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Recommendations for Future Public Demonstrations of Vehicle-Grid Integration (VGI) Pilots

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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Valuable input and conclusions came from the participants of the EU-U.S. Industry Workshop for this workstream held at ANL on September 26, 2023.

1. Introduction

Vehicle-grid integration (VGI) broadly refers to the end-to-end considerations for connecting vehicles with the electric grid, including aligning the grid's physical infrastructure, regulatory framework, and market design with the charging network. This report focuses on the technical underpinning of VGI, i.e., implementation of standardised connectivity and communication between electric vehicles, the charging infrastructure, and the power grid to enable vehicle charging/discharging while recognising the capabilities and requirements of the grid. VGI spans the spectrum of vehicle interactions with charging infrastructure, ranging from controlled charging to smart charge management, including bidirectional charging. To further clarify these terms:

- *Controlled charging* – One way communication to the vehicle/charge equipment, putting certain time or power limits on charging processes in favour of grid stability.
- *Smart charge management* – Two-way communication between the vehicle/charging equipment and the charging infrastructure to balance the charging needs of multiple electric vehicles with the ability of the grid to supply the requested energy.
- *Bidirectional charging* – Electric vehicles temporarily deliver power to support building or workplace loads, stabilise the local/regional grid, or provide grid services. This can include 'vehicle-to-grid' (V2G), 'vehicle-to-building' (V2B), and 'vehicle-to-home' (V2H); collectively called V2X or 'vehicle-to-everything.'

VGI necessitates compatibility from the charging infrastructure to energy service providers' backend systems to meet the needs of their standard services, e.g., customer identification, billing, cybersecurity, etc. In addition, successful VGI on the distribution side encompasses projected charging demand and impact analysis to support grid planning. Implementing advanced levels of VGI helps to increase the capability of the grid to take up evermore renewable electricity because the latter is intrinsically intermittently available and thus needs balancing by grid flexibility.

Public demonstrations of vehicle-grid integration are critical to the deployment of e-mobility infrastructure. Demonstrations can build experience in the implementing organisations and expose EV users to the benefits of controlled and smart charging. This joint report, published under the U.S.-EU Trade and Technology Council's Climate and Clean Tech Working Group, provides insight into industry perspectives on demonstration programs and recommends the development of best practices to prepare for large-scale VGI demonstrations, inform and objectively educate potential customers, and incorporate requisite customer-related factors into demonstration programme designs. The recommendations aim at supporting communication and coordination on these issues between the United States and the EU. They also intend to inform the development of demonstration projects and programmes that will support ongoing standardisation discussions and the development of legal regulations. More broadly, this report supports the expansion of e-mobility as well as U.S. and EU clean energy and de-carbonisation commitments.

On September 26, 2023, Argonne National Laboratory (ANL) and the European Commission's (EC) Joint Research Centre (JRC) conducted a workshop on public demonstration of vehicle-grid integration at ANL. The workshop gathered first valuations, and as far as available, recommendations from experts and stakeholders regarding specific public demonstration targets of

VGI that would be valuable to them, their concerns regarding such demonstrations, and their reactions to requirements that might be placed on demonstrations supported by government funding. The 38 participants (ca. 50 percent onsite and 50 percent online) represented:

- The private sector, including utilities, charging network providers, charging equipment suppliers, and the electric vehicle industry;
- Standards development organisations and members of already ongoing vehicle-grid integration demonstration projects;
- The U.S. Departments of Energy and Commerce and the European Commission (EC)'s Directorates General for Research and Innovation and Mobility and Transport; and
- The EC's Joint Research Centre supporting the EC Policy Directorates General, and U.S. National Laboratories supporting the U.S. Department of Energy, including Argonne National Laboratory, the National Renewable Energy Laboratory, and Pacific Northwest National Laboratory.

