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New Task on Quick Charging Technology of Electric Vehicles in IEA IA-HEV (Hybrid and Electric Vehicles)

Ignacio Martin[1] ,Tony Markel[2], J.F Sanz[3]
[1]*Operating Agent Task 20, IEA IA-HEV, IGNACIO MARTIN JIMENEZ, CIRCE Fundation.C/Mariano Esquillor Gomez, 15, 50018 Zaragoza (Spain), Tel.: +34 976 761863, Email; imartin@fcirce.es, Web.: www.fcirce.es*
[2]*Senior Researcher, TONY MARKEL, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401 (United States), Tel.: +121 303 275 4478*
[3] *Deputy Director with the IER Area of the CIRCE Fundation.C/Mariano Esquillor Gomez, 15, 50018 Zaragoza (Spain), Tel.: +34 976 761863, Email; jfsanz@unizar.es, Web.: www.fcirce.es*

Abstract

The Task 20 was approved by the Implementing Agreement-Hybrid and Electrical Vehicle of the International Energy Agency in November 2011 and plans to run through the end of 2014. It addresses quick charging technology for plug-in electric vehicles, with the following goals; discuss objectively how quick charging technology can contribute to the deployment of electric vehicles, share knowledge on quick charging technology deployment developments and trends, get consensus and provide joint conclusions to the stakeholders related to the standardization process. This initiative aims at ensuring the build-up of a framework to facilitate the use and smoothly integrated quick charging technology in deployment of a larger electric vehicle in real roads. A large event was held in Japan last June 2013 focused on business cases with the participation of a large number of worldwide top experts, from OEMs, utilities, charger providers and public administration representatives. Some key findings of the discussions at the Task 20 workshop include that there is no single business model for QC to succeed. The trend is for QC customers to charge their EVs for about 15 minutes, which charges the battery to between 50 and 80 percent of capacity. This implies that the customers can use services such as shopping while their EV is charging. According to some studies, fast charges occur most frequently in the evening, often coinciding with grid peak demand. Solutions to avert excessive demand charges could include adaptive power electronics, vehicle-to-grid (V2G) and V2X solutions, and integrating QC with renewable resources and energy storage. However, more demonstration data is required to solve technological and non-technological barriers. Due to the co-existence of CHAdeMO standard and SAE Combo connectors fleets, compatibility of various chargers and EVs will need to be tested as well as harmonization of test procedures are also necessary.

Keywords: Quick charging, grid impact, business cases, compatibility, large deployment

1 Introduction

Quick charging technology represents one of the most promising technologies for promoting EVs in order to help decarbonisation of the transport sector. It will also contribute to innovative zero-emission drivetrain systems. Finally, quick charging opens a branch of possibilities to create economic opportunities as well as new challenges, both technical and nontechnical challenges before it can become widespread.
Some of the main technical issues include the impact on battery performance degradation over time, power grid stability and quality, the higher infrastructure costs, and the high average level of energy consumption that occurs during the first part of the PEV battery charging process. Other challenges include improving public awareness of maintenance needs for public charging stations, and communicating the technical requirements and benefits of quick charging to help local governments and organizations negotiate administrative barriers to installing this technology.

Because the required charging energy is delivered by the power system, EV charging has an impact on the power system. This impact is dependent on the time, location, and power rating of charging.

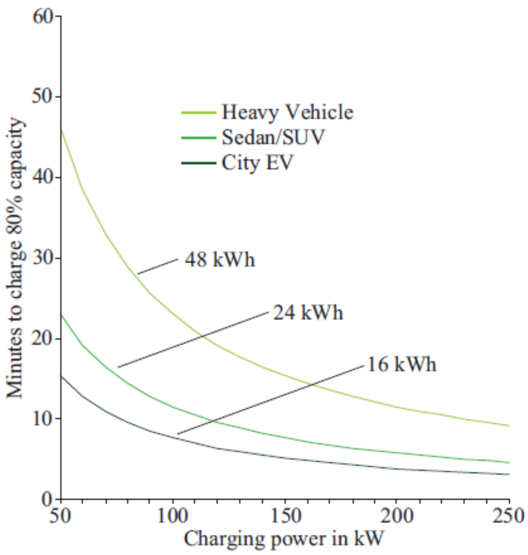

Figure 1. Charging time depending on the type of vehicle and power of chargers[1]

Passenger PEVs are typically charged through the low-voltage (400/230 V) grid, due to the low power rating. For the so-called quick chargers of greater than 40 kW, the chargers might be connected to a higher voltage level, and if so, the grid network must be reinforced. As a result, planning for the power to supply the quick charging stations is necessary to allow for proper load management and avoid problems with the local electrical system. In addition, there is still a lack of a quick charging infrastructure network in appropriate places and offering reasonable charging times.

It is widely accepted that there is a growing need for widely distributed, publicly accessible charging stations, some of which support quick charging at higher voltages. Subject to the power handling of the car-charging electronics and battery chemistry, higher-power charging stations reduce charging time significantly.

