Final Report - Task39

“Interoperability of e-mobility services”

“User centric charging infrastructure”

ExCo55 – June 2022

Member Countries

Belgium, Canada, France, Spain, Switzerland, The Netherlands, USA

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Task39 "Interoperability of e-mobility services"

Introduction

Task39 focused on user friendly charging infrastructure and more specifically at the interoperability aspects for charging passenger cars in the public and semi-public domain. Also smart charging is within the scope of Task39.

The IEA TCP HEV Executive Committee (ExCo) unanimously approved Task39 at the 48th ExCo meeting held in April 2018 in Dublin (Ireland). At the 52nd ExCo meeting held in November 2020 as an online meeting, an extension has been requested due to the impact of COVID-19 on the Task39 planning. The extension has been approved and Task39 has been running from 01/04/2018 until 30/03/2022.

Belgium initiated Task 39 and The Netherlands officially joined from the start. During the first year, many countries expressed an interest to join Task39: Switzerland, United States, Spain, Canada, Germany, UK, Sweden and France. Most of these countries have joined officially. Also with the European Commission contacts are ongoing to share experiences related to their interoperability activities within the "European Interoperability Centre for Electric Vehicles and Smart Grids" and related to Alternative Fuels Infrastructure Regulation (AFIR).

The market of electric vehicles is growing worldwide at an increasing speed. More and more electric vehicle models are being introduced on the market. End users and governments get more and more interested in the potential benefits of electric mobility since it offers a great potential to solve many of our environmental, societal and economic challenges. Therefore, policy makers are implementing supportive measures to facilitate the further uptake of electric mobility in their region. Main barriers to be addressed are the higher purchase cost, limited driving range and limited charging infrastructure. The European Green Deal, published by the European Commission in December 2019, states that by 2025 about 1 million public recharging points will be needed for the 13 million zero- and low-emission vehicles expected on the roads of the European Union (EU). Governments and industry are making huge investments in charging infrastructure in the public and semi-public domain to facilitate the further uptake of electric mobility. Charging infrastructure will be needed, in more or less quantities, at all locations: residential, workplace and the semi-public and public domain, and at different speeds (both regular and fast charging).

By the end of 2020, there were about 2 million passenger cars (BEVs and PHEVs) in the 27 EU Member States and this number increased to more than 3.8 million end of 2021. By the end of 2021, there were about 260,000 publicly accessible recharging points across the EU-27 Member States of which 85% were normal power recharging points (up to 22 kilowatts) and 15% high power recharging points (above 22 kilowatts). The top 5 countries with the highest numbers of publicly accessible recharging points in EU are: The Netherlands, Germany, France, Italy and Sweden (source: EAFO - European Alternative Fuels Observatory).

In Canada, EV adoption is projected to stay at 22% compounded growth per year. At the end of 2019 there were almost 150,000 BEVs on the road, accounting for just under 0.7 percent of the 23 million passenger vehicles on the road in Canada. In 2020, Canada had between 12,000 and 15,000 publicly available EV chargers. To meet its emission reduction targets, Canada will need to reach over 825,000 zero-emission vehicles on the road by 2025. Using a 10:1 ratio that could require 82,500 charge points by 2025.

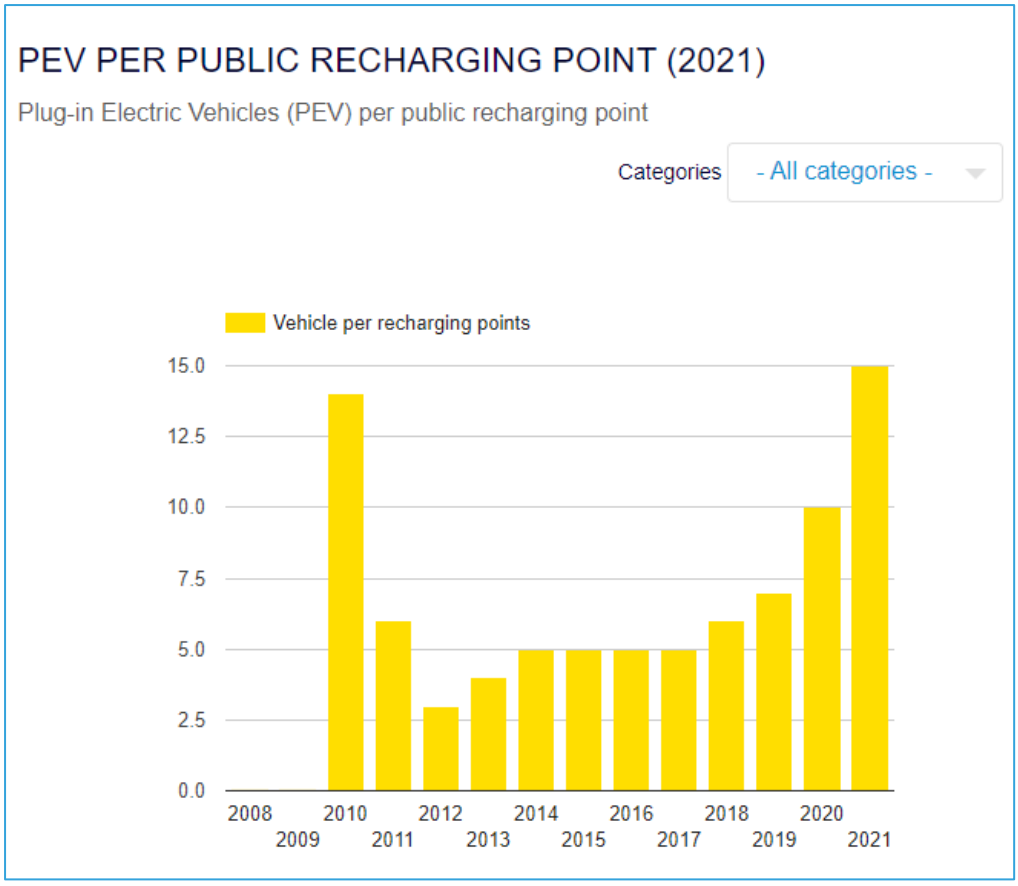

Figure 1: Number of Plug-in Electric Vehicles (PEV) per public recharging point in European Union (Source: EAFO - European Alternative Fuels Observatory)

Different studies refer to an indicative ratio that is needed of at least 1 charging point per 10-12 electric vehicles, but this ratio is of course very dependent on the local situation. In places like Canada for example, the population can be quite distributed, and while cross-country travel is common, it can also involve long distances between metropolitan areas. Currently much of the EV charging is concentrated in these urban areas. This kind of ratio may not be useful for international comparison, or may need to be framed differently or adapted in some way to be useful for comparisons. On European Union level we see that in 2021, due to the quicker increase of new electric vehicles compared to new public charging infrastructure, this ratio went from 10 in 2020 up to 15 in 2021 (see Figure 1).

However, it is not only about the quantity of available charging points in a region. Equally important to this ratio vehicles/charging points, is the quality of the charging service offered to the end users. This charging service needs to be easy to use, reliable and cost transparent. Information about the location and availability of charging points, about the way to get access to these charging points, about the tariffs and how to pay for the service, the capacity of the charger, all are crucial for the end user the be confident enough to make the step the electric mobility. Interoperability between the different e-mobility services offered today is therefore crucial for the comfort and ease-of-use of the end users. Look at the roaming in the telecom sector. But interoperability is equally important for the governments and companies making investments in charging infrastructure and services. Information exchange between the back offices of the different stakeholders like charge point operators and mobility service providers is an important aspect and having open and interoperable solutions can have a positive impact on the business case and on the flexibility to offer higher quality and/or combined e-mobility services to the end user.

Objectives

Today, most EV drivers are still lacking easy access to all necessary information about the charging possibilities in their region. Interoperability between countries is even a bigger problem. Many initiatives are being taken to improve information and interoperability, but today EV drivers still have to put too much time and effort in collecting all crucial information about the charging infrastructure (location, availability, accessibility, pricing, …) for their specific charging needs. Only the early adopters will take this effort but he majority of people interested in electric mobility will wait to step-in until this situation improves. Steps for improvement are being made, but not all issues have been solved completely like e.g. having a clear upfront view on the costs of charging at all locations.

Task39 brings together experts from member countries to share information and best practices to improve the interoperability and accessibility of charging services:

- Overview of the ongoing initiatives to stimulate interoperability of e-mobility services.
- Detailed country reports, explaining the current local market organization (market players & supporting policy measures).
- Set-up recommendations for governments and industry how to improve the interoperability of charging services. Main focus in Task39 was on "standard" charging services, but also the aspect of "smart" charging and its interoperability aspects have been taken into account.

On European Union level, progress is being made via the Commission's proposal to revise the Alternative Fuels Infrastructure Directive (AFID) and to transform it into a regulation setting binding targets (AFIR) for charging infrastructure rollout at member state level (see Alternative Fuels Infrastructure Regulation (AFIR) on page 12).

In Canada, regulation of the electricity sector, including most policies related to pricing and tariffs, occurs primarily at the provincial level. With energy sources varying across the 10 provinces and 3 territories the fees for EV charging also differ across the country. At the national level Natural Resources Canada (NRCan) develops policies and programs within the natural resources sector and promotes scientific innovation and technology transfer across Canada. NRCan also represents Canada at the international level to meet the country's global sustainable development commitments, such as GHG reduction targets. NRCan's Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative (EVAFIDI) is rolling out charging infrastructure across the country, with interoperability as one of its cornerstones.

Working Method

Task39 was executed in a pragmatic way and made use of mainly telco's and workshops to collect, discuss and write down the existing knowledge available at the experts from the member countries. This information has been complemented by additional **desktop research** and contacts with different initiatives to collect the most recent information.

