of parking spots on public roads for charging		
Enforcement of administrative offenses for parking		
Regulation of measuring instruments (i.a. measuring instruments directive)		

• Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure
Regulation of tariff models regarding payment for the use of public CPs
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)
Provision of real time availability data/dynamic data by CPOs to other stakeholders
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability
Regulation of roaming for EV charging/regulation of roaming platforms
Regulation on V2G charging/reverse charging (national)
Regulation of inductive charging (national)

Annex 4

Mini Workshop Results (Organisational Layer)

1) Barcelona

INCAR	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: USER-CHI Project manager in AMB, demoleader of Barcelona pilot site				/
Other roles involved within the implementation in your demo site:				/
CPOs	AMB Electrolineres	Provide the charging points connected to INCAR platform	UTE ETRA-GIC is the maintenance agent in AMB Electrolineres (agreement between AMB and ETRA for support)	/
EMSPs	UTE ETRA-GIC (on behalf of AMB Electrolineres)	Manage the transactions from users in AMB charging points, all of them connected to INCAR platform	UTE ETRA-GIC is a technological partner of AMB Electrolineres (collaboration between AMB and ETRA)	/
E-roaming platform operators	UTE ETRA-GIC	Guarantee the OCPI communication with another	No collaborations with other charging	/

		charging point network, for instance in Rome or other city Test and demonstration of e-roaming	networks/cities up to now	
Public authorities				/
Distribution system operators (DSOs)				/
Metering point operators	AMB Electrolineres			/
Power supply companies				/
Car/bike sharing operators				/
Housing companies				/
Public transport operators				/
E-mobility associations	Taxi ECOLOGIC AMB is the manager of the taxi system in Barcelona, taxis are privately owned	Provide professional e-drivers (e-taxi drivers)	Taxi ECOLOGIC is a USER CHI collaborator assuring the relationship between e-taxi drivers and AMB	/
Users (private, tenants, professional, public authorities, ...):	Other professional e-drivers?		AMB has a relation to all potential users (inhouse and external)	/

Other roles:				/
Marketing	AMB Eurocities in specific role	Information about the demo sites Important for AMB: informing the people		/

SMAC	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: USER-CHI Project manager in AMB, demoleader of Barcelona pilot site		Involve another municipality in the metropolitan area of Barcelona as a show case → probably Cornellà de Llobregat, but could change in the future New charging infrastructure is needed to demonstrate SMAC → no bidirectional/V2G chargers implemented so far (only load balancing technology)	Diplomatic relationship between AMB and Cornellà	/
Other roles involved within the				/

implementation in your demo site:				
CPOs	AMB Electrolineres	Provide a charging station with several charging points	UTE ETRA-GIC is the maintenance agent in AMB Electrolineres	/
EMSPs	UTE ETRA-GIC (on behalf of AMB Electrolineres)	Manage the transactions from users in AMB charging points, all of them connected to INCAR platform	UTE ETRA-GIC is a technological partner of AMB Electrolineres	/
E-roaming platform operators				/
Public authorities	Ajuntament de Cornellà de Llobregat ? AMB	City hall where the charging station will be located	AMB – Cornellà	/
Distribution system operators (DSOs)	ENDESA (ENEL subsidiary)		AMB (CPO) – DSO	/
Metering point operators	AMB Electrolineres			/
Power supply companies	ENDESA (ENEL subsidiary)		AMB – Endesa Relation only important for grid connection of charging infrastructure → power supply contract	/

Car/bike sharing operators				/
Housing companies	No relevance in Barcelona			/
Public transport operators				/
E-mobility associations	AMB is the manager of the taxi system in Barcelona, taxis are privately owned			/
Users (private, tenants, professional, public authorities, …):	Professional users from INCAR test or private users of AMB charging network	Perform charging operations in order to prove SMAC utilities	AMB has a relation to all potential users (inhouse and external)	/
Other roles:				
Marketing	AMB Eurocities in specific role	Information about the demo sites Important for AMB: informing the people		/

INDUCAR	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: USER-CHI Project manager in AMB, demoleader of Barcelona pilot site				/
Other roles involved within the implementation in your demo site:				/
CPOs				/
EMSPs				/
E-roaming platform operators				/
Public authorities	AMB			/
Distribution system operators (DSOs)	ENDESA (ENEL subsidiary)			/
Metering point operators				/
Power supply companies	ENDESA (ENEL subsidiary)			/
Car/bike sharing operators				/
Housing companies	No relevance in Barcelona			/
Public transport operators				/
E-mobility associations				/
Users (private, tenants, professional, public authorities, ...):	Workpeople of AMB organization		AMB has a relation to all potential users (inhouse and external)	/

.....				
Other roles:				
Owner facilities	AMB Facilities manager	Inductive charging points installation	The inductive charging points will be installed in AMB parking offices Relation: AMB inhouse collaboration	/
Technological provider	IPT	Provide the inductive equipment for the chargers to be installed in AMB parking offices	USER CHI partner and WP5 leader	/
Technological provider	Mechanical and electric garage, automotive sector To be selected	Support for electric car retrofitting (two AMB electric cars)	No included in USER CHI partners	/
Marketing	AMB Eurocities in specific role	Information about the demo sites Important for AMB: informing the people		/

