Electric Cars - Traction batteries

Lesson plan for teachers

Funded by the Erasmus+ Programme of the European Union

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
2018-1-SK01-KA202-046334

Electric Cars - Traction batteries

The aim of the lesson:
Introduction to electric cars contribution to environmental issues, considering it from its production point of view, and also the electric energy consumption for consecutive battery charging.

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

The aim of the activity: Discussing about electric cars being beneficial or not, considering both our environment, and human beings and animals health

Step 1	Brief description of the activity	We are going to discuss about electric cars being beneficial or not, considering both our environment, and human beings and animals health. Before playing a video, we will split the class group into 2. We will ask each group members to sit close to each other in the classroom. This would imply moving tables and chairs to make them fit into two real groups. In one of the big tables created, one group will defend the praises of electric vehicles. Meanwhile, the other group will defend the opposite view, that is, the scarce or even non-existent advantages coming up from electric vehicles.
	Instruction (what you need to tell the students)	Split the class group into 2. Each group will carefully listen to the information provided by the video. You will write down any idea you consider important to support your position in the discussion. At the end of the video, each group will share the ideas they have gathered to make a common document about "ideas in favour of electric vehicles" or "ideas against electric vehicles", depending on the group they have been placed. These ideas will be read out loud to the whole class by one of the students of each group, "the group spokesperson". Both groups documents will be shown in the classroom notice board. The following prompt might be used as an example:

Pros of electric cars	Cons of electric cars

Step 2	Brief description of the activity	Creating explanatory computer graphics about each of the positions defended, depending on the group.
	Instruction (what you need to tell the students)	Each student will design a computer graphics, using the program they prefer. On it they should clearly explain the pros or cons listed in Step 1, depending on the position they are defending. These computer graphics will be designed out of school hours, as homework. The resulting posters will be uploaded to the school website, or to the school Moodle platform. Another option is uploading it to the class blog if there is one. It is suggested to use free websites to edit those posters such as: https://www.canva.com/en_uk/
Tools for the activity(everything you need to take to the classroom)		Overhead projector and an internet-enabled computer to play the video in the classroom on the screen. https://www.youtube.com/watch?v=17xh_VRrnMU
Estimated time (max. 40 min.)		10 min. for Step 1, plus 30 minutes of homework for step 2.
Notes		Resources: https://www.youtube.com/watch?v=17xh_VRrnMU It is recommended to take Step 2 only as additional classroom activity, or, to be done at home, depending on time availability. Students can be assigned this task also at the end of the lesson, as part of the reflection on what they learnt. In such a case, your evocation part of the lesson will be finished by Step 1.

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

The aim of the activity: Get the students to know the main features of electric cars traction batteries.

<table>
<tr><td rowspan="2">Step 1</td><td>Brief description of the activity</td><td>Students, in groups of three, using the text and resources from Appendix I, will work on:
• Introduction
• Traction batteries
• Battery charge status

Students should underline the main ideas and data. Afterwards, they should copy all of them on their classroom notebooks.
After 10 minutes from the beginning of the activity, the suggested video from Appendix I will be played in front of the classroom. And they will be given a copy of Appendix 2 document.</td></tr>
<tr><td>Instruction (what you need to tell the students)</td><td>Each student will get a copy of Appendix 1. They should carefully read the text, underlining or highlighting everything they consider to be relevant. In case they need it, they can write down the selected ideas on their notebook. This information will be required for the next activity. After watching the suggested video they will be given a copy of Appendix 2.</td></tr>
<tr><td colspan="2">Tools for the activity (everything you need to take to the classroom)</td><td>One copy of Appendix 1 for each student. Overhead projector and an internet - enabled computer</td></tr>
<tr><td colspan="2">Estimated time (max. 40 min.)</td><td>20 minutes</td></tr>
<tr><td colspan="2">Notes</td><td>Resources: Step Ahead Project
Appendix 1 and 2 – Video: https://www.youtube.com/watch?v=jzRRivm-Osk</td></tr>
</table>

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

The aim of the activity: Summarizing what has been learnt in this didactic unit. This will allow our students to reinforce key concepts from the unit.

