

TECMEHV – An European Project for professional formation of Electric and Hybrid Vehicle operators

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Abstract—The European Project TECMEHV, started in October 2011 and extended to September 2014, in the frame of the EU Lifelong Learning Programme Leonardo Da Vinci, is aiming to the definition and development of a Competence Framework with Training Modules for online courses dedicated to operators on electric and hybrid vehicles, especially for maintenance and repair operations and technical assistance. The Training Modules are developed addressing operational and technical competences needed to approach maintenance and repair operations on vehicles in the key technical areas of the system architecture and especially in the field where the safety attention is prominent.

The Project is coordinated by ASCAMM, with partners ATA, EPFL, NORAUTO, University Duisburg and associated partners CRF and STA.

Keywords—*Electric and Hybrid vehicles; maintenance; repair; professional formation.*

I. INTRODUCTION

The significant application of Electric and Plug-in Hybrid vehicles postulates an appropriate infrastructure for energy supply and an adequate network of technical assistance support for the relevant maintenance operation in the field of the emerging new technologies.

A specific professional formation is a requisite for the technical operators in these fields.

Addressing these needs, a project was started in October 2011 in the frame of the EU Lifelong Learning Programme Leonardo Da Vinci, the Project TECMEHV “Knowledge Training and development of European Competences on Maintenance of Electric and Hybrid Vehicles.

The aim of the Project is to define a method to induce a professional competence in the dedicated experts involved in the technical assistance, maintenance and repair of electric and hybrid vehicles and in the relevant infrastructure for energy supply. The final goal is to create a Professional Qualification for technical assistance, to be accredited to the operators acting in this field.

The project activity is performed by a consortium comprising five partners and two associated partners from five European countries, bringing together experience and resources in the

areas of: training programmes, professional qualification advice, research and development, automotive industry knowledge and technical aftermarket maintenance:

ASCAMM Technology Centre, Coordinator
ATA, Associazione Tecnica dell'Automobile
EPFL, Ecole Polytechnique Federale de Lausanne
NORAUTO

Universitat DUISBURG ESSEN

Centro Ricerche Fiat, associated partner

Sociedad de Tecnicos de Automocion, associated partner

II. FORMATION OF NEW SKILLS FOR NEW JOBS: THE METHODOLOGY

The overall objective of TECMEHV is to create a professional Qualification for Electric and Hybrid Vehicles maintenance and technical assistance, to be accredited to the operators acting in this field.

The method to reach this goal is the establishment of a Competence Framework according to the intended EC Vocational and Educational Training, to ensure homologation for the whole European Community territory.

The training initiative should be consistent with the strategic framework “European Education Environment”. The long term strategic objectives of EU education and training policy are:

- making lifelong learning and mobility a reality;
- improving the quality and efficiency of education and training;
- promoting equity, social cohesion and active citizenship,
- enhancing creativity and innovation, including entrepreneurship, at all levels of education and training.

An acknowledgement of degrees of training, at the international level, can be assured by a credit-transfer system for academic recognition, for example the “European Credit Transfer System (ECTS) and the “European Credit system for Vocational Education and Training (ECVET), allowing

transparency and recognition of vocational education and training.

A professional qualification system is proposed by TECMEHV project, to balance the training offer and implement the new professional skills addressing the electric and hybrid maintenance and repair market.

Two major steps are considered and being implemented to establish a Professional Qualification Structure:

- Definition of a Competence Framework on Electric and Hybrid Vehicles Maintenance, Repair and Operation.
- Development of a set of e-learning course modules on selected key topics related to the Unit of Competence, for online training. The e-learning modules are addressing the formation of operators to achieve technical competence and professional skill for maintenance and repair Electric and Hybrid Vehicles on the areas of key technologies.

A Professional Qualification is considered as a set of professional competences that can be achieved through vocational education and training modules, or any kind of learning structure, as well as through work experience. From a formal point of view, a professional qualification is a group of knowledge and capabilities that satisfy occupations and job posts in the labor market.

