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The 27th INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM & EXHIBITION
BARCELONA
17th-20th November 2013

TECMEHV - Training and Development of European Competences on Maintenance of Electric and Hybrid Vehicles

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A Project Coordinated by ASCAMM
From October 2011 to March 2014

In the frame of EU Leonardo da Vinci Programme
for professional formation of Electric Vehicle Operators

Organized by Fira Barcelona avele
Hosted by AVERE mea Ajuntament de Barcelona
In collaboration with EVAAP EDTA
Supported by European Commission

Summary

- TECMEHV Objectives
- The field of operation: Electric vehicle system
- The integration with infrastructure
- Development of the Competence Framework
- Workflow of Competence Units
- Development of Training Modules
- An example: Training Module Safety
- Conclusions

TECMEHV Objectives

The overall objectives of TECMEHV are:

- **To define, develop, implement and support, in the medium and long term future, the European wide Professional Qualification for the electric and hybrid vehicles maintenance and an**
- **E-learning platform within the European HEV industry to learn and understand how to manage HEV**

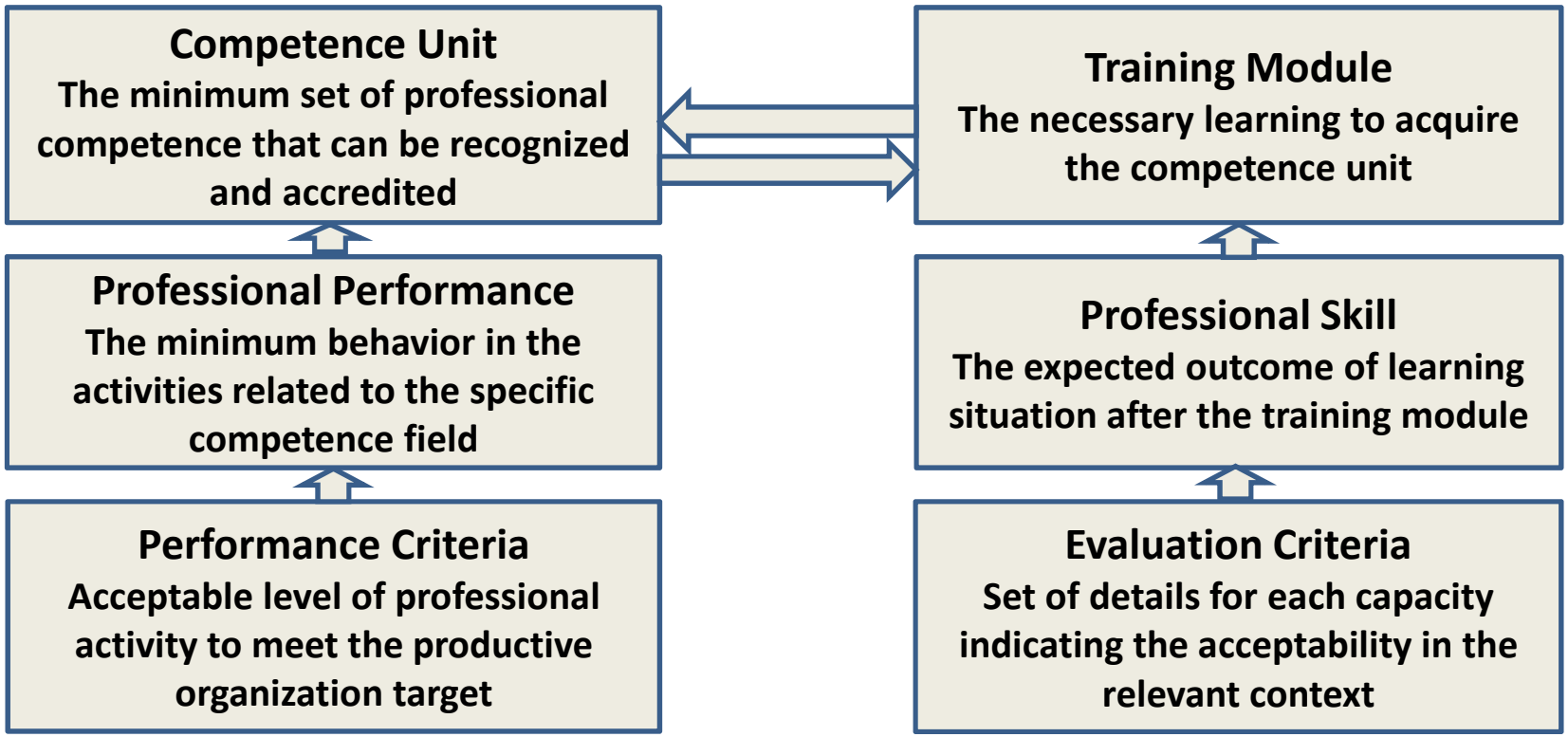
TECMEHV project comprises two major activities:

- **Definition of the Competence Framework on Electric & Hybrid Vehicles Maintenance, Repair & Operation**
- **Development of a set e-learning courses on selected key topics, related to the Unit of Competence for online training**

