The Evolution of Electrically Propelled Vehicle Technology and the Multidisciplinary Challenge for Standardization and Regulation

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Abstract

The electrically propelled vehicle (this term encompasses battery-electric, hybrid and fuel cell vehicles) can be considered as a device uniting several technologies: automotive construction, mechanical drives, electric drives, power electronics, batteries, fuel cells, compressed gas storage, etc. In the case of the electrically propelled vehicle, where automotive and electrical technologies meet, special considerations have to be taken to come to an efficient standardization scene; the interaction with vehicle regulations, which are legal documents related to vehicle type approval, has also to be taken into account here.
The electrotechnical industry has a strong tradition of standardization which has given rise to a specific culture and approach to standardization matters. For practical and historical reasons, different traditions are present in the automotive industry. The paper gives an overview of the evolution in this domain, with a view towards further developments such as new drive train topologies and fuel cells.

Keywords: standardization, regulation

1 The different standardization bodies working around the electric vehicle

Standardization, on a global level, is mainly dealt with by two institutions: the International Electrotechnical Commission (IEC), founded in 1904, deals with all things electrical, whileas the International Organization for Standardization (ISO), founded in 1948, deals with all other technologies.
With standardization of the electric road vehicle becoming a key issue, the question arises which standardization body would have the main responsibility for electric vehicle 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 [1]:

on one hand, the electric vehicle is a road vehicle, the standardization competence for which is the province of ISO;
on the other hand, the electric vehicle is an electrical device, the standardization competence for which falls under the wings of the IEC.

Furthermore, there is a fundamentally different approach taken towards the concept of standardization in the automotive and the electrotechnical world. There is a different "standard culture", the origin of which can be traced back to historical reasons. This dichotomy had been encountered by the European Electric Road Vehicle Association AVERE [2] in its studies on standardization and regulation.

There is a long tradition for standardization in the electrotechnical industry, as well a stronger tendency to standardize all and everything. Electric motors are covered by extensive IEC standards covering their construction and testing. Even subjects such as the colour code of wires are standardized (e.g. green and yellow for the protective or earth conductor). In the electrotechnical industry in fact, the role of specialist

component manufacturers acting as suppliers to equipment manufacturers has always been more common.
Electricians do not only want to define the vehicle as a whole, but also to standardize its components, on a point of view of safety, environment, quality and interchangeability.
Furthermore, the customers of the electrotechnical industry are more likely to be powerful corporations (e.g. railway companies) who tend to enforce very strict specifications on the equipment they order or purchase, hence the need for more elaborate standards to ensure the compliance of the equipment. Industrial electrical equipment is also designed for an extended service life: continuous operation during several years, which corresponds to up to 100000 hours.

In the car manufacturing world on the other hand, standardization is limited to issues which are subject to government regulations (safety, environmental impact, performance measurement) and to the areas where interchangeability of components is a key issue. Since car manufacturers desire to develop their own technical solutions which embrace their proprietary technological know-how and which give their products an unique market advantage, there are few standards covering combustion engines for example.
Car manufacturers accept that a vehicle, as a whole, is subjected to safety and environmental regulations, but do not feel the need for definition of individual components.
Furthermore, the automobile has become a mass-market product: extensive routine tests on every produced vehicle would be prohibitively expensive, and the customer is more likely to be a "consumer", less interested in providing the supplier with written specifications demanding compliance to specific international standards. The expected service life of an automobile (5000 to 10000 hours) is also much lower than of an industrial electrical machine.

This difference is further reflected in the constitution of the technical committees and their working groups which deal with electric vehicle standardization in respectively IEC and ISO. In the IEC committees many of the delegated experts are electricians or component manufacturers, whileas in ISO there is a much stronger input from vehicle manufacturers.

