HEV-TCP TASK 26 WORKSHOP

MEETING 4: INTEROPERABILITY & STANDARDS

28-29 JUNE 2016
HOSTED BY

SS ROTTERDAM
3E KATENDRECHTSE HOOFD 25,
3072 AM ROTTERDAM, NETHERLANDS

ABOUT US

International Energy Agency (IEA) Mission and Work

The International Energy Agency (IEA) is an autonomous intergovernmental organization that was established in 1974 through the framework of the Organisation of Economic Co-operation and Development (OECD). Over the years, the IEA has evolved and expanded and today, it works to examine the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management, and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability, and sustainability of energy in its 29 member countries and beyond.

IEA Organisational Structure

The Governing Board is the IEA's main decision-making body and is composed of energy ministers or their senior representatives from each member country. The Governing Board is supported by six internal groups – four Standing Groups and two Standing Committees – as well as affiliated groups from business and industry that provide input into the agency's work.

IEA's Committee on Energy Research and Technology (CERT)

One of the IEA's Standing Committees is the Committee on Energy Research and Technology (CERT). Comprised of senior experts from IEA member governments, the CERT considers effective energy technology and policies to improve energy security, encourage environmental protection, and maintain economic growth. Within the CERT are four working parties that consider national policy developments and technology trends relating to their area of specialization. These are the Working Party on Energy End-use Technologies (EUWP), the Working Party on Fossil Fuels (WPFF), the Working Party on Renewable Energy Technologies (REWP), and the Fusion Power Co-ordinating Committee (FPCC).

Comprised of programme managers and technology experts representing member governmental agencies, each of the four working parties supports and facilitates research, development, demonstration, and deployment (RDD&D) co-operation among member countries, and, as appropriate, seeks opportunities to collaborate with partner countries. In particular, each working party oversees the RDD&D activities of IEA's Technology Collaboration Programmes that fall within their respective portfolios.

Technology Collaboration Programmes (TCPs)

IEA's Technology Collaboration Programmes (TCPs) are at the core of the agency's RDD&D and knowledge transfer efforts and comprise its energy technology network. TCPs are independent, 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. At present, there are 39 TCPs involving over 6,000 experts globally and nearly 300 public and private organisations in 51 countries. With the exception of two cross-cutting TCPs, the work of each TCP is overseen by one of the four CERT working parties. TCPs are governed by a flexible and effective framework. Their activities and programmes are managed and financed by the participants. To learn more about the TCPs, please consult the short promotional film or the *Frequently Asked Questions* brochure.

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 CERT's 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. Each of these task-force projects is known as a Task. For further information on the HEV TCP including a complete list of ongoing and completed Tasks, please see http://www.ieahev.org/.

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V 1.0	April 3, 2017	Added Conclusions & References sections	Julie Francis	Richard M. Todaro, Editor	April 12, 2017
V 1.1	April 12, 2017	Revised About Us	Julie Francis	Task 26 Members	May 25, 2017
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1 Task Approach

Multilateral task-force projects within the Technology Collaboration Programme (TCP) on Hybrid and Electric Vehicles (HEV TCP) are known as Tasks and are organised under the auspices of the Implementing Agreement for Co-operation on Hybrid and Electric Vehicle Technologies and Programmes (IA-HEV). 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 (e.g., JARI, SAE, ISO/IEC), technical approaches, grid interactions, regulatory policy, and safety codes for WPT. The Task that operates from Summer/Fall 2014 through May 2019 conducts two workshops per year, with each workshop focused on a particular aspect of wireless charging.

It is hoped that participants in this Task benefit from their involvement in the following ways:

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

1.2 Focus of Workshop

This was the fourth workshop conducted under Task 26 as shown in Figure 1. The focus of this workshop was interoperability and standards as they pertain to wireless charging technologies. Speakers were sought with good insight into both the technical and practical challenges associated with the interoperability of wireless charging of vehicles and the standards pertaining to these technologies. With the support from the Task Members, workshop participants were able to review these two topics from various perspectives.

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**

Figure 1. Task 26 Workshop Topics

2 Workshop Activities

2.1 Host Location

This workshop took place in Rotterdam, the Netherlands on 28 – 29 June 2016. The hosts for this event were Theo Dusseldorp and Jac Turlings of proov B.V., Sonja Munnix of the Netherlands Enterprise Agency, and IEA's Technology Collaboration Programme on Hybrid Electric Vehicles (HEV TCP). Rotterdam is the second most populous city in the Netherlands with about 639,000 inhabitants and covers an area of 319 square kilometers.[1] By total cargo volume, Rotterdam is the busiest cargo port in Europe and the fifth busiest in the world.[2]

2.2 Host Activities in Support of PEV Deployment

In 2015, the Netherlands was ranked as the world's third best-selling country market for plug-in electric vehicles (PEVs) according to HybridCars.com.[3] This is a result of active efforts both by the Dutch (national) and Rotterdam municipal government. In the case of the Dutch government, it is promoting electric mobility by offering reduced tax rates for electric and semi-electric vehicles.

