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Transatlantic Technical Recommendations for Government Funded Implementation of Electric Vehicle Charging Infrastructure

EU-U.S. Trade and Technology Council

Working Group 2 - Climate and Clean Tech

Workstream: Electro-mobility and Interoperability with Smart Grids
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LIST OF ACRONYMS

AC: Alternating Current (e.g., household current)

ANL: Argonne National Laboratory

CharIN: Global association dedicated to promoting interoperability based on the Combined Charging System (CCS) as the global standard for charging vehicles of all kinds

CPMS: Charge Point Management System

DC: Direct Current (e.g., as supplied to and by a battery)

DER: Distributed Energy Resources

DNP3: Distributed Network Protocol 3 as referenced in IEEE 1379-2000, and also IEC62351-3 with TLS (Transport Layer Security)

DOE: U.S. Department of Energy

EM/EMC: Electromagnetic/Electromagnetic Compatibility

EU: European Union

EV: Electric Vehicle

EVE: Electric Vehicles and the Environment (a Working Group of the UN-ECE's Working Party on Pollution and Energy)

EVSE: Electric Vehicle Supply Equipment (aka chargers)

GTR: Global Technical Regulation

HLC: High Level Communication

IEC: International Electrotechnical Commission

ICT: Information and Communications Technology

ISO: International Organization for Standardization

JRC: Joint Research Centre of the European Commission

NIST: National Institute of Standards and Technology

OCA: Open Charge Alliance

OpenADR: Open Automated Demand Response protocol (of the OpenADR Alliance)

OpenFMB: Open Field Message Bus, an Energy Internet of Things (EnergyIoT) initiative of the US Smart Grid Interoperability Panel (SGIP)

OTA: Over-The-Air (communication)

RD&D: Research, Development and Demonstration

RDD&D: Research, Development, Demonstration and Deployment

SAE: Society of Automotive Engineers

SCM: Smart Charge Management (assumes networked-connected EVSE to enable integrated communication and control)

SDO: Standards Development Organization

SOCE: State of Certified Energy of batteries (defined by UN-ECE to replace State of Health, SoH)

SSO: Standards Setting Organization

TTC: EU-U.S. Transatlantic Trade and Technology Council

UN-ECE: United Nations Economic Commission for Europe (producing Global Technical Regulations)

U.S.: United States

V2X: Vehicle-to-X (where X may be the home, workplace or grid, or even other mobile devices)

VGI: Vehicle-Grid Integration

WPT: Wireless Power Transfer (for inductive charging)

Introduction

While reliable, widely available, electric vehicle (EV) charging infrastructure is essential to expand e-mobility, smart charging technology also provides significant benefits to the power grid, especially as the share of EVs and renewables in the market grows. For example, smart charging technology can stabilize the grid by managing EV demand and can even increase the uptake of renewable electricity in the grid by better managing fluctuations of solar and wind power. EV batteries also have the potential to serve as power grid storage, enabling greater deployment of renewable electricity and providing back-up power in case of emergency.

The recommendations in this joint report, which are published under the EU-U.S. Trade and Technology Council's Climate and Clean Tech Working Group, respond to the current and expected growth of the electric vehicle market and support EU and U.S. commitments to clean energy and decarbonisation. They build on more than a decade of close, pre-normative research cooperation between the U.S. Department of Energy's Argonne National Laboratory (ANL) and the European Commission's Joint Research Centre (JRC), and consultations with government, research, industry, and grid-service stakeholders[1]. They are intended to:

- Help accelerate the smarter use of EVs, charging infrastructure, and power grids, and offer suggestions on how best to improve the quality, the communication protocols, and the rapid implementation of intelligent charging infrastructure. All of these are needed to advance the rollout of e-mobility on both sides of the Atlantic.
- Better integrate EVs into modern power distribution grids so as to enable EVs to help manage fluctuations on the grid caused by power demand and the variability of renewables.
- Support shared technical understanding, which will advance the development of international standards, thereby helping to minimise trade barriers and to augment the economies of scale for our industry.

Policy makers can help facilitate the success of Vehicle-Grid Integration at large scale, including by setting the right frameworks for: a transatlantic Standards Support Strategy; the systematic exchange and development of best practices, bringing more certainty to public authorities and private investors; and joint pre-normative research that helps our industries thrive and our communities benefit from electro-mobility.