These recommendations are based on the discussion initiated by a set of key questions that were posed to the 38 experts/stakeholders at the workshop and additional experts that contributed separately. As a result, this joint report represents stakeholder views and the state-of-the-art of an evolving sector as of fall 2023 and identifies persisting gaps in the knowledge base. Future efforts can further develop these recommendations with even broader stakeholder input as the technology and the business models for implementing VGI mature. The reader is referred to Annex II for an overview of the key questions discussed at the workshop and summaries of individual answers.

Key questions posed for the September 2023 Workshop:

i. What are the key objectives of public-private demonstrations? … specific grid services, workplace grid integration, or reducing industry's risk of employing new technology?

ii. What are the lessons learned from, and the major hindrances to, conducting VGI demonstrations?

iii. The pertinent public funding authorities could restrict publicly funded demonstrations to those using common standards and non-proprietary solutions. Would you participate under these conditions?

iv. Ownership of vehicle and charging-column (EVSE) data could pose a challenge to vehicle-grid integration. Do you support sole data rights of the owner? Would you support a government-imposed restriction?

v. Are there quantifiable key metrics of demonstration program participation rates, e.g., load flexibility, client service/satisfaction, or other variables, with which we can internationally compare VGI projects?

2. Overview of Feedback and Derived Recommendations

Some of the most significant feedback from the industry representatives was that the technology, utilities, and today's markets might not yet be ready for large-scale public deployment of vehicle-grid integration due to the limited numbers of production vehicles, smart charging equipment, or backend systems to implement large-scale smart charging. This recalls the earlier days of e-mobility, when the auto industry was waiting for the responsible implementers of charger roll-out in the public space, and vice versa. On the other hand, a European project cluster reported about ongoing VGI and V2G implementation in *specific* urban environments with optimised conditions for demonstration of at least a "lighthouse" character. Therefore, we concluded that for large-scale demonstration, the *quantitative objectives* of VGI beneficial to the industry and the customers should be determined during 2024, e.g., by a better structured dialogue between utilities and electro-mobility industry, consumer organisations, etc. Such objectives may include:

- Energy quantities and thus grid flexibility values realistically "tradable" via smart charging with e-vehicle owners;
- Planned evolution of e-vehicles and charging columns offered on the market that are capable of smart charging; and
- Broadly agreed approaches to use only the mid-range of the state-of-charge envelope of car batteries in bidirectional power exchange, in order to minimise accelerated battery ageing.

Interestingly, in the bilateral discussions with the auto industry in the later wrap-up phase of the workshop conclusions, the aspect of data rights was highlighted. Specifically, whether the important use-case-related and individual behaviour data would remain with the owners or should, by law, be shared with, e.g., automakers, charge-point operators (CPOs), or charging-service operators (CSOs). In our view, this may also contribute to the hesitation expressed by industry regarding readiness for large scale public deployment of VGI: In a market economy, market participants first want to best position themselves before a large market of power-grid flexibility becomes available. We conclude from this that the maturity of smart-charging is not only a question of technology, but also requires regulatory, legal, and standardisation policy preparation.

Demonstration co-funding programs with competitive selection criteria intrinsically choose real-world environments, where VGI can be demonstrated best, but they also need to distil lessons learned useful for broad application elsewhere. Streamlined reporting schemes of demonstration projects would greatly facilitate sharing and comparison of results produced in different demonstrations. This should ideally go hand-in-hand with industry-wide harmonised standards for communication between vehicles and smart chargers, as well as between smart chargers and the grid, in order to forge a system environment with better planning certainty. Organisationally, this evolving market needs assurance of functionality of products and systems, which can be gained by apply a conformance testing method, and by developing a scheme to check end-to-end interoperability.

Further, the participants noted additional challenges with launching VGI pilot projects today. These challenges include uncertainty of the electric vehicle market still partially dependent on government subsidies and still being in a phase of having to convince the general public. Hence, this report focuses on recommendations to address these concerns and to develop best practices to prepare for VGI demonstrations, educate potential customers, and incorporate requisite customer-related factors in demonstration programme designs. The recommendations are summarised below, and are explained in more detail in the balance of the report (*see* Section 3).