Step 1	Brief description of the activity	Each student should make a block diagram (or a mind map) on a sheet of paper. This diagram (mind map) should summarise the most important ideas presented in Appendix 1, such as the types of batteries, practical advice for battery maintenance, etc.
	Instruction (what you need to tell the students)	The block diagrams or mind maps should be made by each student on a separate piece of paper sized A-4. On the same piece of paper they should stick bits of text on different coloured papers, and also those images, arrows, lines, computer graphics, data or whatever information they consider to be relevant to offer an information as clear and concise as possible.
Tools for the activity (everything you need to take to the classroom)		Appendix I for each student. - coloured paper, glue, markers, scissors, pens, pencils, etc.
Estimated time (max. 40 min.)		20 minutes
Notes		Resources: Step Ahead Project. Appendix 1

APPENDIX 1

Introduction

In electric cars, the traction electric motor transforms the electric alternating power into mechanical power to propel the vehicle. This process also happens the other way around. Reverse gear is done by the reversal of the original engine working direction.

In electric cars we can observe some pieces using high voltage (HV), low voltage (LV), direct current voltage (DC) and alternating current (AC)

Traction battery

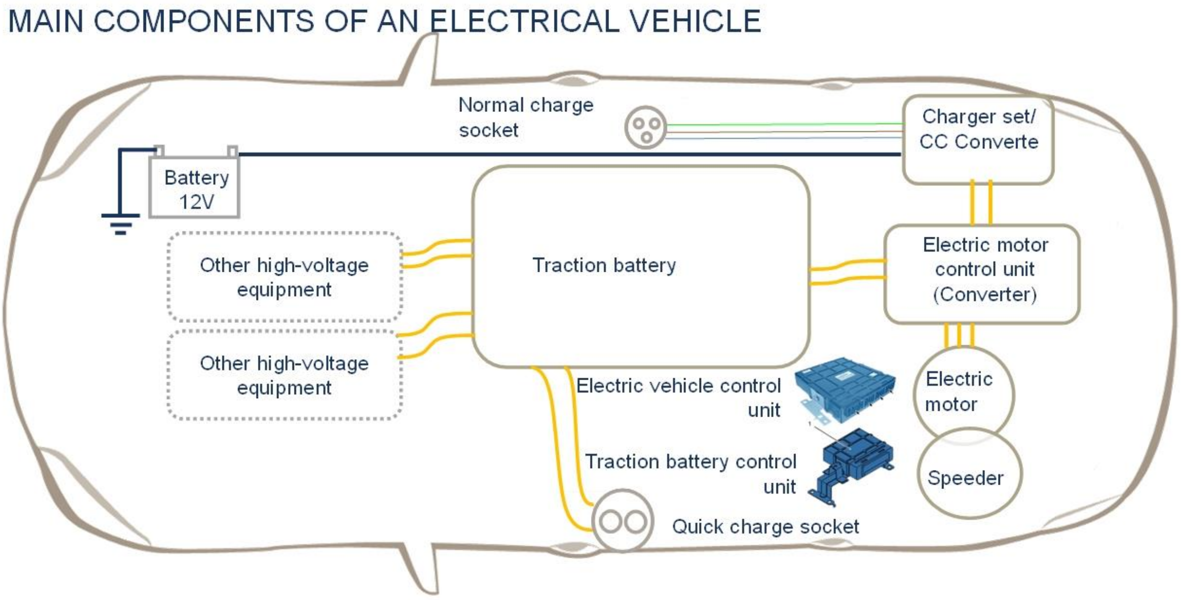
The electric power required to move a car is provided by the traction battery, although within the car we can find other type of conventional batteries for accessories.

Traction batteries use direct current voltage and the technology used to produce it, in electric vehicles, is Ion-Lithium. This technology allows to charge batteries at any moment, without waiting for complete charge and discharge cycles to be finished.