Standards are also a key element for the full deployment of quick charging technology. Standards will help to ensure that drivers enjoy a convenient recharging solution that avoids a multiplicity of different cables and adaptors and/or retrofit costs for adapting to new charging systems. A standardized interface between the distribution grid and electric vehicles will ensure the required safety and security level for the consumer. A lack of interoperability between the different systems can cause some fear in the consumers, which can slow down the development of this market. Also, the different safety standards must be considered (IEC 62196-3 Combo-1, IEC 62196-3 Combo-2, IEC 62196-2/3 Type 2, IEC 62196-3 CHAdeMO, IEC 62196-3 China).

The main actors in this field agree that the use of EVs and charging could realize environmentally-friendly "green" mobility. Achieving this will require the cooperation of multiple stakeholders to implement efficient EV charging timed for minimal impact on the electrical grid.

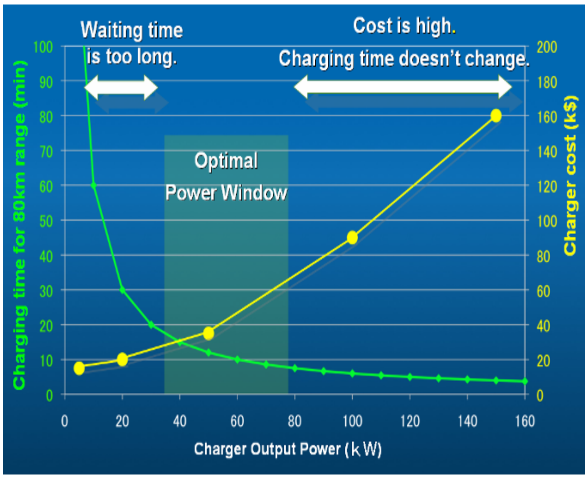

Figure 2.: The complexity of the current situation requires participation and collaboration of different stakeholders to tailor the optimal power window and maximise its rewards. (Source; TEPCO)

2 Targets

A special focus will be on:

- Minimizing the impact of quick charging on the grid and EV batteries
- Breaking down nontechnical barriers to installing quick charging
- Establishing a standard framework for quick charging to be shared among several common applications in order to promote vehicle electrification across the globe.

The main topics to be addressed in the three-year working period are:

1. Current quick charging technology development trends worldwide
2. Outcomes from the latest quick charging pilot projects and the issues to be resolved
3. Lessons learned from past charging network deployment plans
4. Impact of quick charging on PEV battery ageing and behaviour
5. Different charging infrastructure options (e.g., specific charging stations that can charge one or many cars in private or public locations)
6. Relationship between the energy efficiency and the charge power of the charging station
7. Managing the trade-offs between the shortest time to a full charge and the charger cost
8. The need for quick chargers and public charging stations to counter range anxiety
9. Quick charging solution that will help to popularize EVs
10. Issues in the relationship (technical and socioeconomic) between the PEV and the grid, including power quality, tariffs, regulations, incentives, etc.
11. To analyze and propose the best technical solutions for interoperability and the optimum use of the electric infrastructure already in place
12. How emerging technologies (smart grids and EVs) can join efforts to accelerate their market penetration
13. The requirements and issues of quick charging technology for future smart grid promotion
14. Designing and ensuring convenient, safe, and secure handling for consumers
15. Future technology roadmap to help promote vehicle electrification
16. Analysis of the optimum location of chargers in order to foster both a short and larger long distance use (including cross border network)
17. Feasibility and integration of storage energy systems

3 Working Method

The Task is a networking activity. Each participant contributes to the different topics in the Task based on a work sharing principle (data, experiences, forecasts, etc.). All participants are welcomed to the workshops and provide inputs based on their background and forecasts. Participants that are participating come from industry, research organizations, and technology policy institutions around the world representing the utilities, OEMs and battery and charger providers.

The participants of the task 20 identified business cases an issue where IA-HEV Task 20 can play a significant role through fostering information exchange over the next three years. Real-life data from EV users is needed to determine pricing models for quick charging that customers will find attractive and that allow it to be a financially sustainable business. Also, new ways of integrating information and communications technologies (ICT) with power distribution (also known as the "smart grid") may encourage adoption of EVs and charging technologies. Finally, business cases may need to be tailored according to regional requirements.

As a result, after the kick off meeting, hold in conjunction with the EVS26 in L.A., US, with a large participation and interest (more than 40 top attendees from EU, Japan and US), the 2nd Workshop took place last June 2013 in Japan with the support of METI (Ministry of Economy, Trade and Industry of Japan). Three days of discussion and technical visits to significant facilities were devoted to better understand and manage smoothly business cases using quick charging technology.

3.1 Next Steps

The third face to face meeting of the Task 20 is taking place the 17th of November in Barcelona, in conjunction with the EVS27 with the presence of a new number of related stakeholders. Lack of data and experiences, as realized in the previous workshop is hampering the application and the decision-making processes that will define the investments and further actions. Larger number of simulations and modelling are urged to keep strengthening the public perception and the industrial and public administration strategies.

