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Project no. 2020-1-IT01-KA202-008555

“Innovation Garage of Garages”

IO6 – Intellectual Output 6

Training programme related to customer care and first intervention procedures, based on the work-based learning methodology located inside the innovation garage

Output Type: Open / online / digital education

OER – Open Educational Resource

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Training Program on customer care and after sales of EVs/HEVs

Language: English

Author:

Innovation Garage of Garages Partnership

Coordinator: Cisita Parma scarl, Italy

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Intro: the learning model

Since VET providers maintain close cooperation with the industrial sectors, especially within the automotive field, workplace training is the most valuable asset that educational institutions hold to develop job-related skills, facilitating the learners' transition into the labour market.

In this view, the "Innovation Garage of Garages" project (named "IG2" below), holds the purpose to bring VET providers and automotive companies together (either construction houses, OEMs manufacturers, dealers, car-repair workshops) to co-design training paths & learning environments suitable for the development of green mobility skills, in terms of:

a-learning goals & contents;

b-layout of the training workplace;

c-tools, machinery and equipment.

According to the panorama of the green skills and job profiles within the Automotive sector, identified in the IO1 paper, the main 5 work processes that IG2 project deals with are:

IO2: Installation & Assembly of EV/HEV engines

IO3: Maintenance of EV/HEV engines

IO4: Configuration & calibration of Avionics systems in e-vehicles

IO5: Maintenance of Avionics systems in e-vehicles

IO6: After-sales & customer care assistance as well as road-rescue and safety procedures related to EVs/HEVs

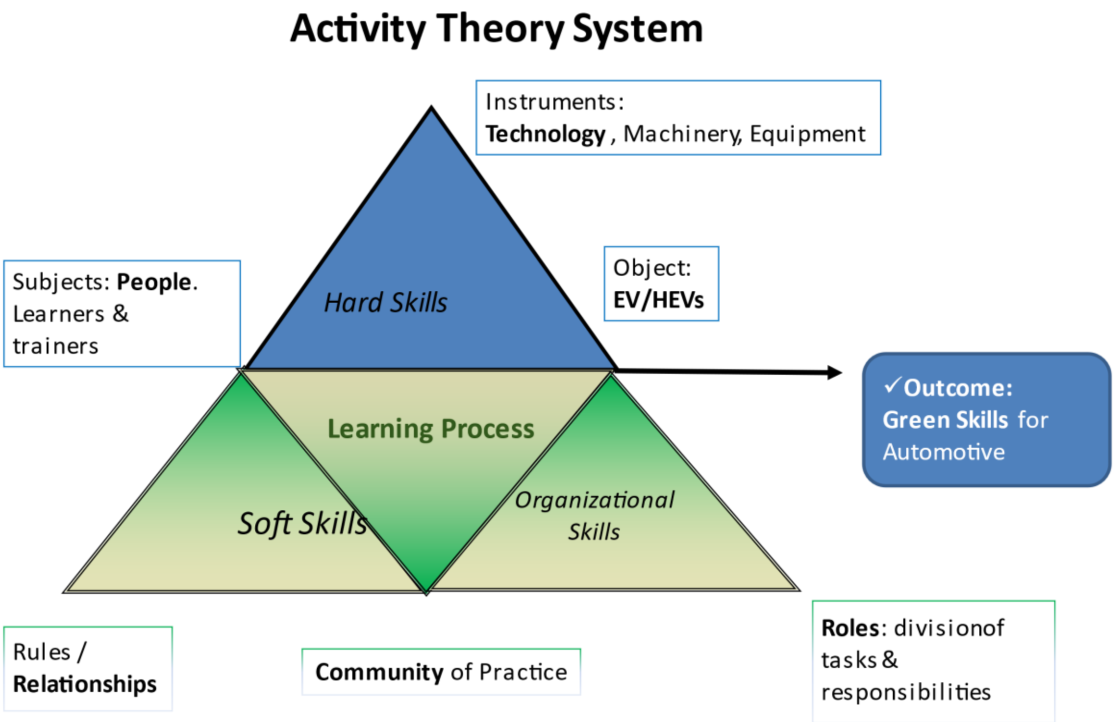
The training environment should make practical learning accessible and inclusive, and students should learn from work processes and organizational structure, as well as use technological assets that are the closest possible to the real workplace layout.

This is what IG2 partnership agreed to call "situated learning", identifying the dynamics of a training environment equipped with technological tools, where learners are immersed into a productive process governed by supervisors performing a mentoring and leading role, aimed at manufacturing a given product.

The learning model inspiring the project methodology is the "Activity Theory" framework by Yrjö Engeström (1987/2015), representing the third generation of academic researchers studying the topic, after the contributions of cultural-historical psychology from the Russian Vygotsky to Leontyev.[1]

[1] For a very introductory documentation over the "Activity Theory" system please see:

- Andy Blunden "Engeström Activity Theory and Social System", 2015



According to such model, the overall learning process is composed of two main dimensions: the immersive experience of actually doing some activity or of producing a real product within a given environment, such as the school lab or the training facility, or workplace itself. This is the dimension where the e-mobility hard skills are being developed, thanks to the interaction of 3 main elements: people (learners & trainers) as *subject* of the process; tools (such as technology, equipment and machinery) as *instruments* making the learning process come true; the *electric/hybrid vehicle* or one or more of its components, as the *object* of the learning process itself. The outcome of the interaction of such 3 elements is the expected learning goal itself for the relevant testing, or, more generally, the green skills for the automotive sector.

Underneath the upper triangle, the Activity Theory puts the hidden or intangible part of the learning process, which is related to the development of all the soft skills implied by interacting within a complex organisation of people. This is what happens to workers in a company, but workplace learning or workplace simulation actually reflects the very same dynamics. As a matter of fact, within an automotive production site or within a car repair workshop, for example, workers are assigned different roles, responsibilities and tasks which actually shape the interpersonal relationship happening over there. VET learners, either in their initial training at school, or involved in lifelong and continuous training at work, are immersed in a community of

- Oliver Ding, Yrjö Engeström: the Activity System Model, 2021

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practice, where knowledge, skills & behaviours are shared, promoted, rewarded or even confuted or rejected.

IG2 project, by bringing together VET providers and companies, aims at co-designing learning experiences for the development of e-mobility skills, keeping in mind such behavioral and organizational learning model.

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Innovation – Garage of Garages

1. Referencing Output 6 e-mobility skills to the current job qualification frameworks

Output 6 of the IG2 project is focused on the development of skills related to the customer care or after sales services, as well as to the road rescue and safety procedures in case of crash, failure or fire events, related to electric or hybrid vehicles.

According to IG2 partners, such tasks can range from simple and basic ones, attainable from EQF 3 operators or even lower, e.g. C-VET operators achieving EQF2 vocational qualifications, to technical or supervisory roles (EQF 4 - EQF 5).

Output 6, outlining the train-the-trainers program for VET teachers willing to introduce e-mobility in their didactic courses, collects the job qualifications in the automotive sector according to the ESCO framework and from the job-profiles and skills card classified by the Erasmus+ Sector Skills Alliances DRIVES 591988-EPP-1-2017-1-CZ-EPPKA2-SSA-B (for the general automotive sector) & ALBATTS 612675-EPP-1-2019-1-SE-EPPKA2-SSA-B (specifically for the battery sector).

According to such classifications, Output 6 refers to the following job roles matching the EV/HEV engine assembly operations:

	DRIVES Development and Research on Innovative Vocational Education Skills	albatts
Motor vehicle assembler		EV Automotive Repair and Inspection Personnel
Automotive Electrician		
Electrical Cable Assembler		
Electrical Equipment Assembler		
Electrical Equipment Inspector		
Electrical Mechanic		
Electrical Supervisor		

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Automotive Battery Technician		Battery Manufacturing Technician
Battery Assembler		Battery Module Assembly Technician
Battery Test Technician		Battery Quality Technician
		Battery Recycling Technician
	Predictive Maintenance Technician	
	Functional Safety [Engineer/Technician]	
	Sustainability Manager	
Automotive Test Driver		
Fire Service Vehicle Operator		
After Sales Service Technician		

Among all the e-mobility related job qualifications that ESCO, DRIVES and ALBATTS put together, the one listed above are the ones that are at least partly relatable to the training programs that were designed and tested by the IG2 VET providers' consortium, and that will be described in the chapters below.

2. Designing, testing and evaluating results of training programs about the after sales, customer care and road rescue of EVs/HEVs

During the Pilot Phase of IG2 project (Output 1), partners agreed that the basic structure of any topic-specific program about e-mobility should start with a joint business-VET design phase, including:

– identifying learning objectives,

– setting knowledge or skills entry requisites for VET learners,

– identifying the work procedures to implement,

– setting the training workplace layout and necessary tools/equipment,

– deciding on the expected outcomes of the troubleshooting,

– establishing supervisory and tutoring roles

VET providers were not assigned prescriptive rules about which relevant topic should be chosen for a training program about EV/HEV engine assembly or installation. Multiple reasons usually affect the choice of the specific topic to focus on, and the following criteria should be taken into consideration while evaluating the potential options:

a) whether or not the VET provider is already including specific training modules or contents about EVs/HEVs in the institutional offer;

b) the EQF level of the training course where e-mobility should be taught or introduced for the first time;

c) the general level of technical knowledge & skills of the target learners as well as their behavioural / communication skills and/or their potential fewer opportunities profile

With regards to point a), this is absolutely the most significant and diriment criterion that should guide the choice of VET trainers: are learners already trained about safety precautions around HV batteries and electric or hybrid engines? Are learners already able to read the electrical schemes of the car? Are they already familiar with the structure and components of internal combustion engines whatsoever?

If this is the case, it is probably a good choice to delve into EV/HEV engines specific topics such as electrical insulation or HV battery modules checks, or calibration of ADAS systems, on-board cameras and radars. On the opposite side, learners who are not trained about electrical risks must never work hands-on with HV batteries. This happens with upper secondary education courses at EQF 3 or EQF 4 levels, where students work just on the mechanical part of engines. In this case, in the first place mandatory electrical safety courses must be attended from students, and demo classes about HV batteries where trainers show the correct battery management procedures without students being involved, or using electronical panels simulating the engine mechanism or the switches of sensors regulating the circuits of the car, are good examples of introductory activities.

Furthermore, VET trainers should take into consideration the general profile of the target learners involved:

-EQF level of the training course and previous knowledge & skills gained by students

-the age of the learners: is it young people in initial learning or is it workers engaged in an upskilling or re-skilling course within C-VET training paths?

-the general lifelong background of the students involved: is there any type of potential disadvantage represented in the learning group?

This might range from physical or cognitive disabilities, to migrant background or language barriers preventing students from a full exploitation of the learning opportunities, or even age barriers, in the case of underqualified over-50 workers in need of a skill upscale to prevent job loss. In any of such cases, special arrangements should be envisaged by trainers in order to choose the most inclusive and barrier-free training environment possible. In case any learner has a physical disability, the workplace should be designed in a way that the learner is safe throughout the testing, yet he or she can either see the work procedures or operate some of them according to both the work safety procedures and to what the medical conditions allow. In case the learner has a mild cognitive disability, VET trainers should design the experimentation assigning tasks to small students' teams with an appointed leader with a distributed share of duties, so that everybody can be involved in the experimentation with different level of difficulty or responsibilities.

Team work and practical learning is especially recommended and effective in case of migrant learners with little command of the local language, as graphic or synthetic work procedures help understand topics or tasks quicker than a theoretical frontal class.