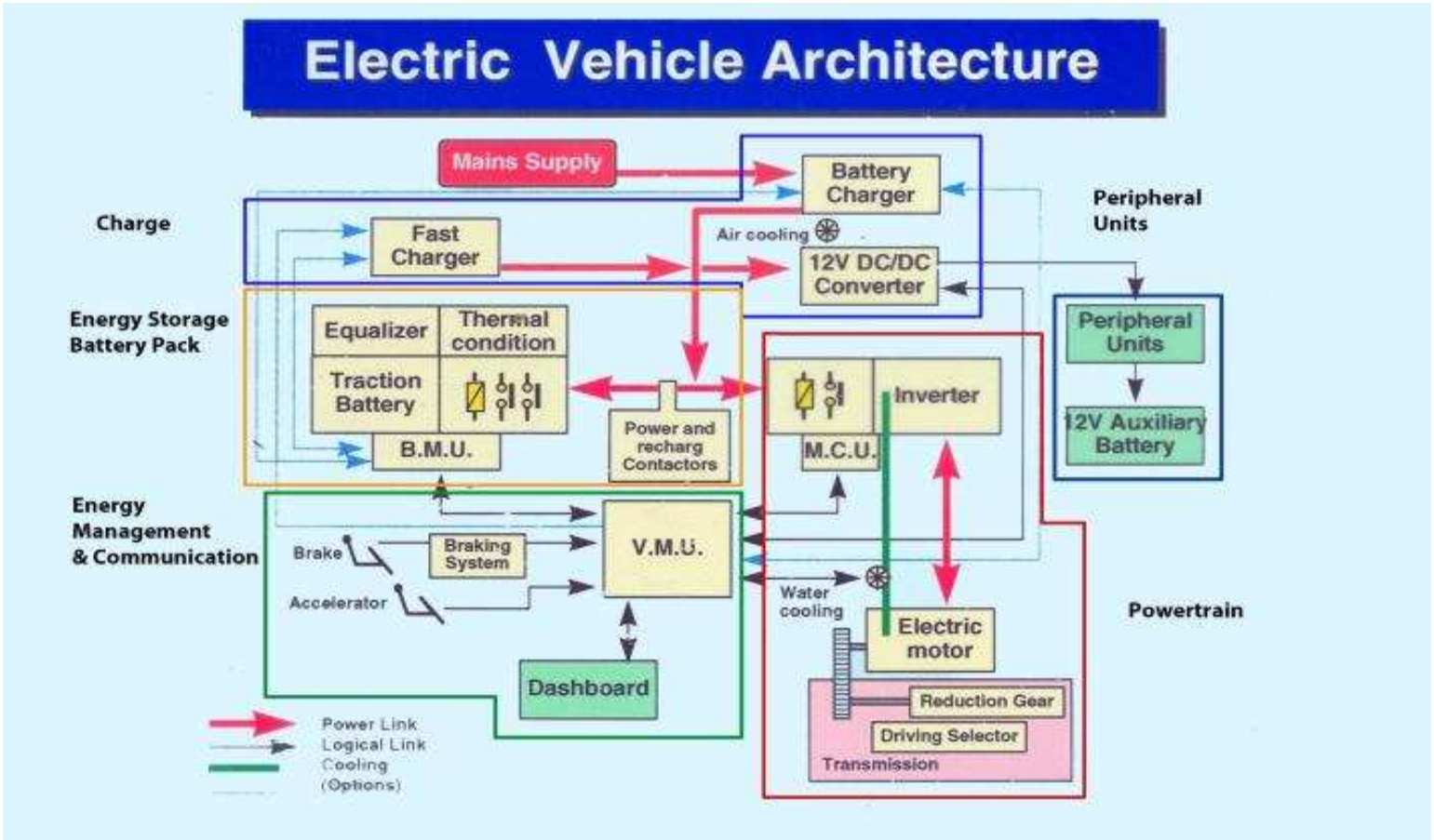
Development of a Competence Framework

Definition of a **Learning Platform**, with **Training Modules**, addressing the formation of operators with technical competence and professional skill for maintenance and repair Electric and Hybrid Vehicles

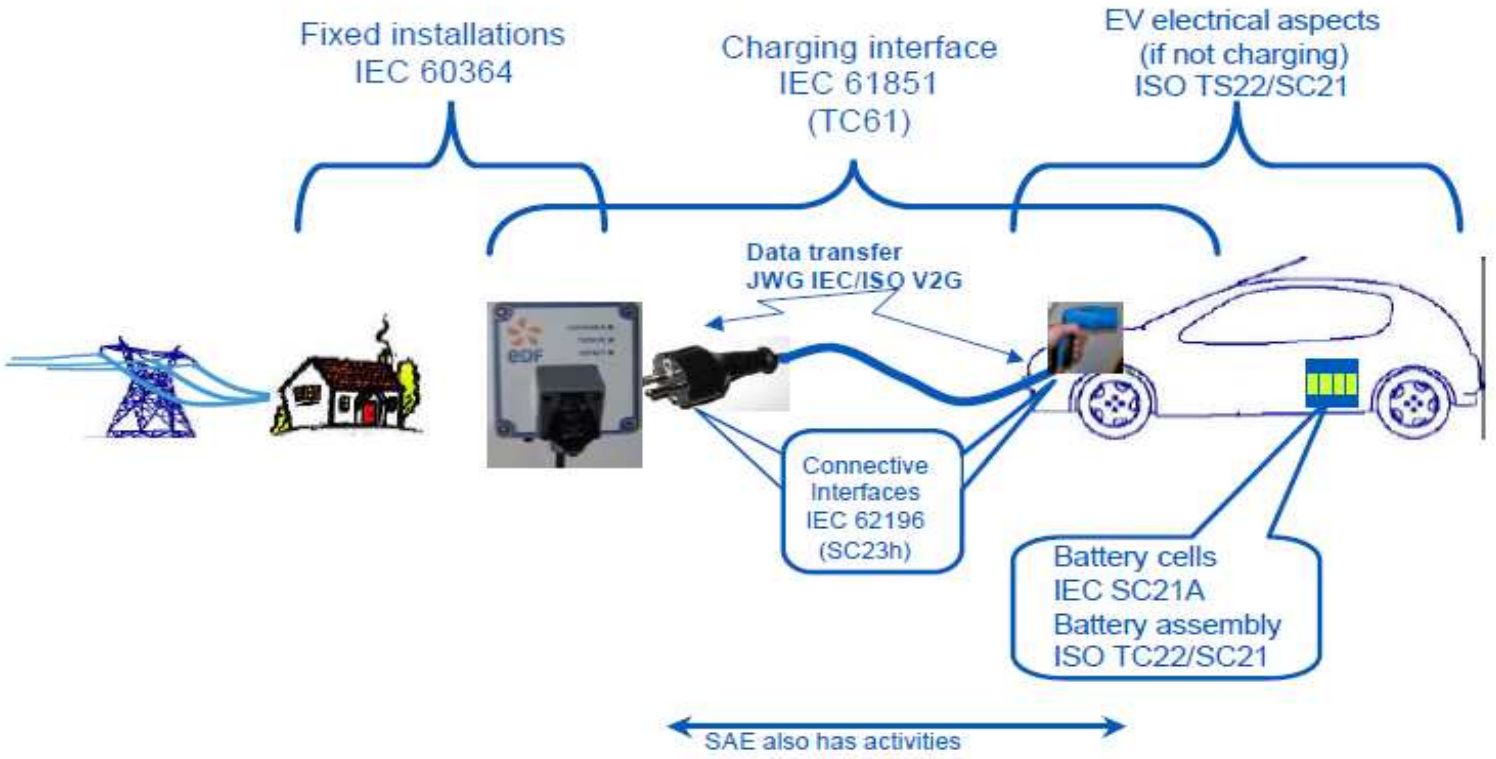
Development of e-Learning Modules for Professional Competences



