A View On Current Trends In Electric Vehicle Standardisation

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Abstract

The increased activity in the field of electric vehicles has also led to an increase in standardisation work. The issues of these standards cover several topics:

- Safety standards, aiming at the protection of personnel
- Performance standards, aiming at defining objective criteria for evaluation
- Operational standards, aiming at the harmonisation of the market

The standardisation work on electric vehicles is performed by several actors in the field: automotive and component manufacturers, energy suppliers, and others like user groups or government agencies.
The paper gives a brief overview of current standardisation activities for selected standardisation documents, analyse the genesis of the standard and define the main factors, which have influenced the contents of the document
As a conclusion, the paper will highlight current trends in standardisation taking into account the societal, technological and economical impact of a widespread distribution of electric vehicles and the role to be played by various actors in this process. This analysis will look at the electric vehicle world from the viewpoint of standardisation, which happens to be a rather unknown and often elusive aspect of the overall electric vehicle environment.

Introduction

The development of electric vehicles into a real product is one of the major issues in the automotive market of the end of this century. The introduction of electric vehicles is justified for several reasons, of which the environmental aspect is considered the most important. In urban traffic, due to their beneficial effect on environment, electric vehicles are an important factor for improvement of traffic and more particularly for a healthier living environment.

Standardisation issues

The increased activity in the field of electric vehicles has also led to an increase in standardisation work, performed by both world-wide organisations like the IEC or the ISO, as by regional and national bodies such as CEN, CENELEC, SAE or JEVA.
The issues of these standards cover several topics:

Safety issues

The main aim of these standards is the protection of personnel. In many cases, they are enforced as regulations. They enable to control hazardous situations that may be present in or around electric vehicles. Electric vehicles represent a complete different technology compared with internal combustion engines. This means that new safety hazards, mainly related to the characteristics of high-power electric equipment, may be present.

To ensure that the electric vehicle, considered as a system together with its charging infrastructure, be designed to operate safely in all conditions, standardisation and regulations work must be performed. These standards will be mainly based on the existing regulations for road vehicles. The use of high-power electric equipment on board the vehicles however creates the need for new regulations and standards. This does not signify at all that the electric vehicle should be considered a “dangerous” product. These standards may also be useful to gain the confidence of the potential user, who might at first be frightened by the presence of high voltage equipment inside a motor vehicle (even if using the same voltage levels at home).

Standardisation and regulation authorities have an important responsibility in this field. The electric vehicle being a "new" product however, the safety aspects and potential hazards associated with its operation are often unknown or wrongly assessed, which may lead to an over-restrictive regulation policy. A well-designed electric vehicle does not present any more potential safety hazards than any other properly designed electrical device. It has no reservoir of highly flammable fuel on board like a gasoline-powered vehicle, which, when invented today, would probably never be allowed on the public road.

The safety standards applicable to electric vehicles can be subdivided as follows:

Electrical hazards: protection against electric shocks, relating to both the traction circuitry on the vehicle and the connection to the grid whilst charging.

Mechanical hazards: generally equivalent to existing standards for thermal vehicles (brakes, seatbelts, etc.)

Special hazards relating to electric vehicles (e.g. battery location, etc.)

Performance issues

The aim of performance standards is to define objective criteria for evaluating vehicle or component performances. This is particularly important for a rapidly evolving technology like electric or hybrid vehicles. In such an environment, new products are competing for a place on a developing market, and the potential customer needs to assess the performances of these products in a clear and unambiguous way. This is notably significant for mission-critical criteria such as vehicle range, as well as for energy consumption. Validated standard procedures for performance measurement will undo performance claims that are given on an arbitrary basis, for publicity reasons.

Operational and dimensional issues

These aim at the harmonisation of the market through the introduction of dimensional and operational requirements for vehicle components. A good example of such standards is the standardisation of vehicle charging connectors, enabling vehicles of different makes to use the same charging infrastructure. Furthermore, these standards are very important from a manufacturer’s point of view, taking into consideration the choice of vehicle components for a certain application.