Evaluation. As a part of O1 train-the-trainer program results, IG2 project partners established a protocol for the evaluation of the work-based testing, to assess to which extent the program itself was successful for VET learners to develop e-mobility skills. Such assessment is a simple form with questions addressed both to VET teachers or trainers, and to business technicians, since the workplace training should be co-designed on both parts.

Teachers or trainers should assess:

– whether or not the learning goals have been met,

– whether or not the work-based testing delivered the expected outcomes,

– to which extent the expected knowledge and skills have been gained by the students or not,

– whether or not the diagnostic tools were used properly,

– whether or not the supervisory and tutoring activities were adequate to provide learners with the guidance they needed.

When relevant, teachers might also provide additional information about the main difficulties overcome, which tasks were missing or not correctly performed during the experimentation, as well as suggestions on how potentially making the experimentation easier or harder according to the learners' profiles.

On the other hand, business technicians should assess to which extent the knowledge and skills that students developed thanks to such a training experience are indeed useful and transferable to the job market. Furthermore, business technicians might as well provide further examples of troubleshooting and diagnostics experimentations on similar topics, that they believe might help learners develop missing skills about working on EVs/HEVs at different EQF levels.

Let's see examples of the training programs that each country team participating in IG2 project designed & tested.

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Option 1 – Cause of hazard in operation and maintenance of battery systems @ Göteborgs Tekniska College (Sweden)

This resource provides a brief and summative theoretical lesson about a huge topic: how to handle lithium-ion batteries and how to prevent external or internal factors causing hazards for both the human health & safety and the natural environment.

According to the E-mobility training suite available at Göteborgs Tekniska College, such topics might be tackled in the "Battery system overview" and in the "Lithium-Ion battery system" modules.

Module Title	Duration	Contents
EV Awareness	4 hours (theory)	● Environmental Issues & Constraints ● Market development ● Total cost of ownership ● Technology involved
Battery System Overview	8 hours (theory and practice)	● Battery Technology ● Electric Safety ● Battery Management ● Usage ● Durability
Lithium-Ion battery system	16 hours (theory and practice)	● Cell Formats ● Physical Chemistry ● Supply Chain ● System Design ● Production
EV charging and power supply	12 hours (theory and practice)	● Modes ● Behaviour ● Infrastructure ● Business Model ● Power Components
Electrical machines and transmission	16 hours (theory and practice)	● Drives overview ● Hybrid powertrain typologies ● Circuit theory

This is a totally frontal lesson. It implies developing knowledge about the physics and the chemistry affecting HV batteries and their modules and cell. On the other hand, it does not imply any practical skills or hands-on work. Because of the advanced contents about chemical reactions, chemical components and the law regulating electrical fields, target learners for those contents go from EQF 5 and above. Nonetheless, given the fact that the program is totally theoretical, it is suitable even for EQF 3 learners without any work-safety qualification about electrical works.

Task: Understanding the cause of hazard in operating with battery systems

DESIGN FORM	
Task	**Cause of hazard in operating with battery systems**
Learning Objectives	Safety and security concerning Lithium-ion battery system; How do the batteries work; Power losses concerning heat; Environmental impact of battery cell commodities.
Entry Level Knowledge (Theoretical)	Basic knowledge about chemistry; Able to read and understand procedures in battery system; Manuals and diagnostic tools.
Hard Skills involved	Ability to operate a diagnostic tool. Ability to identify real physical components. Knowledge about Lithium-ion cell
Soft Skills Involved	Ability to read and understand procedures in workshop Manuals and diagnostic tools on Lithium-ion battery system
Activities & Procedure required at EQF level (forecast)	EQF 5
Equipment & Tools to be used	Diagnostic tool (Vida)
Other Professional Roles involved	EV teacher/employee

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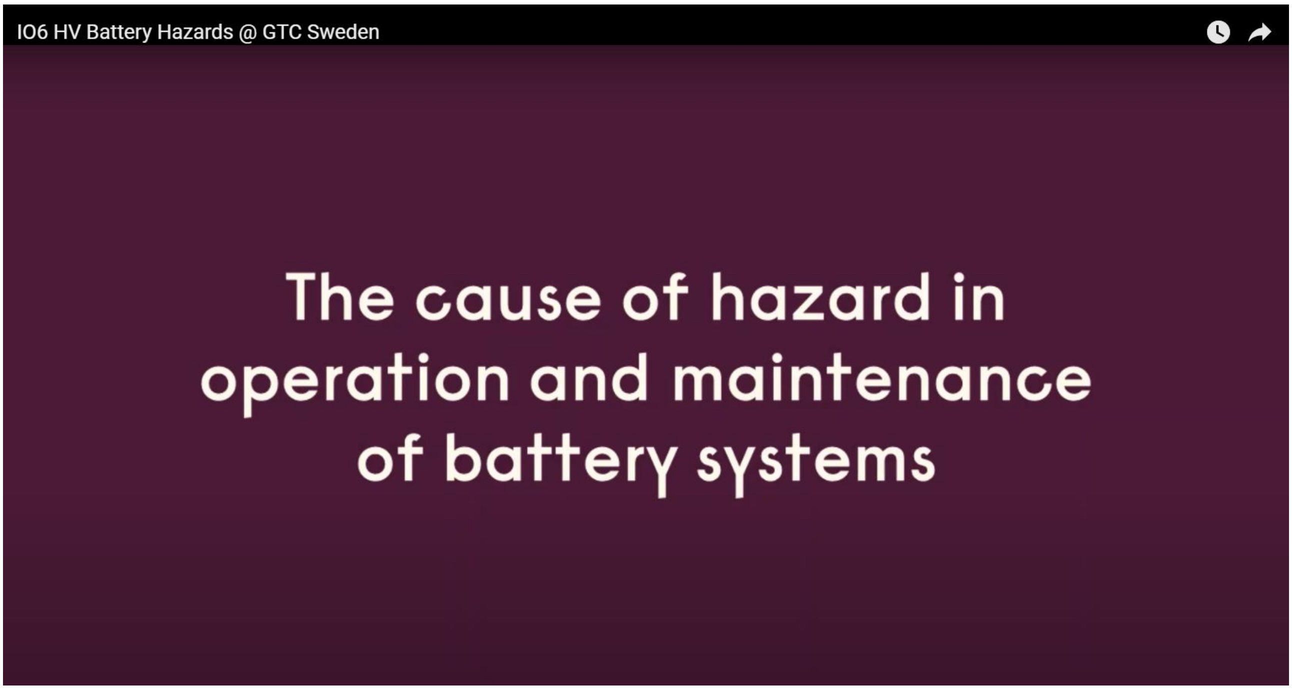
Supervision & Tutoring Activities	EV teacher/employee overview of processes during lesson, involving preparation and evaluation.
Expected Results / Solution	Students will have a better understanding of complete HV battery including the cause of hazard in operation and maintenance of battery systems.

The program was performed according to the technical procedure portrayed by the following video available on the IG2 Official YouTube Channel @innovationgarageerasmuspro1264:



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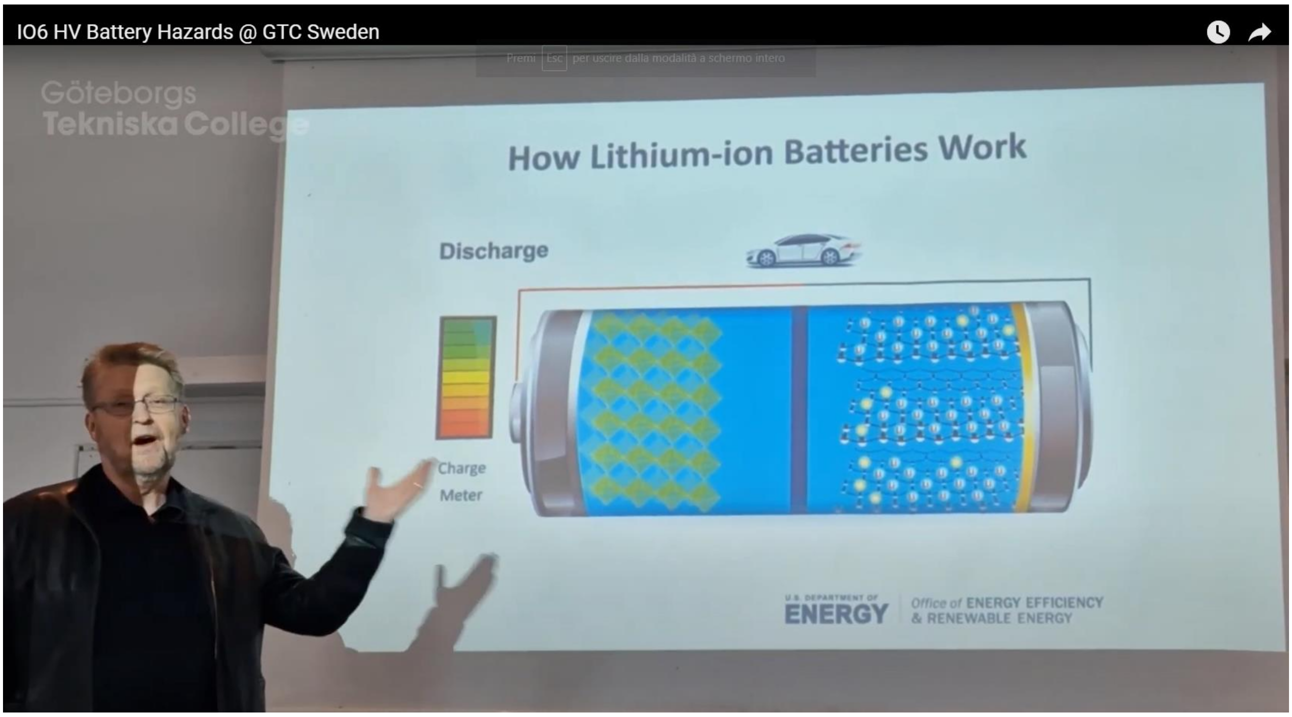
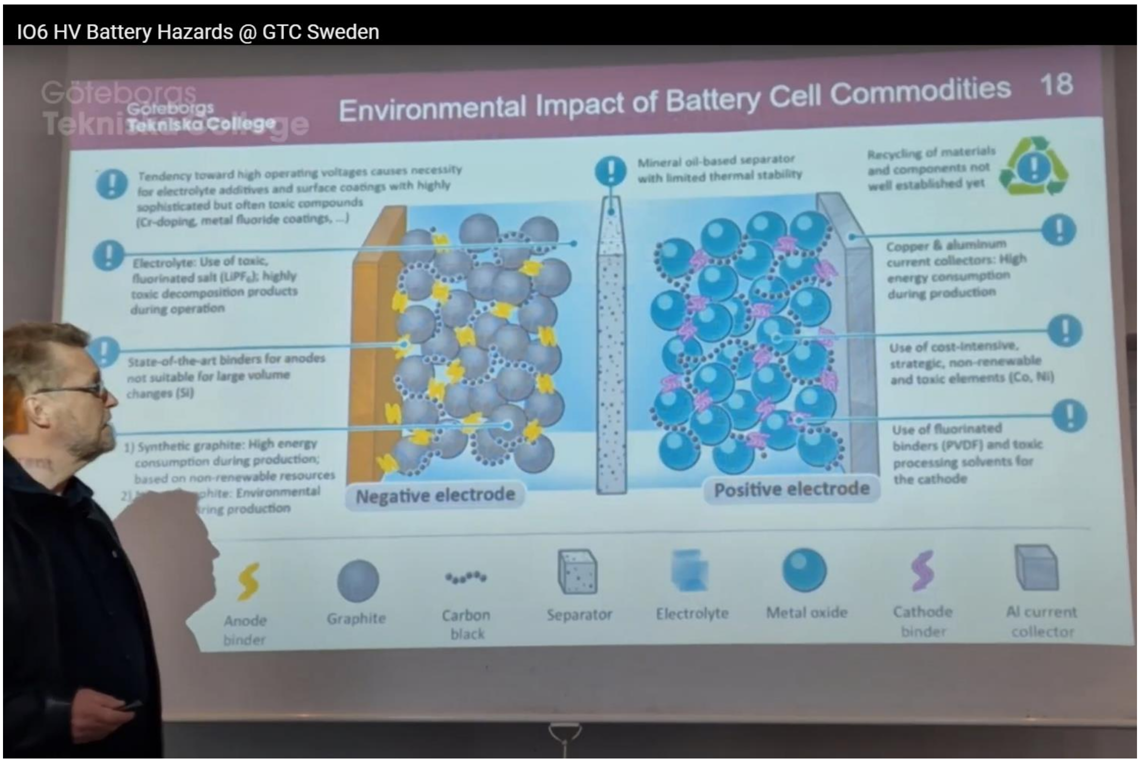
Index of Main Topics

The speaker in the video is Mr Fredrik Hannerz, teacher of electro-mobility at Göteborgs Tekniska College and expert in physical and chemical reactions within batteries.