INSOC	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: USER-CHI Project manager in AMB, demoleader of Barcelona pilot site				/
Other roles involved within the implementation in your demo site:				/
CPOs				/
EMSPs				/
E-roaming platform operators				/
Public authorities	AMB			/
Distribution system operators (DSOs)				/
Metering point operators				/
Power supply companies				/
Car/bike sharing operators	AMB e-Bicibox AMB Mobilitat	Provide e-bikes and e-bike theft-proof parking	AMB – AMB e-Bicibox & AMB Mobilitat	/
Housing companies	No relevance in Barcelona			/
Public transport operators				/
E-mobility associations				/
Users (private, tenants,	Workpeople of AMB organization		AMB has a relation to all potential	/

professional, public authorities, …): ……	Private users from e-Bicibox		users (inhouse and external)	
Other roles:				
Owner facilities	AMB Facilities manager AMB Bicibox	Adapt e-bike theft-proof parking facilities to INSOC test	All the e-bike parking facilities are property of AMB Relation: AMB inhouse collaboration	/
Technological provider	Photovoltaic panels To be selected	Install the Solar DC-Charging for LEV	No included in USER CHI partners	/
Marketing	AMB Eurocities in specific role	Information about the demo sites Important for AMB: informing the people		/

CLICK	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: USER-CHI Project manager in AMB, demoleader of Barcelona pilot site				/
Other roles involved within the implementation in your demo site:				/
CPOs	AMB Electrolineres			/
EMSPs				/
E-roaming platform operators				/
Public authorities	AMB			/
Distribution system operators (DSOs)				/
Metering point operators				/
Power supply companies				/
Car/bike sharing operators				/
Housing companies	No relevance in Barcelona			/
Public transport operators				/

E-mobility associations	AMB is the manager of the taxi system in Barcelona, taxis are privately owned			/
Users (private, tenants, professional, public authorities, ...):	AMB mobility planners	Test the CLICK tool and confirm the ongoing expansion project for AMB charging network	AMB has a relation to all potential users (inhouse and external)	/
Other roles:				
Data provider	AMB Open data catalogue Other Open data provider in Barcelona area VMZ as developer of CLICK	Provide metropolitan data as an input for CLICK tool		/
Marketing	AMB Eurocities in specific role	Information about the demo sites Important for AMB: informing the people		/

2) BERLIN

Role	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Roles involved within the implementation in the demo site:				
CPOs	Qwello	Data Delivery (online, after installation of charging points), Requirement Spec, User of the platform Align with city to comply with general regulations on (semi) public charging infrastructure in Berlin and safeguard exemption from "Berliner Modell" Apply for CPO role according to Berlin Process for new CPOs, sign bilateral contracts with all EMSPs based on aligned tariff model Adapt product, backend, and software according to demo site and USER-CHI requirements Coordinate with Gewobag on energy supply contract/		INCAR, SMAC, CLICK

		provider selection and sign contract Register CP at Ladesäulenregister Ensure CP registration at all relevant platforms/apps Invoicing and billing Summarizing lessons learned from location planning in semi-public space and integration into CLICK and Stations of the future handbook Preparation of business dashboard to share with demo city partners Hotline (24/7) and maintenance, 1st level, 2nd level	
EMSPs	Qwello	Register at Berlin authentication platform Align tariff model with competition Prepare Roaming Card, Charge Card and potentially Bluetooth tokens Ensure service readiness for registration etc.	INCAR, SMAC

		Offering authentication and billing services to users in the form of charging services contracts		
E-roaming platform operators	SenUVK; ETRA	Data Delivery		INCAR, SMAC
Public authorities	SenUVK Role “City of Berlin” is missing in the project; support by SenUVK is needed, SenUVK should become partner of the project	Requirement Spec, User, Data delivery	Point of contact to the “Berlin Model” for charging infrastructure	CLICK, INCAR, SMAC
Distribution system operators (DSOs)/Metering point operators (MPOs)	Stromnetz Berlin (via IKEM)	Data Delivery Providing meter Information provider for grid aspects / energy net operator view for CLICK Setting up grid connection	Stromnetz Berlin – IKEM – VMZ Gewobag – Stromnetz Berlin	CLICK, INCAR
Power supply companies (PSCs)	Not defined yet	Granting grid connection (if not provided by Gewobag), application process with CPO Potentially offering smart meter options, which could be	PSC – Qwello	SMAC

		integrated into Qwello solution Contract with CPO		
Car/bike sharing operators	All e-mobility operators in Berlin that offer shared services could be potential users (WeShare, Mobileeee, Emmy, Sixt, partners of Jelbi).	Potential users of INCAR	Indirectly Potential users (parking + charging) could be Mobileeee, WeShare or any E-mobility provider in Berlin Possible integration in the products as a special use case	INCAR
Housing companies	Gewobag Wohnungsbau-Aktiengesellschaft Berlin	Support and specification of customer and product requirements for INCAR & CLICK Support and specification of product requirements for SMAC Selection and provision of suitable demonstration site(s) for Berlin Development and deployment of new business models combining parking and charging for tenants and public charging Implementation support and		INCAR, CLICK, SMAC

		integration of the research approaches Administrative preparation and integration of development of the technical infrastructure Strategy development to maximize project's results Provision of parking API parking spot/site provision for charging infrastructure Promoting/usage of INCAR as an end product (e.g. tenants as a small group of potential users)		
Public transport operators				
E-mobility associations	eMo (not part of the consortium)	Dissemination		
Users	Private EV users, Mobility sharing providers, public authorities			CLICK, INCAR, SMAC
Other roles:				
Industry (technology provider):	VMZ	CLICK Developer & Operator, Promoter and Disseminator	ETRA, Qwello, Gewobag, SenUVK, IKEM	CLICK