Task39 also organized **workshops** between experts to share information and best practices. The workshops have been focusing on important aspects like transparent pricing, EV market protocols and the importance of open protocols to stimulate interoperability, the role of the public and private stakeholders, data quality of available (semi-) public charging infrastructure and even on the growing importance of cyber security. The Task39 workshop on "Transparent Pricing and Invoicing" made clear that improvements need to be made on price transparency. Prices need to be clear to the EV drivers before, during and after the charging sessions. Today, there is still a large divergence and complexity in tariff structures for contract-based and ad-hoc charging.

All collected information has been stored in an **IEA TCP HEV Task39 SharePoint site** accessible to the member countries. With the same login, the member countries also get access to the knowledge database of the Flemish Knowledge Platform Smart Charging with literature on smart charging.

Dissemination has been done via a Task39 chapter in the IEA TCP HEV annual reports. The final report and country chapters will be shared via the IEA TCP HEV website.

This **final report** will summarize some of the ongoing initiatives and best practices to stimulate interoperability. The authors are very well aware that there is a huge amount of initiatives ongoing and the purpose of this final report is to give the reader a global overview without being able to be fully comprehensive. The market is changing rapidly so this final report gives a snapshot of today's situation (June 2022). Where possible, the final report will refer to the most important initiatives, policies and position papers of which some recommendations to stimulate interoperability and user-centric charging experience will be summarized.

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Initiatives to stimulate interoperability of charging infrastructure

Task39 started with the collection of relevant information via desktop research and contacts with experts in the field. Many projects dealing with interoperability and roaming have been studied.

Focus at the start of the desktop research was mainly on Europe, because a lot of the ongoing projects detected have been set-up with European funding (FP7, H2020 or Interreg). Thanks to member countries Canada and United States, also information from outside of Europe was available.

European funded projects (FP7, H2020 or Interreg)

The funded projects selected in the desktop research, study the interoperability aspects from different perspectives.

Examples of European funded projects studied in the first period of Task39 were:

- **Electric Mobility Europe - evRoaming4EU:**
  - https://www.evroaming4.eu
  - The main objective of the project is to facilitate roaming services for charging electric vehicles and provide transparent information to consumers about charging locations and prices of charging in Europe, by making use of the open independent Open Charge Point Interface (OCPI) protocol. The goal is to allow any EV driver to charge at any charging station in the EU.
- **PF7 – Cotevos:**
  - http://cotevos.eu
  - Concepts, capacities and Methods for Testing EV Systems and their Interoperability within the Smart Grids
- **H2020 - NeMo:**
  - http://nemo-emobility.eu/
  - NeMo's vision is to create a Hyper-Network of new and existing tools, models and services which will provide seamless interoperability of electro mobility services, creating an open, distributed and widely accepted ecosystem for electro-mobility. The lack of interoperability gave rise to the recent concept of electro-mobility roaming platforms, often called e-roaming or eRoaming. The problem of interoperability between platforms still remains. In order to tackle this, the pan-European eRoaming initiative was announced in 2015 and its objective, namely the interconnection of existing eRoaming platforms, will be specifically pursued within the NeMo Hyper-Network for electro mobility.

More recently, the **H2020 call on "User centric charging infrastructure" (LC-GV-03-2019)** was launched which focused on many Task39 related topics.

Three projects have been funded within this call:

- **eCharge4Drivers: Electric Vehicle Charging Infrastructure for improved User Experience**
  - https://echarge4drivers.eu/
  - As the popularity of electric vehicles (EV) grows, users' needs and expectations on charging solutions and services are increasing. The EU-funded eCharge4Drivers project (with 32 partners from 12 countries) will improve the user experience as regards available charging options and services. Specifically, it will develop and demonstrate user-friendly charging stations, smart services and charging solutions, including mobile charging and battery swapping stations. User-centric

services such as route planning, booking, and charging location planning will be developed to further improve users' experience and foster e-mobility growth. The project's user-friendly charging systems and interoperable services will be demonstrated in 10 areas, covering cities, the Trans-European Transport Network and cross-border routes. The project will conclude with recommendations for legislative and regulatory amendments, as well as guidelines for the sustainability of charging infrastructure investments.

- **INCIT-EV: Large demonstratIoN of user CentrIc urban and long-range charging solutions to boosT an engaging deployment of Electric Vehicles in Europe**
  - https://www.incit-ev.eu/
  - INCIT-EV aims to demonstrate an innovative set of charging infrastructures, technologies and its associated business models, ready to improve the EV users experience beyond early adopters, thus, fostering the EV market share in the EU. The project will seek the emergence of EV users' unconscious preferences relying on latest neuroscience techniques to adapt the technological developments to the users' subjective expectations. 5 demo environments at urban, peri-urban and extra-urban conditions will be ready for the deployment of 7 use cases, addressing:
    - Smart and bi-directional charging optimized at different aggregation levels
    - Dynamic wireless charging lane in an urban area
    - Dynamic wireless charging for long distance (e-road prototype for TEN-T corridors)
    - Charging Hub in a park & ride facility
    - Superfast charging systems for EU corridors
    - Low power DC bidirectional charging infrastructure for EVs, including two-wheelers
    - Opportunity wireless charging for taxi queue lanes in airports & central stations
  - INCIT-EV consortium counts with 33 partners, including 3 OEMs, 6 charging technology providers and 5 public authorities, 6 RTOs, 2 ICT companies, 2 road infrastructures companies, 4 DSOs, 2 TSOs, 2 SMEs with expertise in user behavior and e-mobility exploitation, a car sharing services SME and an EV users association. Finally, ENTSO-e or the TInnGo project on gender issues support the project.
- **USER-CHI: Innovative solutions for USER centric CHarging Infrastructure**
  - https://www.userchi.eu/
  - The EU-funded USER-CHI project (32 partners) will promote large-scale electromobility market take up in Europe through smart solutions, novel business models and new regulatory framework conditions. The aim will be to integrate innovative charging technologies and put the user at the centre of the entire transition. The project will also exploit the synergies between electromobility and the process of greening and smartification of the grid. To pave the way for more EVs, the project will integrate the technological tools, business models and regulatory measures to be tested and validated in five EU cities (Barcelona, Rome, Berlin, Budapest and Turku).
  - USER-CHI aims at unlocking the massive potential of electromobility in Europe. This will be achieved by:
    - integrating different innovative charging technologies with a holistic perspective
    - putting the user at the centre and empowering it

- exploiting the synergies between electromobility and the process of greening and smartification of the grid which is taking place to achieve the energy transition in Europe
- integrating the technological tools, business models and regulatory measures which will transform the elements cited above into an actual, working ecosystem which improves the user experience of EV drivers beyond the current levels of ICE vehicles drivers, whilst at the same time makes financially attractive for the relevant private and public actors the large scale deployment of Europe's required user centric charging infrastructure.

Platforms - Associations

Besides funded projects that focus on stimulating interoperability, we also see market players joining forces in initiatives/platforms/associations to discuss and solve the interoperability challenges. Below you can find some examples.

AVERE

AVERE (The European Association for Electromobility) is the European association that promotes electromobility and sustainable transport across Europe. The Association is a non-profit organization governed by the Belgium law.

AVERE (www.avere.org) is a European association representing and advocating for electromobility on behalf of the industry, academia, and EV users at both EU and national levels. Members consist of National Associations supporting and encouraging the use of Electric Vehicles and electromobility across Europe. Currently AVERE has active members in 21 European countries, notably some of the most successful EV countries like Norway, France, The Netherlands and Belgium. Within these Associations, there are close to 2.300 industry members, ranging from SME's, OEM's, and other companies with a commercial interest in electromobility and about 100.000 EV users. Furthermore, AVERE's network includes Users of Electric vehicles, NGOs, Associations, Interest Groups, Public Institutions, Research & Development Centres, Vehicle and Equipment Manufacturers and other relevant Companies. This extends beyond Europe into global outreach. Next to advocacy, AVERE provides its members with a forum for exchanging knowledge, experience, and ideas on how to stimulate electromobility throughout Europe.

AVERE has a Working Group on Infrastructure that focuses on upcoming regulations related to the charging infrastructure market, notably the revised Alternative Fuels Infrastructure Regulation (AFIR) and the Energy Performance of Buildings Directive (EPBD). It also addresses technical charging infrastructure concerns such as data, cyber security, and communication protocols.

ChargeUp Europe

ChargeUp Europe (www.chargeupeurope.eu) is the voice of the electric vehicle (EV) charging infrastructure industry, working towards an expeditious and effortless rollout of EV charging infrastructure in Europe. It is committed to delivering a seamless charging experience for EV drivers, incentivizing investment and creating a consumer-centric, open market model for charging infrastructure in Europe.

ChargeUp's mission is to:

- Push for an infrastructure roll-out that starts from the consumer needs.

- Make EV driving convenient across borders and so strive for an open-market model supported by open standards and protocols.
- Remove market barriers related to concessions, grids, data sharing and building codes.

CharIN

CharIN (www.charin.global) is a global association with over 250 members dedicated to promote interoperability based on the Combined Charging System (CCS) as the global standard for charging vehicles of all kinds.

eMI3 "eMobility ICT Interoperability Innovation Group"

Under the umbrella of ERTICO, a public-private partnership developing, promoting and deploying Intelligent Transport Systems and Services (ITS), the eMI³ Group (www.emi3group.com) was an open interest group of global market players to enable global EV services interoperability by harmonizing standardization of ICT data standards & protocols including security and authentication. It has issued to documents of standards. eMI3 is now in process of dissolution.

E-clearing.net

e-clearing.net (www.e-clearing.net) is a platform that enables the exchange of roaming authorization, charge transaction and charge point information data. e-clearing.net is a collaboration between ElaadNL (Arnhem, Netherlands) and smartlab Innovationsgesellschaft GmbH (Aachen, Germany). The OCHP protocol (Open Clearinghouse Protocol) is designed to give parties the opportunity to use their own back-end to connect to e-clearing.net.

eViolin (The Netherlands)

eViolin (http://www.eviolin.nl/) is an association of charging station operators and service providers pursuing national roaming with international connections, using open standards.

eViolin encourages correct and clear tariff information provided by its members when using charging infrastructure. Charging rates are not determined by eViolin. Determining the rates and the correct information about them remains the responsibility of the individual operators and service providers.