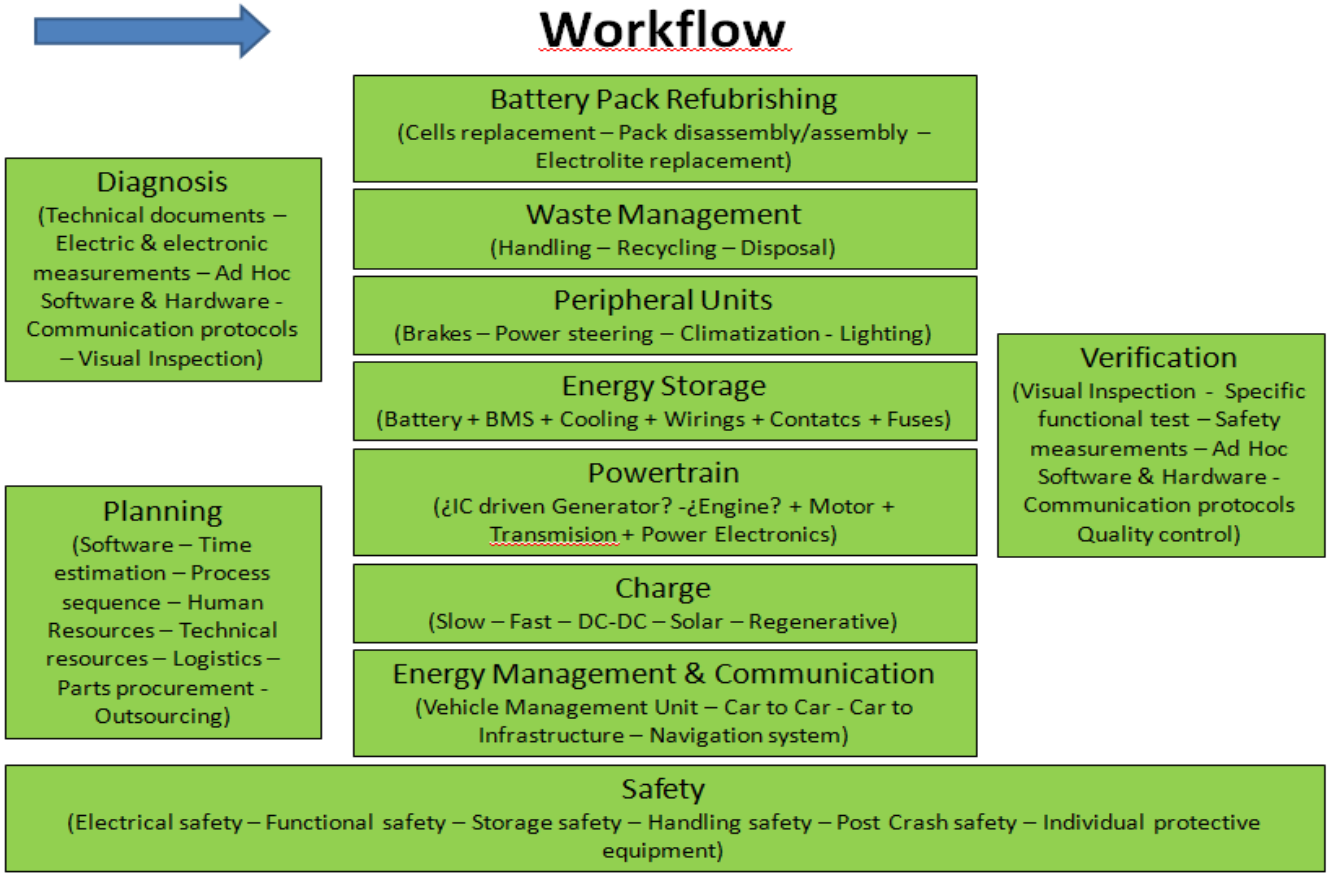
The field of operation



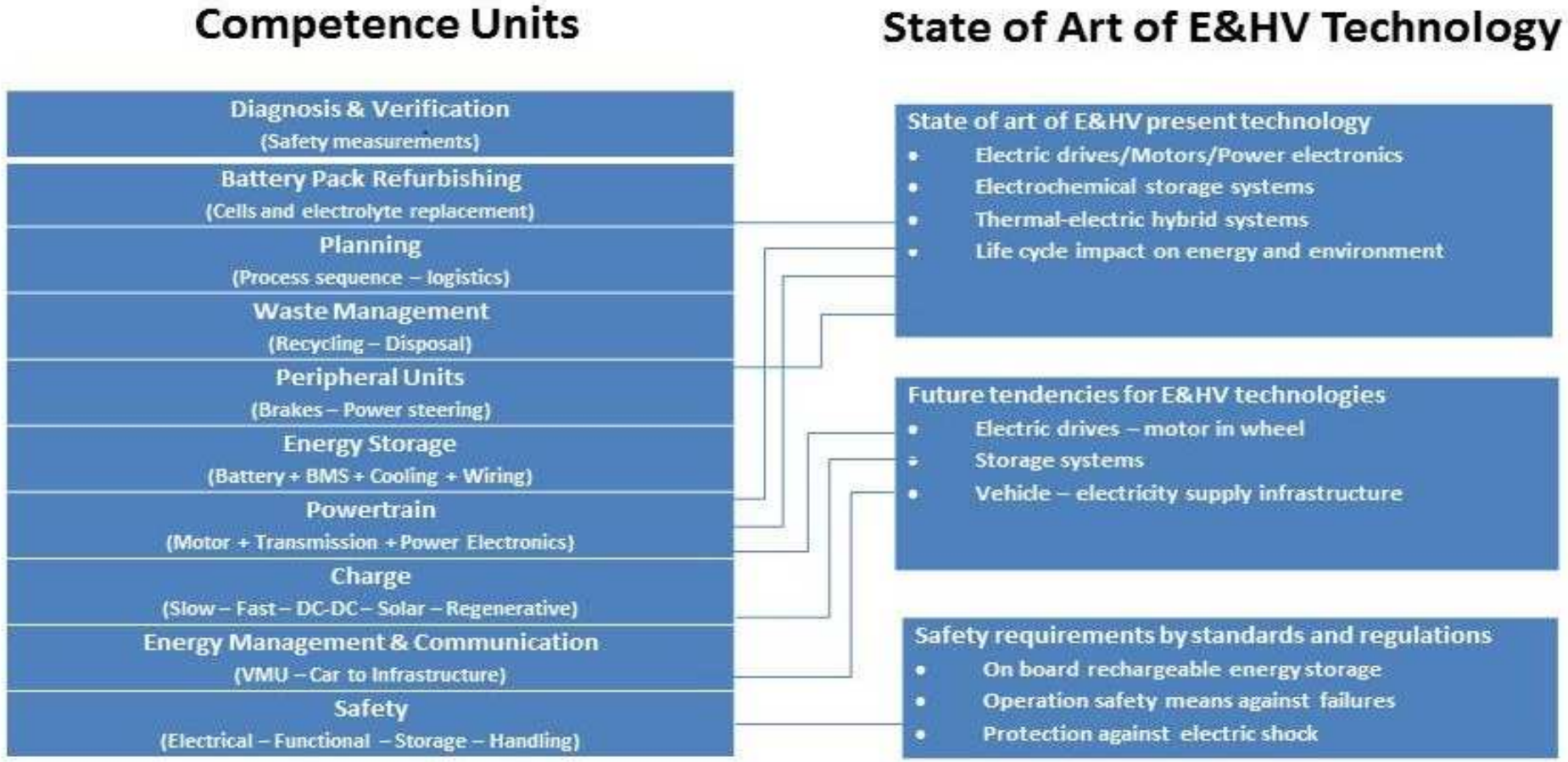
Integration within the infrastructure



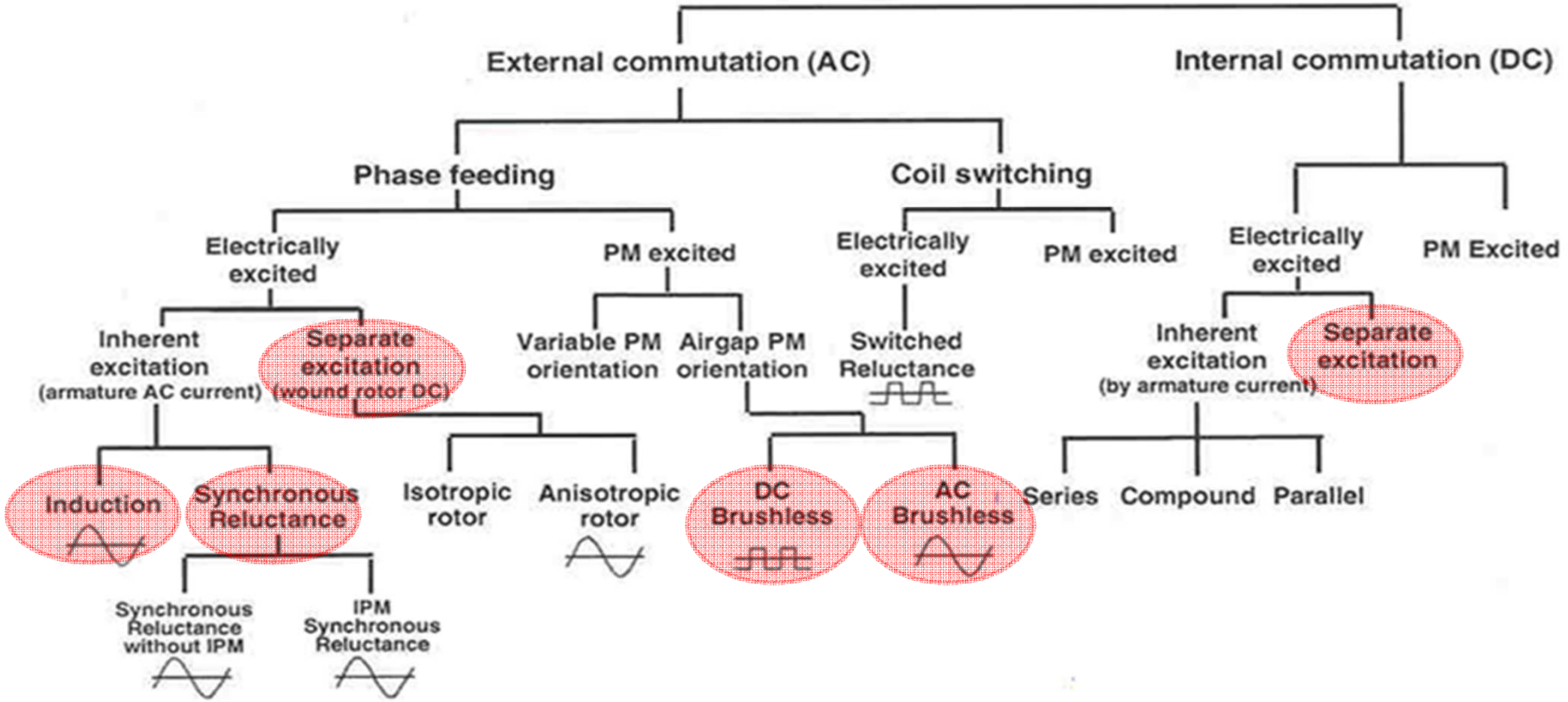
Development of a Competence Framework



Relation competence Units to E&HV technology



State of the Art: Electric Drive Machines classification