Each qualification has a general competence that defines in synthesis the essential tasks and functions of the operator. Other elements are also described, including the professional environment in which the qualification takes place, the corresponding productive sectors and the relevant occupations or posts, that can be accessed with the qualification.

III. THE COMPETENCE UNITS AND THE TRAINING MODULES

A competence unit is the minimum set of professional competences that can be partially recognized and accredited. Every competence unit is linked to a **learning module** that describes the necessary learning to acquire that particular competence unit.

This structure facilitates the assessment and accreditation of every competence unit acquired by an employee, both through work experience and non-formal or informal learning. Recognized and accredited competence units can be accumulated in order to obtain the accreditation of a qualification. Each **competence unit** will have a standardized format, which includes its identification information and the specifications of that competence.

The competence units are divided into **Professional Activities (PA)**. These establish the expected behavior of one person, i.e. the expected consequences or results of the activities performed by that person. They help to show whether person is competent in a competence unit.

The **Performance Criteria (PC)** express the acceptable level of one professional activity to meet the productive organization's targets and are reference guides for the assessment of professional competences.

The following prospect shows the structure of the competence framework, as a basis for the e-learning platform.

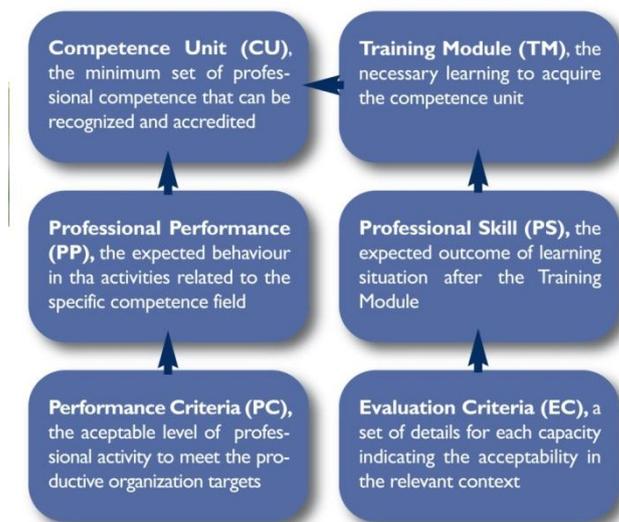


Fig.1 Framework structure of Competence Units and Training modules

Each **competence unit** is associated with a **Training Module**, which describes the **necessary learning to acquire that competence unit**.

A **Training Module (TM)** is a coherent set of training associated with the units of competence that make up skills. It is the **smallest unit of training** to determine the diplomas and professional certificates.

Training specifications contain **Professional Skills (PS)**, the expression of the expected outcomes of peoples' learning situations at the end of the training module.

The **Evaluation Criteria (EC)** is a set of details for each capacity that indicate the degree of detail acceptable to it. They define the scope and level of ability and the context in which it is to be evaluated.

The competence units are associated to the corresponding training modules, which describes the learning content, which is required for their acquisition. The Competence Units for maintenance and repair electric and hybrid vehicles have been identified in relation with the technical areas of intervention in the vehicle system and in relation with the procedure to follow for the intervention. The CU's related to the technical areas have been defined and developed on the basis of the technology state of art of electric and hybrid vehicles, which was object of a first part of the project.

The following schematic shows the technical areas, which have been considered for the definition and description of the Competence Units.