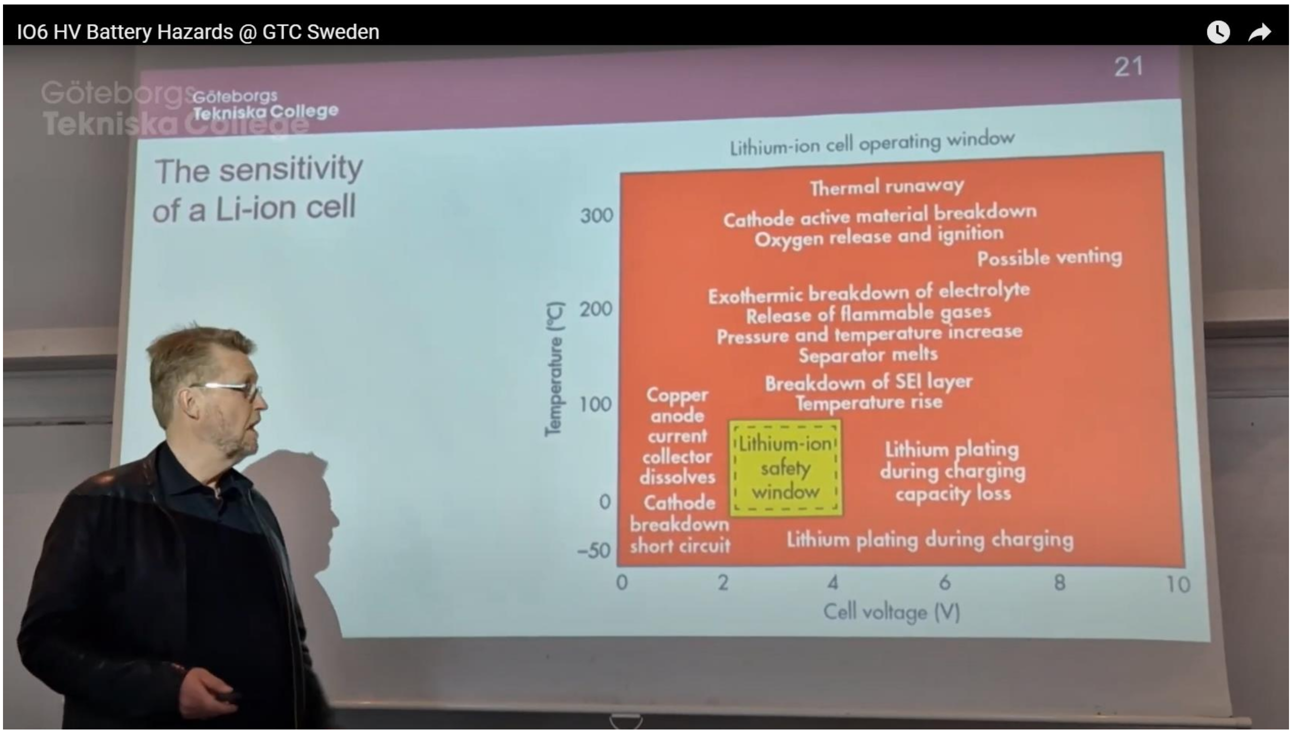
1)The chemical structure of a cell composing a module of a lithium-ion battery



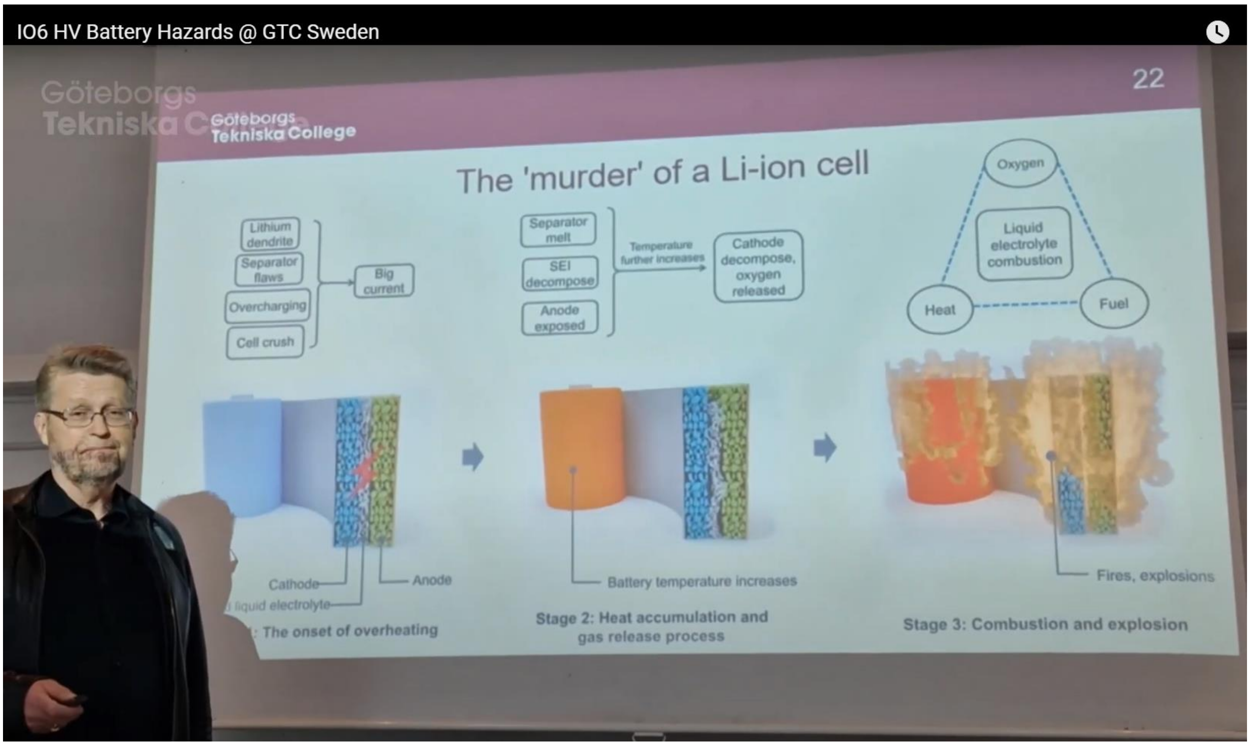
2) Chemical Substances inside a lithium-ion battery cell



3) The sensitivity of a Li-Ion battery cell and its safety window in terms of temperature and voltage



4) The “murder” of Li-Ion cell: voltage and temperature fluctuations as cause of damage and hazard



EVALUATION FORM		
Students’ Performance		
Students were engaged and interested	YES	Very interested despite the theoretically hard topic.
Students are able to apply theoretical knowledge to practical tasks	YES	More knowledge on battery systems and diagnostics is needed

tudents were able to perform task	NA	
Students are able to work autonomously	In part	More knowledge on battery systems and diagnostics is needed
Students were aware of safety procedures	YES	
Students were able to use diagnostic tools	In part	More knowledge on battery systems and diagnostics is needed

VET Teachers & Trainers	
Learning Outcomes	Achieved
Expected results	Achieved
Entry level knowledge and skills of the students	More knowledge on battery systems and diagnostics is needed
Equipment & Tools	Deeper knowledge of the dealers' software would be needed to operate effectively

Supervision & Tutoring	Effective
Business Technicians	
Extent of transferability of the developed skills to the job market	Complete
Suggestion for further development	More knowledge on battery systems and diagnostics is needed
Missing skills for students:	Ability to apply work procedures
Development of teachers' role:	✓ Wider access to teachers' training or update ✓ More corporate trainers appointed to VET teaching would be needed
Further examples of topic-related troubleshooting problems	
EQF level 3	-
EQF level 4	-
EQF level 5	-

Option 2 – International regulations on safe shipping of HV battery @ VAVM and Moller Auto, Lithuania

This program was designed and tested by the Lithuanian Team, composed by the VET provider **VAVM - Vilniaus Automechanikos ir Verslo Mokykla** and **Moller Auto Lietuva**, Volkswagen & Audi national dealer, both based in Vilnius

At VAVM - Vilniaus Automechanikos ir Verslo Mokykla there are two main specializations running on:

-Automotive Mechanic (EQF 4)

-Automotive Electric Equipment Repairer (EQF 4)

Courses do not currently provide a specialisation in HEVs/EVs or avionics circuits, yet work-based training also include maintenance and diagnostics operations on hybrid or electric vehicles. Training modules include contents, knowledge and skills suitable to become the starting point which further e-mobility training can be based upon. Such topics include the following modules:

-Engines technical maintenance

-Transmission technical maintenance

-Automobile electrical equipment repair

-Engines electrical equipment

-Transmission electrical equipment

-Automobile comfort and safety electrical equipment

Task: International regulations and safety precautions around the shipment of Li-Ion Batteries

