Full Hybrids

Lesson plan for teachers

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STEP AHEAD II

The support of Professional development of VET teachers and trainers in following of New trends in Automotive Industry
Automotive Innovation & Teacher training Academy
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Full hybrids 4 x 45 minute lesson

The aim of the lesson: Make a difference between various hybrid systems in automotive technology and turn focus on Full Hybrid System

Activity No.1 Part of the lesson: **EVOCATION**

The aim of the activity: Find out what students know about the topic

Step 1	Brief description of the activity	Starting the lesson by small talk about the topic. Ask questions from class about the hybrids whether they have the knowledge about it, etc who have driven the hybrid car or do someone own one. Introduce the idea of hybrid technology. Students should have the knowledge about combustion engine and drivetrain technology. Discussion about hybrid systems by brainstorming method.
	Instruction (what you need to tell the students)	What comes to your mind in relation to hybrid technology? Have you ever driven a hybrid car or do you know someone who drives it? What is a drivetrain technology? Have you ever heard about it? Can you explain the others how does it work and relates to hybrids?
Step 2	Brief description of the activity	Gather the main points from students by listening the discussion and write main points down using white board. Write down main points that students come up with, pay attention if there is knowledge about the different hybrid systems.

	Instruction (what you need to tell the students)	Together we write down the ideas and information you came up with. You can write your notes down, and key information, that you are interested in, too.
Step 3	Brief description of the activity	Start making difference about hybrid systems. Ask students directly if someone has a hybrid car in a family or in close neighbourhoods. If someone owns or knows about one, ask if this student(s) know what hybrid system the car uses. Ask students if they have Start-Stop function in the cars (micro-hybrid) and discuss about it.
	Instruction (what you need to tell the students)	Does any of you have a contact with a hybrid car, in your family or neighbourhoods? Do you know what hybrid system the car uses? What hybrid systems do you know or have heard about?
Tools for the activity (everything you need to take to the classroom)		Whiteboard and marker.
Estimated time (max. 40 min.)		20 min
Notes		

Activity No. 2 Part of the lesson: **APPRECIATION**

The aim of the activity: Focus the students attention to Full Hybrid vehicles

Step 1	Brief description of the activity	Introduction to various hybrid systems (Micro-Hybrid, MHEV, HEV, PHEV) Short brief about the abbreviations of different hybrid systems. Let students work with the texts (eg. Annex 1), internet or other materials prepared and delivered by teacher. Tell the students to find out the very basics about hybrid systems without teachers´

		presentation and make them focus on the subject. Text about hybrid systems (eg. Annex 1, other text documents) OR internet/depending on the timing of the lesson (internet search might take more time than work with ready texts). For writing down the information on each of the presented technologies, you can use table from Annex 2. Students can use the table individually and/or you can work with it on a white board.
	Instruction (what you need to tell the students)	Work in pairs. Go through the text from Annex 1 (or browse on internet), finding out as much information about Micro-Hybrid, MHEV, HEV, PHEV as possible and try to mark/note the information that you find interesting. Discuss it with your classmate. You might split the tasks among yourselves and let one student work on Micro-Hybrid, MHEV and the other on HEV, PHEV, or choose the type of technology according to your interests and preferences.
Step 2	Brief description of the activity	Summary of students´ findings. Together with students make notes on a white board on the key words related to Micro-Hybrid, MHEV, HEV, PHEV. How do these technologies differ? Is there anything that is similar? Ask volunteer students present concrete technology and, letting others add the information or comment on it. Shortly brief all hybrid systems in automotive technology and leave the Full Hybrid last. If there is any key information missing, let students search for it at home/browsing the internet and present it to the others on the next lesson.
	Instruction (what you need to tell the students)	We are going to together summarize your findings on each of the technologies: Micro-Hybrid, MHEV, HEV, PHEV What do you think are the key words and key information related to each of them? Present your findings. Volunteer can present concrete technology and others please add your ideas or notes.
Step 3	Brief description of the activity	Introduce and focus on the Full Hybrid system, watching the videos.

