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Swiss Participation in IEA TCP HEV: Task 43

"Vehicle Grid Integration"

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Summary

Switzerland participates in Task 43 "Vehicle Grid Integration" (VGI) from the IEA Hybrid and Electric Vehicle Technology Collaboration Program (HEVTCP) via Bern University of Applied Sciences (BFH-TI) and Novatlantis GmbH. At the October 2018 meeting in Burgdorf, Switzerland, the IA-HEV Executive Committee approved Task 43 as the follow-on to Task 28 – “Home Grids and V2X Technology”. Building on the results of Task 28, this Task aims to explore, identify and give answers to the gaps preventing the electric vehicles to be fully integrated in the electrical grid. In addition, it is also intended to improve the joint work between the electric sector and the mobility sector, which is a key point for the real energy transition. Activity mainly consists of expert workshops for researchers, industry and policy makers to work together in order to tackle the various technical, regulatory and social challenges of VGI. Ms. Cristina Corchero from the Catalonia Institute for Energy Research (IREC) is the Operating Agent of Task 43.
The kick-off meeting took place in May 2019 in Lyon, France. Followed by an international workshop on regulatory challenges for VGI, held on November 2019 in Brussels, Belgium. Participants countries are: Spain, Great Britain, Switzerland, Korea, Ireland, France, Belgium, Italy, Canada, Denmark, Netherlands, Germany. This report provides an overview of the work carried out through Task 43.

Contents

Abbreviations

BFH-TI	Bern University of Applied Sciences
DER	Distributed Energy Resource
DSO	Distribution System Operator
EV	Electric Vehicle (Plug-in Electric Vehicle and Plug-in Hybrid Electric Vehicle)
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gases
IA-HEV	Implementing Agreement on Hybrid and Electric Vehicle
IEA	International Energy Agency
OEM	Original Equipment Manufacturer
PEV	Plug-in Electric Vehicle
SCCER	Swiss Competence Centers for Energy Research
SFOE	Swiss Federal Office of Energy
TCP	Technology Collaboration Partnership
ToU	Time of Use
TSO	Transmission System Operator
V2G	Vehicle to Grid
V2X	Vehicle to Everything

1 Introduction

1.1 Background information and current situation

Around the world sales of electric vehicles (EVs) are growing at an accelerated rate. For the first time global electric vehicle annual sales exceeded the 2 million mark in 2018, bringing the global population of EVs to just over 5 million (1).

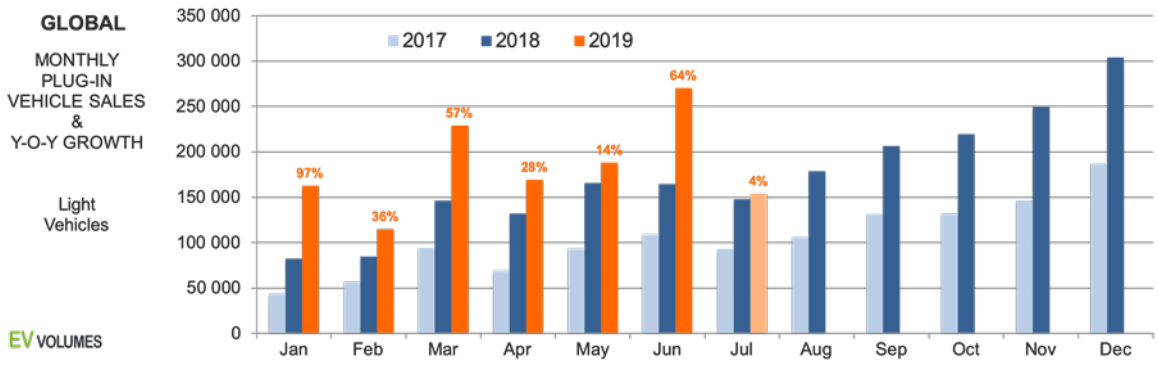

Figure 1 Global EV Sales for the 1st Half of 2019 (Source: EV Volumes (2))

The mass uptake of electric mobility along with increased levels of distributed generation leads to several technological challenges. Some of the key challenges for the full integration of electric vehicles in the electrical grid include the security and sustainability of the electricity supply, electricity market design, as well as the regulatory framework for the connection to the distribution network.