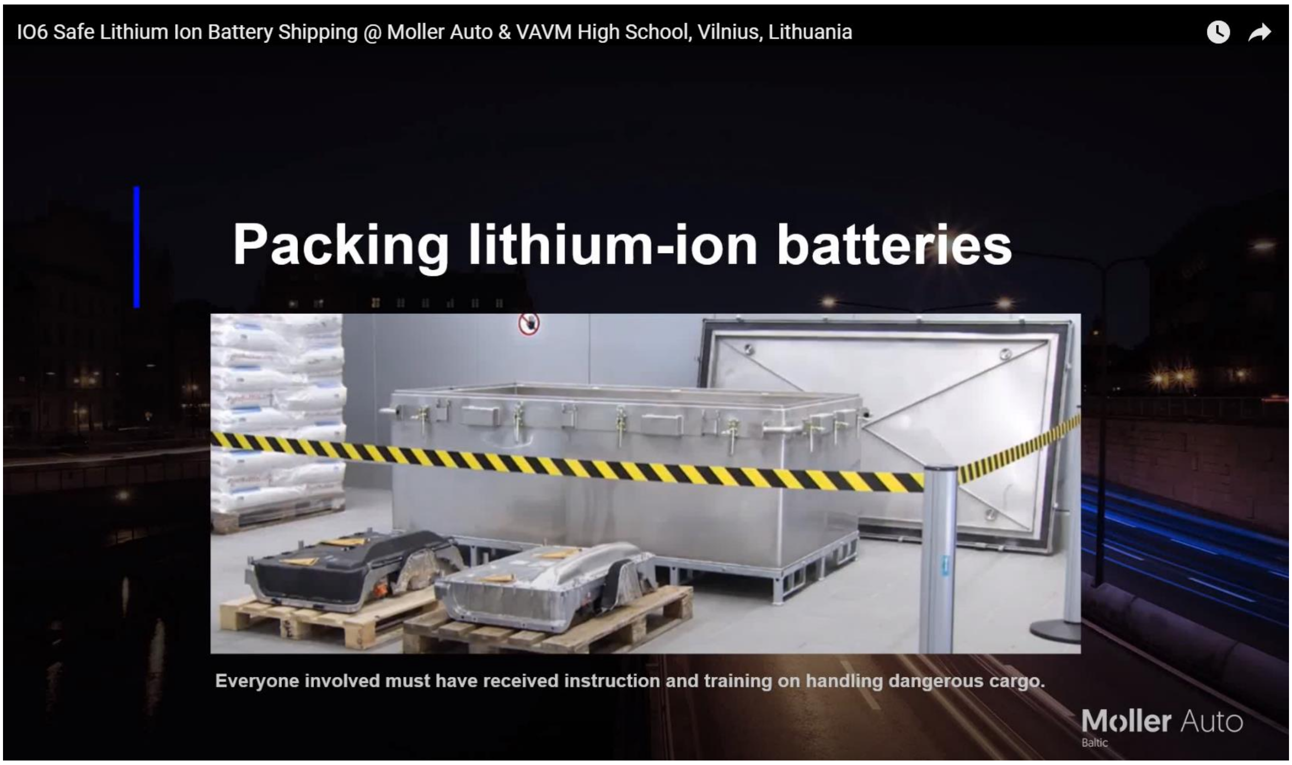
This is a totally frontal lesson. It implies developing knowledge about the physical and chemical hazards causing damage to battery as well as health risks to human beings. On the other hand, it does not imply any practical skills or hands-on work. Given the fact that the program is totally theoretical, it is suitable even for EQF 3 learners without any work-safety qualification about electrical works.

DESIGN FORM	
Task	***International regulations and safety precautions around the shipment of Li-Ion Batteries***
Learning Objectives	Developing knowledge about how to pack and prepare for shipment different size Lithium-ion batteries
Entry Level Knowledge (Theoretical)	Basic Electrically instructed Person qualification
Hard Skills involved	Prerequisites - Lithium-ion batteries as a dangerous cargo; Roles in the transport process in accordance with ADR[2]; Handling lithium-ion batteries; Packing lithium-ion batteries
Soft Skills Involved	English language Obligations to report and documents
Activities & Procedure required at EQF level (forecast)	III Level
Equipment & Tools to be used	Specialized containers, packaging materials, heavy weight moving equipment
Other Professional Roles involved	BEV/HEV Specialist/Supervisor Service advisor
Supervision & Tutoring Activities	Overview of processes during lesson

[2] ADR is the European Agreement concerning the International Carriage of Dangerous Goods by Road, dating back to a UN conference in 1957. The original French name for the 1957 Treaty was *"**A**ccord européen relatif au transport international des marchandises **D**angereuses par **R**oute".*

Expected Results / Solution	Students will learn how to prepare, pack and ship HV batteries.

The testing was performed according to the technical procedure portrayed by the following video available on the IG2 Official YouTube Channel @innovationgarageerasmuspro1264:



Index of main contents:

-Every operator involved in the process of preparing a battery for shipping or of receiving and unpacking a battery, must receive instructions and training about how to handle hazardous cargo.

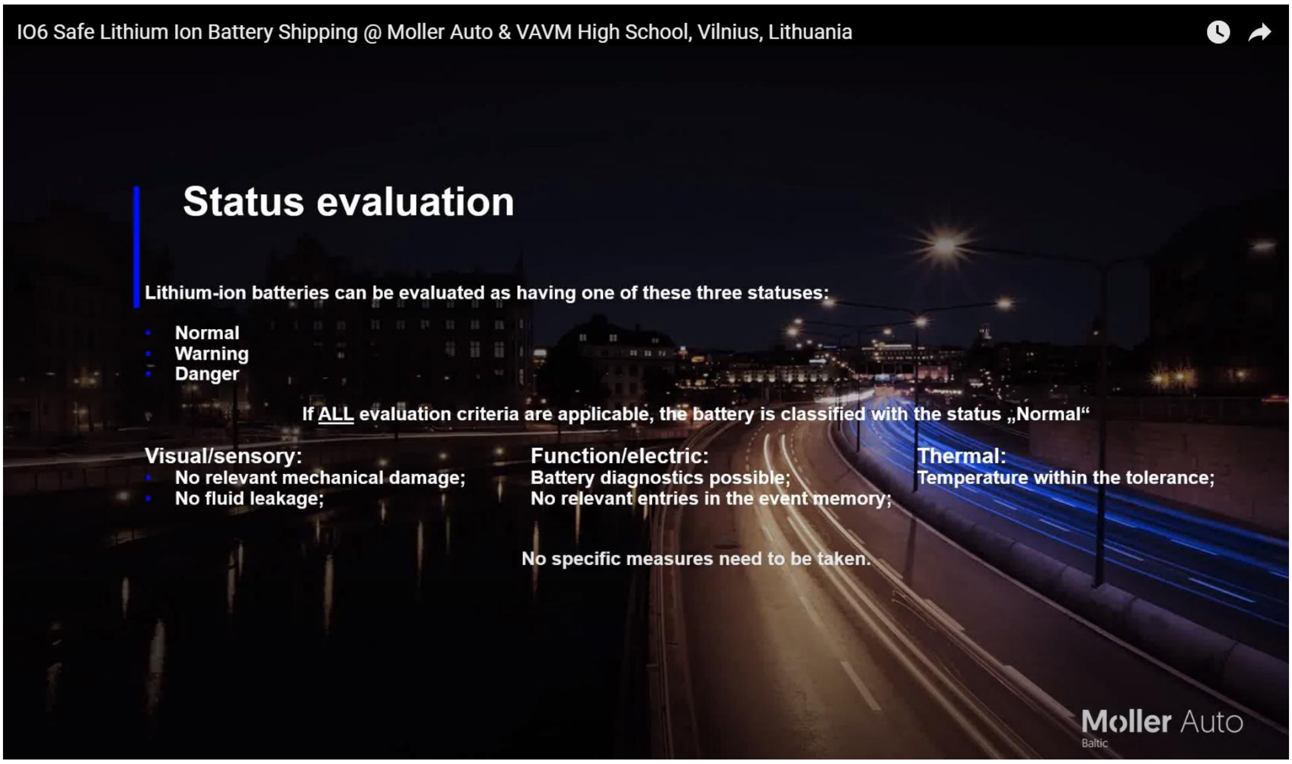
-Potential dangers of Li-Ion batteries: chemical dangers (leakage of toxic components such as electrolyte liquid, risk of chemical pneumonia, blood poisoning, skin burn or material corrosion) and risk of fire and of explosions.

-Health & safety risks involved with electrical voltage close to or above 60V.

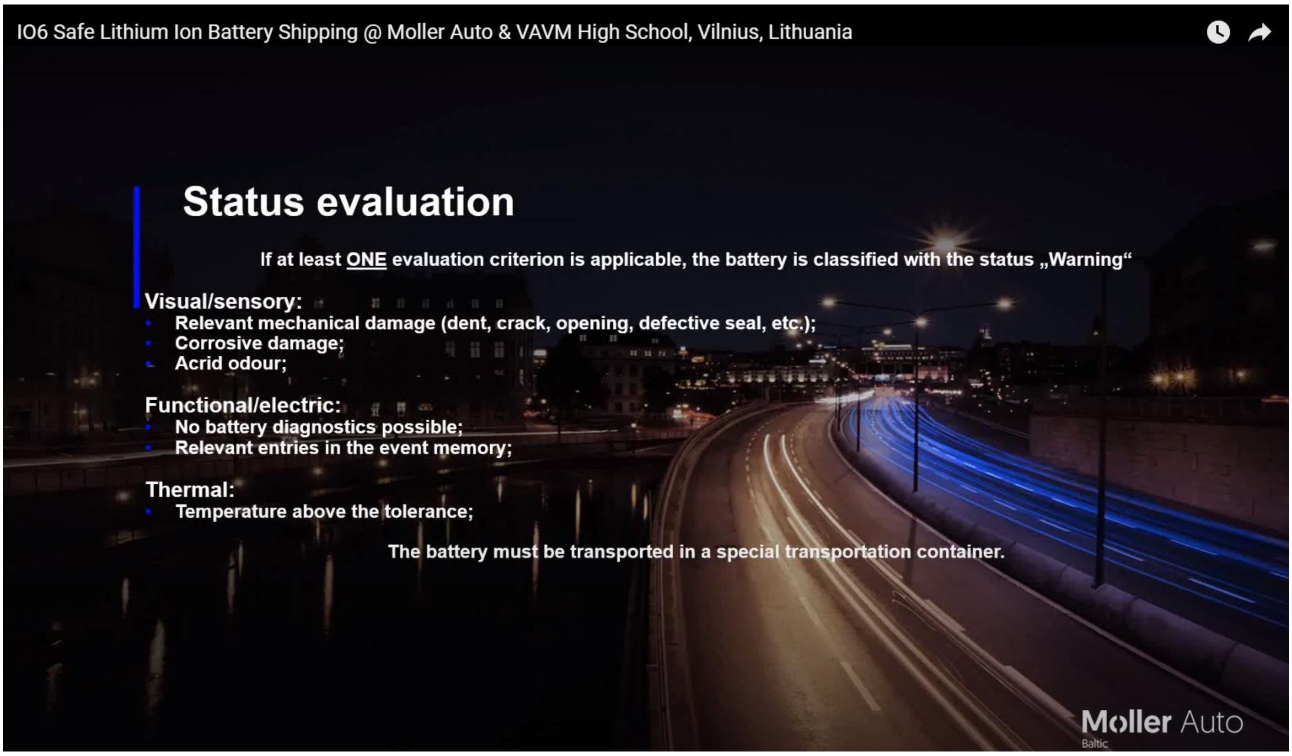
-Difference between battery cells, battery modules and battery packs. Classification of items for shipping according to the ADR Treaty about the transportation of hazardous goods.

-Criteria for the evaluation of the state of health of the batteries: conditions range from “normal” to “warning” to “danger” level.

Visual inspection (no evident cracks, mechanical damage or fluid leakage), electrical function (battery diagnostics is possible) and thermal conditions (temperature) are responsible to determine the status of the battery:



If all evaluation criteria are met, the battery is in normal status and can be prepared for shipping.