In many cases, one document presented as a standard may cover several of these issues. Before having a closer look to the electric vehicle standardisation scene, and in order to get a closer understanding of the matter, let’s consider the essence of standardisation.

What are Standards?

In today's world, the term "standards" is frequently used. However, in the context of standardisation, the concept "standard" is well defined: according to the International Electrotechnical Commission (IEC), a "standard" is *"a document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievements of the optimum degree of order in a given context."*
The word "consensus" is very important here. An international standard represents a common viewpoint of those parties concerned, both manufacturers and users. Furthermore, the standard should be *"aimed at the promotion of optimum community benefits"*. A standard is there to aid industry, government agencies and the general user. Standardisation results from consensus agreements between all players in a certain economic sector, e.g. electric vehicle manufacturing and use. The standards relate to specifications and criteria to be applied in the provision of materials, products and services.

A standard should not be considered, as is sometimes done by the general public, as some irrelevant regulation forced upon the community by some class of bureaucrats: an important point when considering standards, is the fact that the adoption of a standard on one hand, and collaboration to its definition on the other hand, are entirely voluntary. International standardisation is wholly based on a voluntary consensus in the technical working groups that prepare the standards. This means that an international standard is to some degree a compromise between the various interests involved, but it is a way to ensure that every standard published is authoritative.

There is an important difference between "standards" and "regulations". While standards are voluntary, and are adopted in order to gain a mutual benefit for manufacturers, suppliers and users, regulations are the law, and are imposed by local or national government bodies. A set of harmonised regulations is however adopted by the countries of the European Union. These regulations are called "directives".

All vehicles are subject to a number of regulations in order to be allowed to circulation. Most of these regulations are safety-related: braking, lights, seat belts,...; there are also environmental regulations, for example relating to emissions. In some cases, regulations may contain refer to existing national or international standards. In this way, standards may obtain force of law.

Standards should also not be confused with manufacturer's specifications. These documents, although they may be similar in content and format to standards, are written by individual manufacturers to describe product specifications, for internal use as well as directed to suppliers. In most case, unlike standards and regulations, such documents are not available to the public.

Benefits of Standardisation

The consistent application of standards in a certain field may have the following benefits:

- The definition of an acceptable level of safety and environmental protection to be achieved with the product
- The compatibility and interoperability of goods and services
- The improvement of quality and reliability through the introduction of agreed performance criteria
- The improvement of distribution and maintenance efficiency through simplification and reduction in the number of different components.

The international character of the standardisation is essential in order to avoid the existence of non-harmonised standards for similar technologies in different countries, which leads to the formation of so-called "technical barriers to trade". Such barriers may or may not be voluntarily imposed; national standardisation may in fact have the additional scope to "protect" the own market. The importance of worldwide co-ordination of standardisation activities becomes even more critical when considering

fields like new technological developments involving several technical or economic sectors (the electric vehicle being an excellent example of this).

The Writing of Standards

International standards are drafted by international standards organisations; the most important of which are the International Electrotechnical Committee (IEC) and the International Organisation for Standardisation (ISO). National standardisation committees are members of IEC and/or ISO.
The development of a new standard follows a procedure that is common to IEC and ISO. The need for standardisation in a certain field is expressed in a “new work item proposal” which is voted upon by the relevant National Committees If this is accepted, the technical scope and the specifications of the standard are drafted by committees of experts which are delegated by National Committees. It should be stressed upon that this work done by experts in the technical committees and working groups is performed on a complimentary basis. The draft standard thus prepared is voted upon by the National Committees, for acceptance and/or comments. When the final version is accepted, a new International Standard is born.

Electric vehicles and standardisation

The past decennia have seen an unprecedented development of electric vehicle technology all over the world, up to the point where only market forces impede the breakthrough of the electric vehicle as a clean and efficient mode of transport. Electric (and hybrid) vehicles are in fact more and more being considered as a positive solution for today's traffic and pollution problems; their deployment can be an important factor for improvement of traffic and more particularly for a healthier living environment.