Relevance for Switzerland

The integration of a large amount of fluctuating PV electricity production as part of the "Energy Strategy 2050" leads to an increase in the residual load and load gradients (2). To ensure secure grid operation and to avoid curtailment of renewable energies, the energy system needs additional capacity and flexibility. The growing fleet of electric vehicles with their large batteries (40-100 kWh) and fast response times could support the grid as a distributed energy resource (see SCCER-Furies). For example, in the Parker project, it was demonstrated that EVs can participate in advanced smart grid services including the use of Vehicle-To-Grid (V2G) (2). Furthermore, EVs in combination with Switzerland's renewable electricity mix can help to reduce greenhouse gas (GHG) emissions from the transport sector (3).

HEV-TCP Task 28: Home Grids and Vehicle to Everything (V2X) Technologies

Task 28 – “Home Grids and V2X Technology” was carried out between 2014 and 2018 as part of the International Energy Agency’s (IEA) Technology Collaboration Partnership on Hybrid and Electric Vehicles (HEV TCP). Activity consisted of biannual expert workshops for researchers, industry and policy makers to address the technical and economic knowledge gaps including regulatory issues that slow down the development of V2X technology. The key output from Task 28 is a “V2X Roadmap” [1], which summarizes the lessons learnt from the Task activities and defines future priorities. It can be used by policy makers and industrial partners to promote V2X technology.

In 2019, the HEV TCP Executive Committee approved to continue from Task 28 with a new Task, titled “Vehicle-Grid Integration”. This follow-on Task aims to cover different charging technologies,

[1] HEV TCP Task 28 V2X Roadmap; http://www.ieahev.org/assets/1/7/IEA_HEV_V2X_Roadmap-1.pdf

including smart charging, fast charging and V2G, and focuses specifically on the issues associated with connecting EVs to the power system.

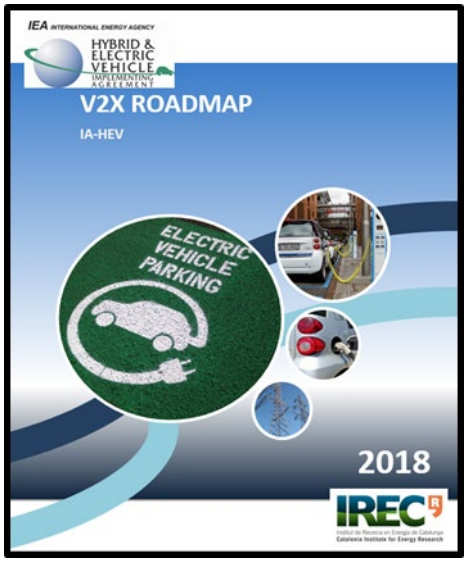

Figure 2 VTX Roadmap (4)

1.2 Purpose of the project

Utilizing the existing HEV TCP framework, Task 43 organizes a series of expert workshops to bring together stakeholders from different sectors including actors form industry, research and energy policy. The basic approach is to jointly analyze all VGI aspects that prevent the full integration of electric vehicles into the electrical grid. In order to exchange information and address the current barriers for the vehicle gird integration, biannual meetings are planned on different strategic topics. By leveraging the technical skills and different experiences of the participants and by understanding the challenges faced in various countries or markets, global solutions in the context of the energy transition can be found.

Switzerland is an active member of the Implementing Agreement for co-operation on Hybrid and Electric Vehicle Technologies and Programmes (IA-HEV) of the International Energy Agency through the Swiss Federal Office of Energy (SFOE). Within the framework of the IA-HEV Switzerland takes part in Task 43 "Vehicle Grid Integration" via Bern University of Applied Sciences (BFH-TI) and Novatlantis GmbH. The activities include participation and information exchange in a total of four workshops of the IA-HEV Task 43, as well as national / local dissemination through presentations in the relevant SCCER's.

1.3 Objectives

The **main objectives** of the Task 43 are the following:

1. To explore, identify and give answers to the gaps preventing the electric vehicles to be fully integrated in the electrical grid.
2. To improve the joint work between electric sector and mobility sector, which is a key point for the real energy transition.

The gaps and actions for V2G identified in Task 28's roadmap are also topics that are addressed through Task 43. These include technical issues such as standardization and interoperability, as well as regulatory aspects associated with the grid connection (grid codes) and the monetization of system services. The countries within the IEA-HEV TCP summarize the main priorities of the vehicle grid integration as follows (4):

- Long term plug-in electric vehicle (PEV) deployment effects on distribution grid
- Business models for utilities to install or support PEV chargers
- PEV and electric vehicle supply equipment (EVSE) demand side management, charging controls
- Grid storage and load shifting from PEVs
- EV charging infrastructure incentives and deployment on the building and city scale
- Cost benefit analysis of EV technologies for VGI

The goal of this Task is hence to investigate the critical barriers and to promote knowledge sharing and dissemination between different stakeholder groups through workshops and conferences. One key outcome developed during the Task 43 workshops will be a scientific paper on VGI challenges that is published at conferences and in a scientific journal.