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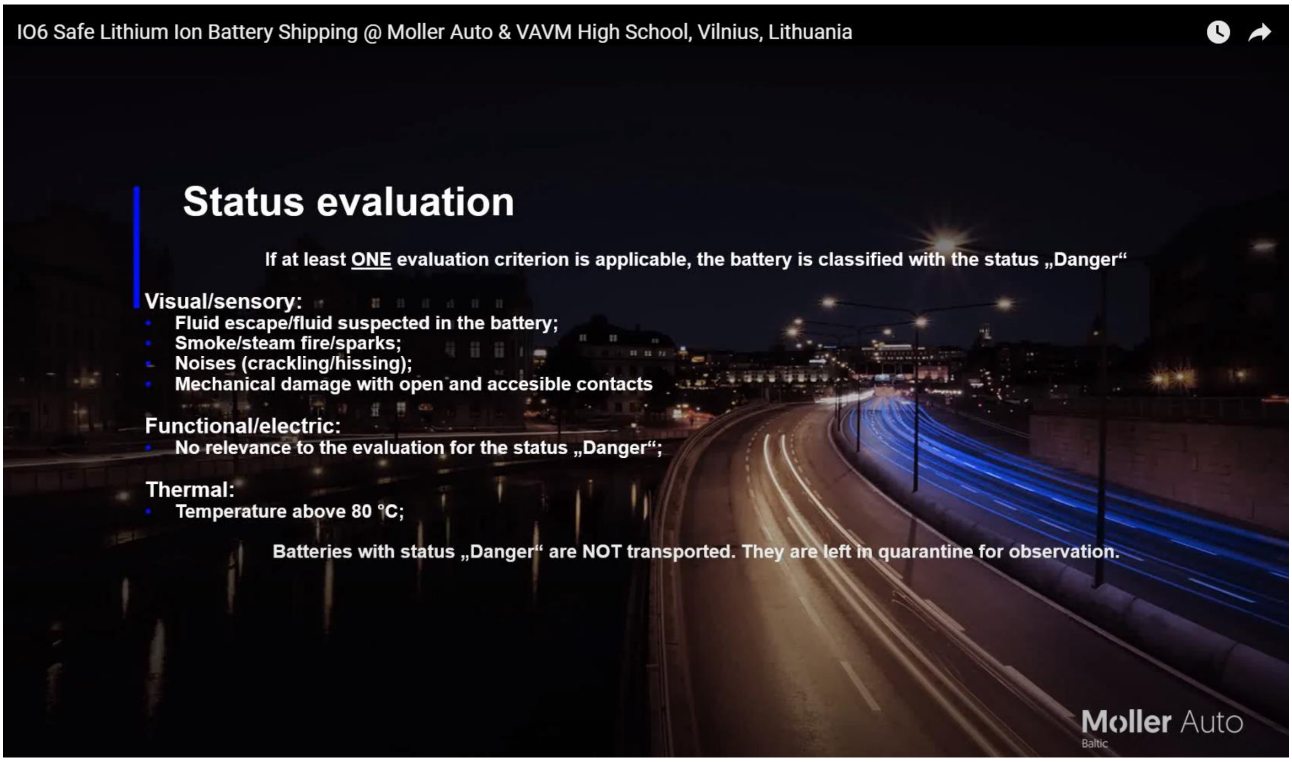
If any of those three criteria is not met, the battery is in “warning” status. It has to be put in quarantine until shipping. After the quarantine period is over, shipment is allowed under special packing conditions.

On the other hand, the “danger” status is declared when either the temperature of the battery pack is above 80 C°, or there are cracking or hissing noises from the battery case, or fluid leakage is present, or smoke / fumes are present, or no measurement about electrical activity is possible. No battery is shipped in such “danger” conditions: it is left in quarantine for observation, possibly immersed in water to reduce temperature.



-For batteries with normal status, the original case is used for packing and shipping, provided that all contacts are protected against external short circuits, while special insulating metal containers are used to ship batteries with “warning” status.

-The containers to pack the batteries for shipping must be filled with glass granulate beneath and above the battery itself. Glass granulates are small glass balls, so it’s a mineral and iron-free material. For this reason, it is great for multipurpose – it protects all wires and contacts from touching each other from potential short circuits. It is also fire proof.

-The battery case must show the sign “hazardous goods – class 9” and the UN3480 code, representing lithium-ion batteries.

-In case the battery is in the “warning” status, the container must also bear the sign “warning: damaged lithium-ion battery”.

EVALUATION FORM		
Students' Performance		
Students were engaged and interested	YES	
Students were able to apply theoretical knowledge to practical tasks	NA	
Students were able to perform task	NA	
Students were able to work autonomously	In part	*Guidance from VET trainers was needed*
Students were aware of safety procedures	YES	*Instructed people only*
Students were able to use diagnostic tools	In part	*Guidance from VET trainers was needed*

VET Teachers & Trainers	
Learning Outcomes	Achieved

Expected results	Partly achieved The topic needs more attention and students need to take seriously the procedures about packing used batteries as well as safety issues
Entry level knowledge and skills of the students	The general level was adequate.
Equipment & Tools	When equipment is appropriate, it is used in the correct way. Nonetheless, it is not easy to find suitable containers and insulation materials to ship used batteries, especially at VET level.
Supervision & Tutoring Potential improvements	Effective Students should be observed and evaluated by two teachers at the same time to make sure assessment is objective.
Business Technicians	
Extent of transferability of the developed skills to the job market	Partial A full preparation about all the necessary requirements, procedures and materials is necessary to access the job market
Suggestion for further development	

Missing skills for students	Ability to put work procedures in practice; Deeper knowledge about HV components.
Development of teachers' role	More connections with the corporate sector More business technicians appointed to VET teaching and training.
Further examples of topic-related troubleshooting problems	
EQF level 3	-
EQF level 4	-
EQF level 5	-

Option 3 –Electric vehicle fire rescue at ROC Midden Nederland

The training program was designed & tested by ROC Midden Nederland (VET provider) and Innovam (company), and is targeting VET students attending the following courses:

- First Car Technician (EQF 3)
- First Truck Technician (EQF 3)
- Technical Specialist Car Technology (EQF 4)
- Technical Specialist Truck Technology (EQF 4)

All of them already include, in the regular training paths, teaching contents about the following units:

- Hybrid and electrical drivetrain
- Electric engines
- NEN9140 (EU regulation about electrical works)
- Charging Systems
- Inverter/Converter Battery Management

This program simulates a danger situation where smoke and fumes are released by an electric or hybrid vehicle. Despite the rescue process involves the fire brigades performing the actual operations, only learners with former training and instructions about electrical risks, explosion risks and chemical hazards should be allowed to participate in this session. On top of this, only trainees holding certified electrical training certificate should be allowed to secure the vehicle or handling water pumps for cooling. For further details about electrical safety when dealing with e-vehicles, ROC Midden Nederland and Innovam do include such topics in a short one-day modular course for students and workers called "Safe working on e-vehicles basics" (see Output 1), as well as in de-energization of HV battery described in Output 2 and Output 3 of the IG2 project.

DESIGN FORM	
Task	**E-vehicle rescue procedures in fire event**
Learning Objectives	Being aware of the dangers of an EV after an accident Being able to use the emergency response guide Being able to use personal protective equipment

Entry Level Knowledge (Theoretical)	Safety operations procedures involving EV/HEV
Hard Skills involved	Knowing how wear individual protection equipment (fire safe suit, helmet, face shield, breathing mask, insulating gloves, safety shoes); Being able to use thermal imaging camera
Soft Skills Involved	Cooperating with other rescue services, in particular the fire brigade. Working under time pressure and dangerous situations
Activities & Procedure required at EQF level (forecast)	Following the procedures in the emergency rescue guide at EQF level 3
Equipment & Tools to be used	Camera and/or drone to capture images, shower tools to water the affected e-vehicle, tablet with fire brigade rescue guide, individual protective materials.
Other Professional Roles involved	Supervisor, teacher, potential fireworker…
Supervision & Tutoring Activities	Teacher and/or fire brigade commander supervises students
Expected Results / Solution	EV can be safely transported to the mechanical workshop for assistance and repair

Testing with relevant work procedures is portrayed in the instructional video available on IG2 project's official YouTube Channel @innovationgarageerasmuspro1264:

Topics/procedure:

1- As soon as a suspected emergency situation about an EV/HEV arises (fumes and smokes from the vehicle), call the local/national emergency number or the fire brigade;
2- As soon as the rescue team arrives at the premises, briefly inform the commander or person in charge about what happened;
3- The fire workers will wear breathing support to protect themselves from smoke and toxic chemical danger;
4- Special shower tools will be placed under and around the car to cool the affected battery down with water;
5- If cooling down is successful and no more smoke is released by the car, the vehicle is safe to be transported to the car repair workshop;
6- For severe battery heating or damage, it might be necessary to submerge the vehicle in water. In such cases the vehicle will be lifted up with a crane and transported to a special tank filled with water to complete the colling process until the vehicle is safe.

EVALUATION FORM

Students' Performance

Students were engaged and interested	YES	
Students were able to apply theoretical knowledge to practical tasks	YES	*Remarks: the entire operation was led and performed by the fire brigade.*
Students were able to perform tasks	NO	
Students were able to work autonomously	NO	
Students were aware of safety procedures	YES	
Students were able to use diagnostic tools	NA	

VET Teachers & Trainers

Learning Outcomes	Partly achieved The fire brigade covered only the practical rescue demonstration procedure but did not cover all the issues related to emergency situations affecting EV/HEV
Expected results	Partly achieved

	Not all information related to rescue safety of the vehicle was available
Entry level knowledge and skills of the students	Adequate level to engage in the experimentation thanks to self-study beforehand
Equipment & Tools	Used properly
Supervision & Tutoring	Effective *Remarks: Students were very eager to learn and listened carefully to the tips of the trainer. At this point in this training no points for improvement to indicate*
Business Technicians	
Extent of transferability of the developed skills to the job market	Partly – some contents are very specific for the fire brigade
Suggestion for further development	More theoretical training about dangers and hazards related to explosions and chemical risks
Missing skills for students:	
Development of teachers' role:	✓ Wider access to teachers' training or update
Further examples of topic-related troubleshooting problems	

EQF level 3	-
EQF level 4	More knowledge and skills needed on how to repair vehicles involved in accidents, brought in the workshop by rescuers.
EQF level 5	More knowledge and skills needed on how to repair vehicles involved in accidents, brought in the workshop by rescuers.

Option 4 –After sales assistance at IIS A. Ferrari, Maranello, Italy (EQF 3-4 levels)

Such tasks were performed by students attending the technical and vocational courses (EQF 4) at IIS "A. Ferrari" in Maranello (Modena, Italy).

Based on the learning objectives of the project - getting students familiar with the electric and hybrid vehicles, batteries and engines, the following study courses were identified as most suitable to run IG2 project's experimentation:

- Maintenance and Technical Assistance (EQF 4)
- Technician for the Construction of Transportation Means - Road Vehicles (EQF 4)

At such a level students attend mandatory work safety courses - both general safety recommendation at work and specific mechanic and electrical risk training, but, given their young age, they are not usually trained as EiP (electrically instructed person) and they cannot work with high voltage batteries or circuits.

Students at such level are trained to perform maintenance operations on the mechanical part of the vehicles, but they are not allowed to install or repair any electrical circuit, including of course HV batteries.