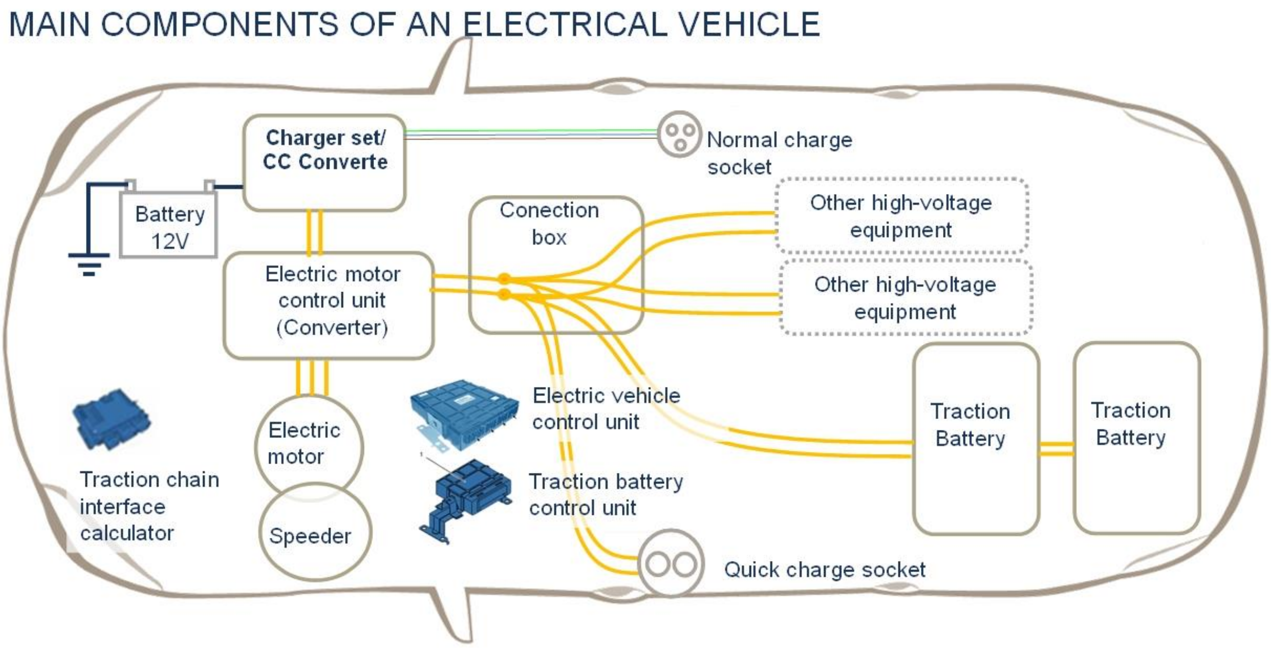
Image by http://www.aficionadosalamecanica.com/coche-electrico_bateria.htm for teaching use only, no commercial use allowed.

The efficiency of any car using an electric engine reaches 90%, meanwhile those cars using combustion engines just reach 18%.

In the following image you can observe different constitutive elements of an electric car with rear wheels traction.



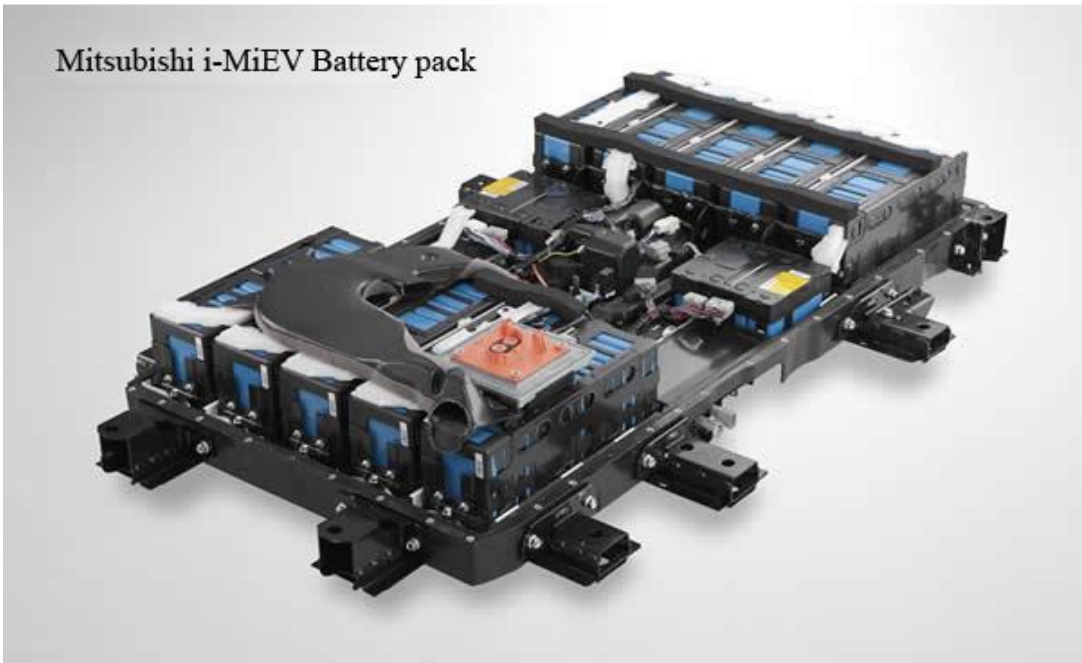
On the following plan you can see something similar for front wheels traction.