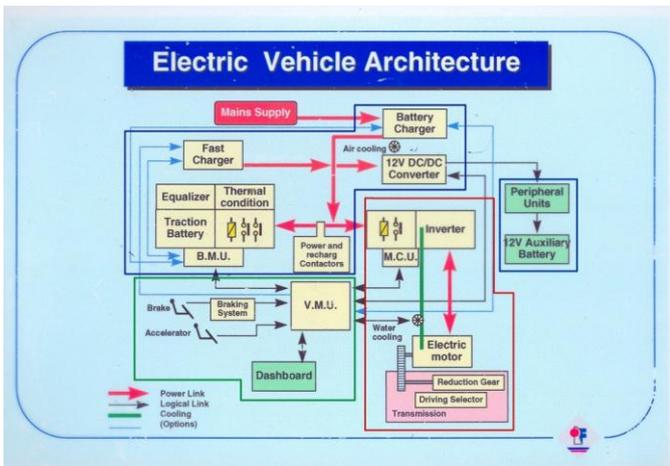


Figure 2 Key technology areas considered for the e-learning modules definition: Energy Storage and charge, Power train, Energy management and Communication, Peripheral Units.

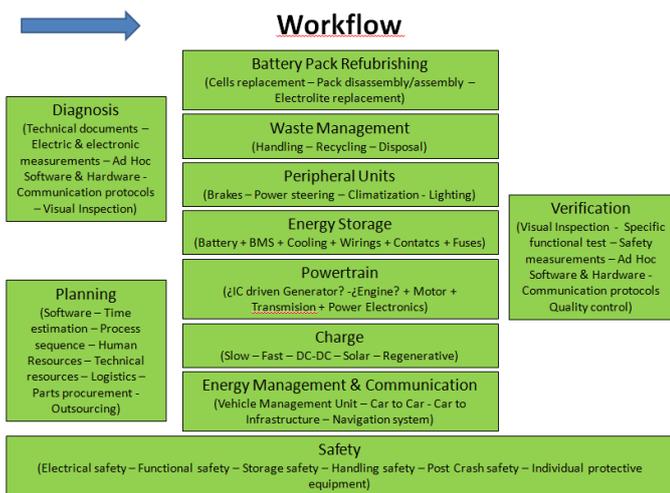


Figure 3 Operation sequence workflow for maintenance and repair

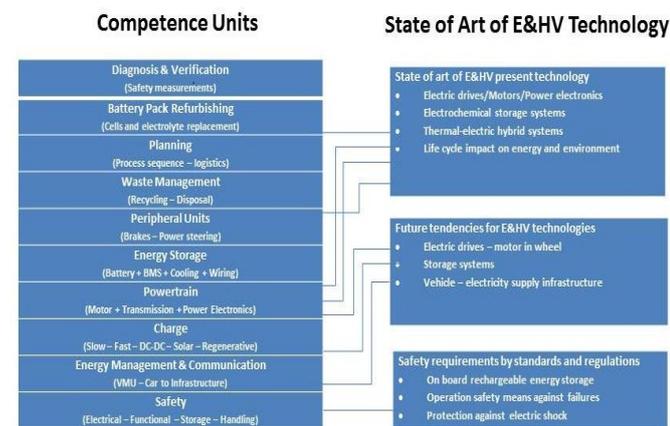


Figure 4 Links between Competence Units and Electric and Hybrid Vehicles technology areas

The definition of the State of the Art of the technologies for on board vehicle system and for the charging infrastructure has been object of the initial part of the program [1].

The key technology areas addressed were the electric drives and the electrochemical energy storage systems [2].

About the electric drives a study has been performed concerning the features of the various types of motors mainly used in the electric vehicles power trains as having impact on the definition of solution for vehicle integration. This definition has impact on the design of the system and also on the following treatment of the product in the maintenance and repair, the implication being the life cycle in terms of energy and environmental impact over the vehicle life.

The parameters have been identified as follows and reported in the diagrams of fig.5:

- **aef** average efficiency TTW (Tank To Wheel)
- **cmp** critical materials presence
- **idf** integration design flexibility
- **lce** life cycle efficiency
- **puf** performance – low torque ripple and NHV (Noise, Harshness, Vibration), user friendliness and comfort
- **sft** specific torque

The following figure 5 shows the comparison of parameters and features for different types of electric motors.

Similarly, an analysis has been made for the energy storage systems and in particular for the lithium-ion batteries, which are the type most presently used for electric and hybrid vehicle application [3].