Netherlands Knowledge Platform for Charging Infrastructure (NKL)

The Netherlands Knowledge Platform for Charging Infrastructure (NKL) (www.nklnederland.com) is a collaboration of organizations that are involved with the public charging of electric vehicles in the Netherlands. NKL is an independent not-for-profit organization, set up by EV market players, Dutch central and local government, universities and grid operators with the goal to lower the total cost for charging infrastructure and promote measures for development of a mature market for EV. NKL held the intellectual property of OCPI and led the development of the protocol until the start of the EVRoaming Foundation.

EV Roaming Foundation

The EVRoaming Foundation (https://evroaming.org/about-us/) manages and supports the **Open Charge Point Interface protocol (OCPI)** as free, reliable standard worldwide. The ultimate goal is to

allow any EV driver to charge at any charging station. The EVRoaming Foundation wants to ensure that OCPI is a sustainable and strong protocol that remains accessible in the long-term. The foundation is not limited to OCPI and can also support other related activities and services.

The OCPI community contributes to the new OCPI developments and versions, but also helps with installations, all kind of questions from other OCPI users, OCPI based roaming agreements, etc. The EVRoaming Foundation will manage this community.

AFIREV (France)

AFIREV (French Association for roaming of EV charging services) is a professional association of owners and operators involved in e-mobility and charging services accessible to the public. Devoted to work out common solutions for a safe and reliable service to final users, it is entitled by the French government to deliver and manage identifiers (IDRO). It is especially implied in consumer protection organization, VAT rules and management, continuous measurement and improvement of quality of service, path and means towards mobility as a service etc.

Electric Mobility Canada

In Canada there are some key initiatives and associations helping to promote interoperability. Electric Mobility Canada (EMC-MEC) is a national membership-based not-for-profit organization with the overarching goal to advance e-mobility in support of Canadian climate change and economic goals. EMC-MEC host events including the EV/VE Annual Conference (https://emc-mec.ca/activities/annual-conference/), EMC Webinars, and publishes white papers as an evolving toolbox for members.

At the provincial level groups with similar mandates include Plug 'N Drive (https://www.plugndrive.ca/, Plug In BC (https://pluginbc.ca/contact/), and Association des Véhicules Électriques du Québec (AVÉQ) (https://www.aveq.ca/).

Alternative Fuels Infrastructure Regulation (AFIR)

Task39 has been closely following the activities around the **AFID Directive 2014/94/EU** on the deployment of alternative fuels infrastructure in Europe. In July 2021, as part of the Fit for 55 Package, the European Commission tabled a proposal to revise the Alternative Fuels Infrastructure Directive (AFID) and to transform it into a regulation, the **Alternative Fuels Infrastructure Regulation (AFIR).** The conversion into a regulation is intended to ensure minimum infrastructure to support the required uptake of alternative fuel vehicles across all transport modes and in all EU Member States to meet the EU's climate objectives, to ensure full interoperability of that infrastructure; and to ensure comprehensive user information and adequate payment options at alternative fuels infrastructure. More specifically, fleet-based targets will ensure infrastructure growth goes hand in hand with EV uptake, resolving the "chicken-and-egg" problem, whereas distance-based targets along the TEN-T network (European main highway arteries) will put an end to range anxiety for drivers across the continent.

The **Sustainable Transport Forum (STF)** was set up to assist the European Commission and serves as a platform for structural dialogue, exchange of technical knowledge, cooperation and coordination between Union Member States and relevant public and private stakeholders. Its mandate has recently been extended until 31 December 2030. DG Mobility and Transport of the European Commission may set up sub-groups, that report to the STF plenary, for the purpose of examining specific questions on the basis of terms of reference defined by DG MOVE. The following Sustainable Transport Forum sub-groups are currently active:

- **Sub-group on the implementation of Directive 2014/94/EU**: this sub-group consists of the Member States only and discusses specific aspects related to the implementation of the Alternative Fuels Infrastructure Directive 2014/94/EU, as well as aspects related to standardization under that Directive.
- **Sub-group on governance and standards for communication exchange in the electromobility ecosystem (with particular focus on ISO 15118-20 and related PKI)**: this sub-group will propose minimum principles and a governance framework for communication between the electric vehicle and the recharging infrastructure, ensuring interoperability in the whole ecosystem. It will moreover prepare the ground for harmonization and convergence of electromobility communication standards and protocols.
- **Sub-group on a common data approach for electric mobility and other alternative fuels**: building on the work of the Program Support Action (PSA) on data collection related to recharging/refueling points for alternative fuels and the unique identification codes related to e-Mobility (IDACS), this sub-group is looking into the different data dimensions (aggregation, quality, sharing, reusability, provision, etc.) and data types (location, availability, price, payment methods, etc.) required to enable the future creation of new digital services in the alternative fuels market. It will propose a framework for data collection and exchange, with the ultimate objective to provide better information to consumers of alternative fuels infrastructure and services.
- **Sub-group on best practices of public authorities to support the deployment of recharging infrastructure**: this sub-group, which consists of public authorities mainly, will further the work on the 2020 STF Recommendations for public authorities for procuring, awarding concessions, licenses and/or granting support for electric recharging infrastructure, generating a (bi-)annual update to ensure the Recommendations remain relevant for public authorities. The sub-group is moreover working on guidance for permitting and grid connection procedures for recharging infrastructure, on recommendations to electrify specialized and captive fleets, and on reviewing the SUMP electrification Guide.

AFIR: NEXT STEPS

The proposal follows the ordinary legislative procedure under the Lisbon Treaty. Following its publication on 14 July 2021, the proposal was sent to the European Parliament and the Council for examination.

European Parliament

The TRAN Committee held two technical meetings with the Shadow Rapporteurs on 27 April and 18 May 2022 to finalize the Report. The TRAN Committee is then expected to vote on the draft Report and on the amendments tabled to it during the week of 11 July 2022. Finally, the European Parliament plenary vote on the final Parliamentary Report has been provisionally set between 12 and 15 September 2022.

Council

Council experts are also expected to meet and examine the proposal, in order to prepare the Council's internal position (General Approach). In particular, the Council Working Party on Transport - Intermodal Questions and Networks was scheduled to meet again to examine the proposal on 5 May 2022. Once both the European Parliament's Committee and the Council have finalized their position on the proposal, informal negotiations with the aim of reaching a first reading agreement on the proposal are then expected to begin. Any resulting compromise would need to be approved by the European Parliament and by the Council. Once adopted, the Regulation would enter into force on the twentieth day following that of its publication in the Official Journal of the European Union.

Task39 member countries

Within the Task39 member countries, one of the first countries taking interoperability serious on a national and cross-border level is **The Netherlands**, where interoperability has existed since the start of the EV uptake 10 years ago. The Dutch developed a national agenda for charging infrastructure (https://english.rvo.nl/information/electric-transport) and have been working many years towards an open and interoperable charging infrastructure market. Task39 was very pleased that The Netherlands joined with 3 experts so that their experience could be shared with the other Task39 member countries: **ElaadNL** (www.elaad.nl), **eViolin** (www.eViolin.nl) and **NKL** (www.nklnederland.com).

Interoperability is of course not only a national or European issue, it is also important that some aspects are being discussed on an international level. Thanks to member countries **Canada and United States**, information from outside of Europe has been exchanged within Task39.

The European Commission's Joint Research Centre (JRC) and **U.S. Department of Energy's Argonne National Laboratory** already work together via their **EV-Smart Grid Interoperability Centers** (EU Interoperability Centre for Electric Vehicles and Smart Grids | EU Science Hub (europa.eu) & EV-Smart Grid Interoperability Center | Argonne National Laboratory (anl.gov)). They provide a venue for global industry-government cooperation that is focused on the joint development of EV standards and test procedures. The objective is to study interoperability issues between the electric vehicles and the charging infrastructure, covering hardware and information exchange protocols. Also interoperability of the EV fleet and the smart grid is investigated. Pre-normative research is conducted to identify gaps in standards or technology and to support to the formulation of regulations addressing interoperability issues.

BCIT's Smart Microgrid Applied Research Team (Canada) is working on research, development and demonstration (RD&D) initiatives aimed at solutions that will reduce barriers to the adoption of Electric Vehicles (EVs). One of the recently funded projects will demonstrate EV infrastructure solutions that improve interoperability issues, grid efficiencies and drivers' charging experience. Federal funding for the project was provided through Natural Resources Canada's Green Infrastructure – Electric Vehicle Infrastructure Demonstration Program.

BCIT also serves on the working group developing a standard for electric vehicle energy management systems (EVEMS). BCIT has authored a research paper on EVEMS for the CSA Group, as the first step towards creating an EVEMS standard. The paper provides details of EVEMS configurations and control schemes towards improving interoperability of EV charging infrastructure for consumers. The paper is available on CSA Group's site: https://www.csagroup.org/wp-content/uploads/CSA-RR_ElectricVehicle_WebRes.pdf

Best practices/recommendations to stimulate interoperability of charging infrastructure

This final report will summarize some of the ongoing initiatives and best practices to stimulate interoperability. The authors are very well aware that there is a huge amount of initiatives ongoing and the purpose of this final report is to give the reader a global overview without being able to be fully comprehensive. The market is changing rapidly so this final report will give a snapshot of today's situation (June 2022).

This chapter will report some best practices/recommendations to stimulate interoperability and a user-centric charging experience (find, access, transparent prices, payment).