Legislation and the awareness of people have created a pressure for zero emission vehicles, which is driving the requirements for electric vehicle standards. These are focused particularly on component interfacing, safety, definitions and methods of measurements.
The technologies involved in electric vehicles are moving very quickly, particularly in the field of batteries, power electronics and drive systems. Generic standards to assure safety of persons, to measure performances and to ensure compatibility will continue to be developed as the technology advances.
With standardisation of the electric road vehicle becoming an important issue, the question arises which body would be responsible for these standards. This problem is less straightforward then it looks: the electric vehicle, which introduces electric traction technology in a road vehicle environment, represents in fact a mixed technology.

- on one hand, the electric vehicle is a road vehicle, the standardisation competence for which is the province of ISO;
- on the other hand, the electric vehicle is a piece of electrical equipment, the standardisation competence for which falls under the wings of the IEC.

This difference is even more stressed by the constitution of the technical committees working groups in the two organisations: in ISO, there is a strong input from vehicle manufacturers, whileas in IEC many of the delegated experts are electricians. Furthermore, there is a fundamentally different approach taken towards the concept of standardisation in the automotive and the Electrotechnical world. There is a different "standard culture", the origin of which can be traced back to historical reasons:

- In the car-manufacturing world, standardisation is not so widespread: every manufacturer desires to develop his own technical solutions, which in fact make his product unique. Standardisation for road vehicles is limited to issues covered by regulations (safety, environmental impact), and to areas where interchangeability of components is important (such as fuel properties and the like). For components like combustion engines for example there are very few standards except from manufacturer’s own specifications.

In the electric world, there is a much longer tradition for standardisation (the IEC was founded as early as 1906, when the Electrotechnical industry was at its very beginning) and a stronger tendency to standardise all and everything; furthermore, standards are more looked upon as being legally binding documents. Electric motors are covered by extensive standards covering their construction and testing. Even the colour code of wires is standardised (e.g. green and yellow for the protective or earth conductor).

To allow for an efficient solution to this problem and to avoid the duplication of work between ISO and IEC, which would lead to redundant or even contradictory documents, discussions are now going on between the relevant bodies inside IEC and ISO to come to a division of work on electric vehicles, in order to come to an agreement. To this effect, a joint steering committee, according to the relevant directives of IEC/ISO on such matters, has been constituted. The committee will have the responsibility to overview and steer the work of IEC and ISO committees on the matter, with the possibility of defining joint working groups on certain aspects.

The main philosophy behind the division of labour between IEC and ISO is the following:

The electric vehicle as a “vehicle” is considered by ISO: standards for performance measurement, etc...

the (traction-related) electric components of the vehicle are considered by IEC

the vehicle, as an “appliance” (i.e. connected to the network for charging) is considered an electric device subject to IEC

non-traction equipment on the vehicle is considered by ISO, except when it is operated above certain voltages

in all cases, collaboration between ISO and IEC will be sought on relevant matters.

Standardisation Bodies Active in the Field

The organisations involved with electric vehicle standardisation work are, on a worldwide basis:

The International Electrotechnical Commission (IEC).

Inside IEC, the Technical Committee 69 (TC69) is dedicated to electric vehicles.
IEC TC 69 (Electric Road Vehicles and Electric Industrial Trucks) was established in the 1970's, at a time when environmental concerns, potential oil shortages and available technology made the prospect of electric vehicles attractive. After a slow start, a number of standards and reports were published in the 1980's dealing with chargers, wiring and electric drive systems. More recently, the increasing awareness of environmental matters, coupled with direct legislation to promote zero emission vehicles, has prompted direct involvement at all levels by the vehicle industry.
Inside TC 69, work is performed by different Working Groups (WG) constituted of experts who are designated by their national committees.