[1] Including the EU-U.S. Industry Workshop held at Ispra, Italy, on 24-25 October 2022. See under: https://futurium.ec.europa.eu/en/EU-US-TTC/wg2/documents/ttc-wg2-report-industry-workshop-pre-normative-recommendations-smart-charging-and-vehicle-grid

Summary of Recommendations

Gaps and incompatibilities in proposed connectivity and communication standards for EV charging in the United States and the European Union may impact interoperability and drive industry to produce for multiple requirements, leading to increased costs, prolonged development times, and trade barriers. Transatlantic collaboration on EV infrastructure technical requirements can help to more efficiently roll out publicly funded charging infrastructure, harmonizing our standards where possible. This would enable our industries to be more competitive across global markets and put us in a much stronger position in international standardization committees to drive towards global standards that meet EU and U.S. ambitions.

These joint EU-U.S. recommendations fall within three recommendation sets, the first of which makes the case for a joint standards support strategy and identifies existing standards that provide a reference for the implementation of EV charging infrastructure in the United States and the EU. The second recommendation set elaborates on the development and implementation of cost-effective smart charging infrastructure that avoids stranded assets for stakeholders involved in infrastructure rollout. The third recommendation set, identifies priorities for further joint pre-normative research in the e-mobility field.

Recommendation Set I: Develop a joint standards support strategy

Harmonized standards, codes, and regulations, along with associated test procedures, will facilitate the growth of e-mobility and its charging eco-system and allow U.S. and EU industries to realize economies of scale. We share manufacturers and suppliers. By harmonizing standards, industries can cut costs and development times without hindering innovation or their competitive edge. Moreover, extending our existing links in smart system engineering and high-quality standard solutions would strengthen our industries' standing in what is a highly competitive world market.

We recommend jointly identifying commonalities and gaps in our standards for e-mobility infrastructure and priorities for moving forward. Priorities should include coordinated and more proactive involvement in Standards Development Organisations. As a basis, there is already transatlantic agreement between the U.S. Government, European Union institutions, and stakeholders' fora on the use of standards for public implementation specifications (IEC 61851, ISO 15118, and UN-ECE GTR EVE 22). Looking forward, we should expand activities to boost collaboration on standards, codes, test procedures, and supporting technology requirements.

Recommendation Set II: Support development and implementation of cost-effective smart charging infrastructure that avoids stranded assets

The success of broad electro-mobility uptake depends on the speedy and widely accepted build-up of charging infrastructure. Recommendations are made on how to overcome the "growing pains" and obstacles in Vehicle-Grid Integration (VGI) and Smart Charge Management (SCM), enabling the optimization of costs and technological potential. This will help our communities, cities, and states to develop and demonstrate VGI/SCM approaches to reduce the grid impacts of on-road light-, medium-, and heavy-duty EV charging; to apply policies and experience to avoid stranded assets; and to address the "soft costs" of installing charging infrastructure via coordination and shared best practices.

Recommendation Set III: Conduct pre-normative research, development and demonstration to support the consumer, industry, and the grid

In times of evermore renewable and distributed power generation, EVs can contribute to grid reliability by helping to avoid momentary overload outages or to control imbalances between generation and demand. Research, development and demonstration (RD&D) and testing methods focused on optimal application of the capabilities of EVs and their charging infrastructure are critical to achieving consumer- and grid-friendly solutions.

A number of recommendations are provided for joint RD&D and development of common testing procedures. This includes proposals to: conduct coordinated research to support grid reliability under mass EV-charging; conduct common RD&D to optimize the capability of EVs and smart chargers and their future Information and Communications Technology (ICT) infrastructure for the provision of grid services; create cost-effective, energy-efficient, and consumer- and grid-friendly charging solutions that integrate EVs with the grid; and support the development of advanced charging solutions, e.g., vehicle-to-X (V2X) and Wireless Power Transfer (WPT).

Recommendations

I. Develop a Joint Standards Support Strategy

Transatlantic collaboration between our government research institutions currently supports the development of standards via technical validation of proposed standards, testing methodology optimization, technical expertise, and pre-normative research.