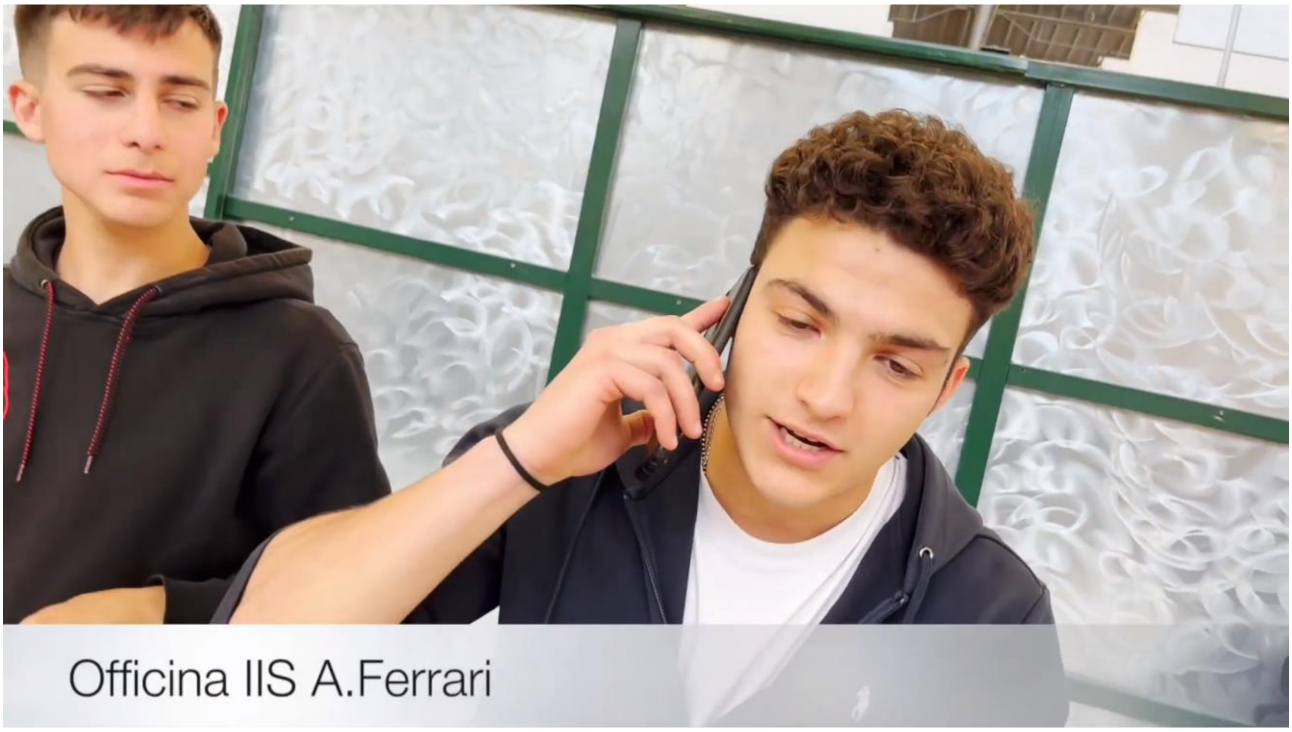
At Ferrari VET school students learned first about the structure and working mechanism of the electrical part of motor engines (see Output 2), then about the maintenance through electronic diagnostics thanks to the OBD software (Onboard Diagnostic Tool, see Output 3).

At this point students were involved in an after sales simulation, performing a negotiation between a customer experiencing a problem with his e-vehicle and the mechanical workshop, providing assistance and options about how to deal with problems affecting an HV battery.

DESIGN FORM	
Task	***After-Sales assistance to customers holding an electric or hybrid car***
Learning Objectives	Being able to offer assistance to customers experiencing problems with EV/HEV; Knowledge of potential failures of HV batteries and their causes; Being able to provide instructions and directions to customers to prevent hazards for human life and further damages to the vehicle.

Entry Level Knowledge (Theoretical)	Basic car mechanics Electrical circuits of vehicles Features and working mechanism of HV batteries
Hard Skills involved	Able to operate with an OBD (Onboard diagnostic tool)
Soft Skills Involved	Able to read and understand procedures in workshop manuals and diagnostic tools. English language Negotiation and communication skills
Activities & Procedure required at EQF level (forecast)	EQF 3-4 Level
Equipment & Tools to be used	OBD dealership software.
Other Professional Roles involved	VET trainer or workshop manager
Supervision & Tutoring Activities	Theoretical explanation of HV battery systems
Expected Results / Solution	Students will be able to understand how to deal with customers in emergency situations and to give them proper directions. Students will also develop sills in understanding which problems and their level of complexity, asking relevant questions to customers to support their own diagnostic hypothesis, and to make the customer happy after looking for the garage assistance.

Testing with relevant work procedures is portrayed in the instructional video available on IG2 project's official YouTube Channel @innovationgarageerasmuspro1264:



The video portrays two main customer care situations:

-in the first one, a customer experience a failure while driving an EV/HEV. The driver calls the car workshop for assistance and the operator warns him about not to touch any orange cable inside the car hood, as this is the high voltage system which is dangerous for human life. The operator will send a tow truck to rescue the car which will be taken care of in the workshop.

-In the second one, a customer complains about the low performances of the battery of his EV/HEV. After talking with the garage operator, they find out the battery already completed 1500 recharge cycle: at this point the battery has a physiological decrease in its performances. The operator offers two options to the customer: either replacing the battery with a new one, or choosing a new vehicle with a lighter battery pack and a higher performance potential.

EVALUATION FORM		
Students' performance		
Students were engaged and interested	YES	Students were assigned the task of making hypothesis of

		typical HV battery failures or emergency situations to simulate a phone call between the customer and the car workshop
Students were able to apply theoretical knowledge to practical tasks	NA	Theoretical training only
Students were able to perform tasks	YES	
Students were able to work autonomously	YES	With some guidance from the teachers about the correct way of communicating technical details to the customer
Students were able to find faults	NA	Theoretical training only
Students were able to identify safety procedures	YES	
Students were able to use diagnostic tool	In part	With some guidance from the teachers about the dealers' OBD tools (onboard diagnostic tools)

VET Teachers & Trainers	
Learning Outcomes	Achieved
Expected results	Achieved

Entry level knowledge and skills of the students	Adequate level of self study
Equipment & Tools	Adequate level of awareness
Supervision & Tutoring	Effective
Business Technicians	
Extent of transferability of the developed skills to the job market	Complete
Suggestion for further development	Practice on finding faults in HV systems using OBD software (onboard diagnostic tool)
Missing skills for students:	Knowledge of organizational / business roles
Development of teachers' role:	✓ Wider access to teachers' training or update ✓ Deeper or up-to-date knowledge of software or diagnostic tools
Further examples of topic-related troubleshooting problems	
EQF level 3	None

EQF level 4	More knowledge and skills needed on how to repair vehicles involved in accidents, brought in the workshop by rescuers.
EQF level 5	More knowledge and skills needed on how to repair vehicles involved in accidents, brought in the workshop by rescuers.

Option 5 – After sales assistance @ ITS MAKER Academy, Italy

Such a program was run by the EQF 5 level courses within the Fondazione ITS Maker, based in Bologna, training Higher Technicians in advanced technology, mechatronics and automotive fields.

Within IG2 project implementation, there are namely two courses with e-mobility related contents:

- Higher Technician in Hybrid, Electric and Endothermic Engines (EQF 5)
- Higher Technician in Electric & Connected Car and Assisted Driving (EQF 5)

Since both profiles envisage high specialisation standards, attainable with a tertiary education course after the general upper secondary certificate (EQF 4), the current IO5 program is only targeting VET learners with prior knowledge and skills about:

- Electrical schemes of vehicle circuits
- Electrical and electronic technologies and applications
- Installation and maintenance technologies and techniques

The IO6 task run by the Fondazione ITS Maker course in hybrid, electric and endothermic engines is about assisting a customer who is reporting a problem in the front camera of his/her electric FIAT 500 vehicle. The front camera is part of the ADAS systems explained in Output 4 and Output 5.

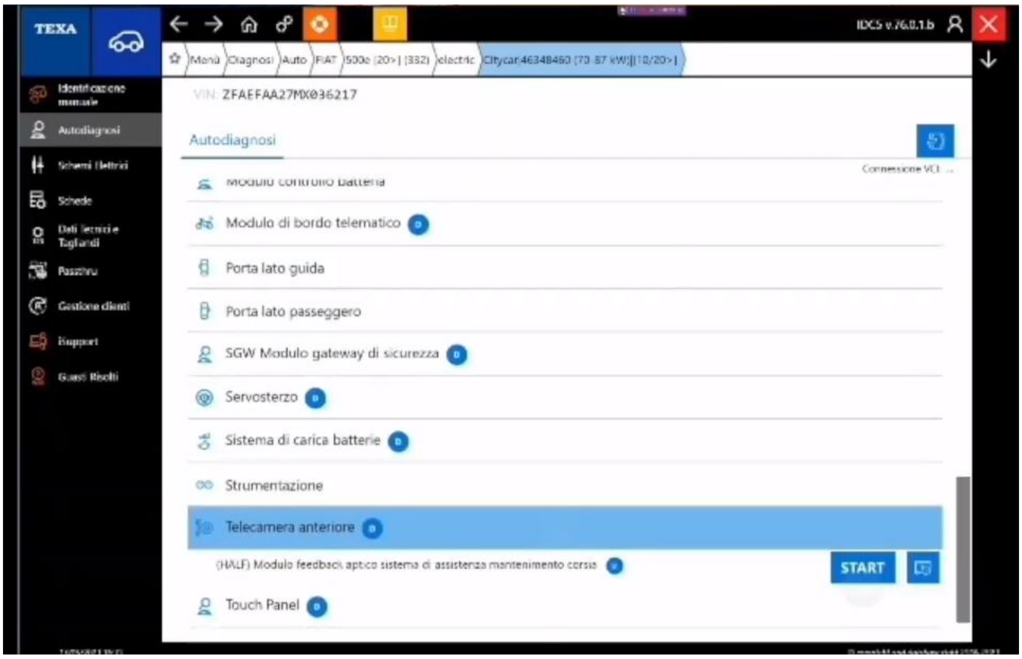
DESIGN FORM	
Task	***Replacing the front camera of an EV through the OBD software***
Learning Objectives	Knowledge of the main electrical and electronic circuits of vehicles in order to carry out correct maintenance in the event of faults.

Entry Level Knowledge (Theoretical)	Reading an electrical diagram, knowledge of laboratory diagrams and basic electronics
Hard Skills involved	Holding a diploma/qualification as well as a minimum of internship experience in the automotive sector
Soft Skills Involved	Complying with safety regulations in the workplace, especially in case of electrical hazards.
Activities & Procedures required at EQF level (forecast)	Measuring and analysing electrical parts and repairing damaged and/or defective parts
Equipment & Tools to be used	Electrical measuring and diagnostic tools.
Other Professional Roles involved	Software programmers and hardware developers
Supervision & Tutoring Activities	Correct use of personal safety equipment and correct use of work tools.
Expected Results / Solution	Knowledge of the main electrical and electronic circuits of vehicles in order to carry out correct maintenance in the event of faults.