Most crucial basic requirement for the deployment of an interoperable and user-centric public charging infrastructure is to set-up a strong collaboration between public and private stakeholders, based on a long-term vision and strategy and ensuring broad multi-stakeholder buy-in. Public stakeholders should include all levels: from national to regional to municipalities and should also take into account cross-border cooperation and the EU level. Electric mobility is bringing the mobility and energy sector very close together meaning that a strong interaction between these previously completely separated markets is now recommended.

Tenders for charging infrastructure – Handbook for public authorities

The European Green Deal aims to make Europe climate neutral by 2050, boosting the economy through green technology, creating a sustainable industry and transport, and cutting pollution. The Smart and Sustainable Mobility Strategy proposes a variety of actions, including the expectation that a possible fleet of up to 13 million electric vehicles in 2025 will require the number of publicly accessible recharging points to grow from approximately 200,000 in 2020 to at least 1 million in 2025.

Public authorities (national, regional and municipalities) play a crucial supporting role in the roll-out of public charging infrastructure. This can be by providing funding but even when the market becomes more mature and funding is not needed anymore, public authorities still play a crucial role since they are responsible for the energy, climate, mobility and urban planning.

At some point, all levels of public authorities will be confronted with choices to be made regarding the deployment of a widespread recharging infrastructure in their territories. They will have to address issues around planning and technical choices while balancing options against long-term climate objectives (e.g. reducing car use overall, ensuring smart charging, etc.). This poses a number of challenges, but also creates opportunities - for instance to stimulate and accelerate the deployment of cost-efficient, grid-beneficial, truly interoperable and user-friendly solutions while avoiding to (co) fund infrastructure that does not meet certain minimum requirements. Through their concession or license award procedures, public procurement procedures or grant award procedures, public authorities of all levels of government can help shape market developments in this area. They can learn from the experience of frontrunners, by avoiding the mistakes they may have made and borrowing the practices that have proven to be successful.

To support them on this endeavor, the Sustainable Transport Forum expert group has drawn up a set of recommendations for public authorities procuring, awarding concessions, licenses and/or granting support for electric recharging infrastructure for passenger cars and vans (M1 and N1 category of vehicles according to UNECE standards).

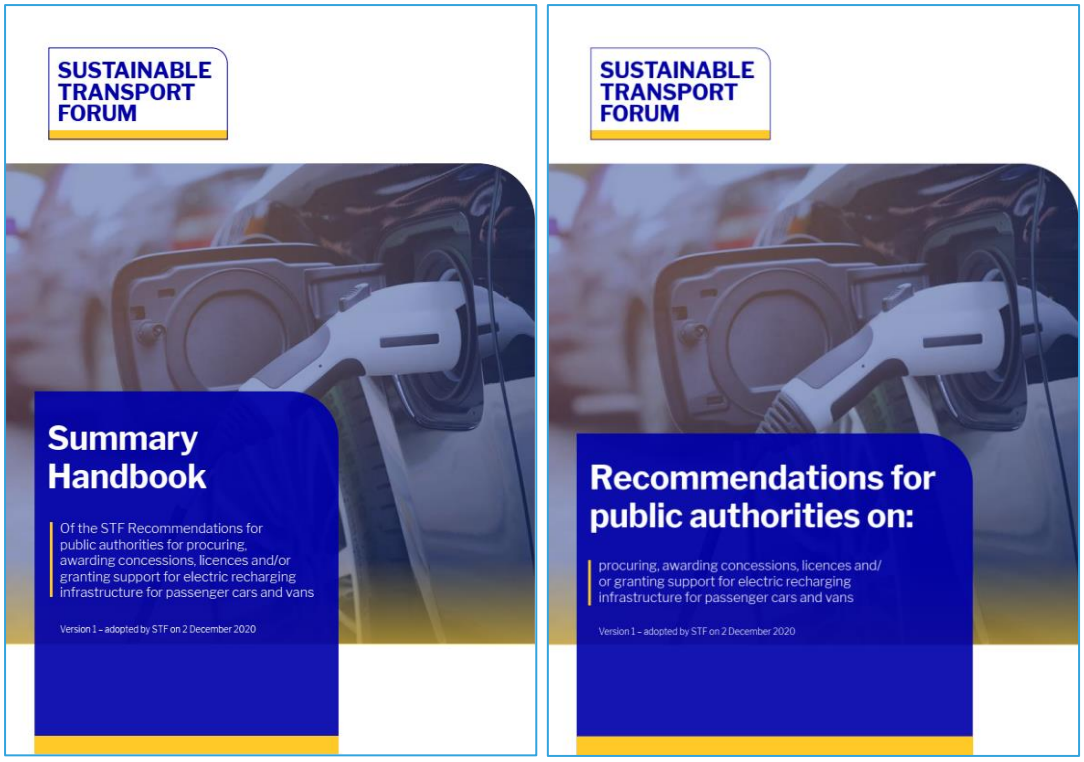

Figure 2: Sustainable Transport Forum

End of 2020, the Sustainable Transport Forum unanimously adopted a Report entitled "**Recommendations for public authorities for procuring, awarding concessions, licenses and/or granting support for electric recharging infrastructure for passenger cars and vans**" as well as a summary Handbook, highlighting the main findings, recommendations and examples of the main Recommendations report. The STF detailed recommendations report is meant to provide practical guidelines for public authorities that are either looking to procure recharging infrastructure or to award concessions for their roll-out and/or operation, possibly linked to the granting of government support. By offering an overview of best and innovative practices by frontrunners, the STF aimed to develop a set of minimum recommendations to public authorities seeking to support the deployment of recharging infrastructure in their territories. Different Task39 member countries gave input to this recommendations report and Task39 partners like ElaadNL and NKL were core reviewer.

How to design tenders for e-charging infrastructure - new Handbook for public authorities (europa.eu)

Task39 is happy to see specific chapters with recommendations for future tenders on making charging infrastructure more interoperable, future-proof and user-friendly.

Checklist Specific Tender Requirements:

- Recharging points are well-designed and positioned
- Infrastructure is interoperable, both in terms of hardware (connector fits vehicle) and software (infrastructure can communicate and interact)
- Infrastructure is future-proof
- It is easy to find and use, and users know in advance what they will pay for recharging
- Infrastructure functions properly, with a high uptime, while errors and bugs are quickly resolved
- It is (cyber) secure

Performance requirements: In order to offer the best possible service to EV-drivers on the one hand, and to get the best value for money on the other hand, public authorities should set minimum uptime requirements for infrastructure. Monitoring is best performed in real time, or at least on the basis of real time data. Financial penalties could be considered as a deterrent to ensure that maintenance is taken sufficiently seriously by the contractor, also towards the end of the concession period. Public authorities should also include minimum support requirements in their tender specifications - such as obligations on the operator to repair infrastructure within a given timeframe, either from a distance (e.g. a software issue) or, if needed, on site. 24/7 phone assistance should be provided as a minimum. Support in at least one, common European language other than the native tongue of the country/region in which the infrastructure is located, is advised. The phone number of the call centre should be clearly displayed on each recharging point.

Example - Flanders' annual concession tender:

The Flemish Region (Belgium) organizes an annual concession tender for and on behalf of interested municipalities. The distribution system operator is responsible for organizing the tender. The aim of the regional concession is to ensure that the infrastructure meets the same requirements (harmonization) and to prevent the creation of small closed networks (interoperability). Participation is voluntary: larger cities like Leuven, Ghent and Antwerp have chosen to organize their own tenders.

Recommendations:

- Public authorities can enforce certain interoperability aspects via these tenders towards an interoperable recharging network in the region.
- Public authorities should develop a long-term mobility vision and strategy with clear goals on future developments. Plans and strategies for the uptake of electromobility and the deployment of its recharging infrastructure should be part of this long-term mobility vision and should ideally include measurable targets to monitor progress and create a stable investment climate. Long-term strategies for recharging infrastructure require a clear vision on how the local mobility and electricity demand situation will develop (urban planning, parking policy, hosting capacity local electricity grid, …).
- To ensure consistency, public authorities should align their recharging infrastructure deployment strategies between different levels of government and between neighboring nations, regions, and cities.
- No access restrictions should apply to publicly accessible recharging points, with non-discriminatory access for all EV-users (as required by AFID 2014/94/EU).
- Mandate the use of open (hard- and software) interface standards between components and systems, so components and systems are interoperable and can be easily upgraded or transferred to a new operator.
- Enforcing high quality (*): Besides setting requirements regarding the quality of infrastructure, public authorities should make sure these can be enforced. To this end, public authorities should require guarantees from bidders or include enforcement mechanisms in their tender specifications. A common example are penalties for failure to meet uptime requirements. In The Netherlands, tenders can define quality specs and in case these are not met it can lead to breach of contract.

(*) In France, it will become mandatory (from 07/2022 on) for CPO and EMSP to publish a commitment to quality of service, and subsequently some statistics related to the quality achieved (like uptime). Since 2021, AFIREV carries out a biannual users satisfaction survey, and global statistics on availability of charging infrastructure accessible to the public.

Standard Set - Uniform Standards for Charging Stations

The use of a **Standard Set** increases efficiency in public tenders for charging infrastructure.

The Netherlands developed such a Standard Set. Based on the experiences of market parties and local authorities, a clear-cut standard set of guidelines on charging electric vehicles has been compiled. The standard set of charging station agreements is a project of the **Netherlands Knowledge Platform for Public Charging Infrastructure (NKL)**. In the context of NKL, a large number of public and private stakeholders work together on the realization of affordable and future-proof public charging infrastructure.

Charging stations must meet standards and regulations such as safety protocols. Grid operators are primarily concerned with safety and the impact on the electrical grid. Meanwhile, governments look toward the requirements of EV drivers and organization of the space. Then there are operating companies, factories and other market players who worry about efficient implementation and management. The interest of all parties is of course that charging stations are safe and functional, with costs kept as low as possible, and that the level of service for the EV driver remains high.