These joint recommendations, aimed at public authorities in the United States and the European Union who are investing in e-mobility infrastructure, indicate where further opportunities for collaboration exist. Policymakers can set the framework conditions for effective, joint standardization activities to bear fruit, by motivating industry, activating their representatives in Standards Development Organizations (SDOs), and enabling pre-normative research.

1.) Adopt an agreed set of standards and regulations in technical requirements for public funding, while expanding transatlantic collaboration to identify and address priority gaps in standards for e-mobility infrastructure.

The following could be implemented now, or is currently implemented by authorities:

a) Require, as a minimum, use of pertinent IEC 61851 and IEC 62196-2/-3 standards[2] for light- to medium-duty EV inlets and their EV-EVSE connectors, **respecting the "Type 1"- and "Type 2"-** form, as commonly used in the U.S. and the EU, respectively.

b) Require use of at least ISO 15118[3] when higher level digital communication is offered by the EV charging device in publicly funded charging infrastructure, whatever the EV-charging power level. This will support uses such as smart charging and secure communication.

c) Facilitate adoption of UN-ECE global technical regulation (GTR) EVE 22[4] to harmonize the metrics for the state of certified energy (SOCE) in EV batteries. SOCE, formerly referred to as SOH (or state of health), indicates the remaining certified usable battery energy-storage capacity. UN-ECE GTR EVE 22 gives a harmonized, reliable definition of SOCE for the use of EV batteries in electric vehicles and later, when these batteries are dismounted for use in stationary storage systems (so-called "second-use").

[2] The the latest versions can be found for:
IEC61851: https://webstore.iec.ch/publication/33644
IEC62196-2: https://webstore.iec.ch/publication/64364
IEC62196-3: https://webstore.iec.ch/publication/59923

[3] The latest versions can be found under: https://webstore.iec.ch/publication/26347

[4] See under: https://unece.org/sites/default/files/2023-01/ECE_TRANS_180a22e.pdf

d) Promote ongoing work at NIST and Standards Development Organizations (SDOs) on precise, affordable, and bi-directional metering for chargers, by supporting ANL, JRC, and EU Member States' metering device approval and calibration authorities to partner with them on metering efforts, for a transatlantic approach, as appropriate. Accurate metering is a pre-requisite for accurate power consumption billing, for intelligent grid management, and to learn from the charging energy market behavior, etc.

Looking forward:

e) Expand activities and work to achieve consensus on high-level requirements for communications, connectivity, interoperability, cybersecurity, resilience, safety, backward compatibility, future proofing, and metrics (e.g., support a compatible solution for the communication between EVSE and back-end/distribution grid).

2.) Expand activities to boost future collaboration on standards, codes, test procedures, and supporting technology requirements.

All of the following could be implemented now:

a) Convene a forum of stakeholders to jumpstart a process to achieve a unified vision and strategy for codes and standards, which would identify and address competing standards to remove barriers for Smart Charge Management (SCM) and Vehicle Grid Integration (VGI). Common pre-normative research in the field has helped and can help this process.

b) Expand activities, motivate, and provide adequate human and financial resources to strengthen engagement - especially in leadership roles - with existing U.S., European, and international SDOs, to enable greater standards harmonization for EV-Grid integration.

c) Promote further coordination and exchange of information between SDOs and consortia of key stakeholders (e.g. Standard Setting Organizations (SSOs) and industry associations such as CharIN, the Open Charge Alliance (OCA), EV Roaming Foundation, etc.) to advance consolidation and convergence of technical specifications, thus accelerating the development of a more mature and robust electromobility market.

d) Expand common activities to support further development of standards and test procedures for diagnostic interoperability-testing for VGI, as well as less expensive field-testing equipment for alternating current (AC) and direct current (DC) -charging.

II. Support development and implementation of cost-effective smart charging infrastructure that avoids stranded assets

Public authorities at all levels of government, including communities, cities, and states, as well as private firms are stakeholders in the implementation of infrastructure for e-mobility. These recommendations focus on strategies for public authorities and private firms to successfully, and in a timely manner, develop and implement infrastructure for e-mobility.