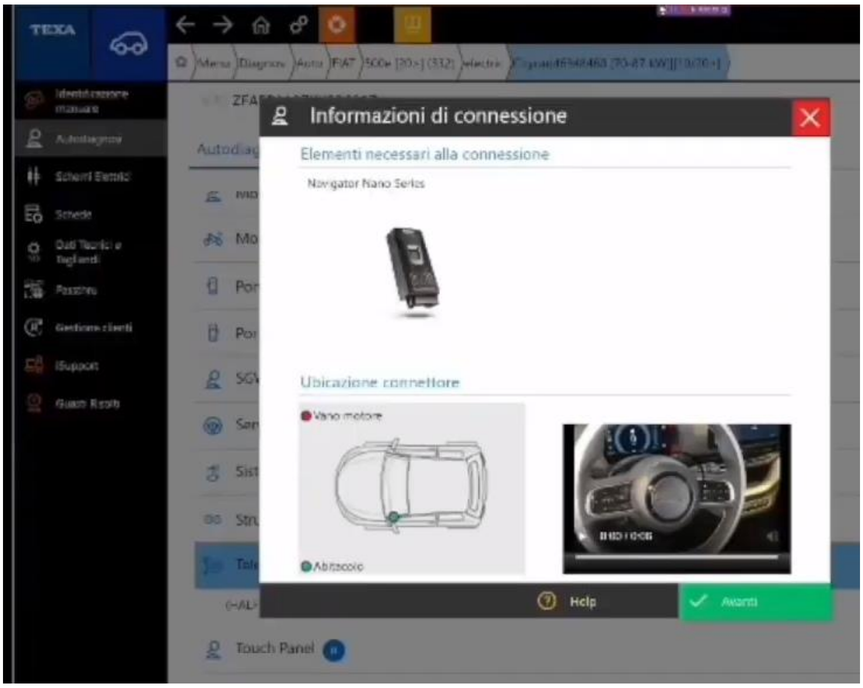
The testing was performed according to the technical procedure portrayed by the following video available on the IG2 Official YouTube Channel @innovationgarageerasmuspro1264:

Procedure:

1) After the vehicle is primed, yellow warning signs display there is anomaly in the system
2) The vehicle is then connected to the TEXA OBD software (onboard diagnostic tool) and a list of detected errors is displayed. The operator is thus able to find out there is a problem in the front camera.



3) Then the operator proceeds to replace the front camera with a new one. Before operating correctly, the new camera needs to be calibrated. The OBD tool offers information about which devices are necessary to calibrate the camera…



…as well as information about which calibration panel is suitable for the relevant kind of vehicle (FIAT 500 full electric).

EVALUATION FORM		
Students' Performance		
Students were engaged and interested	YES	
Students were able to apply theoretical knowledge to practical tasks	YES	
Students were able to perform task	YES	
Students were able to work autonomously	In part	*Guidance was needed from the trainer*
Students were able to find faults	In part	*Guidance was needed from the trainer*
Students were aware of safety procedures	YES	
Students were able to use diagnostic tools	In part	*Guidance was needed to correctly interpret the interfaces of the official dealer's diagnostic tools*

VET Teachers & Trainers	
Learning Outcomes	Achieved
Expected results	In part: it takes more practice to gain experience
Entry level knowledge and skills of the students	Partly adequate. Learners are still lacking practical skills
Equipment & Tools	Deeper knowledge of the dealers' software would be needed to operate effectively
Supervision & Tutoring	Effective
Business Technicians	
Extent of transferability of the developed skills to the job market	Complete
Suggestion for further development	-
Missing skills for students:	Ability to apply work procedures in the learning environment
Development of teachers' role:	✓ Wider access to teachers' training or update ✓ Deeper and up-to-date knowledge of dealers' software or diagnostic tools.

Further examples of topic-related troubleshooting problems	
EQF level 3	Applying safety procedures on voltage vehicles
EQF level 4	Diagnosing assisted driving systems and calibrate them
EQF level 5	Diagnosing anomalies on electric vehicles with ADAS

3. Collecting VET learners' feedback

As stated in the IO1 paper about designing a pilot Train-the-Trainers program about e-mobility, a relevant part of the program itself relies into collecting the learners' feedback about both their appreciation and their self-evaluation about the training experience.

Questions might vary according to the learning objectives of the experimentation and the EQF level of the VET provider, but on a general rule the following criteria should be met in order to administer feedback questionnaires to measure the impact of the training activities:

-forms should be collected anonymously to make sure respondents are free to express their sincere and honest feedback about the training program, either on a paper or digital format;

-questions might be multiple-choice or on a scale, but in any case some room for further comments or remarks should be left;

-the extent to which the training workplace helped students develop e-mobility skills should be assessed;

-the effectiveness of the mentoring or supervisory activities should be assessed;

-the extent to which prior knowledge and skills were allowed learners to make the most out of the training program should be assessed;

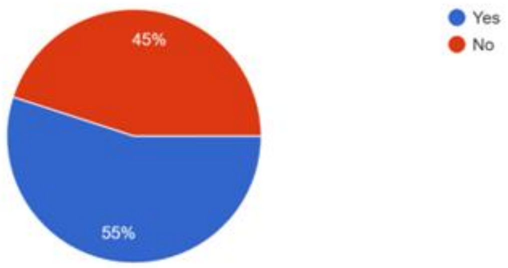
-the perception, on the learners' side, of actual development of e-mobility skills should be assessed;

-the extent to which learners think to be suitably prepared to transition to the job market.

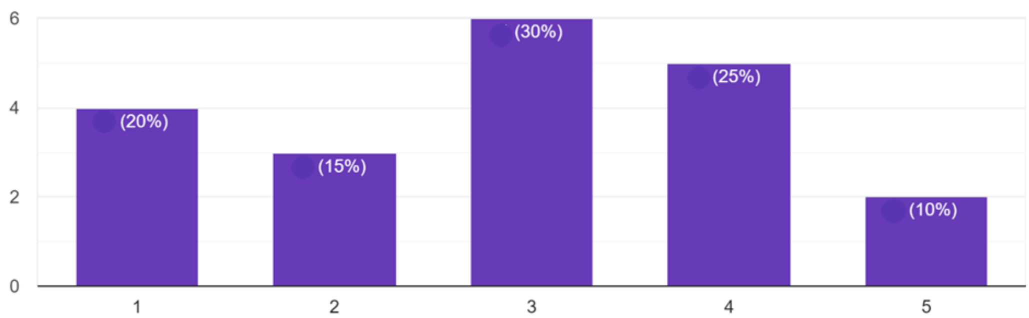
Examples of the collected feedback can be seen from the charts below, which report genderless aggregate data from all the countries and EQF levels involved.

Answers with scale from 1 to 5 mean that respondents were asked to rate the sentence in the questions with a score from 1 (absolutely not) to 5 (absolutely yes).

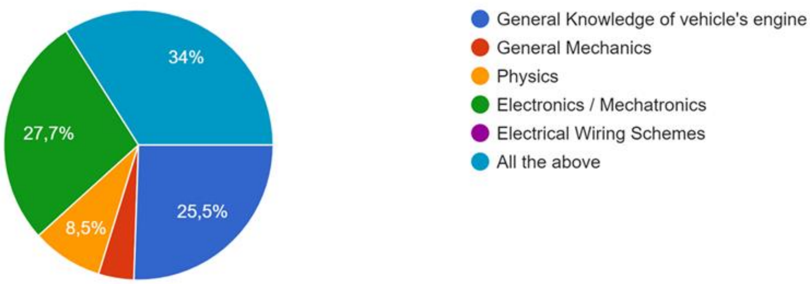
I already took classes in electro-mobility or HEV/BEV before participating in the project



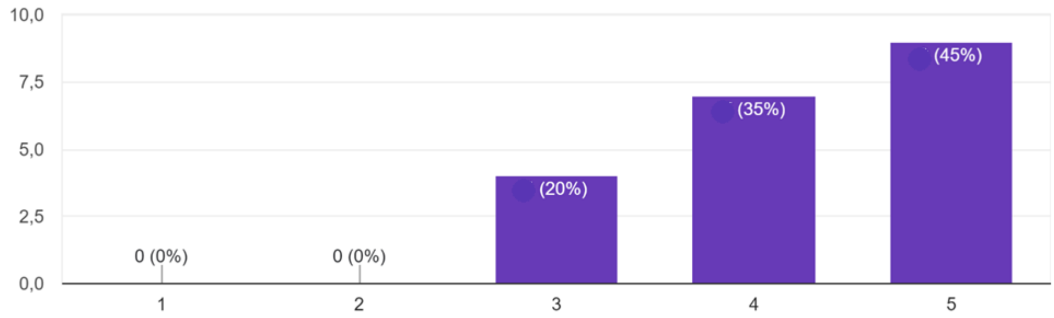
I think my previous knowledge & skills level was enough for me to take part in HEV/BEV testing



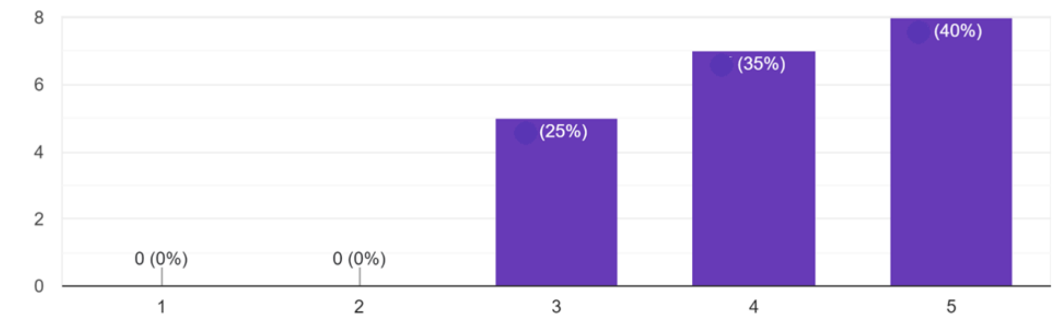
Which of the following was most helpful for you to make the most out of the HEV/BEV testing?



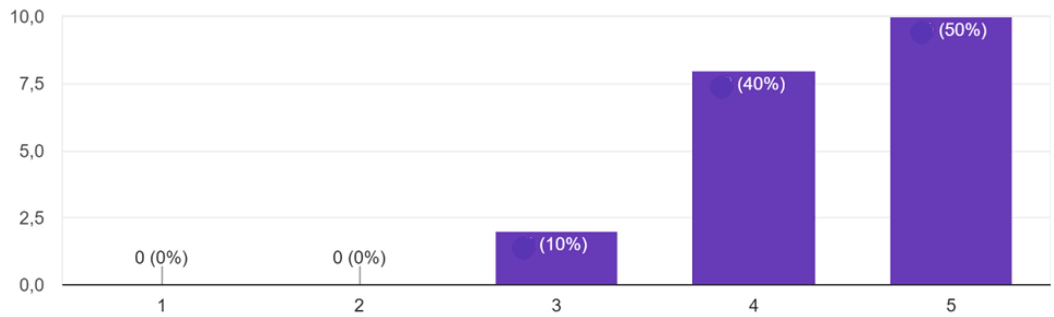
After the testing, I think I developed knowledge and skills about how to work safely on an HEV/BEV vehicle



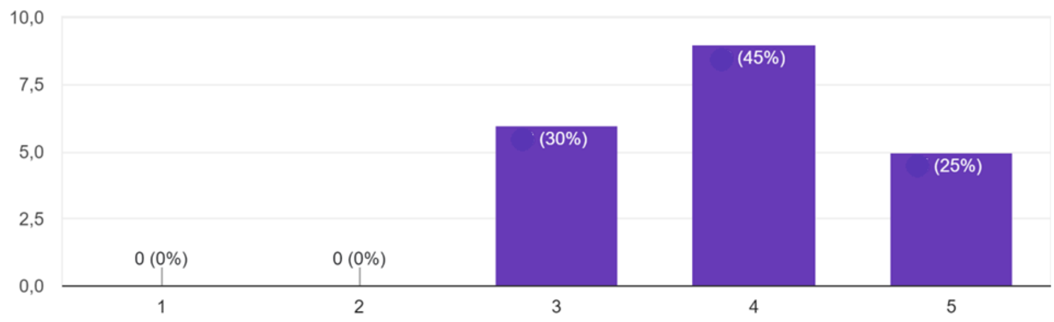
After the testing, I think I developed knowledge and skills about how to secure an EV/HV after an accident