Traction Batteries

The following show the three main types of batteries we can find in nowadays electric vehicles. (also in hybrid and plug-in hybrid cars)

Ion Lithium battery



Battery used by Mitsubishi I-MiEV
http://www.aficionadosalamecanica.com/coche-electrico_bateria.htm

This type of battery technology is used in most electric cars we can find in the market today and also in part of plug - in hybrid cars. The battery fits within the available space we find below the seats.

The battery consists of cells. Each Ion Lithium cell provides a voltage of 3.7 nominal Volts. 50 Ah. 88 of these cells are placed in series. Those cells are gathered in 6 units modules connected in series, in such a way that each of those modules has about 147 V and 50 Ah. The total voltage provided is 330 volts with a charging capacity of 16Kwh.

Lithium - metal - Polymer battery (LMP)

It is a dry battery with a long operating life. They are batteries on continuous discharging, the car should be plugged during parking.

Nickel metal hydride battery (Ni-MH)

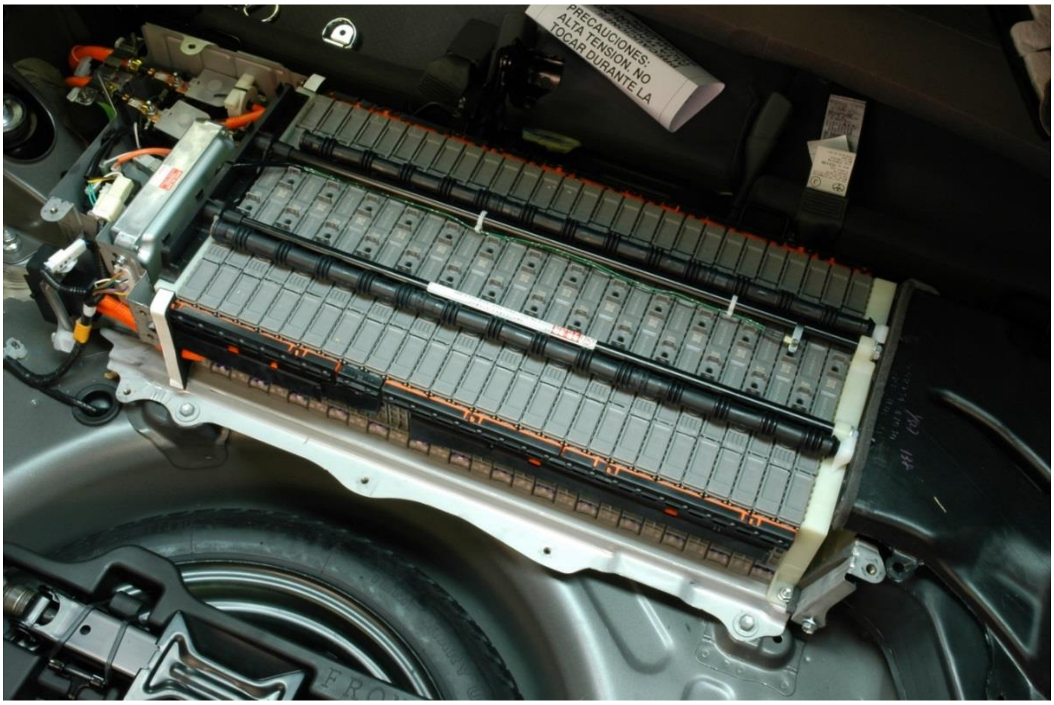
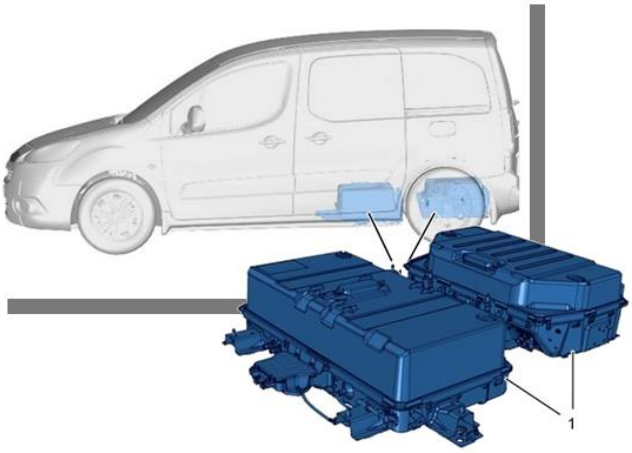
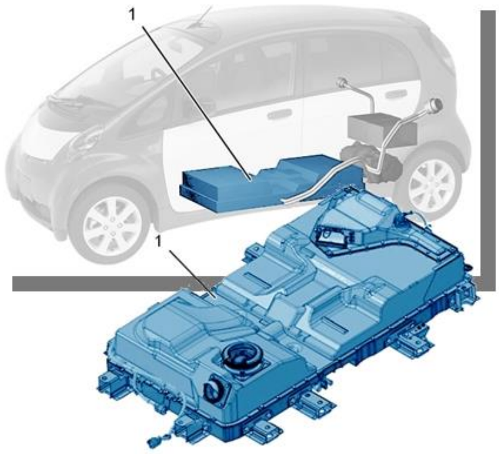