2 Collaboration IEC-ISO on electric vehicles

Collaboration between ISO and IEC in the field of electric vehicles has been established since the foundation of the respective working groups, ISO TC22 SC21 and IEC TC 69, in the early 1970s. During the years however, there have been considerable discussions between the two groups as to the division of the work, in which there were a number of overlaps.
Following the setting up of ISO TC22 SC21, an informal liaison meeting between representatives of ISO and IEC was held in Frankfurt in October 1973 [3]. The representatives of both organizations there unanimously agreed that it was necessary for both to be involved in the wide range of work, and emphasized in particular that a close liaison should exist between the two organizations, to this effect it would be recommended to be involved in each other's work through inviting representative on each other's working groups. A joint IEC/ISO committee however was not feasible for administrative reasons [4].
A provisional division of work was agreed, which was modified very slightly at the subsequent meeting of ISO TC22 SC21. It was agreed upon in general by IEC TC69. As a result of this, a number of results of the work carried out since the start of IEC TC69 in 1969 were transferred to ISO TC22 SC21.

At the IEC TC69 meeting held in Florence in June 1978, it was noticed that the draft of ISO 6469 was overlapping with subjects felt to be the province of IEC, for example electrical safety of vehicles, which was being covered in the draft for the ISO 6469 standard. A proposal presented by ISO TC22 delegates present at that meeting as observers was discussed and accepted as a guideline for future co-operation between the different working groups of IEC TC69 and ISO TC22 SC21 [5].

Although TC69 still abode by the agreement reached in 1973, it was felt that better co-operation was desirable, particularly at WG level, and that the borderline between the two committees should be determined more strictly.

The discussion went on during the next few years, and by 1990 a modification was proposed by ISO, where all work on vehicle standardization, including equipment specifications when assembled in the vehicle, would be ISO's responsibility [6].

This proposal was discussed at the IEC TC69 meeting in Anaheim in 1994 [7], where it was proposed to use only two responsibility levels instead of four (ISO for on-board equipment and IEC for off-board equipment).
During the next year, several proposals for division of work were drafted and circulated.
At t the ISO TC22 SC21 meeting in Berlin in April 1995 [8] , the following remarks were stated:

> Electrotechnical components such as cables are already standardized by ISO for general automotive applications, and shall remain ISO domain for electric vehicles, as to ensure compatibility between all automotive cables and efficiency in standardization. Amendments to specific electric vehicle requirements shall consider expertise of IEC standards, if any.
>
> For electrotechnical components not used in combustion-engined vehicles and only standardized in IEC, the IEC standards shall be checked and adapted, where necessary, to general automotive conditions.
>
> Standards for components and items belonging to the interface vehicle/charging station should be covered by either ISO or IEC standards, according to compatibility reasons.
>
> In any case, all standards on electric vehicles shall be consistent with the overall vehicle conditions and requirements set by the vehicle manufacturer (and legal requirements, if any).

The plenary meeting of TC69, held in Brussels in October 1995 [9], was attended by the chairman of ISO SC21 and the secretary of ISO TC22, who stated that it was essential for standards not to be developed in parallel, and that electric vehicles were to be standardized in the same way as all other road vehicles: ISO deals with the vehicle as a whole, while IEC must concern itself with (electrical) components.
Both IEC and ISO delegates at that meeting agreed the necessity for co-operation, and in some cases, joint working groups would be appropriate and useful.

During the year 1996, intensive discussions on the Work Programme went on within both IEC and ISO committees. At a joint meeting held in Geneva on April 12, 1996, a new document to be used as basis of an agreement between IEC and ISO, was discussed; an updated proposal was subsequently worked out and circulated as an administrative circular within the respective IEC and ISO Committees [10]. The main idea behind the proposed division is reproduced in Table 1.

Table 1: Basic division of work IEC/ISO

ISO	IEC
Work items related to the electric vehicle as a whole	Work items related to electric components and electrical supply infrastructure

3 The IEC-ISO Joint Steering Committee

At the IEC TC69 meeting in October 1996, it was agreed to propose to ISO the formation of a Steering Committee, according to ISO/IEC Directives [11], and to recommend this steering committee to consider a number of activities as suitable for joint working groups. These activities include "terminology", as well as a number of items from both the ISO and IEC listing.
The following resolution was accepted:

"TC69 resolves to propose to ISO that a joint steering committee be formed according to the ISO/IEC Directives, Annex A, clause A3.1, with the responsibility to steer the work and to propose, where necessary, joint working groups placed under the relevant IEC or ISO body to ensure the exchange and circulation for comments of committee documents" [12]

ISO TC22 formally approved the proposal to establish the IEC/ISO Steering Group at its plenary meeting in Berlin in May 1997, where the following resolution was approved:
"TC22 mandates the chairman of SC21 to form a steering committee with the chairman of IEC TC69. With the confidence in the chairman to make decisions, the steering committee is to define the future work program and to allocate the work items to the responsible committee. The work shall be allocated as follows:

ISO TC22: Vehicle and its components
IEC TC69: Infrastructure for electric vehicles

TC22 requests the ISO Central Secretariat to inform the Central Secretariat of IEC." [13]

One should note the difference in scope proposed by ISO in this resolution, which brought all components within the domain of ISO.

A number of work items under consideration were circulated within ISO and IEC for comments in order to develop a project-based work program between ISO and IEC [14]:

Methods of measurement of vehicle response, performance and range
Methods of measuring system efficiencies/energy consumption
Electrical safety; connected to mains and stand-alone
EMC, connected to mains and stand-alone
On-board high voltage cables, connectors and fuses
Methods of measuring drive system power
Dimensions of common components, e.g. batteries
Connection and communications between vehicle and infrastructure
Operating environment for the vehicle, connector and charger
Methods of measuring battery system performance
Measurement of charging times, efficiencies and conditions
On-board communications protocol.

The first meeting of the IEC/ISO Steering Group took place in Paris on October 9th, 1997. The Group was composed of eight members, among them the chairmen of IEC TC69 and ISO TC22 SC21. The author took part in the Steering Group as convener of IEC TC69 WG2.

This meeting defined the terms of reference for the Steering Group as follows:

The Steering Group will deal with issues related to the standardization of battery-electric road vehicles.

The Steering Group shall work on behalf of the vehicle manufacturers, the utilities, the component suppliers and other partners with a legitimate interest in standardization, in the formulation of the work programme related to the standardization of battery-electric road vehicles.

The Steering Group shall first collect information from the relevant parties noted above on the requirements for standards as an aid to safety, commercialisation, functionality and testing.

The Steering Group shall formulate the work programme, advising on the objectives of each work item, setting the timescale, agreeing the host organization and confirming the document circulation procedures.

The Steering Group shall be prepared to recommend that certain items of work within IEC and ISO shall be terminated or postponed.

As for the definition of a work programme, it was agreed to seek guidance from interested parties in the field by letter and direct contact.
The interest of car manufacturers for guidance documents and standards about system safety was recognized, as well as the interest for standardization of charging connections. Product specifications intended for suppliers fell outside the scope of international standardization.
Links with regional standards organizations should be maintained where appropriate; regional differences in practices will occur (e.g. for electric supply networks), but the objective is to ensure that the basic documents are the international standards produced by IEC and ISO.
The Steering Group agreed to have the ongoing work of IEC TC69 WG2 suspended until the work programme had been finalized.
To assess the interest in the field for electric vehicle standardization, a questionnaire was circulated in November 1997, and again in the spring of 1998, to vehicle manufacturers, suppliers and utilities worldwide.
Further meetings of the Steering Group took place in Brussels (March 23rd, 1998) and Esslingen (October 12th, 1998), where the current activities of the different standardization committees were presented. Problem areas identified concerned mostly the co-ordination of European standardization activities by cen-cenelec with those of IEC-ISO, particularly the work of CENELEC TC69x, who had issued ENV documents (European pre-standards) based on a draft version of the corresponding IEC standards, and who was working on a document concerning the communication protocol between vehicle and charger.
The results of the questionnaire, also discussed at this meeting, confirmed the current standardization subjects on electric vehicle and did not indicate strong demand on other subjects. The following topics were given a high priority for standardization work:

- Vehicle-related performance procedures
- Safety issues
- Charging infrastructure communication issues and connectors

The Steering Group reported officially about its activities to both IEC and ISO Central Office, expressing its concern about the apparent lack of co-ordination between international and European standardization, which created the risk of duplication of work and the creation of a dual standard for the same purpose.
A further meeting of the Joint Steering Group was held in Frankfurt on December 7th, 1999, where the main outcomes were the following [15]:

- The work by IEC TC69 WG2 on IEC 61981 "On-board power equipment for electric road vehicles" was to be discontinued. The WG2 was to be reactivated however to address grid-connected considerations (methods of measurement, bi-directional power flow, etc), difference between stand-alone component performance and on-vehicle performance, and design rules for EMC.
- The EMC work by IEC TC69 was to be co-ordinated with IEC TC77 and CISPR. The difference in tests and measurements for EMC was to be harmonized between IEC and ISO. EMC up to 5 GHz would be identified by ISO.
- The development of a communication protocol for d.c. charging would be the task of ISO TC22 SC3 WG1 "Electrical and electronic equipment - Serial data communication", this WG already being involved with similar communication protocol issues for automotive applications. IEC 61851-3 was to be deleted from the IEC TC69 WG4 work programme.
- The progress in IEC/ISO participation, ISO/CEN and IEC/CENELEC harmonization was noted, the idea being for IEC and ISO to provide international standards for regional and national acceptance.
- The new work of the IEC TC105 on fuel cells was reviewed; it was supported by ISO TC22 SC21 and IEC TC69.

4 Future developments in component standardization

The development of advanced drive systems for electric and hybrid vehicles created the opportunity for new action horizons for IEC TC69 WG2 to emerge however.
Further research has been performed on these issues which have led to the findings described in the following paragraphs. The evolution in power electronics in fact showed steady progress, with new components (GTO, MOSFET, IBGT) and new control techniques (microprocessors) which introduced the possible use of a.c. motors (particularly asynchronous induction motors, synchronous permanent-magnet motors and variable reluctance motors) in variable-speed applications including traction. Asynchronous motors are cheaper to manufacture, require less maintenance and are more sturdy then d.c. Ones. The typical a.c. driven electric vehicle contains an inverter which transforms the d.c. from the battery in a.c. for the traction motor. During regenerative braking, the motor functions as generator, feeding a.c. to the inverter, which rectifies it to recharge the battery. The current levels during this braking can be high, up to the maximum acceleration current, corresponding to the full power of the vehicle. This recharging capability of the inverter could also be used however during battery charging from an external a.c. supply, at high power levels. This leads to the possibility of fast charging, with a high-power a.c. connection, which represents a much lighter infrastructure than the off-board fast charging stations which supply the vehicle with d.c.

Furthermore, such structure offers the opportunity of supply network management, using the batteries of electric vehicles (or the fuel cell power plant in a fuel cell vehicle) connected to the network as peak shaving units, feeding a.c. in the network through the inverter. The use of the traction inverter for charging presents the following features which differ it from the “ordinary” charging procedure of batteries:

- The charging of the battery is done through a vehicle component (the inverter) which also performs other functions in traction, and not through a dedicated (on or off board) charger.
- Since the inverter is not necessarily (and in most cases is actually not) providing galvanic isolation between the d.c. “motor” side, the d.c. “battery” side and the a.c. intermediate circuit and external a.c. connection, the vehicle traction circuits, including the battery, are directly connected to the a.c. supply network during charging. This is a fundamental difference with conventional chargers, which in virtually all cases are isolated between input and output through the use of a (low or high frequency) transformer. This may have an impact on equipment safety.
- A bi-directional power flow may exist between the vehicle and the supply network.

The inverter and battery (or fuel cell), being connected to the network, become an” electric device”. There is a clear overlap here between the activities traditionally attributed to IEC (the electric devices connected to the network) and those catered for by ISO (the vehicle itself, including its traction components).

The concept of “electric device” makes it desirable to proceed to standardization, in order to address the following issues:

- Safety: protection of personnel
- Interference with the network, including EMC issues (particularly in the case where a bi-directional energy flow between the vehicle and the network is foreseen)
- Difference between stand-alone component performance and “on-vehicle” performance.

At this moment, few, if any, international standards exist for electric vehicle components. Vehicle manufacturers of course draft specification sheets for components, for the use of their component suppliers. Although these sheets may present the format and the structure of standards documents, they are not to be considered as such, being proprietary documents geared at one specific product, vehicle, or application. Also, contrary to real international standards, such documents are generally not available to the public. The vehicle manufacturers do not perceive the need for such standardization work, which is considered an impediment for technical progress and for the development of proprietary know-how. It is not customary either to define construction standards for thermal vehicles.

Based on these findings, it was proposed to start work on a new document: "Electric traction equipment of electric road vehicles - connection to the electric supply network." with the following scope and object:

"This standard is applicable to electric power equipment on electric and hybrid road vehicles which can be energised by both the main on-board energy source and the external electric supply network. Examples include on-board inverters which are used for traction as well as for charging. The object of this standard is to lay down general rules for the design, installation and testing of electric power equipment on electric and hybrid road vehicles which can be energised by both the main on-board energy source (traction battery) and the external electric supply network, and to indicate the technical requirements and testing conditions for them."

The new document, although clearly falling in the province of IEC, should be an answer to the needs of ISO since it refers to electric vehicle components and thus to the vehicle itself. Due to the close interweaving of vehicle-related aspects and equipment-related aspect, and reflecting the ideas of the agreed division of labor IEC/ISO, close collaboration with ISO would have to be sought on relevant matters. This also implies that the roster of IEC TC69 WG2 would have to be extended with delegates from the automotive sector.

To be acceptable to automotive manufacturers, the new document should not be too restrictive in imposing constructional limitations, but rather give a support for recommended practices. As there has been however no meeting of the IEC/ISO Steering Committee, nor of IEC TC69 since, this proposal has not yet been materialized. The establishment of the IEC TC69 secretariate by the Belgian committee from 2005 on may offer opportunities for expediting this work.

5 Fuel cell standardization work at IEC

The "fuel cell" can be quite rightly considered an "electrical device" since it generates electricity; its standardization would thus be a task of the IEC.

To this effect, IEC Technical Committee 105 "Fuel Cell Technologies" in October 1998, in charge of preparing international standards regarding fuel cell technologies for all applications.

The collaboration between TC105 and ISO TC22 SC21 was deemed essential due to the application of fuel cells for automotive purposes.

The point of view of ISO TC22 was to consider the fuel cell system as a "black box" delivering electricity, to be compared with the battery on a battery-electric vehicle, and it saw its job in the integration of the fuel cell into the vehicle. A formal liaison between the two committees was thus proposed, and undersigned by both parties in August 2000. The work would be divided as follows:

- ISO TC22 SC21was to take the lead in the standardization activities with respect to the integration of fuel cell systems into road vehicles; the activities would be integrated in the existing SC21 structure.
- IEC TC105 was to take the lead in the standardization activities concerning fuel cells for propulsion in its WG6.
- A joint steering committee would co-ordinate the allocation of work to either of the committees.

It is clear that the realization of such collaboration agreement, before the actual start of the standardization work, has been a key step in making a fruitful collaboration possible, without any hitches that might have occurred otherwise.

A similar agreement was signed with ISO TC197, which deals with “Hydrogen”, and which in the framework of the fuel cell standardization would be responsible for all hydrogen infrastructure issues. TC105 started its work on these aspects towards the IEC 62282 family of international fuel cell standards.

However, the international standardization work on fuel cell powered road vehicles has been mostly concentrated within ISO TC22 SC21. For this reason, it has been proposed to exclude road vehicles from the scope of the standard IEC 62282-2 “Fuel cell modules” and to transfer the work to ISO. This was voted upon by IEC TC105 member committees. There is still to be decided however whether the standardization of fuel cells for road vehicle applications should be either within the sole responsibility of ISO TC22 SC21, implying a change of the scope of IEC TC105, or under the responsibility of a Joint Working Group (JWG) which would need to be set up and operate under the lead of ISO TC22 SC21.
This discussion underlines once more again the special case of the electrically propelled road vehicle, which unites automotive technology (typically standardized under the auspices of ISO) and electrical technology (typically standardized under the auspices of IEC). This dichotomy has caused similar discussions in the past about who exactly was to perform the standardization work; such discussions can only be resolved by mutual collaboration and recognition of the characteristics of each technology being put to use.