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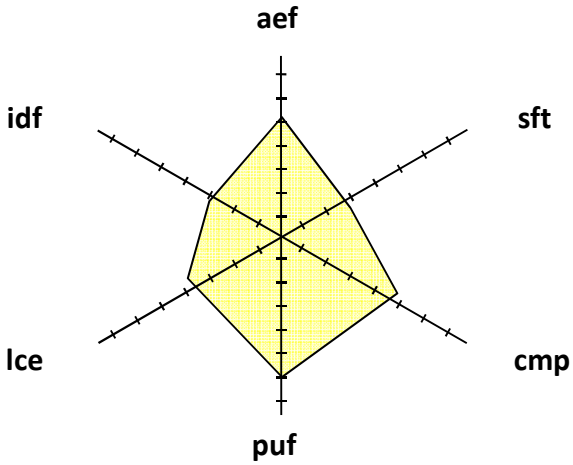
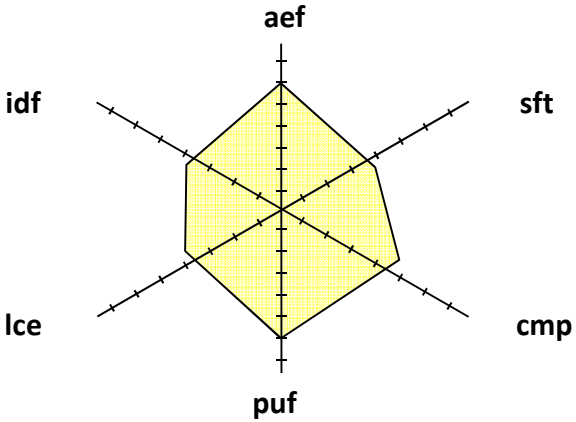
Comparative features of electric drive machines

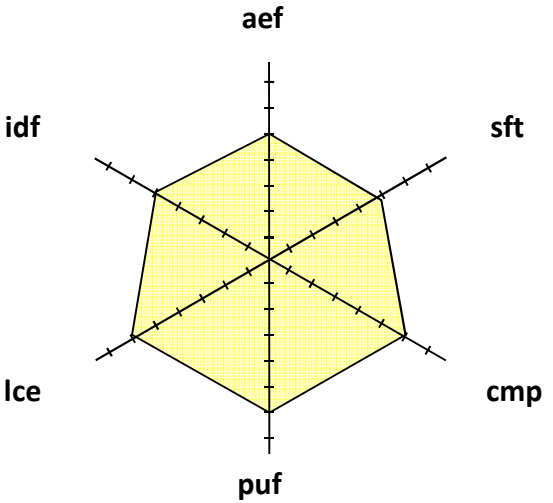
Direct current machine



Synchronous brushless machine with wound rotor



Asynchronous machine



aef:	average (high power/low speed), efficiency (TTW)
cmp:	critical material presence