At the municipal level, the programme known as Rotterdam Electric seeks to create the right conditions to provide the best possible support for the market development of electric mobility and thus speed the introduction of PEVs in Rotterdam. Most notably, the programme is providing sufficient electric charging stations in a network throughout the City and larger Municipality of Rotterdam. At the time of the workshop, there were approximately 1,900 charging points within the Municipality of Rotterdam, with 1,400 of those located in public spaces. Furthermore, as reported in CHARGED magazine in September 2016, the municipal government announced plans to install an additional 4,000 public charging points by 2018 to include 1,800 in the city itself and the rest in the surrounding region.[4]

Rotterdam Electric is designed to meet the objectives for electric mobility including reduced greenhouse gas emissions, improved energy efficiency, better air quality, and reduced noise. The projects within Rotterdam Electric are an integral component of the municipal government's larger efforts in the areas of environmental sustainability and climate change mitigation as embodied in the plan "Making sustainability a way of life for Rotterdam: Rotterdam Programme on Sustainability and Climate Change 2015-2018." [5] While these initiatives are addressing surface vehicle emissions, the large volume of marine traffic at the port, like cargo and cruise ships, also produce emissions that impact the city's air quality. The portion of overall emissions attributed to each of these sectors was not discussed.

2.3 Workshop Presentation Topics

With the support of the Task Members, 11 speakers were identified to present on interoperability and standards as it pertains to wireless charging technologies. Presentation topics included a description of working standards, interoperability tests, and system designs of interoperable coils. Figure 2 contains a comprehensive list of presentation topics, the individual presenters, and their affiliations.

Presentation	Presenter	Affiliation
Interoperability concerns and solution ideas	Conny Börjesson	Viktoria
Recent ORNL progress on wireless power transfer systems: stationary and dynamic wireless charging	Burak Ozpineci	Oak Ridge National Laboratory
Wireless power transfer system testing for interoperability standard development	Shawn Salisbury	Idaho National Laboratory
Addressing interoperability challenges for high power HRWPT systems	Morris Kesler	Witricity
Vehicle pad design that address existing and known future requirements for WEVC	Daniel Kürschner	Qualcomm
SAE wireless power transfer standardization through SAE J2954	Jesse Schneider	Chair SAE J2954 Wireless Charging Taskforce
Current status of 100 kW system and the work on standardizing	Matthias Wechlin	IPT Technology
Extending electric operation of hybrid buses through opportunistic inductive charging	Denis Naberezhnykh	TRL
Wireless power transfer for electric vehicles: interoperability and standards the critical factors towards mass adoption	Giampiero Brusaglino	ATA - Associazione Tecnica dell'Automobile
Actual state of the standardization landscape and possible harmonization strategies	Faical Turki	Paul Vahle GmbH & Co. KG
Important aspects to be successful in a global WPT market	Kurt Hug	BRUSA

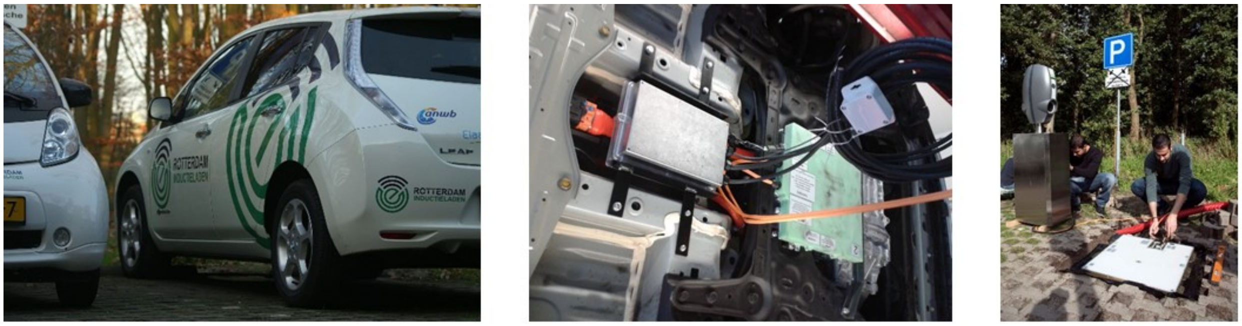
Figure 2. Interoperability & Standards Presentations at HEV TCP Task 26 Workshop 4.