In order for this to happen, public authorities and private firms should share lessons learned from ongoing rollouts of infrastructure for e-mobility. Demonstration projects should reflect real-world conditions and incorporate experiences from communities where e-mobility faces higher barriers to uptake. Public authorities and private firms can use these recommendations to avoid stranded assets and ensure that communication protocols are open and accessible for future improvements.

1.) Develop and demonstrate VGI/SCM approaches to reduce grid impacts of on-road light-, medium-, and heavy-duty EV charging.

All of the following could be implemented now:

a) Develop and demonstrate smart charging ecosystem(s) to implement SCM strategies, **consistent with utilities' operational environments**. This includes consideration of: the rules and regulations under which local and regional utilities operate; utilities' legacy system architectures and communication protocols (e.g., DNP3, OpenADR, or OpenFMB); and, as appropriate, international standardization efforts in grid automation (e.g., under IEC 61850[5] and IEC 62325[6]).

b) Address additional constraints, such as the consideration of e-mobility infrastructure deployment in underserved, environmentally sensitive communities. Lessons should be shared from the implementation of demonstration projects in a broad variety of communities to demonstrate specific solutions. This includes rural areas, suburban districts, and high-density urban areas with frequent street parking of EVs.

c) Require digital connection, smart communication capability, open access, and local control options (i.e., non-proprietary communication) for publicly funded charging infrastructure, to ensure that SCM programs can be implemented on both sides of the Atlantic. Relevant information on the characteristics of the infrastructure in support of information services should also be provided.

[5] For details see: https://iec61850.dvl.iec.ch
[6] For details see: https://webstore.iec.ch/publication/31487 and under "Related Publications" on this website

d) Appropriately implement cybersecurity measures in the communication layers and the memory-devices of the e-mobility charging ecosystem, including VGI and SCM. E-mobility infrastructure cybersecurity is of high importance because of the critical nature of charging systems to enabling operation of electric vehicles.

2.) Apply policies and experience to avoid stranded assets.

All of the following could be implemented now:

a) Avoid dependence on specific, proprietary networks for publicly funded EVSE-installations in order to safeguard against stranded assets due to loss of network providers for business or other reasons.

b) Require in public tenders/procurements that planning engineers and equipment providers include in their proposals plans to upgrade charging devices and networks communication capabilities, which will help to meet future demand (e.g., modular design).

c) Require that new, digitally connected EV infrastructure has capabilities for over-the-air (OTA) updates where available, to patch security gaps, add features/upgrades, and address reliability issues.

d) Support work to identify common diagnostics and data reporting approaches to proactively identify charging failures associated with interoperability, communication, and other factors, which would simplify maintenance and improve up-time of charging infrastructure.

3.) Address the **"soft costs" of installing** charging infrastructure via coordination and shared best practices.

All of the following could be implemented now:

a) Work with all levels of government and the private sector to develop a systematically collected, ranked, and analyzed information database, which would collect experiences about challenges and solutions for charging infrastructure roll-out and planning.

b) Survey the experiences and issues faced by communities, cities, and regions in technical as well as non-technical areas (e.g., delays from hardware availability, building permits, grid-connection approvals, etc.). Results could then be quantitatively ranked for severity of various types of obstacles.

c) Disseminate experiences in planning, financing, workflow and permission negotiations through government-supported publications and websites. This would facilitate the introduction of VGI and smart charging infrastructure and the advent of "*next level*" innovation such as vehicle-to- "anything" (V2X) bidirectional charging.

III. Conduct pre-normative RD&D to support the consumer, industry, and the grid

Publicly funded e-mobility infrastructure can have a catalyzing effect on private industry and private investments as well as improve the consumer experience. Greater shared understanding of technical issues can help harmonize technical requirements and thus the infrastructure rollout process. These recommendations identify outstanding areas which could benefit from further joint pre-normative research.

1.) Conduct coordinated research to support grid reliability under mass EV-charging.