- **Support advanced pilot VGI demonstrations (including V2X) in limited, but exemplary environments with industry and facilitate harmonised enabling standards to build industry confidence and inform the public.**
- **Develop a lexicon to harmonise technical nomenclature that works for the United States and the EU alike.**
- **Develop interface definitions for hardware connectivity and communication consistent with international standards activities.**
- **Develop VGI conformance test procedures for key use-cases.**
- **Adopt a harmonised method to characterise demonstration programs and report conclusions.**
- **Reflect customer perspectives and data rights in the definition of demonstration programmes.**
- **Disseminate the latest recommendations/best practices to all entities proposing public-private demonstrations.**
- **Inform the public/potential participants in a VGI demonstration programme regarding realistic limitations and impacts of V2X.**

3. Expanded Recommendations

3.1 Support advanced pilot VGI demonstrations (including V2X) in limited, but exemplary environments with industry and facilitate harmonised enabling standards to build industry confidence and inform the public.

Intended Actors: Demonstration project-funding organisations

The objective of the pilot programs should be to test the ability of candidate systems to execute grid services in the real-world environments of charging networks and utilities with a limited set of customers. The systems should include all the elements necessary to demonstrate functionality, including vehicles, charging equipment, and backend software of charging network operators and utilities. The demonstrated functionalities – within a whole pilot demonstration portfolio – should include controlled charging to support standard grid services such as demand response and frequency regulation, smart charging to support local grid management (e.g., Demand Side Management (DSM)), workplace charging with Distributed Energy Resources (DERs), and bidirectional charging to supplement grid storage or respond to grid instabilities (‘advanced’ DER). Implementation should use standards-compliant data formats and communication protocols and adhere to regulated backend communication of the charging networks and utilities (*see also* the explanations on standards in paragraph 3.1.2).

More in-depth explanation is provided on some specific points:

3.1.1 Bidirectional Charging

Intended Actors: Demonstration project-funding organisations, and involved utilities and industry

Despite successful demonstrations of bidirectional charging technology (V2X), several economic actors involved in the deployment of e-mobility infrastructure (i.e., utilities, charge-point operators, network service providers, and aggregators) do not see bidirectional grid services as ready yet for widespread deployment in the market. Criticism of bidirectional charging often exaggerates its effects on EVs' battery lifetime. In more systematically structured discussions between utilities and the auto industry, approaches to use only the mid-range of the state-of-charge envelope of car batteries in V2G should be agreed, in order to minimise accelerated battery ageing. Potential participants in a VGI demonstration programme should be informed about the realistic effects of additional cycling due to bidirectional charging on battery lifetime. Correct and realistic information should be planned into demonstration projects from the beginning. More broadly, academic and laboratory research into realistic battery ageing and the results of statistical data analyses of the EV stock should be communicated to the industry and the public alike, for example through easy-to-understand information clips and simulation applications (*see also* recommendation 3.7).

3.1.2. Industry Uncertainty

Intended Actors: Demonstration project-funding organisations, and involved utilities and industry

Requiring the implementation of harmonised communication protocols with a concrete time horizon would provide market certainty to industry and help to de-risk the deployment of bidirectional charging. An example is the deployment of ISO 15118, an international standard defining a vehicle-to-grid communication interface that supports smart (including bidirectional) charging between the vehicle and the charging column. Although the technologies for smart and bidirectional charging are technologically feasible, some U.S. industry stakeholders indicated that the small number of ISO 15118-capable, AC Level 2-ready EVs on the market is a barrier to implementation. In response to limited deployment of ISO 15118 EVs and charging columns, the EC is considering as part of the implementation of its new Alternative Fuels Infrastructure Regulation (AFIR) [1] to mandate by the beginning of 2027, among others, the standard ISO 15118-20, i.e., with its recent "Part 20" that enables both smart and bidirectional charging. In the U.S. National Electric Vehicle Infrastructure programme (NEVI), ISO 15118 (so far 15118 Part 2) is also a requirement for charging equipment suppliers participating, but it details the hardware to be capable of implementing both ISO 15118–2 and ISO 15118–20 [2]. These initiatives aim to provide certainty regarding ISO 15118 EV adoption rates while providing industry flexibility to