2.4 Demonstrations

There were two demonstrations included as part of the workshop: the City of Rotterdam Inductive Charging Pilot and the Utrecht Public Bus System Demonstration. The first was sponsored by the Government of Rotterdam and was designed to answer the question, "How does the market react to the development of inductive charging for vehicles?" The second demonstration was conducted by Qbuzz, a Dutch public transport company that operates buses in Utrecht.

2.4.1 City of Rotterdam Inductive Charging Pilot

For the first demonstration, workshop attendees visited an inductive charging station located in Rotterdam in a semipublic municipal area for use by light duty EVs. This station uses HEVO wireless technology ground assembly that is flush-mounted with the parking surface. The vehicle in this pilot is a Nissan LEAF with a vehicle assembly coil installed beneath the front end of the vehicle. Additionally, an EV-Box charging station was installed to manage the multiple charging spots. The installation of the charging station had been recently completed when the attendees toured the site. Figure 3 shows three pictures from the pilot project including (a) the Nissan LEAF vehicle; (b) the inductive coil assembly; and (c) the ground coil assembly. Figure 4 provides a list of the partners involved in the project.



(a) Nissan LEAF, pilot vehicle (b) Inductive coil assembly (c) Ground coil assembly

Figure 3. City of Rotterdam Inductive Charging Pilot

Figure 4. City of Rotterdam Project Partners

2.4.2 Utrecht Bus System

The second demonstration took place in the Dutch city of Utrecht where the company Qbuzz operates a fleet of public transport vehicles including buses of various models and lengths as well as coaches. The inductive charging pilot in operation since 2014 was being tested on a single route with three all-electric Optare buses capable of both plug-in and inductive charging. The Optare has an 86 kilowatt-hour (kWh) lithium iron magnesium phosphate ($LiFeMgPO_4$) battery. While at the bus depot, the buses have high power plug-in charging available. However, at the terminus point of the bus route, a wireless ground station is located capable of 60 kW charging. For wireless charging, the bus lines up with a ground assembly that is mounted below the road surface – and with the vehicle assembly then lowered to minimize the air gap. The total route is 4.6 km and the daily distance traveled by these buses is as much as 180 km. Figure 5 shows pictures from the Utrecht demonstration project including (a) an all-electric Optare bus and (b) the lowered vehicle coil assembly.

(a) Optare all-electric bus
(b) Lowered vehicle coil assembly
(c) Bus operating company

Figure 5. Utrecht Public Bus System Demonstration

3 Key Findings

Based on the presentations of this workshop and the demonstrations visited, Task Members had an in-depth discussion of standards and interoperability. The consensus of the Task Members present was that more work is still needed for interoperability. Participants remarked that while SAE J2954 has made good progress in the area of interoperability, the standard for light duty vehicles (LDVs) is not scheduled for release until mid-2018 and possibly later for buses and both medium duty and heavy duty vehicles. Given the timing of the standard, it was suggested that the Task revisit this topic at a later date when standards are released, although it was noted that this would require the Executive Committee to permit an extension to the Task.

3.1 Current State of Standards

The standards that pertain to this technology and their current state of completion (as of March 2017) are presented below in Table 1.

Standard	Status (as of March 2017)
IEC 61980: Electric vehicle wireless power transfer (WPT) systems	Part 1 Corrigendum 1 released; parts 2-3 are pending
ISO 19363: Electrically propelled road vehicles -- Magnetic field wireless power transfer -- Safety and interoperability requirements	Intermediate specification
ISO 15118: Road vehicles – Vehicle to grid communication interface	Parts 1 – 3 are released; parts 4-8 are pending

Standard	Status (as of March 2017)
SAE J2954: Wireless Charging of Electric and Plug-in Hybrid Vehicles	Technical Information Report released
SAE J1773: Electric Vehicle Inductively Coupled Charging	Recommended Practice released
SAE J2836-6: Use Cases and Communications	Technical Information Report released
SAE J2847-6: Communication between Wireless Charged Vehicles and Wireless EV Chargers	Recommended Practice released
SAE J2931-6: Signaling Communication for Wirelessly Charged Electric Vehicles	Technical Information Report released
UL Subject 2750: Outline of Investigation, for Electric Vehicle Wireless Charging	Draft released

Table 1. Status of standards applicable to electric vehicle wireless charging technology.