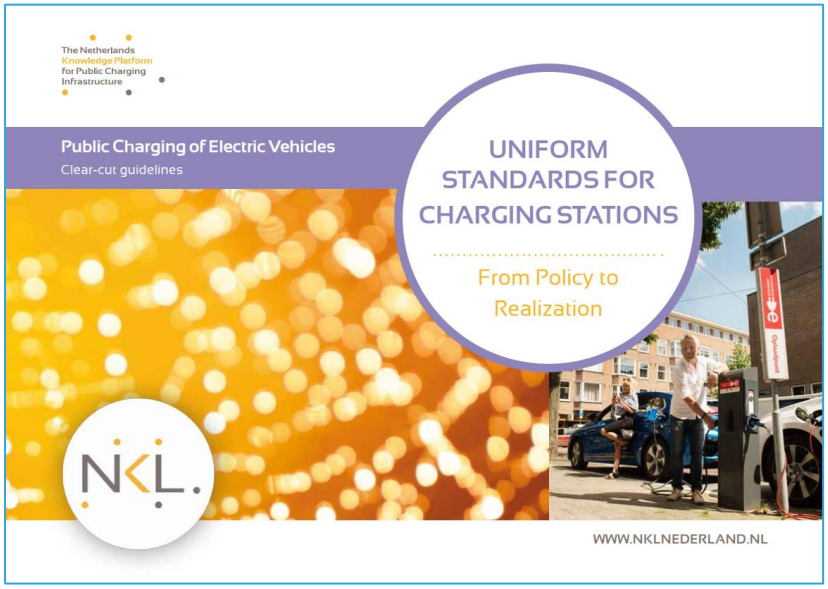

Figure 3: Uniform Standards for Charging Stations (Source: NKL)

This standard set offers an overview of all agreements concerning charging stations and their immediate environs that the various parties can conform to. The use of the Standard Set increases efficiency in public tenders for charging infrastructure. Drawing up tender documentation and other materials is simplified, and costs are reduced. The agreement lists are also easy to use for other parties, such as factories that manufacture charging stations. For both these parties and other market players, the demands of the Dutch market are made clear, and they know the standards that their services must comply with. An example for other markets.

The standard set of agreement lists are straightforward and tie in with international standards. Municipal governments and regions that work with them are not forced to reinvent the wheel, and all information is clearly assembled together. In this manner, nothing gets overlooked in the rollout of public charging infrastructure and interoperability.

Clear Definitions

Talking the same "language" is crucial to stimulate interoperability.

It all starts with clear definitions of the different EV market aspects. What is a charging point? What is smart charging? What is a publicly accessible charging point? What is a CPO and an MSP?

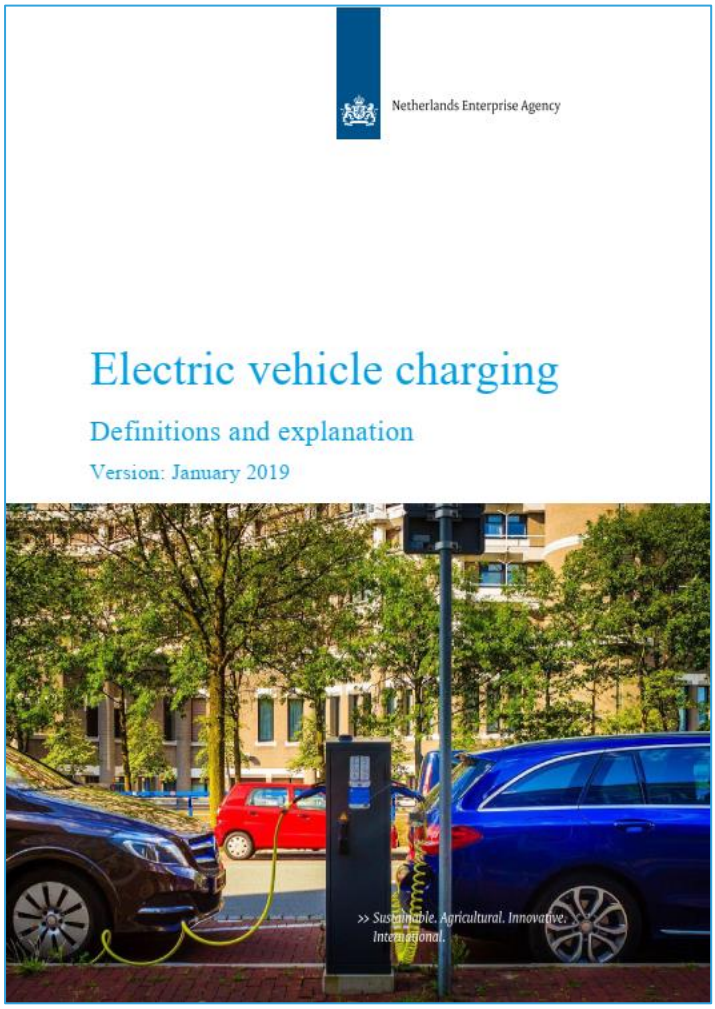

Figure 4: Electric Vehicle Charging: Definitions (Source: Netherlands Enterprise Agency)

https://www.rvo.nl/file/electric-vehicle-charging-definitions-and-explanation-january-2019-0

The Netherlands Enterprise Agency published a report on definitions to support the stakeholders in talking the same "language". We need to avoid different definitions for the same subject because this will lead to confusion and to wrong statistics.

AFIR includes e.g. a definition on "publicly accessible charging point".

We also notice that national legislation often includes certain definitions related to electric vehicles and charging infrastructure.

Interoperability

Interoperability essentially refers to the ability of all electric vehicles to recharge at any recharging point.

Hardware Interoperability

In Europe, all recharging points should comply at least with the technical specifications set out in point 1.1 or point 1.2 of Annex II of the Alternative Fuels Infrastructure Directive or, more precisely, the national transposition of those standards (while leaving it to the market to decide whether or not to add other connectors). The minimum tender specifications should require that:

- Alternating current (AC) recharging points shall be equipped at least with socket outlets or vehicle connectors of Type 2 as described in standard EN 62196-2.
- Direct current (DC) recharging points shall be equipped at least with connectors of the combined charging system 'Combo 2' as described in standard EN 62196-3

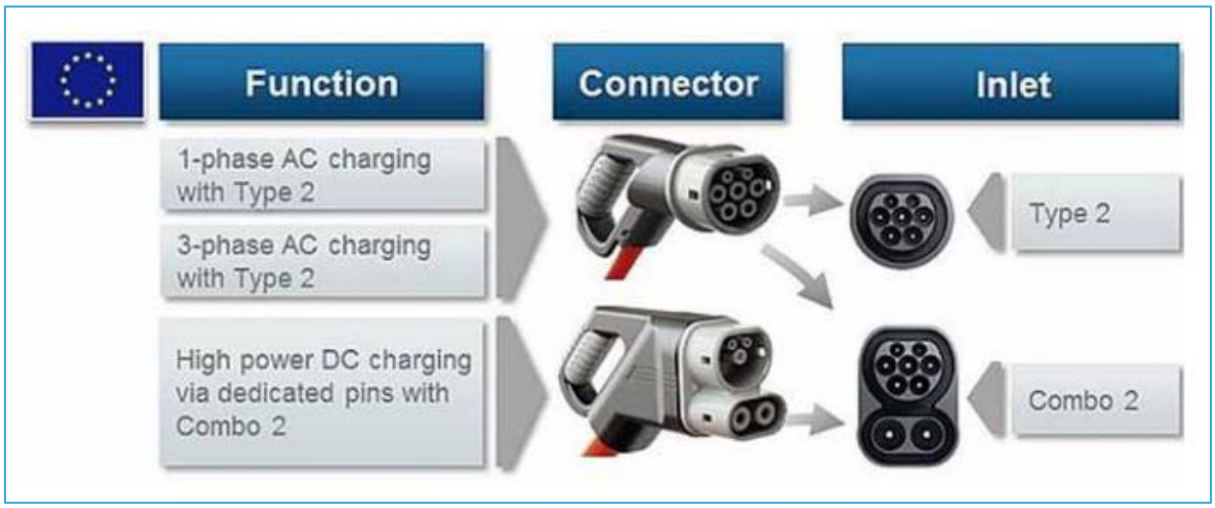

Figure 5: Mandatory recharging connectors in EU (Source: STF Handbook)

Software Interoperability

Software interoperability is relevant to allow seamless contract-based authentication, payment and related services.

In order to offer contract-based recharging, a recharging point must be accessible from a distance. In the absence of such a connection, (direct or indirect, through the CPO) an EMSP cannot obtain the data of a recharging session (identification of customer, kWh charged, time spent) it needs for billing purposes. When an EMSP also acts as CPO and owns/ operates his own infrastructure, this is relatively easy to establish between his own recharging points and back-office. It however becomes more complicated in cases in which his customers recharge at a recharging point owned/operated by another CPO. This is where software interoperability comes into play: it allows the two (or more) software systems to communicate and exchange the necessary data (referred to as roaming, either peer-to-peer or via a roaming platform.

The easiest way of enabling such communications is to ensure that two software systems speak (different versions of) the same language; in other words, ensuring that they use the same protocols for communications.