	IPT Technology GmbH	Specification of the products INCAR and CLICK Elaboration of product requirements Creation of the concept for the product implementation Provision of API		
Parking management system operator (PMSO)	Not known yet	Providing parking API	PMSO-GEW-VMZ	INCAR

3) Budapest

Role	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: Municipality/local authority	BUD	Pilot site identification and implementation		
Other roles involved within the implementation in your demo site:				
CPOs	Municipality or BKK will be the CPO There are other CPOs in Budapest like E.ON (ELMÜ), NKM Mobiliti. (BUD will try to involve other private CPOs)	CPO in Budapest is responsible for the usual tasks of a CPO and has the usual relations of a CPO		
EMSPs	Specific EMSP will be the same as the CPO GreenGo is another EMSP (but no decision on the involvement by now) ELMÜ (E.ON), NKM Mobiliti are also EMSPs.	EMSP in Budapest is responsible for the usual tasks of an EMSP and has the usual relations of an EMSP BUD would like to use mobility points/experiences from other projects		SMAC, INCAR, INSOC
E-roaming platform operators	E-roaming platform operator will be ETRA			INCAR, SMAC

	(No overview about e-roaming platforms that are already active in Budapest)			
Public authorities	District governments (municipalities) of Budapest National government/ministry to be invited as a stakeholder	Responsibility for the selection of possible locations in the city, special use permits for the use of public space		
Distribution system operators (DSOs)/metering point operators (MPOs)	Elmü (EON) (different subsidiaries of E.ON operating in Budapest)	DSO and MPO in Budapest and operates as CPO as well Elmü will be involved when purchasing the charging points	BUD – Elmü owned company (50-50%)	
Power supply companies	E.ON MVM Energy Private Limited Company (not clear yet if MVM will be involved)	E.ON is the PSC in Budapest MVM is the central power supplier for Hungary		INSOC, SMAC
Car/bike sharing operators	E-car sharing operators: ShareNow, Mol Limo, GreenGo No e-bike sharing so far in Budapest			INSOC

	E-kick scooters: Lime E-scooters (motorbikes): Blinkee.City			
Housing companies	No relevance in the demonstration, no housing companies involved in the project in Budapest			/
Public transport operators	BKK	Authority for transport Replication and upscaling of the demos on city level after the project Maintenance of the demo/joint work		
E-mobility associations	Jedlik Ányos Klaszter	Regulatory part as a main task, practical experiences/best practices	Link to the ministry	
Users (private, tenants, professional, public authorities, ...):	local mobility planners (BKK, municipality, private companies, e-mobility cluster) Professional users: delivery services, e-taxi services			CLICK
Other roles:				/

Academic partners/stakeholders (technical or social)	Óbuda University for Technology and Economy + another university in Budapest	
Public lighting company (BDK)	DSO + municipality	BUD – Elmü owned company (50-50%), operates smart lampposts

4) Rome

Role	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: Rome Mobility Agency ……	Local Authority	Pilot site identification and implementation	Planning Mobility, Electric Mobility Plan implementation	CLICK
Other roles involved within the implementation in your demo site:				
CPOs	Enel X Mobility [4 CPOs are forecasted in Rome, but only Enel-X will be involved as CPO (only Enel-X has applied for the city's tender)]	BOO (build, own, operate) operator on site	Interaction with Mobility Planner (ev-charger location), Municipality (building permit), DSO (grid permit), EMSP (commercial aspects) Further CPOs can become part of the INCAR platform	INCAR, CLICK, SMAC, INSOC
EMSPs	Enel X [Enel-X not the only EMSP (all EMSPs that signed the agreement)]	Exclusive EMSP, no interface with other providers → Enel-X has to open its (proprietary) platform (open discussion)	Interaction with DSO (metering) and CPO	INCAR
E-roaming platform operators	ETRA	Regulation regarding e-roaming still unclear in Italy ETRA will be the operator of the e-roaming		INCAR

		platform (INCAR as the native roaming platform)		
Public authorities	Municipality (administrative structure in Rome: districts + municipality)	Main sponsor planning process for charging infrastructure (CLICK tool)	High level coordination High level communication plan Relation to CPO	CLICK
Distribution system operators (DSOs)	ACEA	Grid permit	LV energy supplier, metering and in case AMI	CLICK, INSOC, SMAC
Metering point operators	ACEA	Metering service for energy flow measurement AMI management Concerned in terms of bidirectional charging	Interaction/Coordination with CPO and, in case, with EMSP for commercial metering and related aspects (VAT, fiscal etc.)	
Power supply companies	ACEA and others (only ACEA involved in Rome)	Due to the regulation, HV generation could be done by different operators, LV distribution only by ACEA marketing (grey market for green energy (RES))	Interaction with CPO	INCAR, INSOC, SMAC
Car/bike sharing operators	Helbitz, Lime, Dott, Wind (kick scooter tbc),	B2B target customer for some USER-CHI	Interaction with Mobility Planner (parking intemobility hub),	INSOC, SMAC

