IEA INTERNATIONAL ENERGY AGENCY

HYBRID & ELECTRIC VEHICLE TECHNOLOGY COLLABORATION PROGRAMME

HEV TCP TASK 26 WORKSHOP

MEETING 7: WIRELESS CHARGING AND V2X GRID AND MARKET INTEGRATION

19-20 MARCH 2018

HOSTED BY

Newcastle University

CESI National Centre for Energy Systems Integration

THE SCHOOL OF ENGINEERING AT NEWCASTLE UNIVERSITY

NEWCASTLE, UNITED KINGDOM

ABOUT US

International Energy Agency (IEA)

Established in 1974, the **International Energy Agency (IEA)** carries out a comprehensive programme of energy co-operation for its 29-member countries and beyond by examining the full spectrum of energy issues and advocating policies that will enhance energy security, economic development, environmental awareness and engagement worldwide. The IEA is governed by the IEA Governing Board which is supported through a number of specialised standing groups and committees. For more information on the IEA, see www.iea.org.

IEA Energy Technology Network

The **IEA Energy Technology Network (ETN)** is comprised of 6,000 experts participating in governing bodies and international groups managing technology programmes. The Committee on Energy Research and Technology (CERT), comprised of senior experts from IEA member governments, considers effective energy technology and policies to improve energy security, encourage environmental protection and maintain economic growth. The CERT is supported by four specialised Working Parties:

- Working Party on Energy End-use Technologies (EUWP): technologies and processes to improve efficiency in the buildings, electricity, industry, and transport sectors
- Working Party on Fossil Fuels (WPFF): cleaner use of coal, improvements in gas/oil exploration, and carbon capture and storage
- Fusion Power Co-ordinating Committee (FPCC): fusion devices, technologies, materials, and physics phenomena
- Working Party on Renewable Energy Technology (REWP): technologies, socio-economic issues and deployment policies

Each Working Party coordinates the research activities of relevant IEA Technology Collaboration Programmes (TCPs). The CERT directly oversees TCPs of a cross-cutting nature.

IEA Technology Collaboration Programmes (TCPs)

The **IEA Technology Collaboration Programmes (TCPs)** are international groups of experts that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues, from building pilot plants to providing policy guidance in support of energy security, economic growth and environmental protection. The first TCP was created in 1975. To date, TCP participants have examined close to 2 000 topics. Today TCP participants represent more than 300 public and private-sector organisations from over 50 countries. TCPs are governed by a flexible and effective framework and organised through an Implementing Agreement. TCP activities and programmes are managed and financed by the participants. To learn more about the TCPs, please consult the short promotional film, the *Frequently Asked Questions* brochure, or the IEA website www.iea.org/tcp.

TCP on Hybrid and Electric Vehicles (HEV TCP)

Created in 1993, the activities of the TCP on Hybrid and Electric Vehicles (HEV TCP) are coordinated by the Working Party on Energy End-Use Technologies (EUWP). The aims of the HEV TCP are to produce and disseminate balanced, objective information about advanced electric, hybrid, and fuel cell vehicles. The HEV TCP accomplishes this through multilateral task-force projects. For further information on the HEV TCP see http://www.ieahev.org/. Views, findings, and publications of the HEV TCP do not necessarily represent the views or policies of the IEA Secretariat or of its individual member countries.

Version	Date	Details	Prepared by:	Reviewed by:	Approved on:
V 0.0	January 17, 2019	Initial Draft	Richard Bogacz	Burak Ozpineci Lee Slezak	n/a
V 0.1	January 30, 2019	Updated Key Findings & Conclusions	Richard Bogacz	Burak Ozpineci	
V 0.2	March 2019	Incorporated Edits	Richard Bogacz	All Task Members	
V 0.3	June 2019	Task Member Edits	Richard Bogacz	n/a	FINAL RELEASE

Table of Contents

1 Task Approach

Multilateral task-force projects within the TCP on Hybrid and Electric Vehicles (HEV TCP) are known as Tasks. Participation in a Task is an efficient way of increasing national knowledge, both with respect to the specific project objective and in terms of information exchange with peer institutions. Shared activity allows Task members to combine strengths, optimize resources, mitigate risk, and share knowledge.

1.1 Objective of Task 26

Task 26 aims to develop a greater global understanding of wireless power transfer (WPT) systems and interoperability through a focused study of WPT technologies being developed in the participating countries. This task includes a study of country-based standards (JARI, SAE, ISO/IEC), technical approaches, grid interactions, regulatory policy, and safety codes for WPT. The task will operate from Summer/Fall 2014 through May 2019 conducting two workshops per year, with each workshop focused on a particular aspect of wireless charging.