Image courtesy of CEIP Virgen del Camino in Navarra (España) from the project Step Ahead

They are placed on a great number of hybrid vehicles. These batteries have a longer duration and they are safer than those of Ion-Lithium, as they are not using flammable liquids, so they are less likely to burn in case of over-heating or battery overcharging. The cooling systems and the electronic control are less complex.

Ion-Lithium batteries position in vehicles

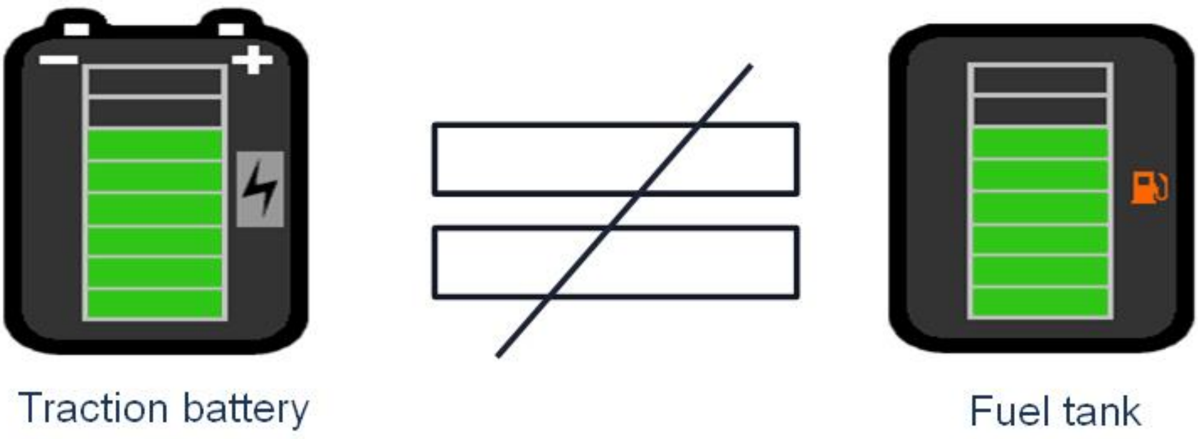




Traction batteries cannot be open at the garage. It is forbidden because of safety reasons.

Battery charge status

The charge markers only show the charge status of the traction battery but not its health status (capacity, range). In contrast to a combustion engine vehicle, a completely full battery (traction battery reaching 100 of its charging status) will not mean the same vehicle range.