2 Procedures and methodology

Task 43 started in mid-2019 and will continue until the end of 2020. Given the numerous goals, a survey was sent to potential partners in the planning phase of the project to determine priorities and develop ideas on how to accomplish the Task. The survey included the following questions:

1. What do you consider to be the three most significant **challenges** for vehicle-grid integration?
2. Which **research questions** do you hope to address through Task 43?
3. What **working method** could Task 43 employ to help achieve these aims?
   & What kinds of **outputs** do you hope to see from Task 43?
4. **Who** should be involves in Task 43?

Out of the 26 participants from Task 28 / Task 43 who were asked to complete the survey, 8 surveys were returned [2]. The challenges and research questions identified from the feedback on the survey have been categorized into 4 groups:

Technology/Standards - This relates to the various issues to do with smart charging and V2G technology, such as interoperability, functionality and cost.

Markets/Services/Regulation - This refers to the challenge of providing the right economic signals to EV users, for example by offering time of use (ToU) tariffs as well as the challenges of selling flexibility services to network operators.

Grid/Planning - This refers to the impacts that EV charging could have on grids and the need for strategic long-term planning to optimize the use of existing grids to minimize reinforcement costs.

[2] ESB, DTU, BFH, Newcastle, NRC, IREC, Fraunhofer

User Engagement - This refers to the lack of buy in from EV users, as well as original equipment manufacturers (OEMs) not providing flexibility capability in vehicles and potential buyers of flexibility, such as distribution system operators (DSOs) and transmission system operator (TSOs), not developing markets and protocols for VGI.

Concerning the working method and the desired outputs, the respondents proposed knowledge exchange workshops, a free web site to map best practices of VGI and V2G and a position paper to support regulatory authorities. To help achieve the objectives, different stakeholders, such as DSO, TSO, OEM, research institutions and regulators should be involved in Task 43: The results from the survey served as the basis for discussion at the project kick-off meeting, which took place on Thursday, May 23rd after the EVS32 in Lyon. In a dynamic session, the Task members were divided into teams and worked individually to identify three goals necessary to address the four different challenges for VGI and then presented these outcomes to the whole group (indicated with an X below)[3].

<table>
<tr><th colspan="2">Challenge 1</th><th>Charging Technology and Standards</th></tr>
<tr><td colspan="3">Make it possible (technical) = Sufficient (value) + Smart (performance):
Cost of CCS + CHAdeMO
AC vs DC (cost, power)
Open standards and smart home integration
Secure layer</td></tr>
<tr><th>Goal 1.1 XXXXXXX</th><th>Goal 1.2 X</th><th>Goal 1.3</th></tr>
<tr><td>Open standards linked between EV, charger and third parties. Short-term, Global</td><td>Security for users and global data protection (GDPR). Short-term, Global</td><td>Cost effective and smart access to AC and DC chargers. Medium-term, Global</td></tr>
</table>

[3] TASK 43: Vehicle-Grid Integration; Summary Expert Workshop I (Kick-off Meeting) Lyon, 23rd May 2019; see “Task_43_WS1_Summary_Lyon_May_2019 DRAFT.pdf”.

Challenge 2	**Markets, Services and Regulation**	
VGI Energy Markets: • TSO services, FCR… • DSO local grid services, incentives (Euro/other), markets? • Neighborhood and building - self-consumption • EV users and owners (group 4)		
Goal 2.1 XXXXXX	**Goal 2.2**	**Goal 2.3 XX**
Regulation: remove barriers to market entry, unity between national energy markets. Global/National	**Technology / protocols:** Technical feasibility to offer different services, reaction time (V1G and V2G), cost of delivering service	**Business models:** Full value chain needs understanding, e.g. impact battery wear

Challenge 3	**Grid Infrastructure and Planning**	
1. Lack of visibility of LV constraints 2. No overview of smart charging / V2G solutions (last mile, combined charging, grid planning) 3. Making #2 accessible for DSO		
Goal 3.1 X	**Goal 3.2 XXXXX**	**Goal 3.3**
Educate stakeholders about smart grid and data must be made accessible. Short term.	Bring knowledge on VGI together: **categorizer + address knowledge gaps.** Short Term	Provide easily accessible **VGI solutions** to DSO. Short/Medium term