Participants in this task will benefit from their involvement. Some of the benefits of participation include:

- Broadening and deepening the expertise of automotive research organizations in WPT for electric vehicles (EVs) and related technologies.
- Strengthen working relationships and international collaborations.
- Access to information on research performed by other participants.
- Receive updates on recent developments in other countries.
- Remaining informed on the state of standards that may facilitate (or hinder) interoperability with WPT for EVs.

1.2 Focus of Workshop

Task 26 has conducted six previous workshops (Figure 1). The Wireless charging and V2X grid and market integration International Expert Workshop is co-organized by Task 26 “Wireless Power Transfer for EVs” and Task 28 “Home Grids and V2X Technologies” in the framework of the HEV TCP of the IEA with the local support of the Newcastle University (United Kingdom). This International Workshop featured high-level world-speakers and academics from the fields of engineering, management, economics, and political science, among others, who exchanged their views and debated about wireless charging and V2X grid and market challenges and related topics. Workshop objectives were as follows:

- Explore grid impact and integration: issues, barriers, enablers, future developments.
- Explore bi-directional wired and wireless chargers: present status and future developments.
- Discuss V2X and wireless chargers’ impact on batteries.
- Consider business models: Is there a market?

Workshop #	Month	Year	Focus	Location / Host
1	October	2014	Kickoff	Vancouver, BC – Canada
2	May	2015	Leading Applications	Seoul, Korea / EVS 28
3	October	2015	Power Levels	Goteborg, Sweden / RISE Viktoria
4	June	2016	Interoperability & Standards	Rotterdam, The Netherlands / proov
5	October	2016	Safety of WPT Systems	Knoxville, TN USA / ORNL
6	April	2017	Installations & Alignment	Versailles, France / VEDECOM
7	**March**	**2018**	**Wireless charging and V2X grid and market integration**	**Newcastle, UK/Newcastle University**

Figure 1. Task 26 Workshop Topics

2 Workshop Activities

2.1 Host Location

This workshop took place 19-20 March 2018 in Newcastle, England, United Kingdom (UK). Our hosts for this event were Sara Walker of Newcastle University, Myriam Neaimeh of Newcastle University, the National Centre for Energy Systems Integration, and the HEV TCP of the IEA. This location was selected for co-locating the workshop with the UK Energy Storage Conference, 20-22 March, Newcastle University. Speakers at this conference included wireless and V2X topics focused on grid impacts and issues. The workshop also included a technical visit of Newcastle University.

2.2 Presentation Topics

With the support of the task members, 18 speakers were identified to present on grid impacts and issues, and bi-directional wireless charging (Figure 2). Technical presentations were grouped among five panels:

- Panel 1: Grid Impacts/Issues—the UK Case
- Panel 2: Grid Impacts/Issues—Other Countries
- Panel 3: Controls, Simulation, and Testing
- Panel 4: HEV TCP Bi-Directional Wireless Charging and Hubs Charging
- Panel 5: Grid Impacts Bi-Directional Wireless Charging

Presentation	Contributor[1]	Affiliation
Introductions & Welcoming Remarks		
Introducing Newcastle University	**SARA WALKER**	Newcastle University
Electric Vehicle Innovation Research at Newcastle University	**MYRIAM NEAIMEH**	Newcastle University
IEA Hybrid Electric Vehicle-Technology Commercialization Programme (HEV TCP) Task 26	**BURAK OZPINECI**	Oak Ridge National Laboratory
Task 28 "Home Grids and V2X Technologies"	**CRISTINA CORCHERO**	IREC
Panel 1 – Grid Impacts/Issues—the UK Case		
V2G Status and Future Roll-out: the UK case	**MARCO LANDI**	InnovateUK
Efficient System Integration of Electric Vehicles	**THOMAS MAIDONIS**	National Grid
Electric Vehicles Impacts & Opportunities	**THAZI EDWARDS**	UK Power Networks
Panel 2 - Grid Impacts/Issues—Other Countries		
Learnings from Denmark	**PETER BACH ANDERSEN**	DTU
AC V2G in The Netherlands	**BRAM van EIJSDEN**	ElaadNL
Commercial Smart Charging with the JuiceNet aggregation platform	**VINCENT SCHACHTER**	JuiceNet by eMotorWerks
Panel 3 – Controls, Simulation, and Testing		
Identifying the dimensions for a viable V2X model	**YUE WANG**, Ghamin Putrus, Dr. Richard Kotter, and Ridoy Das	Northumbria University
Multi-Output Wireless Charger for Electric Vehicles	**BINH VU,** Volker Pickert, Mohamed Dahidah, and Van-Tang Phan	Newcastle University
Learnings from including degradation in the techno-economics of systems that employ lithium ion batteries for storage	**KOTUB UDDIN**	OVO Energy
Panel 4 - HEV TCP Bi-Directional Wireless Charging and Hubs Charging		
Design and implementation of an 85-kHz Bidirectional Wireless Charger	**ALICIA TRIVINO**	University of Malaga
Bi-directional Wireless Power Flow for Medium Duty Vehicle Grid Connectivity	**BURAK OZPINECI**	Oak Ridge National Laboratory
Cost Reduction Methods in high density rapid charging V2G hubs	**CHRISTOPHER JACKSON**	Powerstar
Panel 5 - Grid Impacts Bi-Directional Wireless Charging		
Impact of Static and Dynamic Fast Inductive Charging on the Distribution Network and its Mitigation through Effective Management	**IOANNIS KARAKITSIOS**	National Technical University of Athens