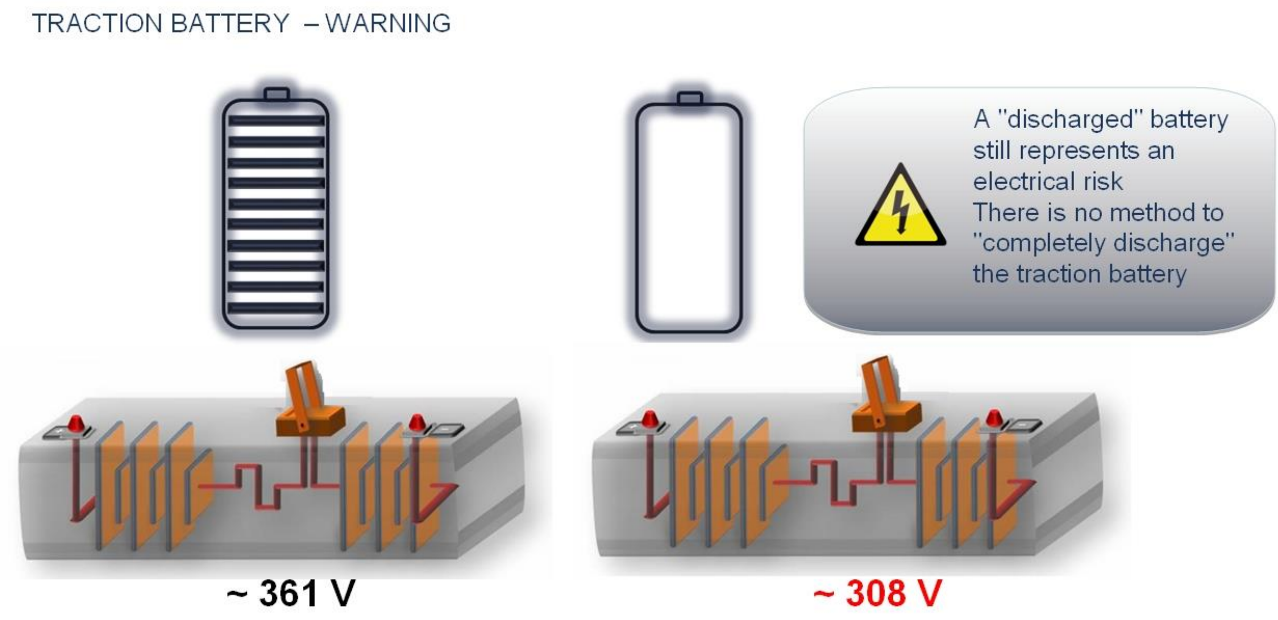


Inappropriate use of a battery (for example, when there is no balance of cells) will result in a degradation of its charging capacity. A specific number of parameters cause battery damage:

The age of the battery and/or its inactivity: the older the battery, the lower its capacity to store energy.

The battery temperature (and indirectly, environmental temperature): higher temperatures, speed battery ageing. An environmental temperature too low, prevent strong charging and discharging currents, and the vehicle performance is limited.

By “updating the charge capacity of a traction battery” we need to know the real evolution of the battery capacity, to avoid some misinformation about the car range.



As we have previously explained, batteries consist of a number of cells, that is, small batteries connected to each other to get high voltage and be able to provide high amperage as well. These small batteries imply some kind of maladjustment during charging and discharging processes, so it can became a problem causing lack of efficiency or even danger as a consequence of their battery overcharging in some of them. Then, it is very important the balancing process of those cells in a battery, to lengthen their life and also to avoid any unnecessary risks.

In the following video you can see how to do an active balancing of battery cells. The video doesn’t have a voice-over explaining the process but it is very informative, though. Images are enough.

Watch video by AutarcTech GmbH (https://www.youtube.com/channel/UC_N4LbiSJfb-oDiHFkyFfqA) at: https://www.youtube.com/watch?v=jzRRivm-Osk

The real capacity of a battery is important to calculate the vehicle range. The traction battery calculator establishes a theoretical model showing the evolution of its capacity (ageing).

Eventually and according to the vehicle use, the real capacity of the battery evolves in a different way from the one foreseen by the theoretical model.

It is important to correct the value assignments according to the real capacity of the battery in order to obtain the real percentage of range and charge level.

An updating process of the real capacity of the traction battery must be done (depending on the car):
- During the new vehicle preparation for delivery to the customer.

- During regular inspections (have a look at the maintenance check-list)

To optimize the battery charging process these patterns should be considered:

- A full charge should be carried out every other week.
- To make sure it is a full charge, normal procedure must be followed (at a home electricity network) without being interrupted till the process is automatically finished. That moment will be indicated by the charge light which going out at the car control panel.
- In addition, every three months this recharging process must be done for the main battery, from a slightly below or equal to three segments charging level
- This same procedure must be done every three months if the car is going to be immobilized for a long time, checking in advance that the accessories battery is not discharged or unplugged.