- Lithium – nickel cobalt – aluminum (NCA)
- Lithium – nickel manganese -cobalt (NMC)
- Lithium – manganese – spinel (LMO)
- Lithium titanate (LTO)
- Lithium – iron phosphate (LFP)

The considered parameters to be considered for the design, operation, maintenance and repair have been identified as follows:

- Specific energy
- Specific power
- Safety
- Performance/efficiency
- Life span
- Cost

The following figure 6 shows the comparison of the trade-off parameters for these batteries.

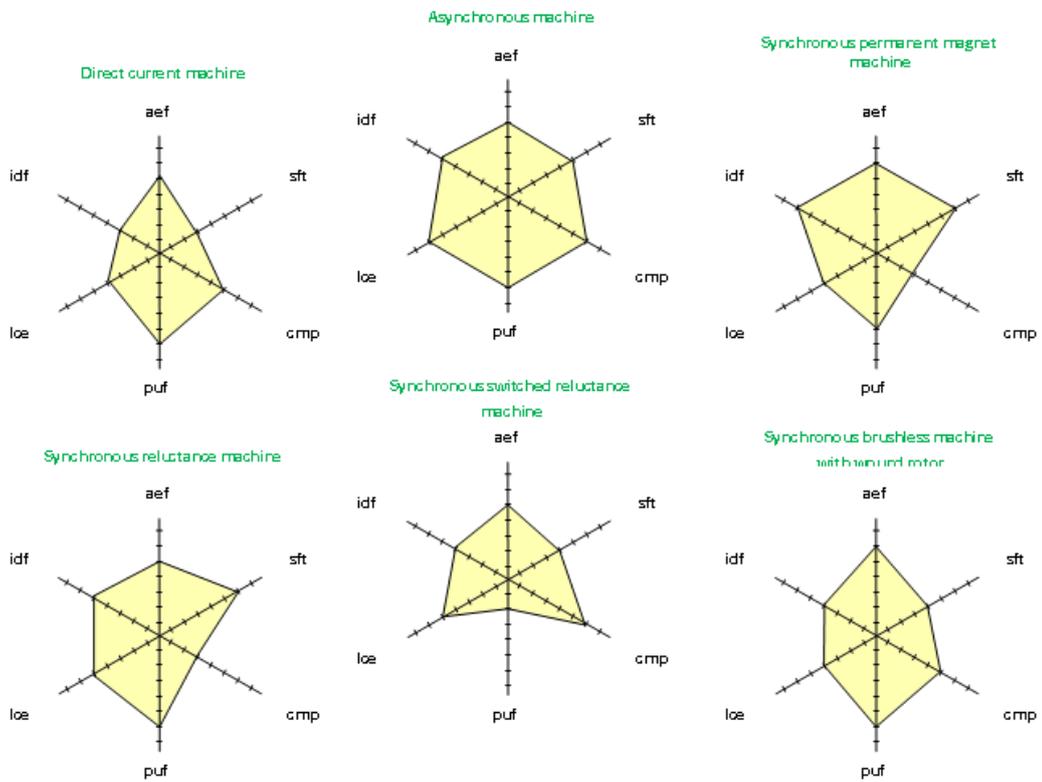


Fig. 5 Trade off parameters of electric motors

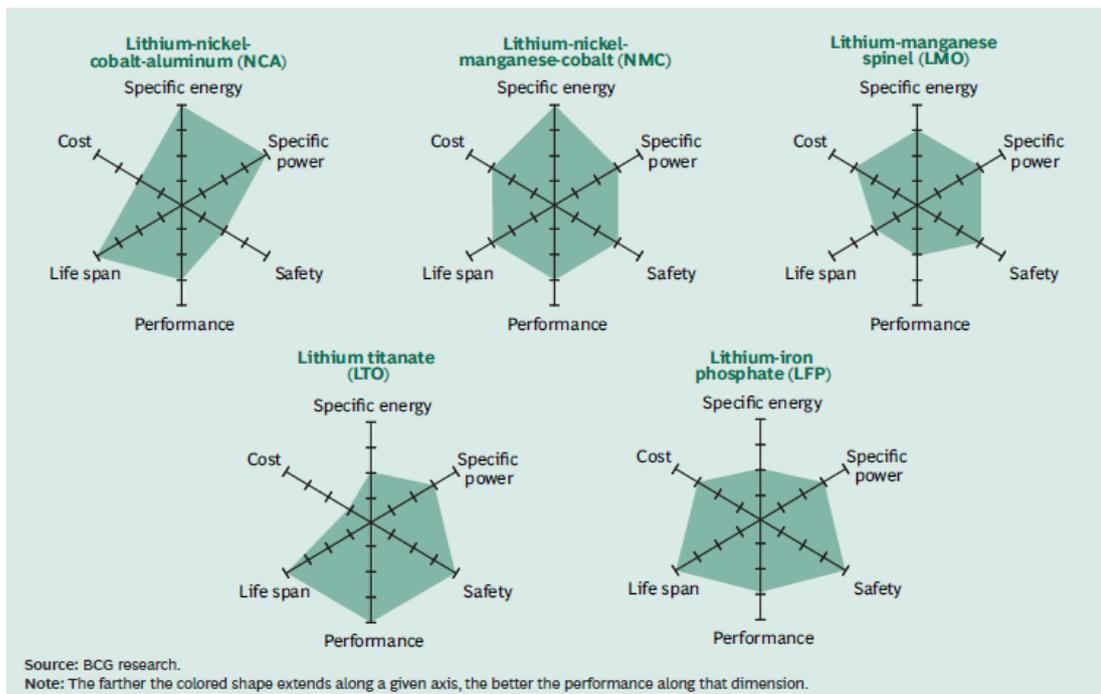


Fig. 6 Trade off parameters of lithium – ion batteries

IV. THE E-LEARNING PLATFORM

The Training Modules related to the various Competence Units and relevant Professional Skills are presently under final stage of development, finalized to e-learning courses.