On the hand, the Task 20 is going to launch a public consultation process by October 2013 in the webpage; http://fcirce.es/web/sites/IEA.es. The goal is to reach as many key actors in the QC field involvement in large-scale projects as possible. Wide stakeholder community like utilities, OEMs, charger providers, battery providers, public administrations, ICT service providers, among others are kindly invited to participate. Their opinions will be taken into account to the final Task 20 IA-HEV IEA report as an extremely useful and updated database document.

4 Results and Discussion

Following up to the experiences in Japan and US, the increase number of quick charging points leads to a larger use of EV, even though the customers do not use it as much as expected. The QC network eliminates the anxiety effect, which is instrumental for a larger deployment of EV. Nevertheless, there is no clear and unique business model solution. None plan can wait until having the full business plan completed. The model should be flexible and evaluated, adapted to prices and real needs in the hope of enlarging the network and reaching different kinds of customers and requirements. The plan users must be available for anybody. Furthermore, not all countries and customers have standard/replicated behaviour, however, in any case, EV network alliances are needed to share costs and investment at the beginning. Quick-charging services alone cannot be economically viable. Moreover, the price of energy (kw/h/$) can affect/have an impact and subsequently, a modification of the potential business case can occur. It is encouraged to offer open interfaces to support the charger flexibility models, as well as establish the system for grasping EV users behaviour /movement and profile of EV users to provide more convenient service in the initial stage after switching from free of charge to charge

First results of the ongoing demonstration activities show that the trend is to charge around 15´(50-80% of the battery). It implies then the kind of services linked to the costumers while the charging process is taking place. Furthermore, there is a strong correlation between the number of quick charger points and the sales rates in the regions that invest in QC points. And as a result, QC is expanding clearly the range around cities and creates corridors.

Based on the US studies, fast charges occur most frequently in the evening, often coinciding with grid peak demand. Mass-installation of Quick Charger may cause the decrease of power distribution capacity of grids and the overload of grids at specific time by the use of charging infrastructure. From the utility perspective, basic management of power quality (current, voltage, and active power) is properly handled in any of voltage level case while introducing QC. However, it requires an additional major investment (low voltage specially). Disturbances in the grid due to the use of QC infrastructure can be avoided by incorporating adapted power electronics to the chargers as well as thinking about solutions (again, additional extra costs with theoretically good outcomes). Lastly, second-life batteries could also reduce the impact in the grid. At the same time, it would enlarge the use of this equipment, which might decrease its costs due to its added value after being used for an automation application.

In order to minimize power spikes on the local grid, it is required to avoid exacerbating peak demand while optimizing system cost-effectiveness/business models. Fast Charge Integration with Renewables and Energy Storage to reduce impact of demand charges should be further developed and integrated in the business model too.

Vehicle to vehicle (V2V) and Vehicle to Home/Building (V2X) is not either a technical challenge but the business case is still unclear. The vehicle always arrives back home with a significant amount of power store in the batteries (most likely over 50% of the total charge capacity of the battery). There is not enough number of large demonstration cases involving news applications and beneficiaries (V2G, V2X). Near-term funding and execution is critical to meet deployment plans.

Cooperative activity among OEM and charger manufacturer is necessary to improve the quality of standard and certification scheme as the fact basis. Compatibility of chargers and vehicles is key while harmonizing the appropriate test procedures (joint tests). Further efforts are envisaged to set test methods.

It is crucial for a larger deployment of QC to identify potential funding for non-recurring engineering and hardware buy/installation. Several political policies are underlining the need to the co-existence of the two more extensively charger systems (COMBO+CHAdeMO). All standards need to co-exist and service all customers during the critical take-off phase of the market. Lastly, it is relevant that it is becoming clear that the majority of OEMs support DC fast charge.

Acknowledgments

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Authors

Present Position; EU Delegate in Brussels of the CIRCE Fundation (Research Centre for Energy Resources and Consumption), Operating Agent of the Task 20. Professional experiences; International R+D project management in the Energy field, responsible of Bilateral Technological Agreements with China, Japan and Canada in energy field and evaluator of R+D projects at national and international level

Tony Markel is a Senior Engineer and has been working on systems analysis of advanced vehicles for the past 14 years at the National Renewable Energy Laboratory in Golden, Colorado. Tony leads efforts in the Center for Transportation Technologies and Systems at NREL and provides support to the U.S. Department of Energy Vehicle Technologies Program. Tony earned a Bachelor’s degree in Mechanical Engineering from Oakland University in 1995 and a Masters degree in Mechanical Engineering from the University of Colorado.

José Francisco Sanz received the Ph.D. degree in electrical engineering from the University of Zaragoza. He is currently the Deputy Director with the IER Area of the Centre of Research for Energy Resources and Consumption (CIRCE), and a Lecturer with the Electrical Engineering Department, University of Zaragoza. His research interests are renewable energy integration, power electronic control for renewable energy sources, energy storage systems, grid connection systems and electrical vehicles