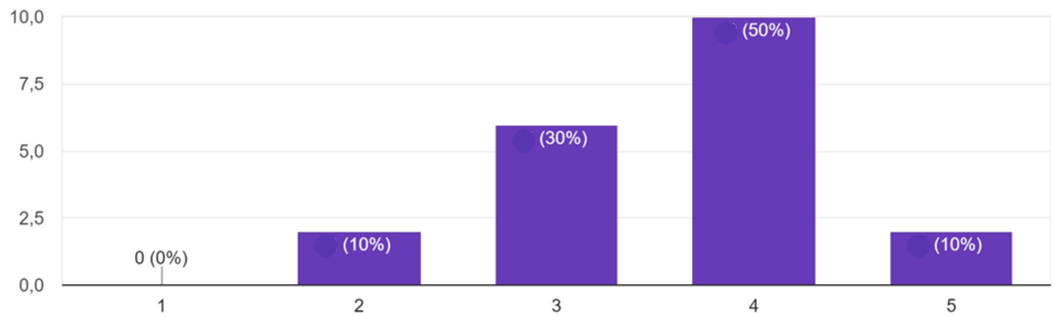
After the testing, I know which personal protection equipments I should wear and why



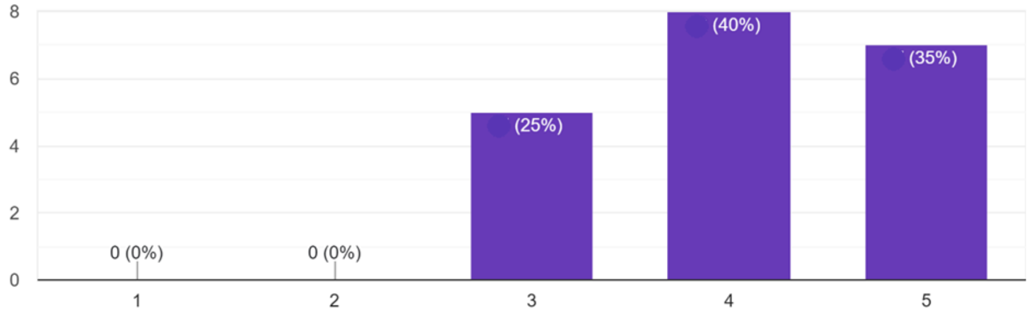
After the testing, I know the procedure to implement in case of emergency event or accident involving an EV/HEV vehicle



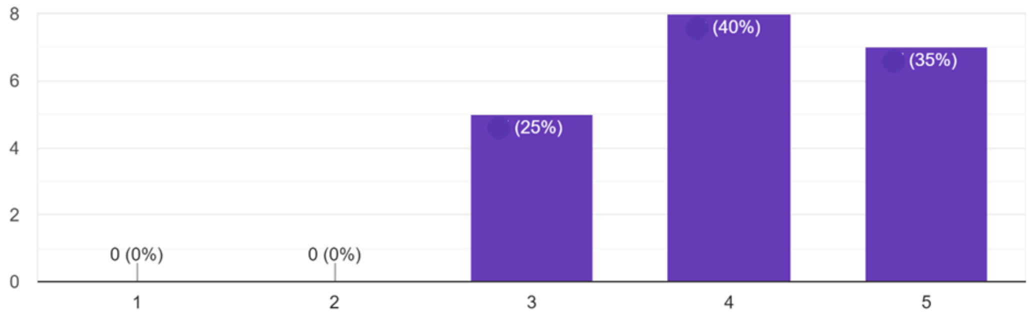
I developed knowledge about national / EU legislation about EV/HEV vehicles



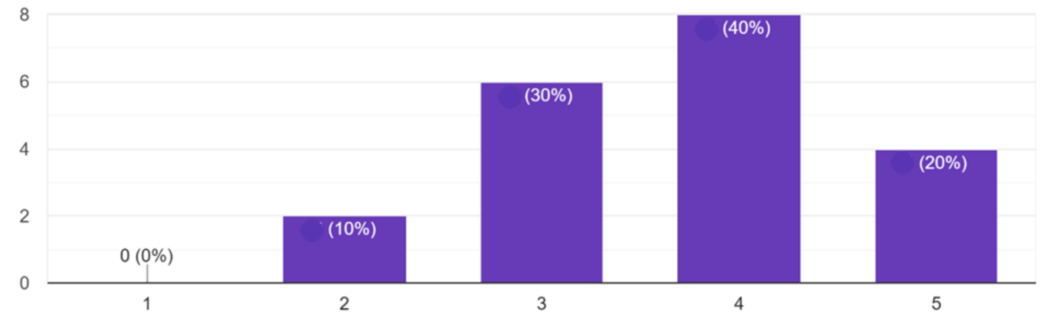
I developed knowledge and skills about EV/HEV battery



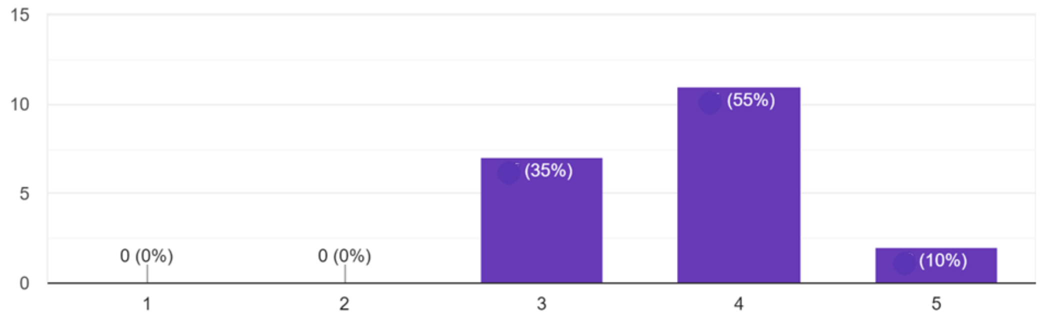
I developed knowledge and skills about EV/HEV battery



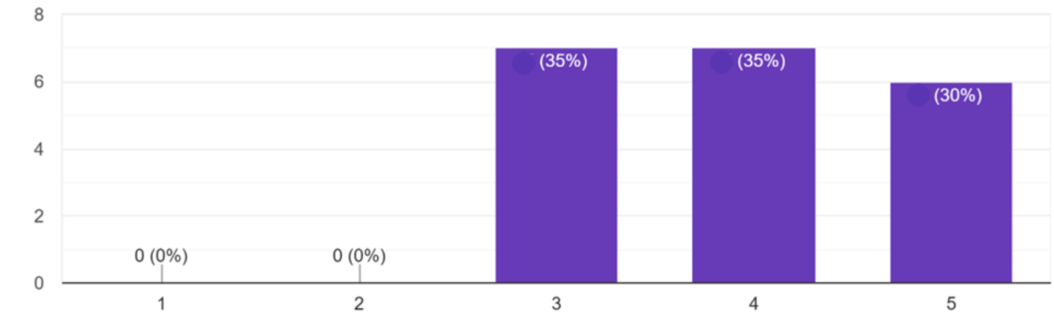
I think I can read electrical circuit wiring schemes



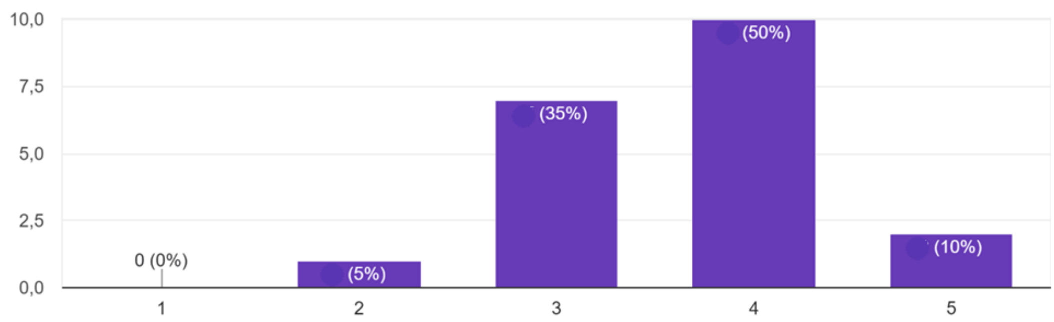
I developed knowledge and skills about how to perform failure diagnosis & repair in a EV/HEV system



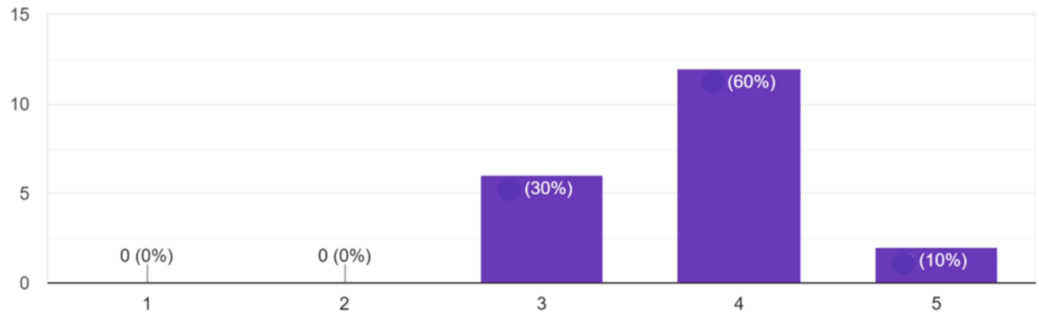
I think I was properly trained and supervised during the testing



I think I have better ideas about how a company workplace or a production plant or car workshops works



Thanks to the testing, I think I am better prepared for the automotive job market



Co-funded by the Erasmus+ Programme of the European Union

Conclusion: who is this paper for?

This paper represents the outcome of Intellectual Output 6 of "Innovation Garage of Garages" Erasmus+ project, aiming at developing green skills for the automotive sector at VET level.

The specific goal of such a paper is to provide guidelines for VET teachers and trainers willing to introduce hybrid or electric engines, high voltage and their components as a modular or integrated path within mechanics or automotive courses.

Multiple actors co-designing the training contents, the workplace layout and tools, as well as the organisational details of the didactic methodology (roles of trainers, facilitators, evaluation and assessment criteria, is the special footprint of the project. Since "Innovation Garage" is a worldwide methodology to introduce bottom-up multi-stakeholders innovation over the workplace premises, what this project is aiming at is renovating the way which "workshops" or "garage" training is usually performed.

So, this is just a proposal that needs to be customised with specific contents according to the target learners and the regular training courses within a VET organisation.

IO6 paper is suitable both for teachers and trainers at I-VET level (schools, training centres for young people or adults) from EQF levels 3-4, or even for H-VET at EQF 5 level (tertiary education other than university level). Nonetheless, e-mobility training can involve managers, technicians or trainers at company level - either at production houses, or repair workshops, or dealers, whenever workers need to develop or upgrade their skills about the management and maintenance of HV batteries, of HEV/EV vehicles and their components.