6 Road vehicle fuel cell standardization work at ISO

The topic of fuel cell vehicles first appeared within ISO TC22 SC21 in 1998, with the idea to start working on safety requirements for fuel cell vehicles. The production of water by the fuel cell stack was in fact perceived as a potential problem for the system electrical insulation, to be considered in standards like ISO 6469. Several national committees declared that their industry had started the development of fuel cell vehicles. One main point of the discussion was whether it would not be premature to start standardization work at this early level of development; it was stated however that: “relevant standardization should not be retarded to avoid unnecessary debates at later work.”
ISO TC22 SC21 WG1 deals with “Vehicle operating conditions, safety and energy storage installation”, and is thus also responsible for fuel cell vehicle safety.
It considered a number of drafts (from Germany, Japan and the USA), and chose the four-part Japanese draft as basis for its further development on the standard “Fuel cell powered road vehicles - Safety specifications”:

- Part 1: Vehicle functional safety
- Part 2: Protection against hydrogen hazards
- Part 3: Protection of persons against electrical hazards

ISO TC22 SC21 WG1 also harbors a task force focusing on the definition of a suitable terminology for fuel cell vehicles, which should be in accordance with existing electric vehicle terminology (as defined in ISO 8713) and fuel cell terminology (as defined through the activities of IEC TC 105).

Performance standards for electric vehicles are dealt with by ISO TC22 SC21 WG2 TF1. These include subjects such as road operating ability (acceleration and maximum speed), energy consumption measurement and emissions (the latter item not being relevant for hydrogen-fuelled vehicles). For each of these cases, the division has to be made between “pure” fuel cell vehicles and fuel cell hybrid vehicles, the test procedures in each case differing. Furthermore, one has to take into account the different energy sources which can be used: compressed or gaseous hydrogen, liquid hydrogen, carbon-based fuels (e.g. methanol) or other fuels.

7 Standards versus regulations

The standardization of road vehicles in particular has to operate in close collaboration with the regulation world. Vehicles, to be type-approved, must in fact be complying with technical regulations, which for the case of Europe, are the ECE-regulations, which are not, as often thought, issued by the "European Commission", but by the United Nations. Within the UNECE (United Nations Economic Commission for Europe), the GRPE (Groupe Rapporteur Pollution et Energie) is responsible for relevant regulations; a number of existing regulations will have to be amended for the use of the fuel cell vehicle (e.g. energy consumption and emission regulations), whileas for the fuel cell vehicle safety a new regulation will be drafted.
A comprehensive overview of the different players in the standardization and regulation field is given in Figure 1 [16]. One can easily see the complexity of the existing structure, which creates specific challenges to allow effective standardization work to be performed.
In particular, it is clear that the regulations will have to be in close concordance with the international standards, otherwise a great confusion will arise and the documents will become unworkable.

This can only be realized through a close collaboration between all parties involved.