For interoperability purposes:

1. Public authorities should require that all publicly accessible recharging infrastructure is digitally connected. This implies the installation of the necessary software, standards, protocols and overall IT systems required to ensure the infrastructure is able to send and receive static and dynamic data in real time, as well as to connect the different market actors that are dependent on these data for enabling the recharging process. It is essential to ensure an adequate network connection: in this respect, best practice is to set minimum connection uptime requirements, irrespective of the chosen technology.
2. As most EV-drivers today already have RFID cards, public authorities should consider to at least require the integration in the recharging point of an NFC / RFID card reader. Several public authorities require that such an NFC / RFID card reader communicates at a radio frequency of 13,56 MHz and applies NFC Tag 1-functionality according to ISO/IEC 14443A. Since standards for automatic authentication are either proprietary solutions or not yet fully developed, public authorities should not, at this stage, mandate automatic authentication on recharging points. They should however keep an eye on market developments regarding the ISO 15118-20 “Plug and Charge”-authentication possibilities.
3. Future tenders will need to ensure that communication standards and protocols for the four main communication domains of the EV recharging ecosystem are interoperable. To achieve this, public authorities will have to closely follow developments regarding the adoption of new standards. Tender specifications should include a requirement that the concessionaire implements the ‘latest version’ of a standard, or that future updates of a standard are implemented at no additional cost within a maximum period (e.g. one year) from their adoption. For each respective communication domain, the following considerations should be made:
    a. EV – Recharging point: It is recommended that public authorities ensure that recharging infrastructure is future-proof and thus require that it contains the necessary hardware and software elements to support an upgrade to OCPP 2.0.1 and ISO 15118, at no extra cost to the contracting authority, when the different parts of the standards are both completed and suitable to the specific recharging use-case.
    b. Recharging point - Back-end/network management system OCPP is the current dominant protocol for this communication domain. Standardisation work is ongoing at IEC level to transpose and harmonize the OCPP and its functionalities into an international standard, IEC 63110, which should be backwards-compatible with OCPP. This convergence process may still take many years. At least until a final, OCPP backwards compatible version of IEC 63110 becomes available, the use of OCPP for recharging point to back-end communications should be encouraged in upcoming public tenders.
    c. Roaming - For communications between CPO to EMSP and CPO/EMSP to roaming platforms, public authorities are strongly encouraged to require the use of open, non-proprietary protocols that are free to use. Imposing a requirement on CPOs to implement at least one, specific protocol for roaming communications - ideally one that is not linked to any specific commercial roaming platform - would have the benefit of ensuring that all recharging stations use at least one, common communication protocol to facilitate roaming agreements, while not precluding the use of additional communication protocols. In the future, it is expected that IEC 63119 will harmonize the roaming communication domain, including the interaction between CPOs and EMSPs.
    d. The communication between CPOs, EMSPs, grid operators, grid users and facility managers are expected to be harmonized under IEC 61850. It is important to note that IEC 61850 works as a data model where different open protocols can be used. This approach differs from common standard conception and responds to the

communication needs of power systems. Future tenders should require the use of the newest versions of a standard or protocol, and consequently, allow the use of open data models according to the needs of CPOs and DSOs. The use of open, non-proprietary protocols, that are free to use, fosters the development of the recharging services market as an open and competitive market, with non-discriminatory access to new entrants.

e. E-roaming requirements: Public authorities should require that the CPO concessionaire allows non-discriminatory third party (EMSPs) access to its recharging points, so third party-EMSPs can offer services on these recharging points (start/ stop a session, financial transaction, smart recharging) to their customers. Moreover, this requirement should be complemented by an obligation on the CPO-concessionaire to establish a minimum amount of roaming connections, without, however, mandating the way roaming is implemented (Peer-to-Peer or via a clearing house).

Public Private Partnerships

Initiatives to stimulate the collaboration between public and private stakeholders can contribute strongly in setting up common agreements stimulating an open, interoperable and user-centric charging infrastructure.

Such initiatives can be set-up at different levels e.g. at EU level (like STF forum) or at national level.

In **the Netherlands**, the Dutch Ministry of Infrastructure and Water has drawn up a **National Charging Infrastructure Agenda** to ensure that a well-functioning infrastructure for electric transport can be rolled out. The National Agenda was drawn up in collaboration with public and private stakeholders, who jointly made agreements and defined the goals and actions on the deployment of charging infrastructure.

Figure 6: National Charging Infrastructure Agenda (Source: Netherlands Enterprise Agency)

The Dutch government collaborates with businesses, NGOs and knowledge institutions in Public-Private Partnerships to achieve climate goals. An example of this is the establishment of the 2019 Climate Agreement (Klimaatakkoord), in which over a 100 parties were involved across 5 sectors. This agreement is aimed to reduce the greenhouse gas emissions by 49% in 2030 compared to 1990 levels in an affordable, fair and feasible way. The National Charging Infrastructure Agenda is part of the Dutch Climate Agreement.

The National Charging Infrastructure Agenda (Dutch abbreviation: NAL) consists of a set of agreements between the various stakeholders, which together form a concrete multi-year policy program, combining ambitions & actions.

The Agenda's key elements are:

- Realization Process
- Price transparency, open protocols and open markets
- Boosting Smart Charging
- Promote innovation
- Logistics

Following actions link one-on-one to the Task39 scope:

- Creating a national access point for dynamic data on all (semi) public charge points.
- Ensuring price transparency for e-drivers by making a deal between governments, Chargepoint Operators and Distribution System Operators.
- Developing open protocols and standards for the entire value chain of charging.
- Developing open markets through interoperability of charging infra and open protocols.
- Developing market models, open standards and open protocols for smart charging.
- Making charging infrastructure user friendly, scalable and future-proof requires innovation. Developing a roadmap in which the innovation challenges arising from the Agenda are included and described.

The NAL contains about 70 measures and 5 working groups have been set up to work on the national measures. Also 6 NAL regions have been established that, in collaboration with their municipalities, are responsible for the regional measures and the roll-out of charging infrastructure. All NAL regions have drawn up a RAL (regional approach to charging infrastructure) and an important regional measure is that **every municipality must provide a "charging vision" and an "installation/location policy" for all types of charging infrastructure**. In this, municipalities make choices about how they deal with charging infrastructure for the coming years. The NAL regions provide support in this regard and conduct the region accordingly (https://www.agendalaadinfrastructuur.nl/default.aspx).

In addition, **for the purpose of grid impact, agreements have recently been made between regional governments (NAL regions) and DSOs about charging infrastructure**, based on the agreements of the Dutch Climate Agreement and the NAL, municipalities make plans (charging visions and installation policies) for charging infrastructure in their region/municipality. In this way they can give their investment plans the most accurate basis possible. This is best done if the **charging infrastructure plans are viewed integrally with all other energy transition plans**. In the context of the Regional Energy Strategies (RES) for solar and wind energy generation (https://regionale-energiestrategie.nl/default.aspx), a biennial process has now been set up to retrieve regional forecasts, which are then calculated to determine their impact on to determine the power grid. For the RES (for producers of sustainable energy), the **DSOs have developed a national grid capacity map**.

Charging Infrastructure – Open Charging Data Ecosystem

Consumers need comprehensive and up-to-date information on the location as well as the characteristics and use conditions of recharging points (e.g., power output, availability, ad hoc price). In order to collect recharging infrastructure data (static and dynamic) in a harmonized way and to share it with the stakeholders, some dedicated actions have been set-up at European level.

Programme Support Action (PSA) on ID issuing & data collection for alternative fuels (IDACS)

The PSA IDACS has been set-up by the European Commission to support Member States in setting up their National Access Points (NAPs) for alternative fuels, making these data available and accessible to third parties. The PSA had a duration of three years (2019-2022) and its Consortium consisted of 15 Member States: Austria, Belgium, Czech Republic, Croatia, France, Germany, Greece, Hungary, Lithuania, Luxembourg, The Netherlands, Poland, Portugal, Slovenia and Spain.

In practice, this PSA has allowed to develop an effective, EU-wide coordination mechanism to assign unique identification codes to CPOs and EMSPs. The Consortium developed a format for the establishment of the first 5-digits of the e-mobility IDs for CPOs and EMSPs and an EU-wide/coordinated approach regarding the remaining digits of the e-mobility IDs. Each of the Consortium-members has to establish an **ID registration organization (IDROs)** at national level responsible for issuing and management of e-mobility IDs within each of the participating Member States. And a common **ID Registration Repository (IDRR)** needs to be established for the exchange between national IDROs.

Furthermore, the Consortium mandatorily has to collect data related to alternative fuels infrastructure, namely electric charging points and hydrogen refueling stations (HRS). Other alternative fuels, such as CNG, LNG, LPG and highly-blended biofuels are optional. The data needs to be made available through the **National Access Points**.

The European E-mobility ID Registration Repository (IDRR)

The European E-mobility ID Registration Repository (IDRR) stemming from PSA IDACS, is hosted by the IDRO Benelux on behalf of participant Member States and UK. The IDRR and its website have been introduced by the Consortium of the Programme Support Action IDACS in 2021.

https://benelux-idro.eu/en/more-about/id-registration-repository-idrr.

IDRO - The IDROs need to maintain the ID registration for Charge Point Operators (CPOs) and Mobility Service Providers (MSPs) with a unique ID for each organization. These IDs issued by the IDROs are used to identify charge contracts and charge stations (possibly also charge pools). The use of the unique IDs supports the cross-border use of charge stations by EV drivers, as it enables domestic and foreign ad hoc payments. The AFIR proposal, in Article 18(1) prescribes that Member States shall appoint an IDRO. The IDRO shall issue and manage unique identification (ID) codes to identify, at least operators of recharging points and mobility service providers. This approach brings legal certainty and ensure a common development of IDROs across the EU.

IDRR - The national IDROs are expected to collaborate at European level via the ID Registration Repository (IDRR). The IDRR provides relevant information on IDs, access to national ID registers and ID requests. It is also expected to offer support to national IDROs with their activities and Member

States who do not yet have their IDRO. Furthermore, the IDRR also aims to ensure long-term sustainable ID management.

IDACS is an abbreviation for 'ID issuing and data collection for alternative fuels' and aimed to support Member States in setting up data collecting for alternative fuels and make the data available through the National Access Points and to develop an effective, EU-wide coordination mechanism to assign unique identification codes to CPOs and MSPs.