idf:	integration design flexibility
lce:	life-cycle efficiency
puf:	performance - low torque ripple and NHV, user friendliness and comfort
sft:	specific power and torque (high speed capability)

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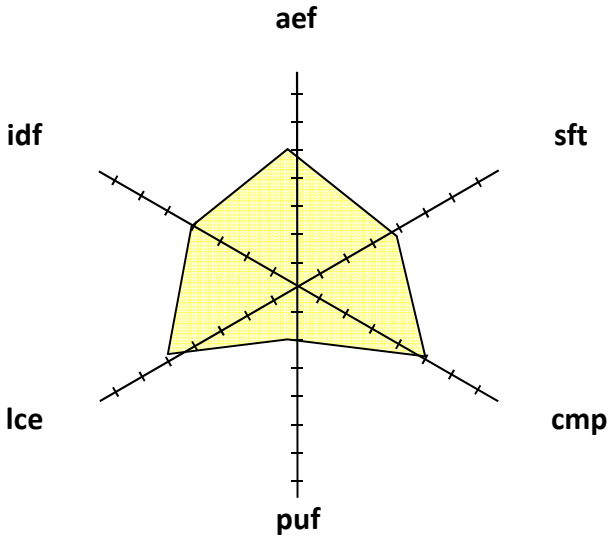
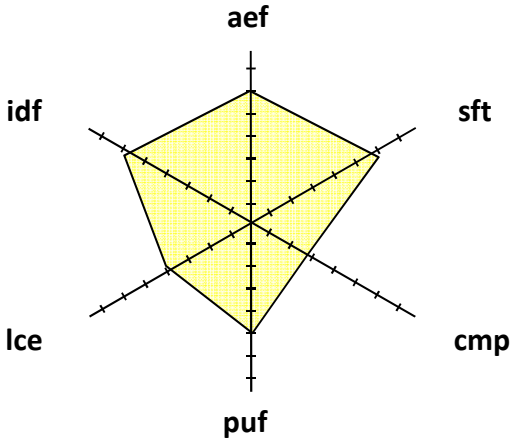
Comparative features of synchronous machines

