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Electric vehicles: The role and importance of standards in an emerging market

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ABSTRACT

After nearly a century with the internal combustion engine dominating the personal transportation sector, it now appears that the electric vehicle is on the verge of experiencing rapid growth in both developed and developing vehicle markets. The broad-scale adoption of the electric vehicle could bring significant changes for society in terms of not only the technologies we use for personal transportation, but also moving our economies away from petroleum and lessoning the environmental footprint of transportation. This article investigates the role of standards, related training and certification for the electric vehicle. It is argued that the potential for the electric vehicle will be stunted without adequate attention being paid to standards, not only in terms of the speed of its uptake and smoothness of this transition, but also in terms of maintaining compatibility between jurisdictions, safety of the public, and helping to ensure environmental sustainability. We highlight a number of areas where new or adaptations of current standards, training and certification may be needed, notably in terms of batteries and charging infrastructures, electricity distribution and accounting for the environmental characteristics of this electricity, and different aspects of vehicle-to-grid and smart grid technologies.

1. Introduction

The emerging opportunity for electric vehicles (EV) to revolutionize both the transportation sector and related technological and infrastructure systems over the next 5 to 10 years is immense. In particular, multiple drivers are now lining up to support broad-based adoption of the EV, while new and emerging technologies offer the potential to establish the EV as part of a two-way electricity system, connecting vehicles with the electrical grid through the homes, commercial establishments or other facilities where the EV may be recharged.

In order for there to be a smooth transition to a future where the EV is a viable transportation option, where there are changes in technologies and infrastructure in terms of the linkage of the EV with the electrical grid, and that these processes occur in a way that protects the environment, there will need to be a host of changes in regulatory environments, operating practices, as well as the training and education of related vocations and practitioners. This article investigates the role of codes, standards and related training and certification in this respect. In particular, we outline and emphasize the importance of standardization in fostering and enabling the adoption of the EV and related technologies and identify areas where adaptations of existing standardization or new standardization may be needed.

1.1. Prospects for the electric vehicle in the coming decades

In 2008 there were less than 500,000 hybrid vehicles sold worldwide, with the market for plug-in hybrids (PHEVs) and battery electric vehicles (BEVs) still limited to conversions of current technologies or high-end vehicles manufactured by specialty producers. Although currently the EV in its entirety represents a very small proportion of the total number of passenger vehicles in most jurisdictions, it is widely expected that the EV will experience rapid growth over the coming decades. In a 2009 study, JP Morgan estimated that by 2020 11 million EVs could be sold worldwide, including 6 million in North America (Automotive News 2009). According to JP Morgan, this will mean that the EV will equal nearly 20% of the North American market and 13% of the global passenger market at that point in time.

The transition to the EV away from the internal combustion engine is expected to be led by the hybrid gasoline–electric vehicle, with this followed by the PHEV, and then finally the full-scaled BEV (Steenhof and McInnis, 2008). In the short-term, government incentives for the EV related to economic stimulus

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and international competitiveness, efforts to mitigate climate change, as well as a push by governments to improve energy security will be the major catalysts for the EV. The United States, for example, recently announced upwards of $2.5 billion US of funding and grants for a variety of EV-related companies and initiatives, intending to have one million EVs on the road by 2015 (Anon, 2009a, b, c). China, meanwhile, is also focusing on the EV from the perspective of economic and energy policy. Notably, the government has made known its intent to position its auto manufacturing sector to be the largest global producer of EVs with a ten billion yuan ($1.46 billion) program to help its industry with automotive innovation in addition to supporting consumption of the EV through generous fiscal incentives (Bradsher, 2009). The importance of Japan in terms of the EV and the emphasis Japanese automakers are placing on the EV should also be recognized, both due to the leading role the country's auto manufacturers already have in the hybrid market as well as in terms of the country strength in battery technology development and production.