		After watching it, let students work in pairs or small teams and ask them to prepare ppt presentation of what they saw. They can browse internet for finding out more information, if necessary. Introduce the various benefits of full hybrids. https://www.audi-technology-portal.de/en/mobility-for-the-future/hybrid-vehicles/audi-q5-hybrid-quattro_en https://www.youtube.com/watch?v=jNuixuVhc5E
	Instruction (what you need to tell the students)	Watch the videos. After watching, work in small teams, finding out more information on full hybrids. Your task is to prepare ppt, presenting full hybrid system for the others. Tell how full hybrids overcome different driving situations, what components it includes and how it differs from normal combustion powered vehicles. Use following links as support: https://www.audi-technology-portal.de/en/mobility-for-the-future/hybrid-vehicles/audi-q5-hybrid-quattro_en https://www.youtube.com/watch?v=jNuixuVhc5E
Tools for the activity (everything you need to take to the classroom)		Laptop, internet, projector, blank paper for notes, Annex 1, Annex 2
Estimated time (max. 40 min.)		STEP 1 + STEP 2 - 30 minutes STEP 3 - 30 min
Notes		Texts about hybrid systems OR internet/depending on the timing of the lesson (internet search might take more time than work with ready texts or ppt) Use freely any other video links that support the lesson. PP-show used in this lesson have copyrights that prevent to multiply, print or take photos from the show.

	Micro-hybrid and hybrid vehicles explained: https://www.yuasa.co.uk/info/technical/micro-hybrid-hybrid-vehicles-explained/ (sample text in Annex 1) Videos on full hybrid to use: https://www.audi-technology-portal.de/en/mobility-for-the-future/hybrid-vehicles/audi-q5-hybrid-quattro_en https://www.youtube.com/watch?v=jNuixuVhc5E https://www.youtube.com/watch?v=g09JV70BWT0

Activity No. 3 Part of the lesson: **REFLECTION**

The aim of the activity: Students to summarise information they received

Step 1	Brief description of the activity	Summary of the main findings/topics on the hybrid vehicles. Ask students to make the short summary about the hybrid vehicles using the presentation materials/ppt they prepared in STEP 3 in the previous activity.
	Instruction (what you need to tell the students)	Please present the ppt that you prepared, to the others. If there is any key information missing, that you hear in other presentations, that you consider important/interesting, you can write down your notes and add it to your presentation, later on, too.
Step 2	Brief description of the activity	Lift pitch method OR group discussion: Let students work in groups of 4 – 5 people in each. Ask them to divide the roles/opinions, some people in a team would prefer mild hybrid, some micro hybrid, some full hybrid, some combustion engine. Let each

		team prepare their arguments for persuading the others of why their preferred technology is the best. They can present their arguments by speaking, using & commenting the videos or by developing posters or mind maps, explaining their opinions. They should be as creative as possible. Preparation time can range from 5 – 25 minutes or longer, presentation time is 5 – 10 minutes for each team.
	Instruction (what you need to tell the students)	Would you buy a hybrid car? Or do you prefer combustion engine, or is it fully electric car? If so, why? Work in groups, preparing the arguments for persuading the others that your choice is the best…you can include the information about the pros and cons of your preferred technology, in your speech/presentation, too.
Step 3	Brief description of the activity	Short summary from step 2 and discussion about pros and cons of each technology/T - graph. Write down plusses and minuses to the white board from each group. Teacher can discuss the information with students if the suggested idea is related to the subject or is valid. For pros and cons activity, you can use T - graph from Annex 3. To conclude the topic, you can ask students question about what car would they prefer to buy, if they could.
	Instruction (what you need to tell the students)	Together we are going to write down pros and cons of each presented technology. If you had a lot of money, that you could spend on buying a new car, which technology and what particular type of a car would you like to buy and why?
Tools for the activity (everything you need to take to the classroom)		Laptop(s), projector, white board and marker, note sheets, smartphones, internet, Annex 3 – T graph
Estimated time (max. 40 min.)		Step 1: 30 min Step 2: 30 min

	Step 3: 30 min for pros and cons + 10 min for telling the opinions on which car would students prefer to buy and why
Notes	Teacher must be an expert on the field of automotive industry to discuss and/or decide if the presented information is valid and related to the subject.