Challenge 4	**User Engagement**	
This is key to making this work, no matter how good the tech is. How do we engage the user to ensure they are willing to participate in VGI (i.e. share control of their car) The user experience needs to be: CONVENIENT, RISK FREE AND PROFITABLE		
Goal 4.1 XXXX	**Goal 4.2 X**	**Goal 4.3**
CONVENIENT: seamless experiences. Bundle transport services (cost of tech + electricity tariff…) Simple requirements from user.	**RISK FREE:** Avoid and or compensate risk. Meet driver requirements + ensure against battery degradation.	**PROFITABLE:** make financial sense. Reduce cost of access + cost of use

3 Activities and results

3.1 Participants

The Task comprises 12 member countries and three private companies, which are summarized in Table 1.

Country	Organization	Description
Spain	IREC Institut de Recerca en Energia de Catalunya Catalonia Institute for Energy Research	Operation Agent for Task 43 and Catalan Energy Research Institute working in building energy management and smart grids, including several V2X projects.
Canada	Natural Resources Canada	Government agency responsible for management of Canada's natural resources. Main contributions on battery degradation of V2X.
Italy	RSE Ricerca Sistema Energetico	Publicly-controlled Company that carries out research into the field of electrical energy.
France	CentraleSupélec	Research institute focused on innovation and applied science.
Switzerland	Bern University of Applied Sciences	University with active energy research departments including solar PV lab.
Ireland	ESB Energy for generations	Republic of Ireland's national TSO and owner of generation infrastructure and EV charging infrastructure in UK and Ireland.
Denmark	DTU	Technical university and smart grid lab developing V2X technologies and standards. Involved in several V2X pilot projects in Denmark doing V2X aggregation.
Belgium	vito	Independent Flemish research organization in the area of cleantech and sustainable development.
Germany	Fraunhofer ISI	Research organization focused on developing of application-oriented technology.
United Kingdom	Newcastle University UK | Malaysia | Singapore	public research university with multi-disciplinary collaborations and various engineering research groups including the National Centre for Energy Systems Integration (CESI)
South Korea	울산대학교 UNIVERSITY OF ULSAN	University involved in research projects to develop V2X technologies and test standards.

Enel X (United States)		Company that offers energy solutions ranging from demand response to battery storage to electric vehicle chargers.
novatlantis gmbh (Switzerland)		Independent non-profit organization in Switzerland for sustainability and knowledge transfer
Vedecom (France)		Research institute with goal of developing disruptive mobility technologies. Working on development of new V2X technologies and standards.
Netherlands		knowledge and innovation foundation in the field of smart charging infrastructure in the Netherlands.

Table 1 Task 43 participants

In addition to the organizations officially involved in Task 43, a number of other organizations have participated in the workshops and contributed with presentations.

3.2 Expert Workshops

1. **Workshop I: IEA HEV Task 28 - Project Closing Workshop.** Task 28 held an open half-day workshop in Lyon on May 22nd, 2019 as a side event of the EVS32 - 32nd International Electric Vehicle Symposium. The V2G workshop was co-organized together with the annual member meeting of CHAdeMO Europe. It contained technical presentations that addressed the main issues of future bi-directional charging technology and key findings of Task 28. In addition, plans for the follow-on Task 43 “Vehicle-Grid Integration” were presented.

2. **Workshop II: Task 43 Vehicle Grid Integration - Project Kick-off Meeting.** This free workshop required pre-registration and was held on May 23th, 2019 in Lyon. The kick-of-meeting aimed to explore VGI challenges in general and was directed at researchers, policy makers and industry players who were interested in becoming a member of Task 43. It included presentations on e-car sharing and V2G, interoperability and performance of bidirectional charging, as well as grid congestion and V2X opportunities for distribution utilities. This was followed by a dynamic session designed according to the prior VGI challenges survey to define the objectives for the Task. Finally, the working method and outputs regarding project planning were discussed.

3. **Workshop III: Vehicle Grid Integration - Regulatory challenges for VGI.** This workshop was held on November 6th, 2019 in Brussels (Belgium). Registration was mandatory and only possible for Task 43 members and invited speakers or guests. In the expert session, aspects of VGI regulation such as European versus country-based regulations, the energy market integration of EV services, transparency and data treatment for EV customers as well as the legal framework for bidirectional charging were analyzed. The workshop was concluded with an internal discussion by Task 43 members.