	Cityscoot, eCooltra, ZigZag (Scooter-sharing tbc), RSM, Enjoy, Sharenow (car sharing, tbc) Division into two groups: e-bikes/e-scooters and e-kick scooters (concrete stakeholders not clear yet)	product (INSOC, INCAR, others in case)	Municipality (licensing), CPO, EMSP, E-roaming operators	
Housing companies	No municipal housing companies involved in the project in Rome (hardly any commercial housing market existing)			/
Public transport operators	ATAC [4 stakeholders in total (i.a. ACEA)]	Exclusive public transport operator, managing both public bus and metro line. Primary stakeholder in case of intermobility	Interaction, in case of interest, with CPO and car/bike sharing operators, to share an "unique" transport solution based on public+private (bus+sharing car, metro +e-bike etc.)	INCAR, SMAC, CLICK, INSOC

		with other services (i.e. bus+-e-bike for last mile). Potential interest in INCAR and SMAC P+R areas as a possibility for EV charging	àindirect involvement of PT operator	
E-mobility associations	Osservatorio Nazionale Sharing-mobility – Motus E (to be concluded), still open who will be involved	Influencer on sustainable mobility, disseminator, communicator	Interaction with Municipality and project partners No specific relation to other roles	CLICK (only information POV)
Users (private, tenants, professional, public authorities, …): ……	Taxi companies, mobility manager both for public (i.e. Postal Service, University) and private (fleet managers of large companies)	Large potential end users interested in INCAR, INSOC, SMAC, others	Interaction with Municipality and project partners	INCAR, SMAC, INSOC, CLICK
Other roles: ……				/

5) Turku

Role Vaso Demo	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role: ……				
Other roles involved within the implementation in your demo site:				
CPOs	Turku Energia (ENER) + Vaso as tandem [Other CPOs will maybe be involved (they need benefits from being involved in the demos)]	SMAC		SMAC
EMSPs	IGL	SMAC		SMAC
E-roaming platform operators	IGL	SMAC		SMAC
Public authorities	TUR			
Distribution system operators (DSOs)	Turku Energia Sähköverkot (DSO = MPO → mandatory in Finland)	SMAC		SMAC

Metering point operators (MPOs)	Turku Energia Sähköverkot	SMAC	SMAC
Power supply companies (PSCs)	Turku Energia	SMAC	SMAC
Car/bike sharing operators	-		
Housing companies	Vaso	SMAC	SMAC
Public transport operators	-		
E-mobility associations	-		
Users (private, tenants, professional, public authorities, ...):	Tenants	SMAC	SMAC
Other roles: Technology Provider	Huippuenergia	Provision of smart metering system for SMAC, PV panels, stationary batteries, production of renewable energy	SMAC

Role Kupittaa demo	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role:				
Other roles involved within the implementation in your demo site:				
CPOs	Turku Energia	INCAR		INCAR
EMSPs	Virta	INCAR		INCAR
E-roaming platform operators	Virta	INCAR		INCAR
Public authorities	TUR			
Distribution system operators (DSOs)	Turku Energia Sähköverkot (DSO = MPO → mandatory in Finland)	INCAR		INCAR
Metering point operators (MPOs)	Turku Energia Sähköverkot	INCAR		INCAR
Power supply companies (PSCs)	Turku Energia	INCAR		INCAR
Car/bike sharing operators	-			
Housing companies	Teknologiakiinteistöt oy			
Public transport operators	-			
E-mobility associations	-			

Users (private, tenants, professional, public authorities, ...):	Public and professional users	INCAR	INCAR
Other roles:			

Role TVT demo	Stakeholder Specification (Names)	Definition/Task	Relation	For which product?
Your role:				
Other roles involved within the implementation in your demo site:				
CPOs	-			
EMSPs	-			
E-roaming platform operators				
Public authorities	TUR			
Distribution system operators (DSOs)	Turku Energia Sähköverkot (DSO = MPO → mandatory in Finland)	CLICK, INSOC		CLICK, INSOC
Metering point operators (MPOs)	Turku Energia Sähköverkot	CLICK, INSOC		CLICK, INSOC
Power supply companies (PSCs)	Turku Energia	CLICK, INSOC		CLICK, INSOC
Car/bike sharing operators	TBD			
Housing companies	TVT	CLICK, INSOC		CLICK, INSOC
Public transport operators	-			
E-mobility associations	TBD (As a part of the project steering group)			

Users (private, tenants, professional, public authorities, ...):	Tenants, Public	CLICK, INSOC		CLICK, INSOC
Other roles:				

Role Turku Masterplan	**Stakeholder Specification (Names)**	**Definition/Task**	**Relation**	**For which product?**
Your role:				
Other roles involved within the implementation in your demo site:				
CPOs	All possible			
EMSPs	All possible			
E-roaming platform operators	All possible			
Public authorities	City of Turku, Neighbouring cities	CLICK		CLICK
Distribution system operators (DSOs)	Turku Energia Sähköverkot, Caruna, Naatalin Energia	CLICK		CLICK

	(DSO = MPO → mandatory in Finland)		
Metering point operators (MPOs)	Turku Energia Sähköverkot, Caruna, Naantalin Energia	CLICK	CLICK
Power supply companies (PSCs)	All possible		
Car/bike sharing operators	All possible Bike sharing is under planning More e-car sharing operators to be coming		
Housing companies	All possible (No further specific plans to involve more housing companies in the project, but engaging as many as possible)		
Public transport operators	Föli, Matkahuolto, taxi companies,	CLICK	CLICK
E-mobility associations	Sähköautoilijat ry	CLICK	CLICK

	(As a part of the project steering group)			
Users (private, tenants, professional, public authorities, ...):	All possible (e.g. city planners)			
Other roles:				

Role Turku Bike charging	**Stakeholder Specification (Names)**	**Definition/Task**	**Relation**	**For which product?**
Your role:				
Other roles involved within the implementation in your demo site:				
CPOs	Turku Energia	INSOC		INSOC
EMSPs	TBD	INSOC		INSOC
E-roaming platform operators	TBD	INSOC		INSOC
Public authorities	City of Turku	INSOC		INSOC
Distribution system operators (DSOs)	Turku Energia Sähköverkot			

Metering point operators	Turku Energia Sähköverkot		
Power supply companies	Turku Energia	INSOC	INSOC
Car/bike sharing operators	TBD	INSOC	INSOC
Housing companies	-		
Public transport operators	VR, Föli INSOC app: incorporation of Föli app (mainly buses and bike sharing) is in consideration	INSOC	INSOC
E-mobility associations	-		
Users (private, tenants, professional, public authorities, ...):	Private users		
Other roles: Technology Provider	No specific stakeholder clear yet (will be tendered) City government will be involved for the budget	Provision of PV panels + battery packs for INSOC; 40 chargers	INSOC

Annex 5

Mini Workshop Results (semantic, technical, and legal layer)

1) Barcelona

2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)	Low (+/-)	ETRA: no barriers → everything is standardised V2G technology is still under development, not yet standardised. IPT: INDUCAR integration in private area – no extra needs for the grid already existing in the AMB private parking.
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements	Low (+/-)	AMB: no barriers for interoperability within the City of Barcelona→ in Barcelona there is only one grid operator (DSO) AMB: barriers for interoperability between cities/transnational → e.g. interoperability between Rome and Barcelona might be a problem IPT: metering functionality not developed by INDUCAR – integration in private area

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Technical connection rules – TCR	Low (+/-)	ETRA: no barriers → everything is standardised
Charging plug components for electromobility (charging plugs standards – conductive charging)	Low (+/-)	ETRA: no barriers → from the point of view of the CPO or DSO everything is standardised
Product standards and electrical safety • equipment and conductive charging • data security	Low (+/-)	/
Hardware requirements for installed charging points (communication unit, IT security)	Moderate (+)	AMB: barriers that may arise are related to maintenance The field is very dynamic and some equipment could be quickly obsolete vs. new equipment
Testing of hardware/charging infrastructure	Low (+/-)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Safety and standard-compliant design of the mounting system	Low (+/-)	/ IPT : no existing barriers
Technical records and documentation	Low (+/-) to Moderate (+)	AMB: it depends on the manufacturer of the CI/CP (e.g. French instructions etc.) → more an organisational b.
Inductive charging (INDUCAR) • electro-magnetic compatibility • magnetic field emissions	Low (+/-) [frequency is important → same type of frequency is required]	No barriers identified; general comment: two systems that are going to be synthesised leads to the question whether they have the same efficiency IPT: no barriers as the magnetic field and the EMC shall comply with very restrictive standard references
Energy storage (INSOC)	Low (+/-) to Moderate (+)	Existing barrier in terms of the components → lack of existing standards for the plugs in the bike/battery side (No interop. Barrier)
Charging plug components for LEV's charging	High (+++)	Existing barrier in terms of the components → lack of existing standards for the plugs in the bike/battery side (no interop. barrier)
Energy supply for LEVs charging box (PV system)	Low (+/-) to Moderate (+)	Existing barrier in terms of the components → lack of existing standards ~~for the plugs~~

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]	High (+++)	Barrier → comm. not only between CPOs+EMSPs → in case of external parties there is a lack of standardisation
Accounting services	High (+++)	?
Authentications services [e.g., OCPI token (USER ID)]	High (+++)	?
Authorization and authentication methods	High (+++)	?
(Online) payment services	~~High (+++)~~ Low (+/-) High (+++)	Usually, the financial/banking sector has strong standards for payment services Barriers due to the complexity of payment and, mainly, accounting procedures between different CPOs and EMSPs in a „roaming" environment IPT: functionality not related to INDUCAR development

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)	Low (+/-)	AMB: if we don't have a contract with the operators, then no charging is possible. AMB, as EMSP, in order to accept ad hoc charging, a minimum user identification is required (and a valid credit card in case of services with payment)
National regulation of interoperability of charging infrastructure operated by different CPOs	?	?
Regulation on construction permits for the installation of charging points in public space	High (+++)	AMB: it is difficult to get the approval; it is handled very differently according to the municipality (it's hard to get the approval – only in public space!)

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Administrative approval of the installation of public charging points	Low (+/-)	You have to follow a standarization process
Regulation of the installation and operation of charging points	Low (+/-)	Operation is not regulated by law. Parking time limitation are crucial in order to increase the use of CP in public space. Nowadays we don't know whether a car is plugged-in or not → when the aim is to increase the use of CP in public space we need info about whether some are charging longer or not

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)	Low (+/-)	?
Booking of parking spots on public roads for charging → question what is the issue between interoperability and parking?	Low (+/-)	?
Enforcement of administrative offenses for parking	Low (+/-)	?

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation of measuring instruments (i.a. measuring instruments directive) • Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure	Low (+/-)	?
Regulation of tariff models regarding payment for the use of public CPs	Medium (++)	?
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems	Medium (++)	?

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)	Low (+/-)	The regulation through GDPR is sufficient
Provision of real time availability data/dynamic data by CPOs to other stakeholders	See communication protocols (INCAR+CLICK)	See communication protocols (INCAR+CLICK)
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability (→ see explanation planning data approach)	Medium (++)	Not directly a problem today; there are only two main CPOs in the AMB
Regulation of roaming for EV charging/regulation of roaming platforms	High (+++)	?

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation on V2G charging/reverse charging (national law)	Low (+/-)	No national law
Regulation of inductive charging (national law)	Low (+/-)	No national law

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2) Berlin

2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)	AC: moderate (+) DC: moderate (+) V2G: Medium (++) DSM: High (+++)	AC - Low voltage - Basic connections - Energy demand issue - Approval process only as crucial point - V2G needs further R&D in order to become market ready
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements	High (+++)	• Smart meter, electricity meter location → needs to be included; any/ every DSO has different solutions, different requirements for each solution • Different hadware and software solutions for demand response

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Technical connection rules – TCR	High (+++)	TAB per city different which is already the barrier
Charging plug components for electromobility (charging plugs standards – conductive charging)	High (+++)	No barriers – Type 2 plug as a market standard
Product standards and electrical safety • equipment and conductive charging • data security	Low (+/-)	No high or big barrier
Hardware requirements for installed charging points (communication unit, IT security)	Low (+/-)	Load management is only managed for one solution
Testing of hardware/charging infrastructure	Low (+/-)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Safety and standard-compliant design of the mounting system	Low (+/-)	No standardized mounting systems, pre-installations for one charging solution can be useless for a different type
Technical records and documentation	Low (+/-)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]	High (+++)	INCAR Defined interfaces and protocols
Accounting services	Medium (++) to High (+++)	INCAR: trying to solve the barriers as a roaming platform with automated invoices to be transfered to CPOs+ EMSPs
Authentications services [e.g., OCPI token (USER ID)]	High (+++)	Multiple solutions available that are not integrated, Every CPO + EMSP registration
Authorization and authentication methods	High (+++)	How the platforms are combined →
(Online) payment services	High (+++)	CPO and third parties communication needed; specific protocols are not compliant with GDPR, usage data needs to be transfered to the data (to whom/where?)

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Application of blockchain technology (e.g., for smart contract solutions)	High (+++)	- Security and transparency - Confidence
"Planning data" / provision of data for planning aspects	High (+++)	No legal obligation yet given, e.g., to provide data for the purpose of planning to the municipality
Parking data standards	High (+++)	- Lack of standardisation - Lack of access to parking data
Routing services (location of park and charge services)	High (+++)	/

3) Budapest

2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)	High (+++)	Redesisgn of the grid, ability to handle the charging infrastructure installed (practical relevance) → synchronised developement of the grid
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements	High (+++)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Technical connection rules – TCR	Medium (++)	No significant barriers from technical point of view, CPOs have clear understanding
Charging plug components for electromobility (charging plugs standards – conductive charging)	High (+++)	AC charging: Cable mounted on the CP or brought by user?
Product standards and electrical safety • equipment and conductive charging • data security	Medium (++)	No significant barriers from technical point of view, CPOs have clear understanding
Hardware requirements for installed charging points (communication unit, IT security)	Medium (++)	- II -
Testing of hardware/charging infrastructure	Medium (++)	- II -

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Safety and standard-compliant design of the mounting system	Moderate (+)	/
Technical records and documentation	Moderate (+)	/
Energy storage (INSOC)	Low (+-)	Energy storage is a component of INSOC, but itself not highly relevant for interoperability
Charging plug components for LEV's charging	High (+++)	No European standards given yet for LEV charging plug components
Energy supply for LEVs charging box (PV system)	Low (+-)	Energy supply (PV) is a component of INSOC, but itself not highly relevant for interoperability

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]	High (+++)	Big providers can provide all services for charging (accounting, authentication, ...)
Accounting services	High (+++)	/
Authentications services [e.g., OCPI token (USER ID)]	High (+++)	/
Authorization and authentication methods	Moderate (+)	/
(Online) payment services	High (+++)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Application of blockchain technology (e.g., for smart contract solutions)	Moderate(+)	Not highly relevant for interoperability,
"Planning data" / provision of data for planning aspects	High (+++)	No legal obligation yet given, e.g., to provide planning data to the municipality
Parking data standards	High (+++)	No standardised protocols for data exchange
Routing services (location of park and charge services)	High (+++)	No barrier, problem is solved with OCPI protocol

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)	High (+++)	Public charging infrastructure in Hungary is developed under the AFID; issues raised in AFID are solved; ad hoc charging is more expensive than for registered users (→ political decision that this is up to the market)
National regulation of interoperability of charging infrastructure operated by different CPOs	Medium (++)	No barriers yet, but new ones can arise (e.g., DC charging)
Regulation on construction permits for the installation of charging points in public space	Low (+)	No actual barriers, it is a resource and organisational issue of the authorities
Administrative approval of the installation of public charging points	Low (+)	/
Regulation of the installation and operation of charging points	Low (+)	No actual barriers

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)	Moderate (+)	Implementation of proprietary technology; unethical competition → market activity
Booking of parking spots on public roads for charging	High (+++)	Lack of space for parking spots
Enforcement of administrative offenses for parking	High (+++)	/

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation of measuring instruments (i.a. measuring instruments directive) • Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure	High (+++)	Issue with asuring instruments in DC charging segment still not solved
Regulation of tariff models regarding payment for the use of public CPs	Low (+-)	Diffrerent prices/benefits for users
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems	High (+++)	/

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)	High (+++)	Data exchange between differnt stakeholders
Provision of real time availability data/dynamic data by CPOs to other stakeholders	Medium (++) to High (+++)	No legal obligation of CPOs to provide data openly to other market actors
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability	Medium (++) to High (+++)	-II-
Regulation of roaming for EV charging/regulation of roaming platforms	High (+++)	Lack of regulation; stakeholders are not very clear in this regard; structure of cooperation; coordination of pricing structures
Regulation on V2G charging/reverse charging (national)	High (+++)	/

4) Rome

2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)	Moderate (+) Medium (++) Medium (++)	 Only very few vehicles that can charge V2G There is only one DSO in Rome
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements	Low (+/-)	No relevance in terms of interoperability

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Technical connection rules – TCR	Moderate (+)	No system with infinite capability, depends on thr grid and local DSO
Charging plug components for electromobility (charging plugs standards – conductive charging)	High (+++)	/
Product standards and electrical safety • equipment and conductive charging • data security	Medium (++)	/
Hardware requirements for installed charging points (communication unit, IT security)	Medium (++)	The plan for Rome is related to the national standards; technical agreement between EVSE provider and city
Testing of hardware/charging infrastructure	Medium (++)	The city relies on standards or national plans; problems for the building of facilities → different conditions in private areas

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2) Discussion on technical requirements and barriers for interoperability

Technical requriements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Safety and standard-compliant design of the mounting system	Low (+/-)	/
Technical records and documentation	Low (+/-)	/
Energy storage (INSOC)	Low (+/-)	Mostly linked to the product, no real barrier
Charging plug components for LEV's charging	High (+++)	No uniform standards for LEV charging plugs on EU level
Energy supply for LEVs charging box (PV system)	Medium (++)	Lack of standardisation for DC low power charging

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]	High (+++)	Providers stick to proprietary solutions; missing regulation on using/imposing protocols; not a specific technical problem, it is more a contractual problem
Accounting services	/	/
Authentications services [e.g., OCPI token (USER ID)]	/	/
Authorization and authentication methods	/	/
(Online) payment services	/	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Application of blockchain technology (e.g., for smart contract solutions)	Medium (++) to High (+++)	Necessary technology to have it involved in roaming platform with contractors exchanging data; different value to different users – decentralised verification relevant and necessary
"Planning data" / provision of data for planning aspects	High (+++)	Planning aspects not reflected in the data flows; GDPR-compliant provision of data for planning purposes
Parking data standards	?	?
Routing services (location of park and charge services)	High (+++)	/

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)	Medium (++) to High (+++)	Some discussions on the national level, but national implementation not done in Italy
National regulation of interoperability of charging infrastructure operated by different CPOs	High (+++)	No national regulation in Italy yet
Regulation on construction permits for the installation of charging points in public space	High (+++)	Responsibility of each municipality, local regulation is relevant when it comes to the deployment of charging infratructure
Administrative approval of the installation of public charging points	High (+++)	-II-
Regulation of the installation and operation of charging points	High (+++)	-II-

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)	High (+++)	The market is not yet ready for charging infrastructure; interoperability in public tenders is addressed national plans
Booking of parking spots on public roads for charging	Medium (++)	/
Enforcement of administrative offenses for parking	?	?