STF - Sub-group on a common data approach for electric mobility and other alternative fuels

The Sustainable Transport Forum decided at its plenary session of 26 November 2020, on proposal of DG MOVE, to set up three new sub-groups, including the sub-group on a common data approach for electric mobility and other alternative fuels.

Building on the work of the Program Support Action (PSA) on data collection related to recharging/refueling points for alternative fuels and the unique identification codes related to e-Mobility (IDACS), this sub-group is looking into the different data dimensions (aggregation, quality, sharing, reusability, provision, etc.) and data types (location, availability, price, payment methods, etc.) required to enable the future creation of new digital services in the alternative fuels market. It will propose a framework for data collection and exchange, with the ultimate objective to provide better information to consumers of alternative fuels infrastructure and services.

The creation of new services that will improve the overall quality and user-friendliness of the alternative fuels infrastructure will strongly depend on the openness of the data generated (e.g. access to in-vehicle data) in the whole ecosystem, and the potential connectivity with data from other sectors, such as e-commerce, insurance, banking or telecommunications. Coordination between the results of the STF Sub-group on Data and PSA NAPCORE (National Access Point Coordination Organization for Europe) will be ensured.

The **European Alternative Fuel Observatory (EAFO)** displays important online data on alternative fuels infrastructure, including an interactive map that contains a comprehensive and up-to-date overview of the alternative fuels infrastructure deployed in the EU and neighboring countries. It also contains a basic gap analysis, which allows the identification from a policy perspective of gaps in the alternative fuels infrastructure coverage on the TEN-T network. In the future, it will allow an even more sophisticated data analysis, to superimpose alternative fuels infrastructure on different thematic layers such as traffic flows, population density, air quality etc. Other functionalities that will be added include a new Knowledge Platform for public authorities with a dedicated consumer information section. In the medium-long term EAFO has also the potential to become the common European access point for the accessibility and reuse of real time data on alternative fuels infrastructure.

EAFO 3.0 can be visited at https://alternative-fuels-observatory.ec.europa.eu/

In coordination with ongoing work streams to develop a Mobility **Data Space (MDS)** and the Programme Support Action for the coordination mechanism to federate the NAPs **(PSDA NAPCORE)**, the Sustainable Transport Forum will discuss and gather recommendations from industry members about technical specifications and policy requirements for the development of an **open data ecosystem** for alternative fuels. The goal is to ensure the free, real-time access and reuse of data for electro-mobility and other alternative fuels. To this respect, the Sustainable Transport Forum will work on the particular static and dynamic data types needed to create new services, building on the outcomes of the PSA IDACS, as a basic input to work on a possible delegated act, planned from 2022 onwards.

Feedback on the open data ecosystem approach is being collected. AVERE published a reaction paper on AFIR in 2021. The new data sharing requirements under Article 18 may further increase competition, transparency and user information, whilst enabling new data-based and digital business models as well as roaming. AVERE supports making the data currently specified under article 18(2) accessible at no cost via National Access Points (NAPs). Furthermore, to guarantee the desired open ecosystem, data provided free of charge to national access points should also have to be provided free of charge to end users.

Price Transparency & Payment Methods

Before charging their electric cars at EV charging stations, consumers must be able to see what the charging rates are. All costs must be clear: from purchasing a charging card to the invoice of the charging session.

In the Netherlands, providers of charging stations and charging cards are statutorily required to be transparent about prices. In some cases though, some still are not transparent about pricing. That is why, from 1 December 2020, the Netherlands Authority for Consumers and Markets (ACM) checks whether providers comply with the rules. If they do not, ACM can take action. Providers must make clear what the different price components of a charging session are. The basic principle is that such information must be available prior to the charging session, either at the charging station or online. Once the charging session has been completed, it must be made clear how much was charged, and what the total costs are. In that way, consumers are able to compare that information with their invoices to determine whether they received what they had agreed to. If providers do not comply, ACM will take enforcement action.

In Canada, there have been recent discussions too on payment transparency, and about the appropriate unit of measurement for EV charging services. The Canadian government has invested in a five year program to develop and implement a coordinated set of codes and standards for ZEV charging and refueling stations. While sales of electricity is not federally regulated, the work will include consumer consultation, direction and funding for Measurement Canada to develop standards for energy-based pricing to enable accurate and transparent pricing for electrical vehicle charging for consumers. In Canada, the various EV charging network operators use different and often proprietary payment methods. Under the proprietary models consumers are require to subscribe to the different networks, and the network operators measure their business by the number of subscribers they have. Recently Canada is beginning to see movement towards open software protocols for payment which is helping to improve driver experience and overall interoperability.

Future proof charging infrastructure - Smart Charging & Interoperability

Smart Charging will be a key enabler for the uptake of EV's. Making sure that charging infrastructure is **"Smart Charging Ready"** will make the investment future-proof and "Smart Charging Ready" should be the norm for all new charging stations.

If done properly EVs can play a big part in improving grid stability by providing flexibility services such as load balancing, peak shaving, regulation of frequency, and support for the incorporation of renewable energy.

Interoperability enables communication between different assets from different manufacturers. This applies to any link between systems and assets. Interoperability enables access to charging infrastructure and additional services, is a precondition for the further development of the EV domain

and ensures the connection with the electricity system. Interoperability is implemented in the Netherlands through the use of open protocols.

Almost all protocols use the term open. In the context of protocols for EV, this term can refer to open access to charging infrastructure, but it can also mean that the protocol is an open standard. What constitutes an open standard, in terms of standardization, is part of an ongoing discussion. In response to the discussion on open standards, the World Trade Organization Commission on Technical Barriers to Trade (WTO TBT) formulated the following six conditions for international standardization processes:

1. Transparency; regarding documentation on proposal for standards and final standards,
2. Openness; open membership at every stage of the standardization process,
3. Impartiality and consensus; no privilege or representation of any particular party,
4. Effectiveness and relevance; facilitate international trade,
5. Coherence; no duplication of, or overlap with, any other labor of other standardization bodies,
6. Development dimension; no one should be de facto excluded from the trial.

In the Netherlands the definition of 'Open' is taken one step further by also including license and royalty free. The OCPP and OCPI protocols are openly available free of charge, without any other terms, and their use is subject to no terms (license fees or otherwise). This is in contrast to ISO and IEC standards, for which the standard itself has to be paid for and which has been developed under F/RAND conditions.

An open protocol is a standard that is publicly available and to which various usage rights are attached. The term is mainly used for hardware and software because it is precisely there that many closed standards are used, whereby a license must be requested to view the specifications. The aim of open standards is to increase interoperability (including interchangeability) between different information systems or data collections and to record information in a future-proof format. A side effect of open standards is more freedom of choice and therefore less chance of a "vendor lock-in" (dependencies on the suppliers). However, it is not the manufacturer that determines whether a protocol is also a standard. The authorities that can do this are the generally recognized standardization institutes and the market. In the first case one speaks of "de jure" standards ("by law"), while in the second one speaks of "de facto" standards ("more or less" standard due to mass use). Most "de facto" standards are later fixed as "de jure".

Interoperability is equally important for governments and companies making investments in charging infrastructure and services. Information exchange between the back offices of the different stakeholders like charging point operators and mobility service providers is an important aspect and having open and interoperable solutions can have a positive impact on the business case and on the flexibility to offer higher quality and/or combined e-mobility services to the end user.

The EV market in the Netherlands has a mature, interoperable system. The market and infrastructure for EV charging points is open, transparent, interoperable and future-proof. To scale this up some actions are needed. A national access point needs to be created for dynamic data on all (semi) public charging points. Price transparency for e-drivers should be ensured internationally by making a deal between governments, Charging Point Operators, DSOs and Mobility Service Providers. Open protocols and standards for the entire value chain of charging should be developed and homologated.

EV Charging Systems - Cyber Security Requirements

Task39 is focusing on interoperability and on making public charging infrastructure more user friendly.

To improve the services to the EV driver, it is required that the charging stations are "digitally connected". Via the Charge Point Operators back-office-system, a two-way communication will be set-up. Information will be collected (e.g. for invoicing purposes) or sent to the charging point (e.g. for smart charging purposes). Business sensitive information or privacy sensitive information should be protected.

Therefore, (cyber) security is getting more and more important. With more and more charging stations available of which most charging stations are "digitally connected" and "smart charging ready", the impact of getting "hacked" becomes bigger. Since recharging infrastructure is an essential and critical infrastructure, tender specifications should set requirements for electric recharging infrastructure in terms of cyber security. In particular, public authorities should try to minimize security disparities, by including in their tenders requirements for incident reporting and promoting an information sharing culture among the different players in the EV-ecosystem to reduce the risk of threat propagation. Finally, as concessions may run for a long period of time, public authorities should require in their tender specifications that they can, if necessary, in the future, require the upgrading of infrastructure to the desired level of cyber security.

ElaadNL, the EV innovation and knowledge center of the Dutch DSOs, has been studying the security requirements already since many years. Already in 2016, a guideline has been developed for ElaadNL by the European Network for Cyber Security (ENCS). This guideline describes security requirements for Electric Vehicle charging systems.

Figure 7: EV Charging Systems - Security Requirements (Source: ElaadNL)

Two sets of requirements are included:

- A set of requirements for the procurement of Charge Points. This set includes requirements to make sure the Charge Point itself is secure, that it has all functionality needed to set up secure operational processes, that its vendor takes measures to ensure its security throughout its lifecycle, and that measures are taken to assure that security measures have been implemented well.
- A set of requirements for secure communications between the Charge Point Operator (CPO) and Distribution System Operator (DSO). These requirements can be used as part of the security requirements when new server systems are procured or set up.

Figure 8: Impact of cyber security risks on national charging infrastructure (Source: Berenschot)

Within the framework of the Dutch National Charging Infrastructure Agenda working group on safety, the task group on cyber security developed a report summarizing the risks and impact when the aspect of cyber security is neglected during the roll-out of charging infrastructure. The ambition is to have smart charging infrastructure that is smart and secure by design based on encrypted communication.