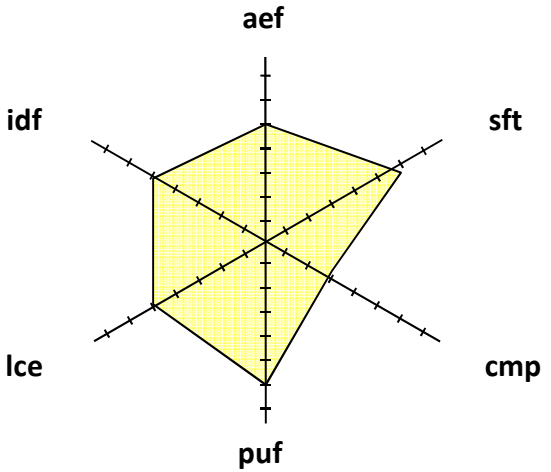
Switched reluctance machine



Permanent magnet machine



Synchronous reluctance machine



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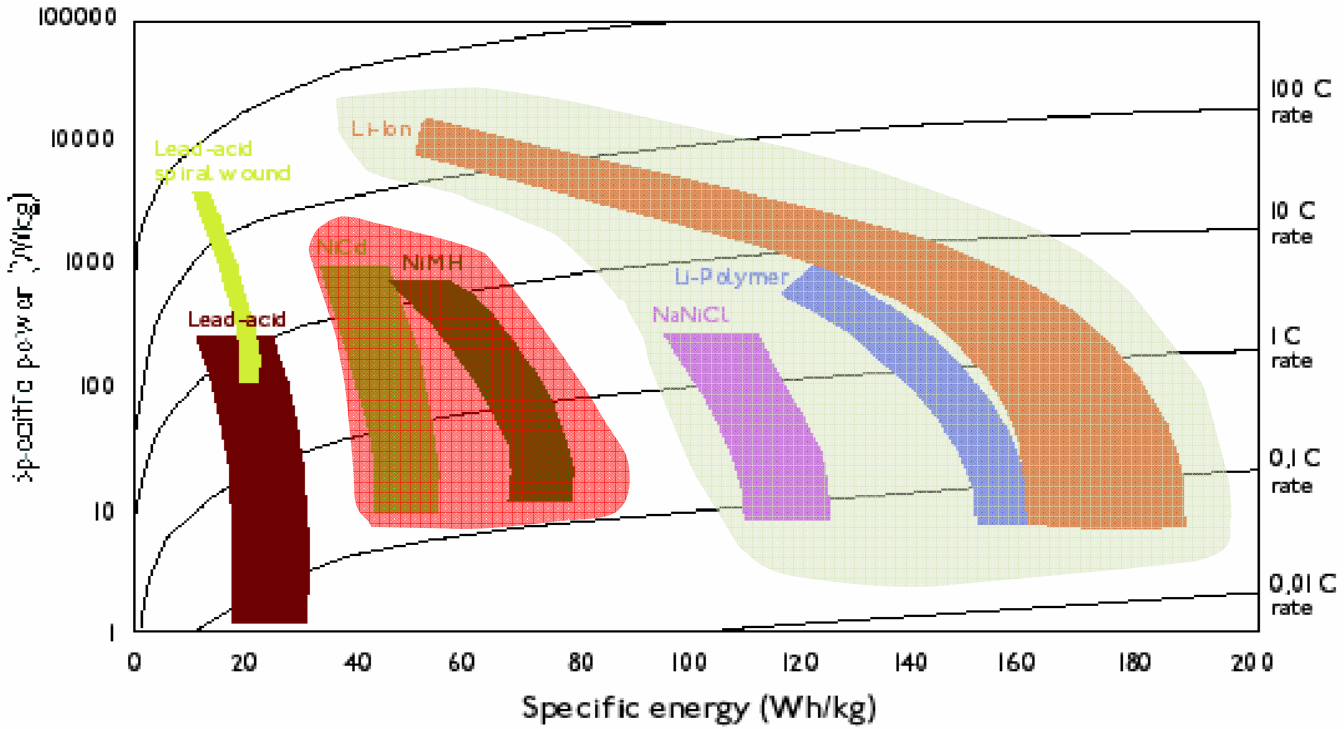
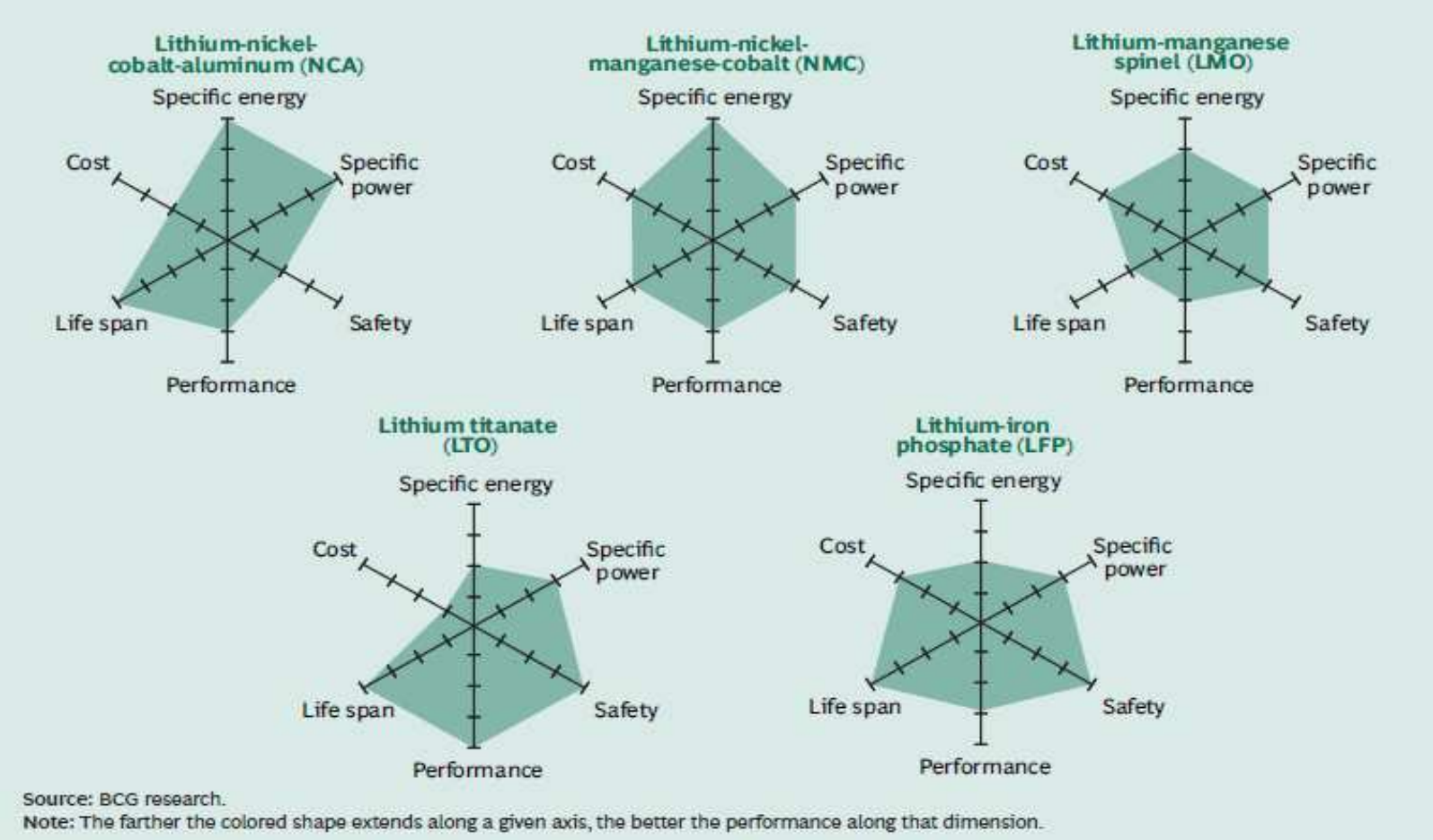
Specific performance of battery cells for E&HV

Basic comparison energy/power of cells

- Ragone chart



Comparative features of Lithium batteries



Source: BCG research.
Note: The farther the colored shape extends along a given axis, the better the performance along that dimension.