Example of topics are here presented, which are considered particularly sensitive for the attention in the maintenance and repair of electric and hybrid vehicles.

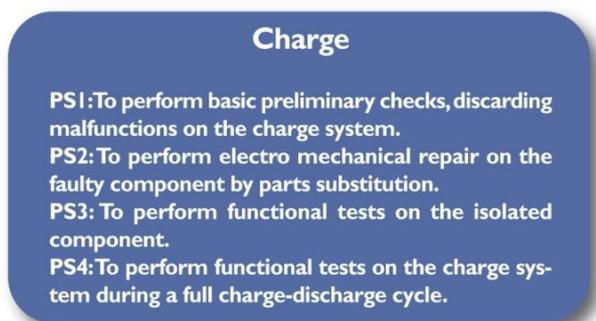


Fig. 7 Competence Unit for charge operation

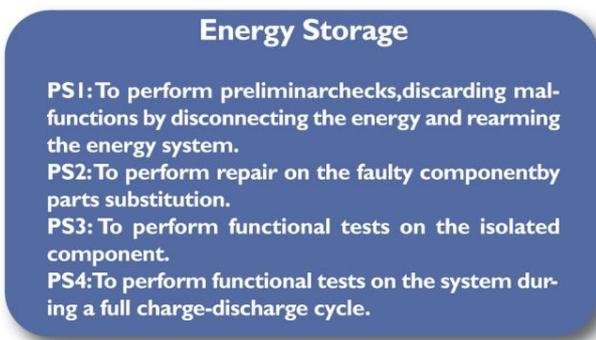


Fig. 8 Competence Unit related to Energy Storage system

All Training Modules are presented with the precondition of performing maintenance and repair operation according to manufacturer specifications, the risk prevention specification and the environmental protection specifications.

In line with this concept, a Module is developed concerning the professional skills safety addressed, related to the most critical areas and operational situations.

The Competence Units the professional Skills for the various disciplines and activities are being prepared with great detail description.