The following could be implemented now:

a) Quantitatively and qualitatively identify the benefits of EVs to support grid reliability in controlled, smart, and bidirectional charging.

b) Support U.S. and EU industry efforts to leverage EVs in an overall Distributed Energy Resources (DER) framework by optimizing use of EVs' electric energy storage to balance intermittent production from renewables such as solar and wind.

c) Investigate new reliability metrics with our industry to capture the impacts of customer-provided and novel technology DER services, including those from EVs.

d) Assess innovative strategies to minimize the impacts of EV charging infrastructure on distribution grids in dense urban, rural, and capacity constrained areas.

Looking forward:

e) Explore simple ways of informing the charge point management system (CPMS) about the energy needs and departure time of the driver in AC-charging without higher level communication (HLC), which could help achieve an effective level of grid-friendly charging. Due to cost, millions of low power charging points will remain simple, AC-chargers of limited smartness. If there were an easy and straightforward way to inform the CPMS of the driver's energy needs and departure time, then an effective level of controlled, grid-friendly charging could be achieved, thereby supporting smart charge management.

2.) Conduct coordinated RD&D on furthering and optimizing the capability of EVs and charging infrastructure to provide grid services.

All of the following could be implemented now:

a) Evaluate the effectiveness of charge management strategies to identify which strategies provide the most value to the grid. This is especially important in view of future mass adoption of EVs.

b) Analyze how EVs can enable greater integration of clean DER to benefit the grid by shifting demand (typically over hours) and addressing grid-optimized charging strategies within load patterns over the course of the day.

c) Develop and validate the capability of cohorts of charging EVs and smart charge hubs to reliably serve load flexibility patterns (from seconds to minutes to longer time frames), including grid services typically implemented by utilities, e.g., grid stabilization/disturbance ride-through (resilience), dispatchability/flexibility, and frequency regulation.

d) Identify communication latency requirements of devices, from the EV throughout the charging infrastructure, and evaluate the state-of-the-art. Evaluate round-trip response times and the frequency of control of telematic communication pathways vis-à-vis the requirements for smart charge management and grid services provision.

3.) Create cost-effective, energy-efficient, and consumer- and grid-friendly charging solutions that integrate EVs with the grid.

The following could be implemented now:

a) Collaborate and exchange pre-normative research results on the electric energy efficiency of chargers that contain power inverters, and on the stand-by power consumption of all kinds of chargers.

b) Collect best practices of implementing smart charging infrastructure without substantially increasing smart charging infrastructure's stand-by power consumption.

c) Provide technical assistance to local and regional EV adoption programs and utilities across light-, medium-, and heavy-duty classes. Use data-mapping and -analysis approaches for optimized EVSE density and placement. Forecast grid impacts and assist in the development of appropriate incentives that balance grid and customer benefits.

d) Identify and develop best practice to disseminate information to consumers. This would help increase consumers' understanding and eventual acceptance of smart charging in view of economic advantages *and* charging functionality.

e) Collect information about consumer satisfaction regarding the quality of infrastructure, including the development of specific metrics to capture existing challenges.

Looking forward:

f) Conduct demonstration projects to evaluate and help address regulatory, policy, behavioral, and market barriers to enable the development of effective incentives to use EVs to provide load flexibility for bulk power and distribution system services.

4.) Support RD&D of advanced charging solutions, like V2X and Wireless Power transfer.

All of the following could be implemented now:

a) Develop test procedures to support the certification of V2X-capable products, including requirements for metrics regarding bidirectional power flow.

b) Inform product certification requirements that enable vehicle-to-grid (V2G) interactions, while ensuring consistency with other DER. This could be done e.g., through collaboration with NIST, Standards Setting Organizations, pre-normative researchers at DOE National Laboratories and the JRC, as well as with manufacturers.

c) Study the potential for V2X-capable vehicles to benefit the grid through load-shifting in the 24-hour demand curve by leveraging their storage capability.

d) Explore the options to collect information at the identification or charge-start stage about a specific EV's capacity for, and its owner's acceptance of, V2X maneuvers.

e) Identify and evaluate critical communication latencies for V2X as per recommendation III.2.d. on communication latency requirements.

f) Support the implementation of WPT standards and best practices, including for more powerful WPT-systems in view of further WPT evolutions. Assure electromagnetic compatibility of WPT through common efforts in quantifying electromagnetic stray fields and real impacts on radio equipment, ideally in transatlantic round-robin approaches. Regularly inform SDOs about results.

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