APPENDIX 2

Video Transcription:

https://www.youtube.com/watch?v=17xh_VRrnMU

0:00
Do electric cars really help the environment? President Obama thinks so.
0:05
So does Leonardo DiCaprio. And many others.
0:08
The argument goes like this:
0:10
Regular cars run on gasoline, a fossil fuel that pumps CO2 straight out of the tailpipe
0:15
and into the atmosphere. Electric cars run on electricity. They don’t burn any gasoline at all.
0:21
No gas; no CO2. In fact, electric cars are often advertised as creating “zero emissions.”
0:29
But do they really? Let’s take a closer look.
0:33
First, there’s the energy needed to produce the car. More than a third of the lifetime
0:38
carbon-dioxide emissions from an electric car comes from the energy used make the car
0:43
itself, especially the battery. The mining of lithium, for instance, is not a green activity.
0:50
When an electric car rolls off the production line, it’s already been responsible for
0:54
more than 25,000 pounds of carbon-dioxide emission. The amount for making a conventional car:

1:01
just 16,000 pounds.
1:03
But that's not the end of the CO_2 emissions. Because while it's true that electric cars
1:09
don't run on gasoline, they do run on electricity, which, in the US is often produced by another
1:15
fossil fuel -- coal. As green venture capitalist Vinod Khosla likes to point out,
1:21
"Electric cars are coal-powered cars."
1:25
The most popular electric car, the Nissan Leaf, over a 90,000-mile lifetime will emit
1:31
31 metric tons of CO_2, based on emissions from its production, its electricity consumption
1:37
at average U.S. fuel mix and its ultimate scrapping.
1:41
A comparable Mercedes CDI A160 over a similar lifetime will emit just 3 tons more across
1:48
its production, diesel consumption and ultimate scrapping. The results are similar for a top-line
1:54
Tesla, the king of electric cars. It emits about 44 tons, which is only 5 tons less
2:01
than a similar Audi A7 Quattro.
2:04
So throughout the full life of an electric car, it will emit just three to five tons less CO_2.
2:12
In Europe, on its European Trading System, it currently costs $7 to cut one ton of CO_2.
2:19
So the entire climate benefit of an electric car is about $35. Yet the U.S. federal
2:26
government essentially provides electric car buyers with a subsidy of up to $7,500.
2:32
Paying $7,500 for something you could get for $35 is a very poor deal. And that doesn't
2:40
include the billions more in federal and state grants, loans and tax write-offs that go directly
2:46
to battery and electric-car makers.
2:48
The other main benefit from electric cars is supposed to be lower pollution.
2:53
But remember Vinod Khosla's observation "Electric cars are coal-powered cars."
2:59
Yes, it might be powered by coal, proponents will say, but unlike the regular car,
3:04

coal plant emissions are far away from the city centers where most people live and where damage
3:09
from air pollution is greatest. However, new research in Proceedings of the National Academy
3:15
of Sciences found that while gasoline cars pollute closer to home, coal-fired power actually
3:22
pollutes more -- a lot more. How much more?
3:25
Well, the researchers estimate that if the U.S. has 10% more gasoline cars in 2020, 870
3:33
more people will die each year from the additional air pollution. If the U.S. has 10% more electric
3:39
vehicles powered on the average U.S. electricity mix, 1,617 more people will die every year
3:46
from the extra pollution. Twice as many.
3:50
But of course electricity from renewables like solar and wind creates energy for electric
3:55
cars without CO2. Won't the perceived rapid ramp-up of these renewables make future electric
4:01
cars much cleaner? Unfortunately, this is mostly wishful thinking. Today, the U.S. gets
4:08
14% of its electric power from renewables. In 25 years, Obama's Energy Information
4:14
Administration estimates that number will have gone up just 3 percentage points to 17%.
4:21
Meanwhile, those fossil fuels that generate 65% of U.S. electricity today will still generate
4:28
about 64% of it in 2040.
4:32
While electric-car owners may cruise around feeling virtuous, the reality is that the
4:37
electric car cuts almost no CO2, costs taxpayers a fortune, and, surprisingly, generates more
4:44
air pollution than traditional gasoline cars.
4:47
I'm Bjørn Lomborg, president of the Copenhagen Consensus Center.

NOTE: *Images and some other artwork are used with permission by the authors of the presentation in Ribadeo (Galicia- Spain) 2019 about electric vehicles by PSA for its didactic use, non-profit, belonging to the project Erasmus + "Step Ahead". The rest of the images sources are shown on the caption and they are licensed for this didactic, non-profit use.*

NOTES:

The opinions presented in this document are the views of the STEP AHEAD II project partnership and do not have to express the opinions of the EU.