The E-Learning Platform structure and the Modules content are being evaluated by professional experts from Industry and Universities, in the scope of assuring the correct and easy understanding by the users.

The e-learning courses will be made available on line with the moodle scheme.

The check for the acquisition by the user of the e-learning Modules acquisition will be done by questionnaires, whose

response could be considered as a basis for a Certification at the Europea level.

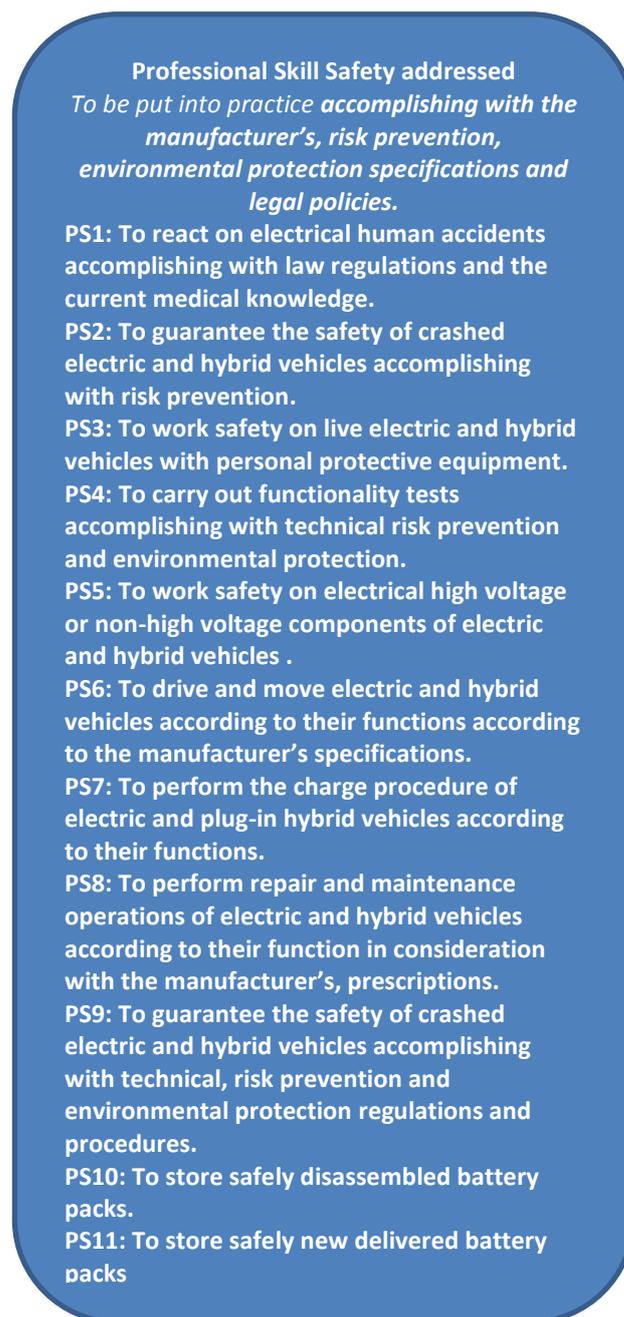


Fig. 9 Professional skills safety addressed for vehicle operation

V. CONCLUSION

TECMEHV project intends to offer a learning platform, dedicated to the technology of electric and hybrid vehicles and to their assistance, maintenance and repair operation. The specific training modules, to be offered on line and on special courses are finalized to the professional formation of

the operators in the electric and hybrid vehicle field and relevant infrastructures.

It is considered that the TECMEHV project outcomes can contribute to the diffusion of electric and hybrid vehicles, by offering a tool for enhancing the effectiveness of the service and operation support through new highly qualified jobs.

Furthermore, the dissemination of the dedicated courses for handling and supporting the technology of electric and hybrid vehicles and their infrastructures is a tool to pave the future developments and to diffuse the culture and the interest of these ecological and energy effective means of transportation.

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TECMEHV website: www.evtraining.eu