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation of measuring instruments (i.a. measuring instruments directive) • Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure	Low (+/-)	No barriers, because it is already completely regulated as per technical regulation
Regulation of tariff models regarding payment for the use of public CPs	?	No public regulation of charging tariffs; every operator on the market decides on its own
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems	/	No barrier can be identified at the moment

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)	Low (+/-)	No barrier, all actors have to follow the regulation
Provision of real time availability data/dynamic data by CPOs to other stakeholders	High (+++)	Lack of regulation → it is not clear enough that data shall be provided
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability	High (+++)	/
Regulation of roaming for EV charging/regulation of roaming platforms	Moderate (+)	/
Regulation on V2G charging/reverse charging (national)	/	No specific barriers related interoperability

5) Turku

2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Supply of electric energy for EV's charging infrastructure • grid connection • charging speeds • AC/DC charging • V2G technologies • demand side management (DSM)	Low (+/-) Low (+/-) Low (+/-) Low (+/-) Low (+/-) Low (+/-)	Electric supply side is not a real barrier since legislation and standards are fixed
Technical Requirements of the grid operator and metering device operator • grid connection • electricity meter location • grid operator requirements	Low (+/-)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Technical connection rules – TCR	Low (+/-)	/
Charging plug components for electromobility (charging plugs standards – conductive charging)	Medium (++)	/
Product standards and electrical safety • equipment and conductive charging • data security	High (+++)	LEV fire safety very important, EV fire safety important when parking indoor during the winter
Hardware requirements for installed charging points (communication unit, IT security)	Low (+/-)	/
Testing of hardware/charging infrastructure	Low (+/-)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements hardware	Specific relevance/ prioritisation	Existing barriers for interoperability
Safety and standard-compliant design of the mounting system	?	/
Technical records and documentation	High (+++)	/
Energy storage (INSOC)	High (+++)	Battery storage in winter → indoor storage or heating necessary → warranty and liability issue
Charging plug components for LEV's charging	High (+++)	LEVs have Schuko plugs and own chargers
Energy supply for LEVs charging box (PV system)	High (+++)	/

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Communication protocols [(open) charging protocols: communication CPO – EMSP]	High (+++)	Different (open and proprietary) communication protocols with different versions; minimum requirements for INCAR platform not clear yet
Accounting services	High (+++)	/
Authentications services [e.g., OCPI token (USER ID)]	?	?
Authorisation and authentication methods	Moderate (+)	No real technical barriers, more legal barriers
(Online) payment services	?	?

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2) Discussion on technical requirements and barriers for interoperability

Technical requirements platforms / services	Specific relevance/ prioritisation	Existing barriers for interoperability
Application of blockchain technology (e.g., for smart contract solutions)	High (+++)	Different costs per system → validation which price is current
"Planning data" / provision of data for planning aspects	High (+++)	Planning aspects not reflected in the data flows; GDPR-compliant provision of data for planning purposes; no central storage of charging data for the whole city
Parking data standards	High (+++)	No standards for communication between parking operator and EMSP/roaming platform → necessary to access parking garage
Routing services (location of park and charge services)	High (+++)	No barriers: Location of different CPs is included in OCPI/INCAR platform → one of the main goals

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
National implementation of the AFID • Non-discriminatory access to public charging infrastructure • Regulation of ad hoc charging (without contract)	High (+++)	Implementation of AFID in progress → 2022/23; need for open access to users for ad hoc charging Ad hoc charging is a national issue in Finland
National regulation of interoperability of charging infrastructure operated by different CPOs	/	/
Regulation on construction permits for the installation of charging points in public space	Low (+/-)	/
Administrative approval of the installation of public charging points	Low (+/-)	/
Regulation of the installation and operation of charging points	High (+++)	Providing equal possibilites for different companies

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Consideration of interoperability in public tenders (specifications) for EVSE • Local tender specifications demanding stronger minimum standards for interoperability than EU or national legal framework (AFID + national implementation)	Low (+/-)	City of Turku has not tendered charging infrastructure yet
Booking of parking spots on public roads for charging	Low (+/-)	/
Enforcement of administrative offenses for parking	?	?

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation of measuring instruments (i.a. measuring instruments directive) • Regulation of the calibration of measuring devices in charging points (national) • Storage of measured values of electricity within the electricity meters of CPs • Compliance with legal metrology of users of measured values (e.g., EMSPs) • Legal metrology requirements for backend systems of charging infrastructure	Low (+/-)	No actual barriers → there is a standard in Finland for measuring in CPs and smartphone app for users
Regulation of tariff models regarding payment for the use of public CPs	/	No relevance: tariff models not regulated by the city → market-regulated
Regulation on the management of data models for smart metering systems → cybersecurity and data protection of smart metering systems	Low (+/-)	/

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3) Discussion on legal requirements and barriers for interoperability

Important aspects of charging infrastructure regulation	Specific relevance/ prioritisation	Existing barriers for interoperability
Regulation on data protection for personal data generated using CPs (GDPR + national implementation)	High (+++)	/
Provision of real time availability data/dynamic data by CPOs to other stakeholders	Medium (++)	No regulation in this regard yet
Provisions for data sharing processes among CPOs/EMSPs → minimum standards and interoperability	High (+++)	No regulation in this regard yet
Regulation of roaming for EV charging/regulation of roaming platforms	?	?
Regulation on V2G charging/reverse charging (national)	Low (+/-)	/