[1] Official Journal of the European Union, OJ L 234, 22.9.2023, p. 1–47 : https://eur-lex.europa.eu/eli/reg/2023/1804/oj

[2] Code of Federal Regulations CFR 680.108 referenced in this paragraph of the Federal Register: https://www.federalregister.gov/d/2023-03500/p-174

prepare for mass adoption of higher-level communication, rendering bidirectional charging and thus virtual power stations via aggregated EVs possible. For the charger-to-grid communication, efforts are underway to render the Open Charge Point Protocol (OCPP) an IEC standard, and further upstream, the grid communication according to OpenADR 2.0b is already streamlining successfully into IEC standards (*see also* recommendation 3.3). In a cooperative spirit, the industry can therefore help to harmonise communication protocols for the whole chain.

3.2 Develop a lexicon to harmonise technical nomenclature that works for the United States and the EU alike.

Intended Actors: All entities involved in demonstration projects

A harmonised, transatlantic lexicon defining technical terms and abbreviations should be developed and maintained in order to enable mutual technical understanding and comparability of demonstration project results between the United States and the EU. The lexicon should define technical names for single devices, protocols, or vehicle-charging schemes involved, as well as typical use-cases, operating strategies, and behavioural patterns encountered. Work on a first version of such a lexicon has been started at the JRC, but will necessitate further feedback by users from the United States and the EU, and thus maturation in the coming months. Such a common technical lexicon and discussion platform for pioneering smart charging and VGI would ease the preparation of funding documentation, eligibility rules, and project implementation guidelines in both the United States and the EU.

3.3 Develop interface definitions for hardware connectivity and communication consistent with international standards activities.

Intended Actors: Government funding agencies, National Laboratories, and the JRC

Joint U.S.-EU interface definitions should be developed for all VGI-devices and local operators – ideally from existing international standards and developments (i.e., IEC, ISO, SAE, and CEN-CENELEC). To develop the interface definitions not already addressed by the connectivity and communication standards committees, ANL and the JRC will solicit further industry input or convene further stakeholder workshops, if necessary, to find common agreement by technical experts and stakeholders, including the connectivity and communication standards committees.

Foreseeable breakthroughs in standards should be supported and incorporated. Examples include the take-up of OCPP (Open Charge Point Protocol) into IEC Technical Committee TC69 development scheme in view of a future IEC standard for EVSE-to-grid communication and the well-regarded OpenADR 2.0b, now taken up as IEC 62746-10-1:2018, *see* [3], as well as further future adoption developments.

Interface requirements with distribution grids must be respected, or adapted in cooperation with the grid operators, to accommodate smart charging deployment (including bidirectional). Grid operators and utilities should therefore be proactively involved in

[3] IEC 62746-10-1:2018 | IEC Webstore, *and* OpenADR 2.0b Receives Approval as IEC Standard

demonstration projects (i.e., not only included for the sake of sponsoring). In order to achieve this, Funding Opportunity Announcements (FOAs) in the United States, or research programme 'calls' in the EU, could formulate their scope such that projects are required to demonstrate their ability to roll-out innovations within the clientele's utilities and grid-operators. Funding could also account for provable risks of utilities and grid-operators when proactively trying out new solutions with their clients and infrastructure. Project requirements could request a leading role for utilities in demonstrating smart charging, as appropriate.