1.2. The role and importance of standards

The impacts of the EV in regards to public health and safety, environmental sustainability, as well as how quick this technology is adopted will be greatly influenced by the standards to which the EV and related infrastructure are designed and the adherence to these standards by manufacturers, technicians, and other related professionals. In this way, standards and training and certification based on these standards will likely come to play an important role in guiding and fostering the transition to the EV over the coming years. Internationally consistent standards will also be critical for ensuring compatibility between jurisdictions, a pivotal point underpinning international trade within the globally interconnected automotive and automotive parts markets and also the compatibility of EV-related infrastructure (Castaldo, 2009).

Standards are also important when considering some of the theoretical underpinnings of standardization and that standards provide a mechanism to share knowledge and make this knowledge of a public good. This in effect increases the economic efficiency of development as producers and developers can share in best practices and lessons learn change learned to learnt. It is also important that, given the diverse and wide spectrum of technologies involved with the EV and seeing the varying level of development of each, standardization will have to play varying roles across the development spectrum. Namely, some technologies are more advanced, while others, and in particular those related to both batteries and V2G technologies, are at earlier stages of development. In this respect and as discussed throughout this paper, it will be important that standardization be undertaken from a performance-based perspective so that further technological advancement is compatible with all components of the EV electrotechnical system, safe, and environmentally sustainable.

The majority of standards are developed using a consensus-based approach, where stakeholders and experts from industry, government, academia, and the informed public come to agreement on acceptable performance levels and procedures. Their development is not directly under the control of government in most countries, but rather facilitated by accredited Standards Development Organizations (SDOs). SDOs help develop standards where there is a need identified by regulators, academics, industry, or voiced by the concerned public. Some of the most relevant SDOs to this article include the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), both operating at the international level. There are also a range of national-based SDOs focused on developing relevant standards and ensuring compatibility with international standards, such as the Institute of Electrical and Electronics Engineer (IEEE) and Underwriters Laboratories (UL) (both based in the United States), the Standardization Administration of the People's Republic of China (China), Japanese Standardization Association (Japan), the European Committee for Electrotechnical Standardization (Europe), Standards Australia Institute (Australia) or Canadian Standards Association (Canada). There are also the SDOs working in more specialized contexts, of which perhaps the most relevant is SAE International (Society of Automotive Engineers), an organization primarily focused on standards related to the automotive industry.

Standards were historically focused on contributing to health and safety in terms of product use and infrastructure design, engineering, and construction. With time they evolved to become broader in scope to include applications ranging from guidance on good management practice in business, adoption of energy efficiency practices, to the measurement of business performance or the measurement of environmental health. Now, the increasing complexities of both technology and societal challenges mean that standardization again has to move into new directions and areas. Specifically, with these changes there is the need to have standardization that focuses on systems and the components that contribute to the functioning of the system, as well as the consideration of social, cultural, environmental, and economic dimensions and interactions.

The importance for adequate and consistent standardization in supporting the broad-based uptake of the EV can be illustrated by considering technologies where standardization processes played a role in their respective uptake. One example in this regards is the uptake of the VHS relative to the uptake of Betamax technology. Cottwell (1992) argued, for example, that more producers took up the VHS standard with this in turn resulting in consumers moved more readily to that product since there would be alternative sources of it. Thus, it was argued, standardization helped support the uptake of this technology. Another relevant illustration is that of Renault-Nissan Fluence coming out with a quick-change battery replacement feature that is compatible with the Better Place approach to battery switching (Better Place, 2009). Such compatibility and standardization across EV-related technologies and infrastructure will be a crucial enabling force that will drive the uptake of the EV into the future.

It is in this context that the need for standardization is relevant not only for the transportation sector, but also in terms of how electricity is sourced, stored, and the interactions with the electricity grid through vehicle-to-grid (V2G) technologies. New performance standards and regulations for systems, designs, infrastructure, and education will have to play a key role in this technological change by establishing consistent and compatible design and performance for technologies and infrastructure. These standards will have to be international in scope, going beyond national boundaries to ensure the market is not inhibited by incompatible options. This will be important not only in terms of the EV itself but also in terms of the infrastructure and the skills of those who charge and potentially service these vehicles.

1.3. Recent and existing efforts related to standardization and the electric vehicle

A range of international standards as well as country-specific standards have existed for many years as related to the EV. There are also efforts to prioritize standardization efforts and needs in regards to ongoing developments with the EV and related infrastructure.