ANNEX 1

Micro Hybrid & Hybrid Vehicles Explained
Source: https://www.yuasa.co.uk/info/technical/micro-hybrid-hybrid-vehicles-explained/

Stop/Start Technologies & Functionality (Micro hybrid 1)

Initially a manual system now becoming fully automatic, switches off the engine when the vehicle is stationary. The engine is restarted automatically by releasing the brake and depressing the accelerator pedal or clutch pedal dependent on transmission type. Initial Stop/Start systems could be manually switched off, but on next generation vehicles this option is disabled
Increases the number engine starts the battery has to deliver as well as supporting all of the electrical loads on the vehicle whilst the engine is stopped and the vehicle charging system is not operating
Requires new electronic methods of monitoring the battery status including State of Charge (SOC) and State of Health (SOH). As the number of Stop/Start cycles required are increased, the vehicle must be able to determine if the engine can restart when the vehicle comes to rest and the engine is switched off
Initial Stop/Start systems would function if the ambient temperature was below 3°C whereas the latest systems are projected to operate at -10°C. This reduction in system operating temperature increases the demand on the battery to supply minimum voltages to the electronic circuits and control modules on the vehicle when cranking the engine

Various vehicle manufacturers state that, on their standard European drive cycles a typical fuel saving of up to 8% can be achieved by the installation of a Stop/Start system. This in current terms of electronics technology means a relatively low cost solution to reduce exhaust emissions

New technologies such as the Enhanced Flooded Battery (EFB) and AGM (Absorbed Glass Mat) battery have been developed to achieve the new higher duty cycle requirements placed on the battery by particular OEM vehicle manufacturers

The introduction of Stop/Start technology has resulted in a new band of battery failure modes not previously experienced by vehicle manufacturers. This is based on evidence collected from a recent time dependent driving experiment. The experiment featured a journey across London which produced 87 Stop/Start cycles which when compared with a comparable timed motorway journey produced zero Stop/Start events as the feature was not activated

Charge Management & Regenerative Braking (Micro hybrid 2)

Charge Management

It is likely that vehicle owners would not be aware of the installation of this technology as its operation is seamless, unlike Stop/Start which is clearly detectable as the engine stops if all system operating conditions are fulfilled when the vehicle comes to rest

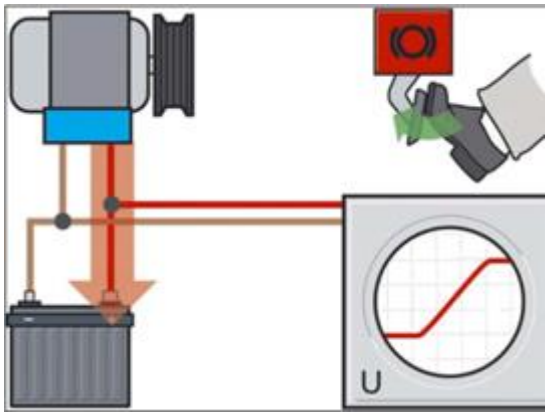
When the alternator is running it can typically consume up to 10% of the power produced by the engine. The charge management system effectively switches off the charging system by disconnecting the alternators drive from the engine. This increases the loads placed on the battery but significantly improves the fuel economy of the vehicle

The major fuel economy benefits of a charge management system are achieved on longer distance journeys. The use of this system shows that one technology alone is not the solution to every drive cycle but is important as part of an overall package of emission reduction and economy initiatives

The life expectations of the battery are greatly increased as it is supporting all of the electrical loads on the vehicle when the charge management system is operating

The introduction of charge management systems has resulted in the development of new battery technologies and designs with increased performance. These include EFB and AGM battery types which have a significantly better cyclic life and improved operation in low states of charge