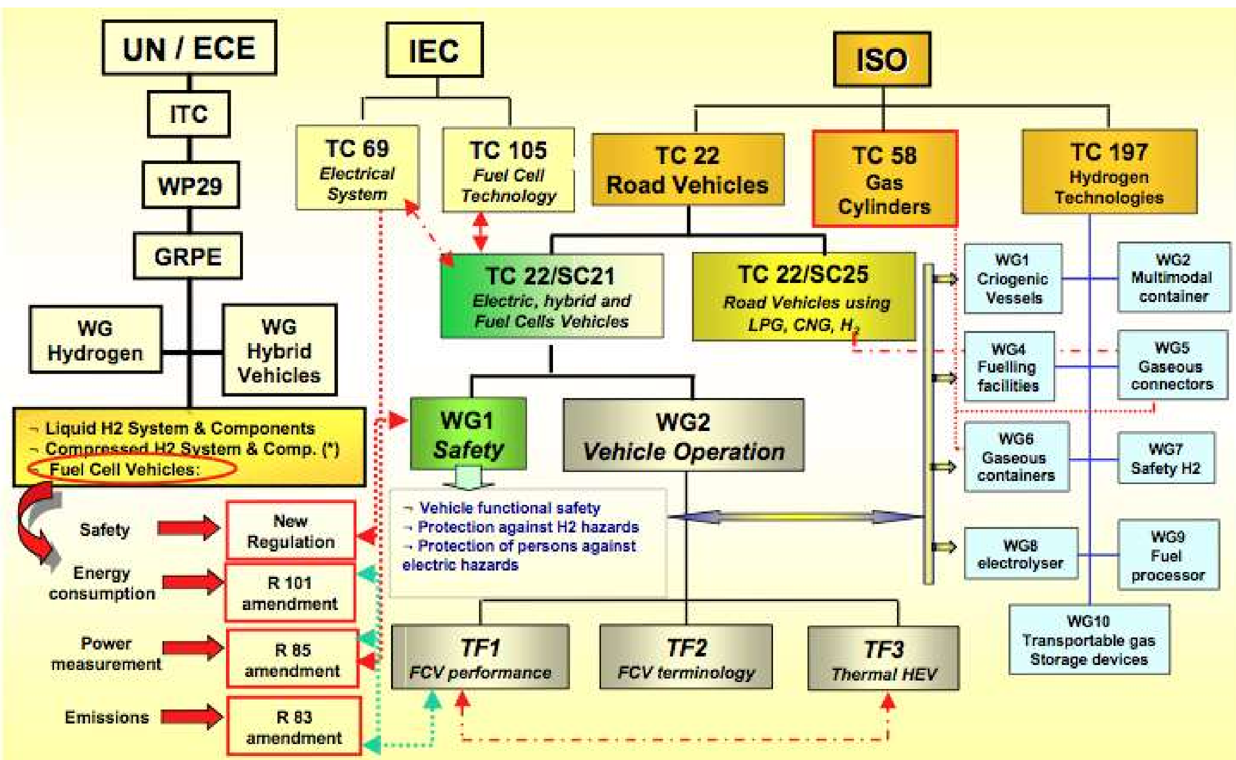

Figure 1: Actors in standardization and regulation

A proposal for such a collaboration scheme is given in Illustration 2. This scheme, which originated in the ELEDRIVE [17] thematic network, will encompass relevant actors in each of the regions where significant developments in the field are taking place: Europe, North America and Japan. In each of these areas, government services, research centers, R&D programs and trade associations have a role to play and are to be reunited in an "advisory coordination group" which is to provide relevant input to the standardization bodies on one hand and the regulation bodies on the other hand.

Furthermore, a harmonization group will scrutinize the work being performed by these bodies, as to come to a strict concordance between standards and regulations.

An ideal situation would be to follow the "New Approach" philosophy which is now being implemented in the European Union, and where regulations enforced by the government (e.g. EU directives such as the machine directive, low voltage directive or pressure vessel directive) define "essential safety requirements", but do not state technical details. For these, reference is made to European or international standards. These standards remain standards, that is, they are voluntary, but complying to the standard implies complying to the directive.

For road vehicles however, this system has not yet been implemented, the type approval regulations being issued by the UNECE which is beyond the level of the EU only. The advantages of the "New Approach" are clear since the discrepancy between standards and regulations is eliminated, and the restriction of technological development through obsolete specifications enshrined in legislation or overspecification by overzealous legislators can be avoided. However, one has to recognize that the main vehicle manufacturers are not in favor of an adaption to this system on EU level, since it could introduce additional discrepancies with the rest of the world which is covered by ECE and might be covered by global technical regulations (GTR).