3.4 Develop VGI conformance test procedures for key use-cases.

Intended Actors: Government funding agencies, standards committees, and National Laboratories

Convene industry experts (e.g., representatives of the appropriate standards committees and pre-normative researchers) to develop consistent test procedures and prove their completeness through testing events ("Testathons"), including realistic backend simulation/emulation. Support the emergence of accreditation and certification entities that create an economic ecosystem for easily assuring product conformance in VGI.

3.5 Adopt a harmonised method to characterise demonstration programmes and report conclusions.

Intended Actors: Demonstration project funding organisations

Demonstration projects should collect and publish harmonised conclusions. Standard harmonised key conclusions tables would streamline information sharing and literature research for results from demonstration projects. In order to achieve this, funding agencies, including the EC's HORIZON Europe and future Framework Programmes as well as the U.S. Department of Energy's programmes, could require the use of key conclusion tables, including the following information:

a. Number of vehicles;
b. Number of clients/users;
c. Type of users (e.g., public charging, private home-charging, work-place charging, captive fleets, etc.);
d. Number and structure of the project implementers (e.g., grid operators, service providers, contractors, third-party aggregators, etc.);
e. Number of utility project partners and communal (or other) stakeholders;
f. Funding mechanism and the amount of funding, including the percentage of public support; and

Type of grid service activities to be reported:

g. Controlled curtailment of power available (DSM), ideally with a short description of:
    - Percentage and absolute kilowatt data of curtailment; and
    - Under what conditions power curtailment is triggered.
h. Controlled increase of power available (DER), ideally with a short description of:
    - Percentage and absolute kilowatt data of increase; and

- Under what conditions power increase is triggered.

i. Time-of-use price incentives/disincentives and critical peak pricing, ideally with:
   - The price differential per kilowatt-hour;
   - Whether this is a static scheme or takes varying grid conditions into account; and
   - How critical peak pricing would scale.

j. Vehicle-to-grid (V2G) with bidirectional charging (advanced DER), ideally with:
   - Number of vehicles/chargers participating in V2G;
   - Range of power back-flow in percent and absolute kilowatt of charge power;
   - Conditions, at which back-flow is triggered (specific state-of-charge [SoC], other conditions, including grid conditions); and
   - Duration and energy of back-flow typically encountered/triggered.

k. Protocols used for grid communication (e.g., OCPP, OpenADR, etc.) and if there were any proprietary elements in the system, such as a specific API (Application Programming Interface) for a charging network;

l. Success rates in terms of participation or sustained participation;

m. Quantifiable delays in authorization, permitting, implementation, and use phases;

n. Areas in which communication standards are still lacking or not applicable for the purpose;

o. Areas in which adequate EVSE hardware is still unavailable;

p. Areas in which adequate EV hardware is still unavailable;

q. Percentage of individual participants whose service to the grid, in monetary terms, including avoided grid expansion cost, is higher than the implementation cost, calculated per participant of the controlled or smart charging programme (i.e., "utility-side profitability"). The information can also be given for a coordinated fleet, if appropriately marked, considering the fleet as one huge participant; and

r. Percentage of individual participants whose monetary benefit in electricity cost is higher than their cost for participating (i.e., "client-side profitability"). The information can also be given for a coordinated fleet, if appropriate, considering the fleet as one huge participant.

3.6 Reflect customer perspectives and data rights in the definition of demonstration programmes.

Intended Actors: Government agencies and associated research organisations

Based on direct feedback from grid operators and utilities, research should be conducted to develop a customer metric – identifying customers with the most potential to provide grid power flexibility (i.e., those with the ability to participate in controlled, smart, or bidirectional charging). This metric would aid demonstration programme enrolment and render demonstrations more attractive for utilities. However, improved targeting of customers must be balanced with equity and justice concerns – otherwise, innovations and better electricity tariffs risk becoming a privilege of people with bigger EVs, homes, or private stationary batteries. One industry non-profit report [4] suggested metrics in order to

[4] SEPA (Smart Electric Power Alliance] Managed Charging Programs: Maximizing Customer Satisfaction and Grid Benefits, March 2023

help prioritising eligible customers that offer a value added greater than the cost per individual for programme implementation.