3.2 Key Points from Workshop 4

A number of key points emerged during the workshop. These idea are listed below. The order in which they are presented is not intended to reflect their relative importance.

- Power transfer efficiency is highly dependent on coil positioning. Self parking assistive technologies will need to know the right place to park for alignment of WPT systems. In public transport, both the driver's ability to align the vehicle and the driver's desire to perform charging played a large role in the efficient and continual electric operation of the vehicle.
- Different power and frequency classes for different vehicle classes present challenges for electric roads development. There will need to be communication between the vehicle and the road so the road powers up appropriately for the approaching vehicle class.
- Timeline for standards development may not be synchronized with OEM high-volume production timelines for WPT.
- The roadmap to an interoperable standard is difficult.
- The testing matrix to be performed at Idaho National Laboratory (INL) in the Fall of 2016 will evaluate interoperability of WPT systems across several manufacturers and wireless power technologies.
- Previous testing of a wireless charging system showed a 4-5% reduction in efficiency from bench testing to vehicle testing which was attributed to the steel chassis on the vehicle.
- Much of the focus to date in the standards groups has been on interoperability of the magnetics, but the more challenging part is likely to be ensuring interoperability of the electronics and controls systems. While the AirFuel Alliance is working on this aspect for consumer electronics, it is not clear which standard will govern electronics and controls for EVs.

- Impact on power transfer efficiency and electromagnetic (EM) fields based on method of mounting ground assembly (i.e, above surface, flush, or beneath) is neither well understood nor defined within the SAE standard.
- In standards development, the challenge is striking a balance between what is important to include in a standard both to keep users safe and the technology moving forward and what to not explicitly define to allow for creative solutions.
- In order for any of the pilot projects to scale up, interoperability will need to be established as it will also drive pricing of these technologies.
- For multiple projects, the installation of the ground assembly along a critical path proved to be real challenge as a result of numerous unforeseen issues with the road works.
- In IEC 61980 the approach is more infrastructure oriented. Similar to a wall outlet where size, conductor position and source voltage is defined, the IEC is trying to “standardize the wireless power socket”. There are three Annexes however which describe three primary (ground) coil configurations. Annex A provides geometric constraints for a ground mounted primary coil such that the secondary coil is kept almost free of constraints for any manufacturer. Annex B describes a in or on ground primary coil that supports interoperability between power classes MF-WPT1 and MF-WPT2. Annex C focuses on MF-WPT1 and MF-WPT2 in the stationary MF-WPT.

4 Conclusions

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

- Standards for wireless power transfer (WPT) remain works-in-progress and closer coordination of the standards being developed by the various standards organizations needs to occur. Task 26 should revisit the standards in the future when they have been released.
- Safety standards are unclear at best with much work needed to resolve confusion over acceptable EM field strengths, proper locations for EMF measurements, ability to obtain accurate results using component testing as compared to fully integrated vehicle testing, etc. Workshop participants recommended that Task 26 should conduct a workshop on safety issues in the future.

5 References

[1]Population estimate of February 2017, Statistics Netherlands; available online at: http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=37230NED&D1=17-18&D2=101-650&D3=l&LA=EN&HDR=T&STB=G1,G2&VW=T (accessed April 10, 2017).

[2]Statistics from AAPA World Port Rankings 2015; in terms of container traffic measured in TEUs, Rotterdam is the busiest port in Europe and the 11th busiest in the world; see http://aapa.files.cms-plus.com/Statistics/WORLD%20PORT%20RANKINGS%202015.xlsx (accessed April 10, 2017).

[3]"Top Six Plug-in Vehicle Adopting Countries – 2015,"by Jeff Cobb, *hybridCARS*, January 18, 2016. Available online at: http://www.hybridcars.com/top-six-plug-in-vehicle-adopting-countries-2015/ (accessed March 23, 2017).

[4]"EV-Box to supply 4,000 public charging stations for Rotterdam," by Charles Morris, *CHARGED* magazine, September 21, 2016; available online at https://chargedevs.com/newswire/ev-box-to-supply-4000-public-charging-stations-for-rotterdam/ (accessed April 10, 2017).

[5]"Making sustainability a way of life for Rotterdam: Rotterdam Programme on Sustainability and Climate Change 2015-2018," City of Rotterdam; Available online at: http://www.rotterdamclimateinitiative.nl/documents/2015-en-ouder/Documenten/Rotterdam%20Programme%20on%20Sustainaibilty%20and%20Climate%20Change%202015-2018.pdf (accessed March 30, 2017).