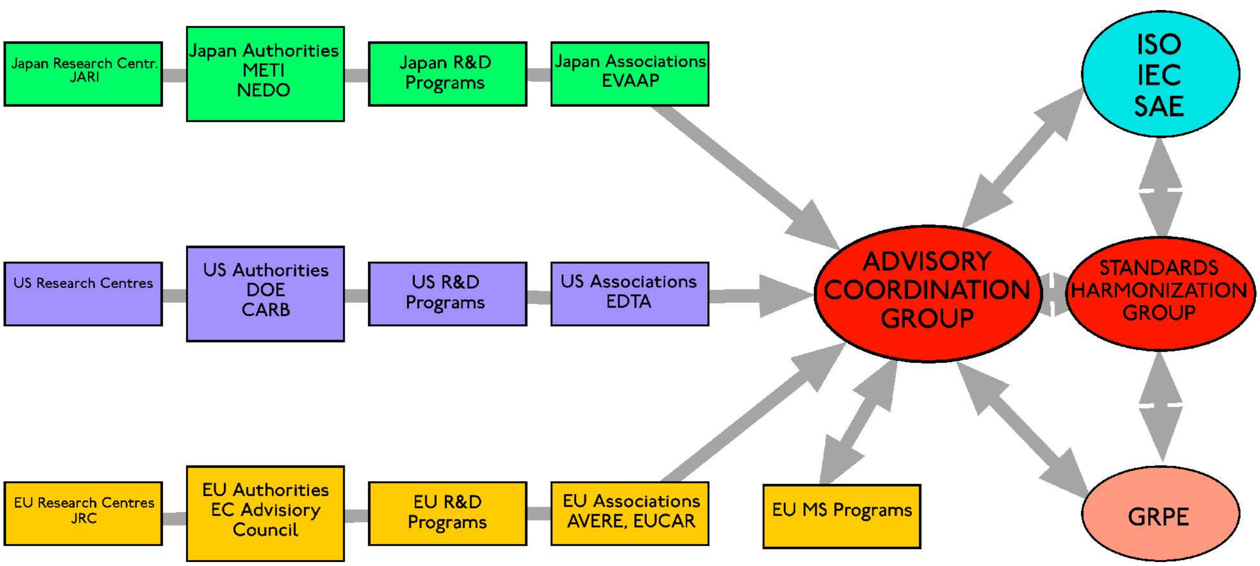

Figure 2: Possible Collaboration Scheme for Efficient Standardization and Regulation

8 Conclusions

The study performed relating to the discussion between IEC and ISO on the subject of electric vehicle standardization are illustrating two main issues which are characteristic of international standardization activities:

On one, hand, with several standardization organizations active on the same subject, there is a real danger that much effort will be lost through parallel work, leading to different and potentially conflicting standards on the same topic. Such "standards" are a source of confusion and are of no useful purpose.

On the other hand, the collaboration between different organizations, if implemented efficiently, will allow standardization work to advance and to obtain positive results.

It should be stressed that IEC and ISO should not consider themselves as competitors, but as complementary bodies, each apporting their expertise to the field. IEC and ISO have been created as separate bodies for historical reasons, but now they exist together (even sharing the same building complex in Geneva), and they should co-exist and collaborate.
The division of standardization work on a specific subject like the electric vehicle has involved a lot of discussions, which can run out of hand when each party keeps defending its "turf" (in this case: is it a car or an appliance?), reasoning out of tradition and emotion. It is essential that such differences be overcome and that the future standardization work is performed in a spirit of collaboration and joint effort toward a common goal which is the drafting of clear and useful standards which benefit both the manufacturer and the user.
For the electric vehicle, the idea to have vehicle aspects treated by ISO and electrical aspects treated by IEC is a reasonable solution; it should be taken into account however that electrical power components clearly belong to the sphere of IEC and can benefit from IEC's long experience in the field.

The same arguments about collaboration between organizations can of course also be cited concerning international vs. regional standardization bodies.

The development of new technologies such as fuel cells has created new challenges for standardization. The construction of an appropriate standardization landscape for this new application has allowed the structuring of effective collaboration and interaction between different standardization committees involved, avoiding double work which might lead to conflicting standards.
The interaction with regulations, codes and legislations however will necessitate the definition of further collaborative structures. The "New Approach" philosophy or the introduction of "global technical regulations" may constitute an worthful example to be followed in this framework.
Although most work on fuel cell standards is still on the working group level at the time of writing, an interesting outcome can be expected.

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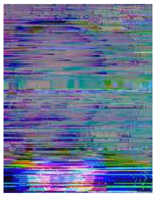

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