Behavioural studies and education initiatives should be conducted to quantify customers' expectations and derive their willingness to participate in VGI programmes. This could include initiatives to introduce the VGI concept and possible benefits of controlled, smart, and bidirectional charging as well as surveys or other means to determine the thresholds for participation, for example:

- Acceptable times of the day for controlled/smart charging;
- Acceptable amount of electric power or energy curtailment; and
- Expected economic incentives/rewards.

Customer feedback from a demonstration project to the involved clientele groups should be planned and documented as much as possible in the project definition phase.

Data management and exploitation rights were mentioned, but not exhaustively discussed at the workshop. Logically, public smart charging data would belong to the EV-owner as much as to the charge-point operator. One vehicle original equipment manufacturer (OEM) expressed that they would want to maintain substantial control over the vehicle charging data for specific functions, while the owner/user would have access to the rest. Though far from settled, the immediate recommendation is that the customer should have rights to some data in every interaction, and data rights should be defined by individual subscription contracts or, in ad-hoc cases of charging without special client-specific subscriptions, by general data protection regulations. If relevant data provisions are established in regulations (e.g., in the EU: Data Act, Alternative Fuels Infrastructure Regulation, or the Renewable Energy Directive), those data provisions should apply accordingly. Public smart charging data is sales data that records a commodity (electric energy) to be sold *from* or, in the case of bi-directional charging, *to* a network operator/grid. Like other sales data, public smart charging data contains information on clients' subscription identities, electronic payment means, geographic locations, and time stamps. Whilst exploiting spatial and longitudinal individual data on charging processes can support business models, these data are individual data assets typically protected by law.

Security measures like anonymisation, or differential privacy should be used to protect personally identifiable information; therefore, it is recommended that data privacy experts and data modellers be involved in demonstration projects. Individual data rights policies are legal and political choices made at a level above that directly implementing e-mobility infrastructure, but have important implications for how a smart charging demonstration project is planned and implemented. Focused resources need to be applied to understand the issues at stake and the legal ramifications. Jurisdictions must decide how to balance the opportunity of monetising aggregated driving and energy data by market participants with individual data protection. Model contracts, as they are known by insurance companies monitoring the driving of their clients, should be widely available and considered at an early stage of smart charging demonstration projects.

Equity and justice goals are explicit tenets of some government agencies and these must be respected in procurements. These aspects should be made explicit and planned with the help of multi-disciplinary behavioural research into regular and opportunity-users.

3.7 Disseminate the latest recommendations/best practices to all entities proposing public-private demonstrations.

Intended Actors: Demonstration project funding organisations

Government agencies sponsoring VGI demonstration programmes should provide the most recent recommendations and best practice documents (e.g., [5], along with Funding Opportunity Announcements (FOAs)) in the United States or relevant funding calls in the EU. Access to the most recent recommendations, whether joint (e.g., [6], or specific to the EU or the United States) will help demonstration project participants compare opportunities, tips, conditions, and constraints for future transatlantic market roll-out of vehicle-grid integration technology.

3.8 Inform the public/potential participants in a VGI demonstration programme regarding realistic limitations and impacts of V2X.

Intended Actors: Research funding organisations and research organisations.

Some proponents of V2X overestimate the amounts of energy available from electric vehicle batteries and the expected compensation, while others overestimate the effects of additional cycling due to bidirectional charging on battery ageing and thus lifetime. Correct and realistic information should be planned into demonstration projects from the beginning. More broadly, academic and laboratory research into realistic battery ageing and the results of statistical data analyses of the EV stock should be communicated to the public, for example through easy-to-understand information clips and simulation applications, based on peer-reviewed research publications.