WG2, responsible of traction components (motors and controllers) has been active in the 1980's, producing several documents regarding cables, instrumentation, motors and controllers. It has been dormant for a number of years, but was revitalised in 1995, its first commitment being the preparation of a standard considering electric vehicle motors and controllers. This document is a merge and a revision of the documents IEC 785 and IEC 786. The rapid evolution of electric vehicle technology makes it desirable to consider a revision taking into account the latest developments. The concept of integrated electric drives makes a merge of the motor and controller parts of the document desirable. The “new work item proposal” regarding this document has been approved; with however a strong opposition from a number of car manufacturers, who, according to their traditions, deemed this standardisation work unnecessary. The new document should be an answer however to the needs of ISO who have requested clear standards including characteristics, specifications and testing procedures for

electric vehicle components. In the field of standardisation of traction components like motors and controllers, the clear opposition between the electrotechnical and the automotive industries mentioned above is in fact obvious. The division of standardisation labour between the two main concerned bodies, IEC and ISO, is the central issue in this field. The activities of WG2 have now been temporarily suspended pending the outcome of the discussions concerning the IEC/ISO agreement.

The activities of WG3, dealing with traction batteries, have been transferred to a joint working group between IEC TC21/SC21A and IEC TC69. This group aims to develop generic standards about electric vehicle traction batteries.

The working group that was most active in recent years has been WG4, which deals with charging infrastructure. The activities of this working group, where delegates from energy suppliers, car manufacturers, component manufacturers and users are present, may be considered as exemplary for a fruitful mutual collaboration between different parties in the view of electric vehicle standardisation.
WG4 has in fact been able to reach a considerable progress, with several new documents being prepared covering the different modes of charge which may be considered for specific applications.
WG4 has defined a specific structure for the development of new standards which are due to replace the old standard IEC718 (1992): “Electrical equipment for the supply of energy to battery powered road vehicles”. The scope of this structure is to accommodate the different kinds of charging which can be taken into account, namely conductive and inductive charging.
Each of these types of charging will be covered in a series of documents with a common structure:

- a first part concerning general requirements
- a second part covering the physical, electrical and performance requirements concerning the charging devices (when not already standardised). This part is subdivided as follows (each part published as an international standard in its own right):
  - electric vehicle requirements
  - charging station requirements (may encompass different parts, according to the technique used: AC or DC charging, types of inductive charging,…)
  - communication protocol

WG4 works together with other IEC Technical Committees on relevant matters:

- TC23, SC23E on circuit breakers and residual current devices
- TC23, SC23H WG6 on plugs, sockets, connectors and vehicle inlets for conductive charging of electric vehicles

The standardisation prepared by WG4 aims primarily at electric road vehicles being charged at standard AC supply voltages. The aspects covered include characteristics and operating conditions of the supply device and the connection of the vehicle, operators and third party electrical safety and the characteristics to be complied with by the vehicle with respect to the electricity supply equipment. The standards do not apply to heavy-duty vehicles (e.g. buses), industrial vehicles (e.g. fork lift trucks), or off-road vehicles (e.g. wheelchairs).

The International Organisation for Standardisation (ISO),

Inside ISO, Technical Committee 22 is responsible for road vehicles; its Sub-Committee 21 (ISO TC22 SC21) is dedicated to electric road vehicles. The following working groups are active:

- WG 1 Vehicle operation conditions, vehicle safety and energy storage installation
- WG 2 Terminology. Definitions and methods of measurement of vehicle performance and of energy consumption

The ISO committees are mostly composed of delegates of car manufacturers.

Regional and National Standardisation Bodies

Europe: CEN, CENELEC and the ECE

In the European Union, regional standardisation bodies are active. The structure of these bodies, CEN and CENELEC, emulate the role of ISO and IEC on the world level.
The aim of CEN is described as “The implementation of standardisation throughout Europe to facilitate the development of the exchange of goods and services and the elimination of technical barriers to trade”. CEN and CENELEC interact closely with the international bodies ISO and IEC; this is of particular importance in order to further reduce barriers to trade at the international level. The main difficulty in this field appears to be the failure actually to implement the International Standards voted positive in the CEN/CENELEC sense, thereby abandoning competing specifications.
Since 1985, the European Union has devised a “new approach” towards standardisation issues in order to use the work of standardisation bodies as a way to devise new directives, which are enforced in the Union.