[1] Contributor listed in **BOLD** was the presenter at the workshop.

Presentation	Contributor[1]	Affiliation
Dynamic wireless power transfer for EV charging: Grid impact and demand management strategies	**CHRISTINA ANAGNOSTOPOULOU** and Hans Bludszuweit	ISENSE ICCS

Figure 2. Wireless Charging and V2X Grid and Market Integration

3 Key Findings

Based on the presentations of this workshop and the demonstration witnessed, Task Members had an in-depth discussion of wireless charging and V2X grid and market integration. A number of key points emerged during the workshop. These ideas are listed below. The order in which they are presented is not intended to reflect their relative importance.

- An attendee discussed considering the customer's perspective with V2G programs. V2G needs to find a way to reward EV drivers. Customers will join V2G schemes if they see clear advantages and no disruption in EV use.
- Innovate UK emphasized that using EVs as a controllable load allows for deferring power system upgrades. As distributed storage, EVs act as a flexibility source by supporting the local grid, providing demand side response, and allowing for the integration of renewable resources.
- Innovate UK pointed out that V2G does not involve bulk energy transfers: only a small percentage of battery state of charge is used to support the grid.
- Attendees emphasized that EVs will increase electricity demand, and unmanaged peak-time charging will significantly impact the distribution networks. Smart-charging and V2G will be essential for efficient system integration.
- UK Power Networks discussed that challenges are V2G charger costs are still high, and regulatory provisions/licenses for vehicles to provide grid services are not established.
- DTU Electrical Engineering noted that challenges in Denmark for providing V2G include technical regulations, energy tariffs and taxation, requirements for settlement meters, and frequency energy bias.
- JuiceBox presented that V2G is not so much a technical problem as it is a business and maturity challenge. Next steps to V2G maturity include new hardware, regulatory and market learnings from pilots, and business model experimentation with commercial smart-charging and V2G pilots. V1G to V2G will be a continuum, not a step change.
- Newcastle University presented on a new concept to implement a multi-output wireless charger using one AC/DC converter and one inverter for several outputs. This setup is expected to reduce components and implementing costs.
- OVO Energy presented that smart grids are a requirement for V2G viability, and for addressing lithium (Li)-ion degradation. Li-ion battery degradation should be addressed in systems modeling and online transactions. Barriers for smart grids are technical, economic, and regulatory in nature, but all can be successfully addressed.
- Attendees discussed that barriers to smart grids include intelligent management of storage assets, business/compensation models, and interoperability.

- EV charging impacts on the grid differ according to traffic, season, location, and charging installation properties.
- Grid operational issues resulting from deployment of static and dynamic fast-charging can be effectively resolved through a management system.

4 Conclusions

The main conclusions of the workshops are listed below. The order of the points is not reflective of their importance.

- Li-ion battery degradation can impact the viability of electricity storage. Li-ion degradation needs to be addressed in systems modeling and online transactions.
- Technical improvements are needed to overcome two-way energy loss, and battery degradation.
- Unmanaged peak-time charging will significantly impact distribution networks. With V2G, EVs can reduce peak loads, provide energy services, and shift demand.
- V2G will be essential for efficient system integration. Investing in charging infrastructure and electricity networks is needed to accommodate the growth of EVs.
- Need to create best possible forecasts of EV uptake and charging behavior.
- Need to perform targeted network monitoring to inform deployment of smart solutions.
- Must optimize existing network capacity first.
- Smart-charging and V2G will be essential for efficient system integration with the grid.