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[5] European Commission, Directorate-General for Mobility and Transport, *Sustainable Transport Forum – Best practices guide for permitting and grid connection procedures for recharging infrastructure*, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2832/944637

[6] Transatlantic Technical Recommendations for Government Funded Implementation of Electric Vehicle Charging Infrastructure, doi:10.2760/542957

ANNEX I: Abbreviations Used in this Publication

AC Level 2 = U.S. abbreviation for alternating current charging at Level 2, i.e., at a tension of 240Volt and in a current range from 12 to 80 Ampere

AFIR = Alternative Fuels Infrastructure Regulation

ANL = Argonne National Laboratory

API = Application Programming Interface

CEN-CENELEC = Comité Européenne de Normalisation - European Committee for Electrotechnical Standardisation

CFR = Code of Federal Regulations

CPO = Charge-point operator

CSO = Charging-service operator

DOE = U.S. Department of Energy

DSM = Demand Side Management

DER = Distributed Energy Resources

EC = European Commission

EV = Electric vehicle

EVSE = Electric vehicle supply equipment, i.e., charging column or wallbox

EU = European Union

FOA = Funding Opportunity Announcement (in the United States)

IEC = International Electrotechnical Commission

ISO = International Standardisation Organization

JRC = Joint Research Centre of the European Commission

OCPP = Open Charge Point Protocol

OEM = Original equipment manufacturer

OpenADR = Open Automated Demand Response

SAE = Society of Automotive Engineers

SEPA = Smart Electric Power Alliance (in the United States)

SoC = State of charge (of an EV battery pack)

TC = Technical Committee (of IEC)

U.S. = United States of America

V2G = Vehicle-to-Grid

V2X = Vehicle-to-Everything

VGI = Vehicle-Grid Integration

ANNEX II: Key Questions Prepared at the Workshop Held at ANL in September 2023

The key questions posed to the workshop invitees and additional experts, alongside summaries of participants' responses, are shown below. The summarised responses to the questions are based on discussion at the workshop, written responses from stakeholders including original equipment manufacturers (OEMs) and funding programme experts, and bilateral discussions with stakeholders who were unable to attend the workshop. Not all of the questions were fully answered in the workshop. The responses, or identification of still existing gaps in the desired knowledge base, have been summarised by the authors *in italics*, recognising some degree of simplification.

i. **What are the key objectives of public-private demonstrations? … specific grid services, workplace grid integration, or reducing industry's risk of employing new technology?**
Not answered completely yet; some utilities perceived VGI technology as "not ready for large scale public demonstration", whilst a European project cluster reported about ongoing VGI and V2G implementation in specific urban environments with optimised conditions for demonstration of at least a "lighthouse" character. Other stakeholders agreed to the above-named key objectives, but signalled some remaining additional hindrances, as per the following questions.

ii. **What are the lessons learned from, and the major hindrances to, conducting VGI demonstrations?**
Participants indicated the major hindrance is VGI technology being still under development for rollout. Others saw rather an issue in the lack of available smart charging e-vehicles and the long permitting processes during charger installation in public project implementation.

iii. **The pertinent public funding authorities could restrict publicly funded demonstrations to those using common standards and non-proprietary solutions. Would you participate under these conditions?**
Not answered completely yet; industry wants international communication standards to be finalised, but realistically some businesses are currently based on proprietary software and features.

iv. **Ownership of vehicle and charging-column (EVSE) data could pose a challenge to vehicle-grid integration. Do you support sole data rights of the owner? Would you support a government-imposed restriction?**
Industry does not challenge the legal aspects of data ownership, but opposes sole ownership by the vehicle owner because it wants access to the data for its purposes and business models. Data exploitation must not lead to proprietary solutions or new monopolies, e.g., in the power flexibility market. Existing, general regulations for privacy and data ownership remain valid.

v. **Are there quantifiable key metrics of demonstration programme participation rates, e.g., load flexibility, client service/satisfaction, or other variables, with which we can internationally compare VGI projects?**
Not exhaustively addressed in the workshop, but strongly supported by research organisations and demonstration project practitioners.

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