CEN TC301 has produced a number of documents which are now registered as Draft European Standards (prEN). They relate to the following fields:

- Electric and hybrid vehicle performance measurement
- Safety aspects

CENELEC TC69X is producing a document set on charging infrastructure. In order to obtain a maximal efficiency of standardisation work, these documents should closely emulate the work of IEC TC69 WG4. Otherwise, the parallel work going on between committees would be a waste of resources, and the existence of non-identical standards on the same subject would lead to confusion.

Furthermore, a number of regulations for vehicle type approval are issued by the “Economic Commission for Europe”, an international organisation based in Geneva. The ECE regulations are often reproduced in European Union directives and included in countries’ national legislation. It should be stated however that the ECE is not part of the EU administration; rather, the EU is a member of the ECE, representing the fifteen EU member states as a single body.
Existing ECE regulations are being adapted to be applicable for electric vehicles. It is important however to perform this adaptation sensibly: the proposed ECE document describing a method for determining the power of electric vehicle drive trains for example, even if it covers a certain need (the determination of drive train power is not only useful for technical reasons but is also needed for purposes such as taxation or insurance) is typical for ill-adapted standardisation work: an existing document about internal-combustion engined vehicles has been “converted” to electric vehicles without taking into account the proper characteristics of electric drives: the proposed document even speaks about the “crankshaft” of an electric motor...

United States

In the United States, the Society of Automotive Engineers (SAE) has issued a number of technical documents concerning electric vehicles. These include both “standards” and “recommended practices”.

Japan

In Japan, electric vehicle standardisation work is being done by the Japanese Electric Vehicle Association (JEVA)

Conclusions

The standardisation work on electric vehicles is performed by several actors in the field: automotive and component manufacturers, energy suppliers, and others like user groups or government agencies. On one hand, the combined expertise of these partners will allow the writing of quality standards which are to become useful working documents for all those in the trade; on the other hand, each of them has their particular social or business interests which may influence their viewpoint on standardisation an which will ultimately define the agenda of the standardisation committees.

The activities of all the committees active in the field will lead to a structured set of documents describing the different aspects of the electric vehicle technology. However, taking into account the rapid evolution of the technology in the field, these documents are in no case to be considered as definitive, and they will be in constant evolution and revision. A too narrow definition of a standard may reflect a momentary state-of-the-art, which is due to change anyway, so that strict adherence to it may impede further technological evolution. This is extremely important when considering applications such as inductive charging, where different technologies co-exist, each having its merits for a particular application.
Furthermore, the standardisation of electric vehicles must take into account the characteristics of these vehicles, and not merely mimic existing specifications for internal-combustion engined vehicles.
Safety of the vehicle and of its associated infrastructure may of course not be compromised, and safety standards will be particularly important in the legislative and regulation fields.

The availability of accepted standards and technical documents is an important factor to allow the user, and more in particular the fleet user, to assess the value of the electric vehicle products which are made available to him or her.
For the vehicle manufacturer, and more in particular for the small and medium sized enterprise which heavily relies on external component suppliers, well-defined component standards will enable a better view on the market in order to make the best design choices.
The availability of widely recognised standards, and the adherence to these, will also allow vehicle manufacturers to present their products on a global market.

The compliance to known and accepted standards will allow to gain user confidence in the product and to develop a wide market for the electric vehicle, which will then confirm its position as the safe, reliable, energetically and economically sound transportation means of the future.

There is clearly an important task in this field for the standardisation bodies, which, in their tradition of voluntary mutual collaboration in an atmosphere of consensus, have a solid contribution to the worldwide acceptance of the electric vehicle. This way, the standardisation work creates a unique opportunity to overcome differences between nations, between economic actors or between business competitors, in order to work together towards a better future for civilisation.