Development of a Competence for Professional Qualification
Professional Skill
to be put into practice with technical risk prevention, accomplishing with protection regulation and procedures
Operation oriented
Technology oriented
Diagnosis & Verification
To analyze the information to define the main maintenance and repair and the tools needed.
To apply measurement techniques on the E&HV's systems and components.
To analyse the data from the OBD that define the maintanance/repair operation.
To determine maintenance/repair needs of an E&HV, by means of a visual inspection.
To prevent injuries and environmental damages during the diagnostic & verification procedures.
To determine the quality control checks on the maintanance/repair operation.
Planning
To determine the process sequences for maintenance and repair E&HVs, taking into account their specifications.
To determine the parts to order to repair or maintain E&HVs according to manufacturer's requirements.
To analyze the requirements of car repair shops according to manufacturer's and car repair shop regulations.
To determine the proper high voltage staff qualification according to the tasks to perform for the E&HV maintenance/repair.
To perform the necessary operation to ship, receive, store and unpacking high voltage batteries.
To perform the necessary operation to ship, receive, store and manage the electric and hybrid vehicle components.
To determine the technical resources, according to the parts to be prepared.
To perform the time estimation for maintenance and repair according to the car repair shop, manufacturer's and law regulations.
Energy Management & Communication
To perform repairs or maintenance operations on the Vehicle Management Unit (V.M.U.).
To perform repairs or maintenance operations on the drive control commands and relevant transducers: accelerator, brake, clutch (if any), gear shift lever, forward/reverse, parking brake.
To perform repairs or maintenance operations on the dashboard displays and switched buttons.
To perform repairs or maintenance operations on the Communication System and the related "Human Machine Interface" system and display.
Battery pack Refurbishing
To assemble and disassemble a battery pack of an Electric or Hybrid Vehicle.
To diagnose the state of health of each component of the battery pack.
To replace damaged cells.
To balance the state of charge of the cells
To parametrize the BMS for the integration of the replaced cells.
Energy Storage
To perform preliminarchecks, discarding malfunctions by disconnecting the energy and rearming the energy system.
To perform repair on the faulty componentby parts substitution.
To perform functional tests on the isolated component.
To perform functional tests on the system during a full charge-discharge cycle.
Powertrain
To perform repairs or maintenance operations on the electric traction motor
To perform repairs or maintenance operation on the electric drive of the vehicle.
To perform repairs or maintenance operations on the transmission.
To perform repairs or maintenance operations on the Motor Control Unit
Peripheral Units
To perform repairs or maintenance operations on the service brake system.
To Perform repairs or maintenance operations on the parking brake system.
To perform repairs or maintenance operation on the climatization system.
To perform repairs or maintenance operation on the lighting system.
Charge
To perform basic preliminary checks, discarding malfunctions on the charge system.
To perform electro mechanical repair on the faulty component by parts substitution.
To perform functional tests on the isolated component.
To perform functional tests on the charge system during a full charge-discharge cycle.

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Professional Skill Safety addressed

To be put into practice accomplishing with the manufacturer's, risk prevention, environmental protection specifications and legal policies.

- To react on electrical human accidents accomplishing with law regulations and the current medical knowledge.
- To guarantee the safety of crashed electric and hybrid vehicles accomplishing with risk prevention.
- To work safety on live electric and hybrid vehicles with personal protective equipment.
- To carry out functionality tests accomplishing with technical risk prevention and environmental protection.
- To work safety on electrical high voltage or non-high voltage components of electric and hybrid vehicles .
- To drive and move electric and hybrid vehicles according to their functions according to the manufacturer's specifications.
- To perform the charge procedure of electric and plug-in hybrid vehicles according to their functions.
- To perform repair and maintenance operations of electric and hybrid vehicles according to their function in consideration with the manufacturer's, prescriptions.
- To guarantee the safety of crashed electric and hybrid vehicles accomplishing with technical, risk prevention and environmental protection regulations and procedures.
- To store safely disassembled battery packs.
- To store safely new delivered battery packs

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Training Module 9 - Safety

EC9.4.1: To describe the procedure to perform a test drive to check the functionality of the vehicles, according to the manufacturer's specified specifications, the risk prevention specifications and the environmental protection procedures

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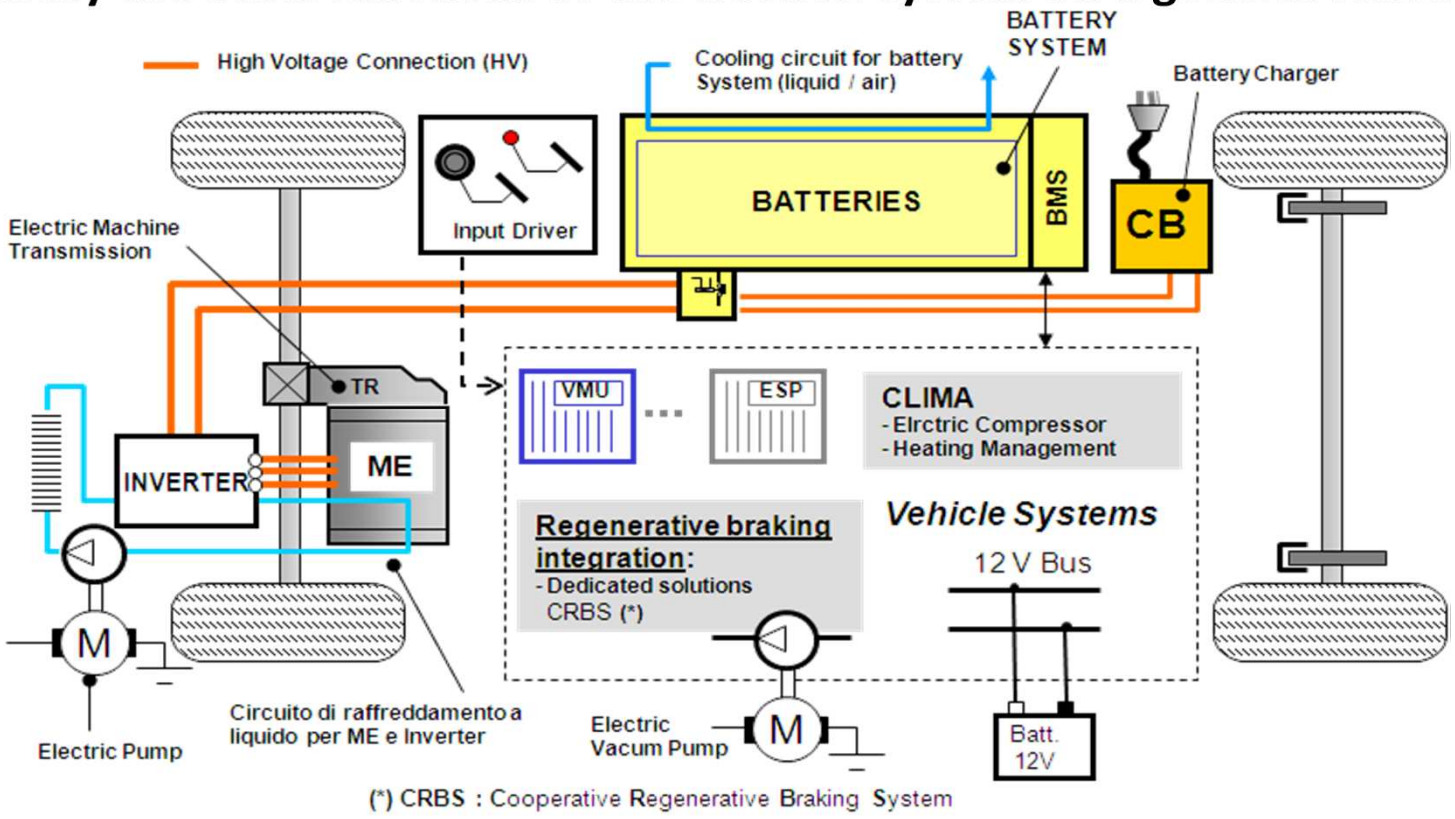
- **Identify the basic functions of the traction system on a general scheme**