3.3 Other Events

In addition to the expert workshops Task 43 participated in another event on VGI technology:

- The official Task 43 members were invited to attend the Flemish Knowledge Platform Smart Charging workshop on policy recommendations for smart charging in Brussels on November 5th. IREC presented lessons learnt from the V2X Roadmap of Task 28.

4 Lessons Learnt from Expert Workshops

The details of the expert workshops are summarized in the official minutes of the operation agent IREC. However, these documents are only intended for internal Task partners and cannot be disseminated or passed on without the author's permission. The summaries from the expert workshops are therefore only available to the project founding agency (SFOE).

5 Next steps

The next workshop is scheduled for June 2020 at EVS33 in Portland, Oregon. It will be a joint expert workshop with HEV-TCP Task 39 (Interoperability) on how to improve electric vehicle integration both in the grids and in the energy markets. As Figure 3 shows, the location for the 3rd Task 43 workshop in autumn 2020 is still open. Paris, Switzerland and Denmark are potential venues for this project meeting about business models, user engagement and interoperability within the VGI ecosystem. Since cybersecurity is not addressed, the members propose to set up a new workshop in London before March 2020. This is to be dedicated to the current state of technology including standards and protocols from charging point to service providers/grid operators.

Dissemination activities include papers and presentation at international events such as the EVS33 and at national level via the relevant SCCER's. As a central result of the Task, a scientific paper is prepared that summarizes the main challenges VGI.

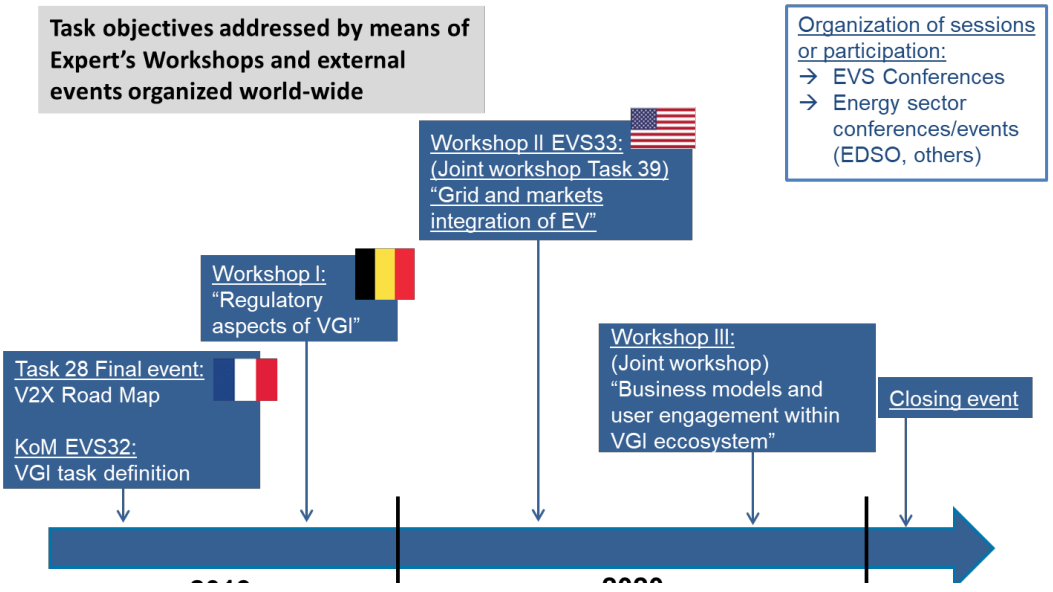

Figure 3 Schedule for remaining workshops

6 Acknowledgements

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6. **Peter Bach Andersen, Seyedmostafa Hashemi Toghroljerdi, Thomas Meier Sørensen,.** *The Parker Project Final Report.* s.l. : DTU Electrical Engineering, 2019.
7. **Cristina Corchero, Manel Sanmarti.** IEA-HEV TCP Task 28 V2X Roadmap. [Online] 2019. http://www.ieahev.org/assets/1/7/IEA_HEV_V2X_Roadmap-1.pdf.

8 Appendix

Summaries of the kick-off meeting and the exert workshops (only available for SFOE):

1. IEA HEV Task 28: Project Closing Workshop:
   “Task_28_WS10_Summary_Lyon_May_2019.pdf”
2. IEA HEV Task 43: Project Kick-off Meeting:
   “Task_43_WS1_Summary_Lyon_May_2019 DRAFT.pdf”
3. IEA HEV Task 43: Workshop I:
   “Task_43_WS2_Summary_Brussels_November_2019.pdf”