The Public Key Infrastructure

Interoperability requires technology to authenticate users and devices in the digital world. With trusted parties digitally signing documents certifying that a particular cryptographic key belongs to a certain user or device, the term Public Key Infrastructure (PKI) refers to technology that facilitates the secure transfer of electronic information for a range of activities such as e-commerce and online banking.

The PKI provides trust in the EV charging system. It can be utilized as a trust-based platform to authenticate users, EVs, charging stations, and others. The PKI can encrypt and authenticate data transfers such as station to vehicle, station to service provider, and station to station, while also offering security across platforms. PKI offers a secure and convenient way to authorize charging services. A PKI in the EV charging industry is also needed for securing the scaling of roaming e.g. via OCPI where security aspects are currently managed in a manual way.

The current monopoly at the PKI for the ISO 15118 standard has these major risks:

- Resilience: if the PKI is compromised ("hacked"), EV drivers can't charge their vehicles and - with large numbers of compromised charging stations - the energy system can be influenced.
- Consumer lock-in: consumers can only use charging points or sign a contract with an MSP if they are connected to the PKI chosen by the car manufacturer.
- Competition lockout: PKI management organization have the option to lock out parties from their PKI system or only allow access under unfavorable conditions. In order to set up a fair, reasonable and non-discriminatory PKI, additional efforts are needed from the regulator (at the national, EU, and global levels), the EV market (car manufacturers, CPOs, and MSPs) and the energy industry (grid operators, energy suppliers, and Balance Responsible Parties). In the Netherlands, the government works together with companies, in which organizations such as ACM (Consumer and Market Authority) are also involved.

PKI and cyber security are also being studied in the recently launched project **Mobena**, led by Vedecom (France). The mission of the project is to support the players of the EV charging ecosystem, operating in France, by defining the roadmap and the means to ensure a successful and harmonized deployment of the e-Mobility services. The project will particularly focus on integrating interoperability as an initial requirement and providing high added value services through a massive adoption of the ISO 15118 standard in a competitive and open market. A particular focus is put on Smart Charging, Plug and Charge and the implicated end-to-end system interfaces, including backend communication protocols (OCPP, OCPI…), PKI and cyber security. This for both AC and DC charging.

V2G

Vehicle-to-grid (V2G) or more broadly Vehicle-to-everything (V2X) is the concept of allowing vehicle owners to expand the utility of their vehicle by exporting electricity from their vehicle to the grid, a building, a home, etc. By dynamically controlling vehicle charging and enabling EV batteries to feed electricity back into the grid, EVs could provide flexibility and capacity at the system, distribution and building level. V2G can provide benefits to end-users, grid operators, grid planners, buildings, energy communities, fleets, and other loads and has potential to reduce the total cost of ownership of electric mobility and thus accelerate the uptake of low carbon transport.

In the past the electricity grid relied largely on controllable generation to meet fixed loads. As the penetration of variable renewable energy sources such as wind and solar increase, this paradigm changes to rely on more flexible loads to accommodate fixed generation. Thus, it is anticipated that in the future there will be an increasing need for flexibility in the power system. EVs through the use of smart charging and V2G could help shape the future load curve to match renewable energy supply and provide grid services to improve grid stability and reliability.

Previous and current IEA HEV TCP tasks have explored V2G. This includes Task 28: "Home Grids and V2X Technologies," which explored the technologies and accompanying issues associated with the use of electric storage from PEVs for uses other than powering the vehicles and Task 43 which focuses on Vehicle/Grid integration (VGI). Those tasks have identified and explored the key needs and challenges with accelerating the development and adoption of V2G. These include Technology development, markets and regulations and social acceptance. These concepts are extensively examined in the 2019 V2X Roadmap[1] developed as part of Task 28.

[1] https://ieahev.org/wp-content/uploads/2021/08/Task28_additional.pdf

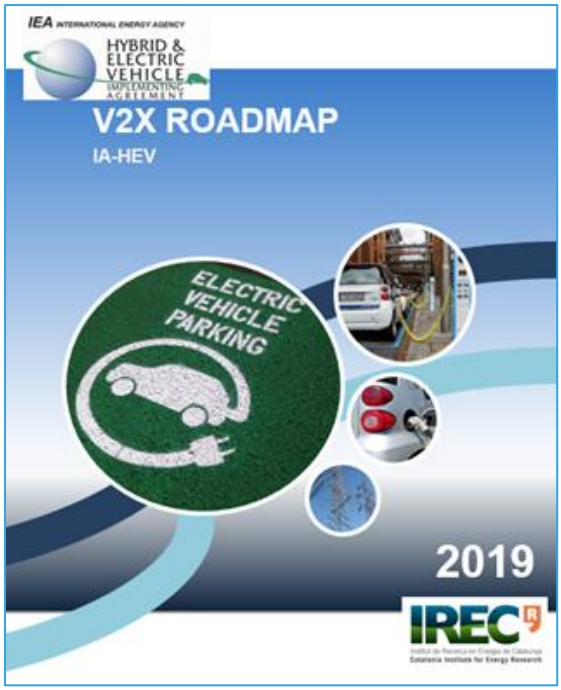

Figure 9: V2X Roadmap (Source: IREC)

Technology development

1. Standardization and harmonization - Develop global standard for V2X technology and harmonize these with existing power, transport and communication systems. Agreement and application of global standards is a route to reduce costs, mitigate negative impacts and encourage participation by manufactures and service providers.
2. Consensus on battery degradation - Cross OEM consensus on impact of V2X on battery degradation and development of set of standards or best practices. This should enable OEMs to include V2X capability without compromising existing and future battery warranties.

Markets and regulations

3. Include V2X in grid codes - Reform grid codes to enable V2X to easily connect to the distribution network and inject power into the grid. This will require certification of equipment for different V2X applications, including V2B back-up power for buildings.
4. Develop new tariffs and contracts for flexibility - Redesign energy tariffs to better reflect the real-time value of energy and capacity in the power system. This will enable buildings with smart flexible resources, such as V2X, to optimize charging and discharging.
5. Redesign TSO system services markets - Remove regulatory barriers which prohibit V2X from participating fully in TSO system service markets, including barriers which prevent resource aggregation and the entry of new player in the market.
6. Develop DSO system services market - Develop new DSO system services markets, such as constraint management or voltage correction, in order to monetize the externalities of flexibility at the distribution network level.

Social acceptance

7. Improve public awareness of V2X technology - Develop higher level of public and political awareness and understanding of V2X technology and its applications.
8. Develop customer centered business models - Improve understanding of V2X value proposition to consumers and develop customer focused business models which distribute benefits and risk.

V2G Interoperability

There are many moving pieces when it comes to enabling interoperability. Standards need to consider current and potential future markets into which V2G will participate, while also synchronizing with an ever growing list of technology developers and end users. This is no simple task, but is essential to maximizing the social and economic benefits and getting the most out of the EV value chain. The figure below illustrates the main entities and the aspects that should be harmonized. These include the plug-in electric vehicle, charging stations, and the grid operator (TSO or DSO), or other down-stream entity (e.g., building, home). There needs to be harmonization of the communication and electrical flows across all these entities. Some of the identified standards are global while others were intended to be used in specific countries.

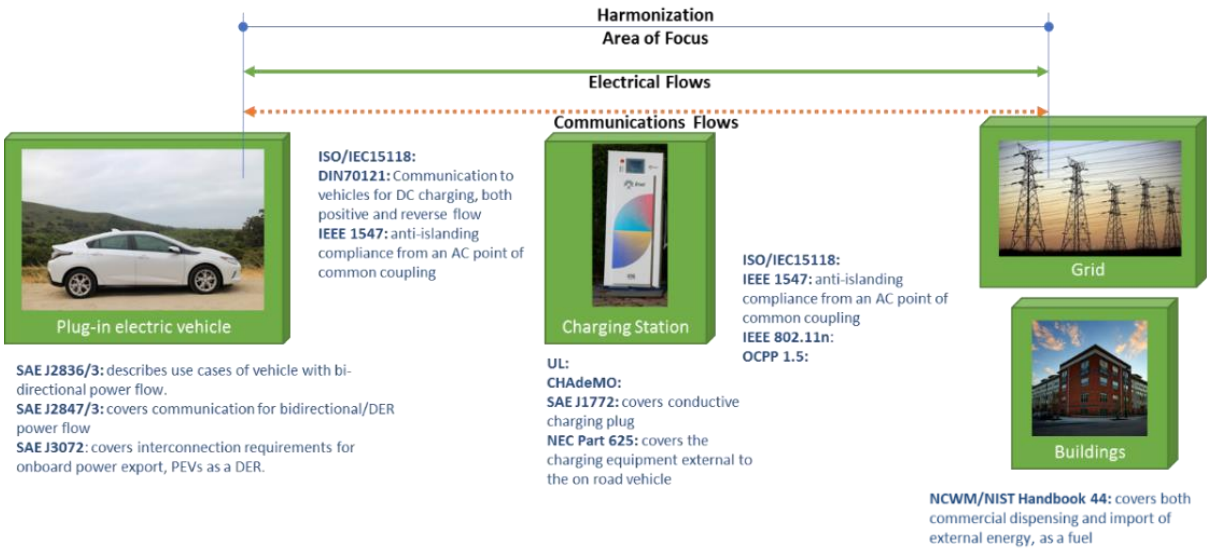

Figure 10: Illustration of the scope of V2G standards (source: IEA HEV TCP Task 28: V2X Roadmap)

Conclusion

In the previous chapters, a lot of information and references can be found on best practices and recommendations to stimulate interoperability and a user-centric charging experience. Interoperability is an enabler to accelerate the transition towards electric mobility. It is not “rocket science” but more a matter of organization and making agreements between all stakeholders with the ultimate goal of having a user-centric charging experience.