Example: IVECO Daily electric 35s – 35C layout

I. Traction battery

2.Battery charger

3.Traction motor

4.Inverter

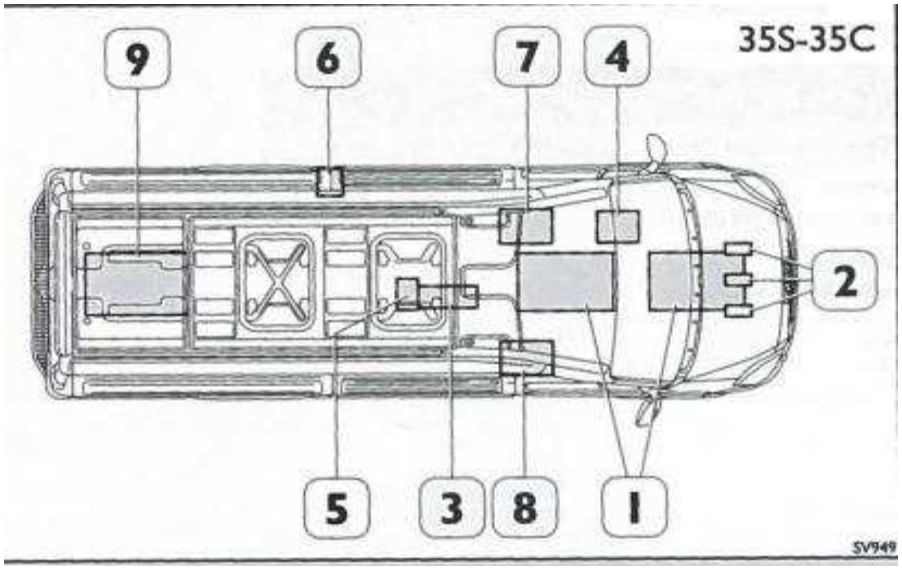
5.Reduction gear

6.Charging plug

7.Charging module

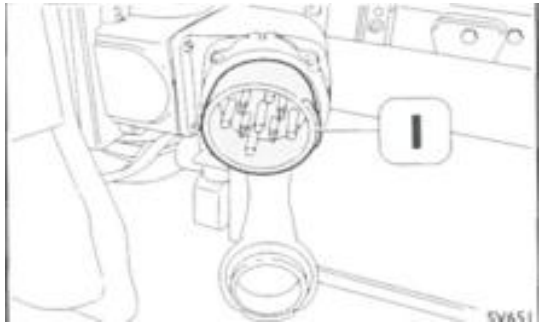
8.DC protection

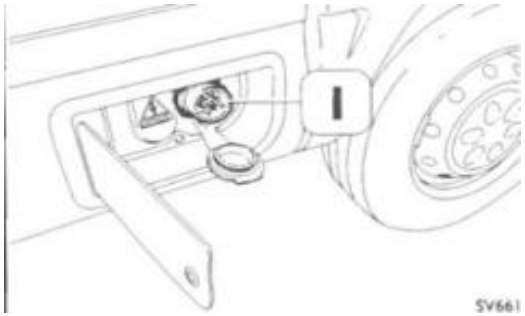
9: Battery (optional)



Visualize the operational elements for vehicle operation, with reference to specific service manual of the vehicle (example IVECO Daily electric)

Charging system
Connection to grid **I**





Dashboard drive command display:
Forward = D
Neutral = N
Reverse = R

Emergency red button on dashboard

Parking hand brake

Focusing driving procedures: acquisition on the information and prescriptions from the service manual of the specific vehicle (present example from Daily electric)

I. Battery State Of Charge
2. Battery temperature
3. Traction motor temperature
4. Status of Vehicle (Economy, Performance, Battery in charge)
5. Direction of run
   D = Drive
   N = Neutral
   R = Reverse
6. Messages for the driver
7. Range

Conclusions

- The e-learning Modules are going to be **validated by Industrial and Academic Entities** from the Countries of the TECMEHV Partners and made ready for application in on-line courses in the various languages.

- The TECMEHV **Competence Framework** definition and diffusion with the e-learning Modules is considered to be a substantial contribution for enlarging the culture on the electric and hybrid vehicles and for **professional formation** of the operators in this field.

- The effective operation along life of the electric vehicles is fundamental for their diffusion and their integration with the electric energy and **environmentally friendly transport system**.

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A future energy integrated system scenario

The electric vehicle as a key protagonist in the eco sustainable energy and transport system

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THANK YOU FOR YOUR ATTENTION!

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