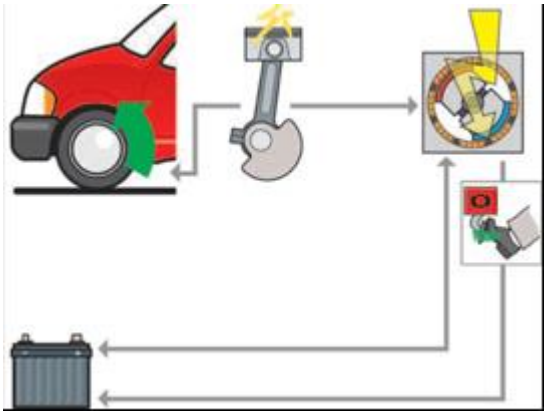
Regenerative Braking



Regenerative Braking systems recover the energy normally converted into and lost as heat during vehicle braking. When available the recovered energy is fed back into the charging system to recharge the battery

A conventional technology battery is very inefficient when utilized in in a regenerative braking system. This type of battery is only able to reuse approximately 5 to 15% of the recovered energy due to its relatively high internal resistance. New battery technology developments such as EFB and AGM with reduced internal resistances provide more efficient use of the recovered energy.

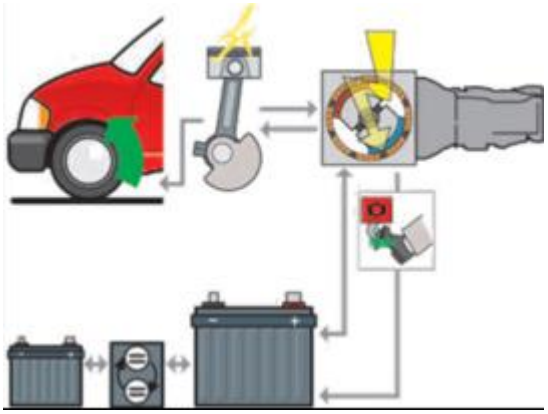
Starter/Generator (Micro hybrid 3)



Starter/generator technology replaces the conventional alternator and starter motor with a combined starter/generator unit installed between the engine and the transmission. The vehicle features both Stop/Start and regenerative braking systems that operate in the same way as for Micro hybrid 1 and 2 vehicles but utilises the starter generator for both start/stop and regenerative braking functions.

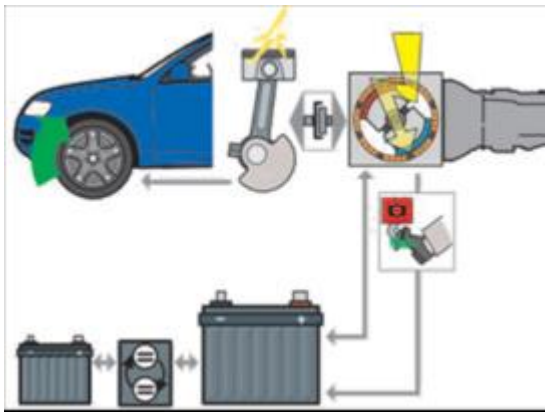
An AGM battery is therefore installed on the vehicle to support the stop/start and regenerative braking systems

Passive Boost (Mild hybrid)



Future new technologies being introduced to the next generation of vehicles include a solution known as “Passive boost”. Passive Boost is a simpler more cost effective system related to the Kinetic Energy Recovery System (KERS) recently introduced into the Formula 1 race series
Passive boost technology replaces the conventional alternator and starter motor with a combined starter/generator unit installed between the engine and the transmission. The passive boost function reverses the generator polarity to convert the generator into a motor and utilise a high voltage battery to assist with the acceleration of the vehicle. The starter generator is only used to supplement the power produced by the internal combustion engine therefore the vehicle is not capable of full electric drive
An AGM battery is therefore only installed on the vehicle to support the electrically operated ancillary components only

Full hybrid



The full hybrid vehicle features a higher power starter generator and an additional clutch between the internal combustion engine and transmission. This allows the decoupling of the engine and starter generator.
The internal combustion engine features both stop start and regenerative braking functions, however this system only utilises the internal combustion engine when required which allows the vehicle to be driven on electric power only
An AGM battery is therefore only installed on the vehicle to support the electrically operated ancillary components only
These new requirements clearly expect significantly more from the battery and the technology has to be improved to match the further increase in demands.

ANNEX 2

Micro-Hybrid	MHEV	HEV	PHEV

ANNEX 3

Combustion engine		Micro-Hybrid		MHEV		HEV		PHEV	
+	-	+	-	+	-	+	-	+	-

NOTES: