Electric Vehicles

User groups – Technology – Infrastructure

Guideline Handbook – Public Education

English version

Green eMotion

Contents

Guideline handbook:

This guideline handbook addresses the basic education and training needs for different professionals in connection with EV deployment.

Purpose of the handbook:

The handbook gives the most important information about EVs to the relevant professionals. The handbook refers to the Green eMotion Project website for more details.

The website:

Can be found at http://greenemotion-project.dk/

The handbook is based on existing material from stakeholders, regional regulations and European standardization, etc.

Languages:

The handbook is available in the main languages:

- English
- French
- German

- Are you considering an electric vehicle?
- Would you like to learn more about electric driving?

If you recognize yourself in one of these occupational groups, you will find useful information in this handbook.

Find more details on

http://greenemotion-project.dk/before-you-decide.aspx

The benefits of electro mobility EVs are:

- Environmentally friendly – run on renewable energy
- Low noise
- Easy-to-operate
- No oil change, etc.

EVs can run on solar energy. Solar energy is the cleanest and one of the cheapest ways to produce useful energy.

While oil, coal and gas will not always be available, solar energy is guaranteed to last for at least a few billion years more.

Consequently, it makes a lot of sense to use solar energy whenever possible. The electric car can do just that because it stores energy in a rechargeable battery, not in a fuel tank.

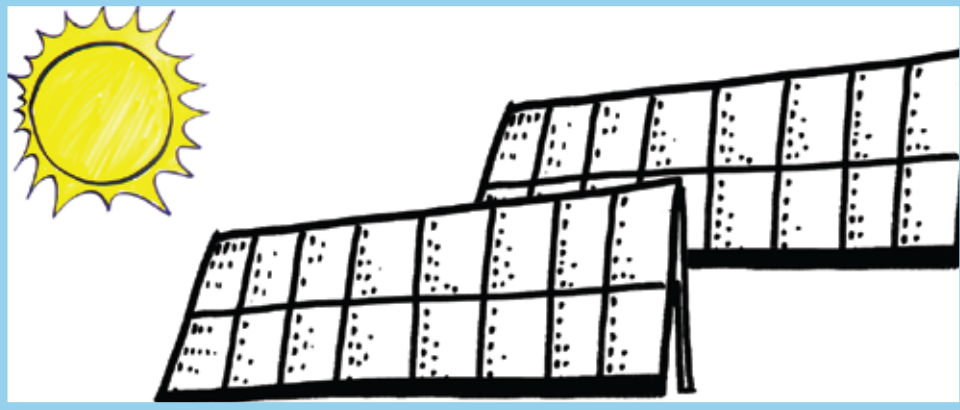
Other benefits include EVs being silent because electric engines make practically no noise and are easy to operate as they have no gear stick, no clutch and require no warm-up phase. Furthermore, electric engines, unlike combustion engines, are particularly good at starting at low RPM.

These are just examples. There are many other benefits from using EVs.

Find more details on

http://greenemotion-project.dk/before-you-decide/the-benefits-of-electro-mobility.aspx

Watch a short film here



2.2 Variations in mileage and range

The big question regarding an EV is how far can it go on one charge?

This depends primarily on:

- Driving style (Speed and start/stop)
- Outdoor temperature (Heating an EV requires up to 4 kW)

The state of charge is the percentage of battery capacity currently available for driving. A certain range is never guaranteed as the range is heavily influenced by your driving style, i.e. how fast you drive, how many starts/stops you make, etc.

When it is cold outside you need energy for cabin heating. An EV produces practically no waste heat unlike combustion engine vehicles, so all heating has to come from the battery. Heating an EV cabin requires up to 25% of the range, which will seriously drain the battery, if it is used for prolonged periods of time. This is why it is essential to preheat the cabin.

Find more details on:

http://greenemotion-project.dk/before-you-decide/variations-in-mileage-and-range.aspx

2.3 Economy, cost of ownership

- The battery is the most expensive part and can be rented
- Servicing costs are lower as the electric EV transmission is much simpler than a combustion engine
- Insurance costs are often lower

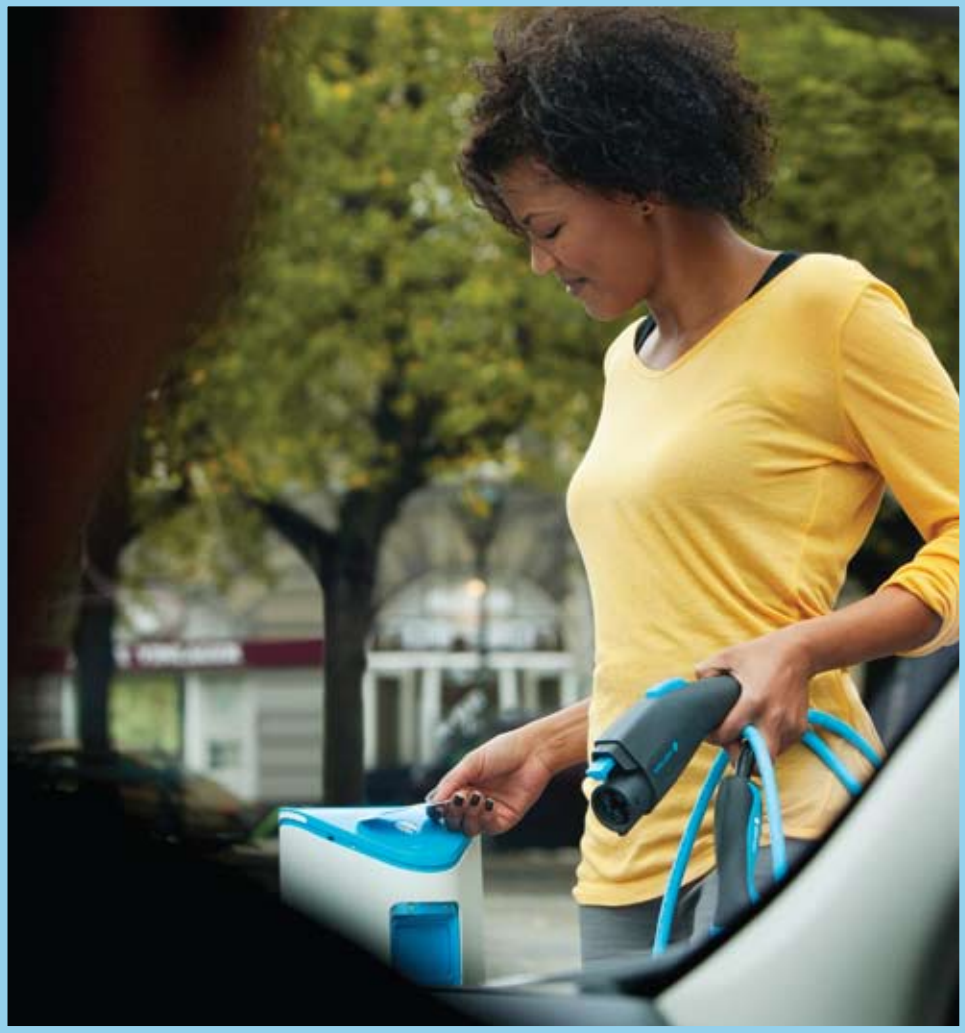
In short, to describe the cost of an EV ownership you should firstly consider owning or renting the EV battery. If you feel nervous about how and how fast the EV battery degrades, you should rent it.

You should expect lower servicing cost as an EV does does not require any oil changes. It has no fuel, ignition and exhaust systems, no catalyst/particulate filter, timing belt, spark plugs, water pump, generator, starter motor, radiator, oil pan and other systems that usually require maintenance.

Furthermore, insurance costs are often lower for electric vehicles. The cost of power (kWh-price) varies with your address.

More details and a comparable budget for conventional car vs. an electric car are available on the website.

http://greenemotion-project.dk/before-you-decide/economy,-cost-of-ownership.aspx



2.4 What happens in the event of a crash?

- EVs have all modern safety features
- Pay attention if the battery leaks fumes and liquids
- Let the proper authorities handle the wreck

Modern EV's have been crash tested and they have all the modern safety features such as airbags and belt tensioners.

There are new challenges when a new type of vehicle is introduced and an EV is no exception. Liquid flammable fuels and CO2 emissions have been replaced with equally dangerous high-voltage batteries and various chemical substances inside the vehicle.

As you would pay special attention to leaking gasoline from a crashed car, you should pay special attention if crashed EV batteries are leaking fumes or liquids and let the proper authorities handle the wreck. Battery fumes and liquids are flammable and can be toxic.

Rescue cards can be found on the website

http://greenemotion-project.dk/before-you-decide/what-happens-in-the-event-of-a-crash.aspx

In this section, you will find practical advice on dealing with EVs in the traffic.

- If you are an EV driver
- Cyclist/pedestrian or
- Anyone who might witness a traffic accident

You will find more useful information in this handbook.

Find more details on

http://greenemotion-project.dk/on-the-road.aspx

3.1 Identifying correct sockets and plugs

- Always charge an EV using the manufacturer's sockets and plugs
- Many different plugs are available today

First, you will compromise safety if you use domestic household sockets, since they are not designed to be connected to powerful sources such as a modern EV battery.

Second, different types of charging equipment and service providers are used to avoid instability in the power grid.

Many different kinds of plugs for EV charging are available. They include communication to ensure safety, compatibility and correct charging speed.

Find more details on

http://greenemotion-project.dk/on-the-road/identifying-correct-sockets-and-plugs.aspx

3.2 Washing and easy maintenance

- Avoid high-pressure cleaning of engine compartment and orange high voltage cables
- Apart from the above, clean your car like any other car
- You can change light bulbs (12 V) and refill windshield-washing fluid

You should not be afraid of letting your EV come into contact with water. Wash the EV like any other car, but avoid high-pressure cleaning of the engine compartment and all orange coloured components.

As regards daily maintenance, you can refill windshield-washing fluid and replace light bulbs, 12 V fuses and the 12 V battery, etc.

However, NEVER try to disconnect any of the orange wires or open the battery case.

Find more details on

http://greenemotion-project.dk/on-the-road/washing-and-easy-maintenance.aspx

High voltage cables are orange coloured

3.3 Using regenerative braking

- EVs regenerate energy when braking

Traditional automobile brakes rely on friction, which only wastes energy. Electric regenerative braking conserves much more energy and helps to save energy.

Only EVs and hybrids are able to recapture energy like this and the benefits are enormous. Regeneration, however, is never as powerful as mechanical braking.

Find more details on

http://greenemotion-project.dk/on-the-road/using-regenerative-braking.aspx

- Heating consumes a lot of energy – preheat your car at home when it is cold outside

Special precautions should be taken in cold weather when planning a drive in your EV. For example, the cabin should be preheated prior to the drive, since the EV has limited excess power available for de-icing while driving.

When plugged in, the vehicle has access to the mains, meaning that the battery is not drained by operating the heater or air conditioner. Most EVs have programmable or remote controlled heating systems that allow you to turn the heater on from your smartphone or using the key fob.

Find more details on

http://greenemotion-project.dk/on-the-road/preheating-the-cabin.aspx

3.5 Impact of tyre pressure, load and wind

- Maximize the EV's range by following driving style recommendations
- Keep the correct tyre pressure
- Avoid excessive speed

An EV uses energy just like any other car, but carries less stored energy. Therefore, you can maximize your EV's range by following the recommended driving style and making sure that your tyres have the correct pressure.

Find more details on

http://greenemotion-project.dk/on-the-road/impact-of-tire-pressure,-load-and-wind.aspx

3.6 How to drive safely without sound/noise

- EVs are practically silent
- Pay special attention to pedestrians and cyclists

New challenges occur because pedestrians, cyclists and other motorists cannot hear when an EV approaches. When driving an EV you should therefore pay special attention to whether other road users are aware of you.

Cyclists and pedestrians crossing the road will often use their hearing rather than their eyes. Silent cars may be perceived wrongly, since people are used to a noisy traffic environment.

Furthermore, pedestrians or cyclists may be unintentionally surprised by EVs in various situations such as a sudden movement out of a parking space.

Find more details on

http://greenemotion-project.dk/on-the-road/how-to-drive-safely-without-soundnoise.aspx

3.7 Information for cyclists and pedestrians

- Use sight increasingly to be aware of the silent EVs

As a pedestrian or cyclist you should always pay special attention to the traffic, but you may need to learn how to use your sense of sight more as silent EVs are entering the traffic.

You may experience new and surprising situations with EVs. Try to appreciate them as they probably did not do it intentionally. They appreciate clean air and bird song just like you.

Find more details on

http://greenemotion-project.dk/on-the-road/information-for-cyclists-and-pedestrians.aspx

3.8 How to rescue people from a crashed EV

- A crashed EV is no more dangerous than a conventional car
- Stop the accident (turn off the ignition of the crashed car, warn other road users, so they don't crash too)
- Call for professional assistance (call 112 in Europe)
- Release belt buckles and watch out for signs of fire or leaking battery liquids/fumes
- Give basic first aid to occupants (speak to them, watch breathing, stop any bleeding)

If an EV has crashed, it is no more dangerous than a crashed conventional car, as the high voltage parts are well protected. If there are no visible sparks, do what you would normally do to help crash victims.

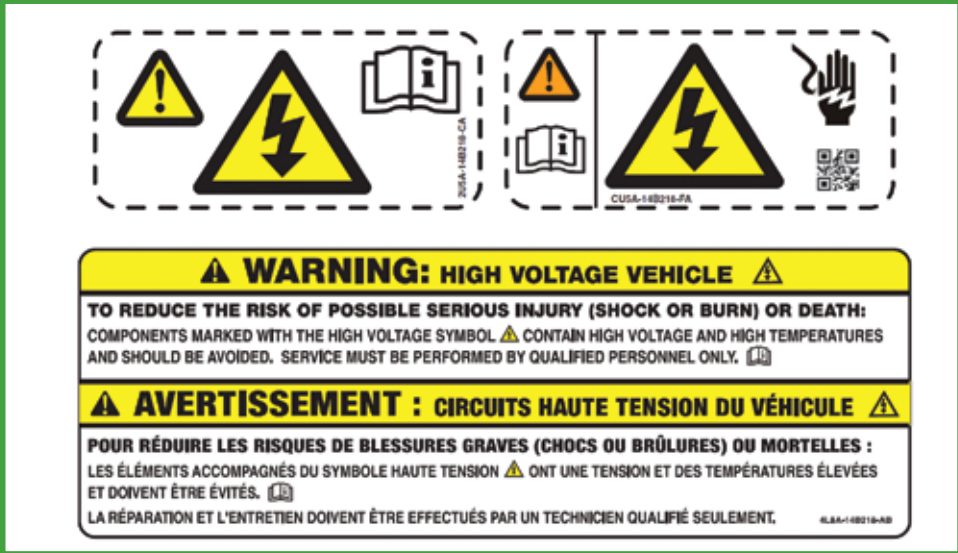
If in doubt whether the vehicle is electric, look for orange cables in the engine compartment or the absence of an exhaust pipe. You may also see the text "Zero Emission" written somewhere on the car, but actual warning signs are only visible under the hood and sometimes in the trunk of the car.

Battery fumes and liquids are flammable, and therefore there is always a risk of fire following an EV crash. Avoid breathing in battery fumes/smoke and avoid touching liquids from the battery.

Due to the risk of neck injury, crash victims should not be moved from the vehicle if they are not in immediate danger. The best thing to do is to open the doors and help release the safety belts so that a quick escape is possible if the vehicle catches fire. While waiting for professional assistance you should provide basic first aid.

Find more details on

http://greenemotion-project.dk/on-the-road/how-to-rescue-people-from-crashed-evs.aspx



3.9 How to put out an EV fire

- EV fires can be extinguished with a water hose or a carbon dioxide extinguisher
- Keep a distance to avoid electric chock
- Avoid breathing in fumes or smoke from burning batteries

A fire involving lithium ion batteries carries new challenges, but in cases where the fire is not in the actual EV battery you can use any ordinary extinguishing agents.

If the battery is on fire, make sure that you use large amounts of water, but keep some distance to the wreck to avoid electric chock. Furthermore, make sure that any battery liquids are thinned out with lots of water to minimize the risk of toxic gas generation and risk of reigniting the fire.

Avoid breathing in fumes or smoke from burning batteries and avoid touching battery liquids.

Find more details on

http://greenemotion-project.dk/on-the-road/how-to-put-out-an-ev-fire.aspx

In this section, you will find arguments for EVs that the following should consider carefully:

- Policy makers
- Developers/planners
- Fleet managers etc.

If you fit into one of these occupational groups you will find useful information in this handbook or

Find more details on

http://greenemotion-project.dk/the-big-picture.aspx

4.1 Climate impact of EVs

- EVs have a very low CO_2 footprint

One of the main advantages of an EV is that it has a low emission when we consider average electricity production.

In the EU, the average EV CO2 footprint is very low and better than even the most efficient fossil fuel cars. Where the EU electricity production will be significantly greener in the future, fossil fuels will only see marginal improvements.

Find more details on

http://greenemotion-project.dk/the-big-picture/climate-impact-of-evs.aspx

- Charging at home is possible
- A network of charging stations
- Battery swap services

If you own a parking lot, you may consider integrating an infrastructure for EV users.

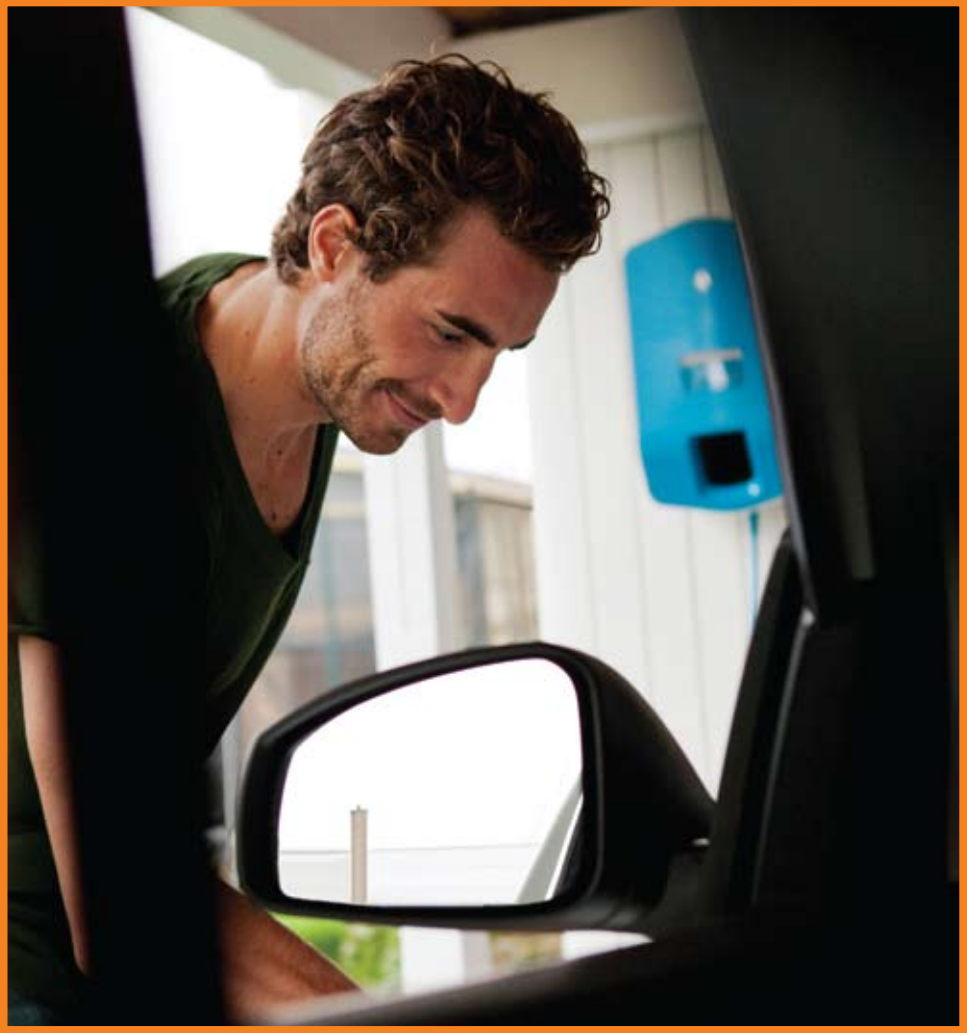
EV owners need to charge their vehicles when at home and away from home, leading to a need to coordinate how EVs can be charged.

A network of electric car charging stations should be within a reasonable radius. The most used charging stations should provide fast charging and/or battery swap services, taking the charging time into consideration for the respective locations.

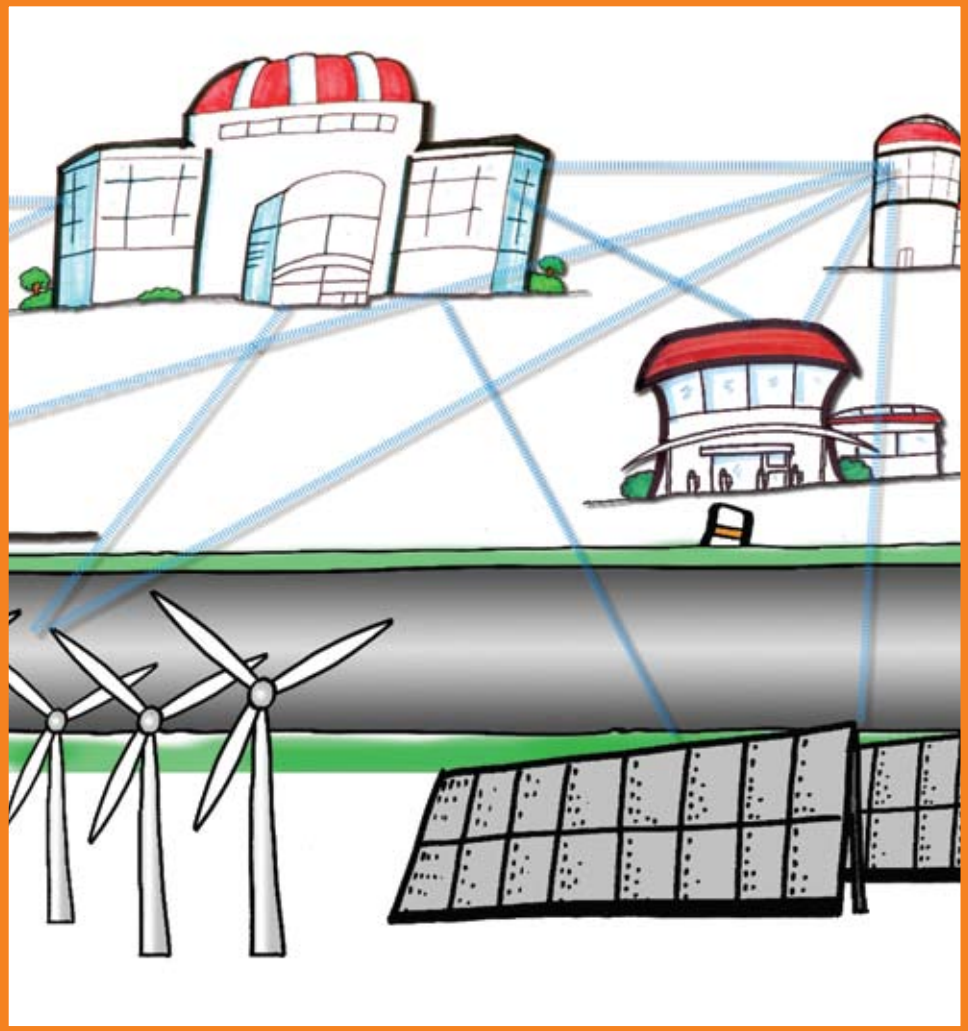
Moreover, different levels of chargers exist with different purposes, such as a low-power level for standard home charging and several types of high-power levels for fast charging.

Find more details on

http://greenemotion-project.dk/the-big-picture/infrastructure-for-evs.aspx



4.3 Utilizing smart grid and roaming



- The future could make use of smart energy consumption – smart grid

The vehicle owner should not only be free to choose the type of vehicle he drives, owns or leases, he or she should also be able to choose between several energy suppliers for his or her journey and be free to use any means of payment that he or she wishes to use.

With EVs, the electrical grid will become a market place where thousands of energy producers and consumers act intelligently to optimize the use of energy across the borders.

Find more details on

http://greenemotion-project.dk/the-big-picture/utilizing-smart-grid-and-roaming.aspx

Watch a short film here

- EVs can also act as an energy storage system

EVs can be charged in situations where the electrical grid has excess power. Similarly, EVs with available power that are plugged into the electrical grid can act as buffer and return power to the electrical grid during shortfalls.

Find more details on

http://greenemotion-project.dk/the-big-picture/vehicle-to-grid-technology.aspx

4.5 How does temperature affect EV performance?

- High or low temperatures affect the performance of EVs
- Energy for heating and defrosting can reduce the range of EVs up to 25 %

All cars are affected by temperature. For example, cold weather increases air resistance because cold air is denser than warm air.

Battery EVs carry only a small amount of energy and therefore there is only little excess energy available for cabin heating or cooling.

Find more details on

http://greenemotion-project.dk/the-big-picture/how-does-temperature-affect-ev-performance.aspx

- EVs are recyclable

Modern vehicles are roughly 90% recyclable. Electric vehicles and their batteries can also be recycled. The Nissan Leaf, for example, is partly made from recycled material and is actually 99% recyclable.

Modern batteries are also recyclable, but for reasons of economy, it is currently not profitable to recycle them.

Find more details on

http://greenemotion-project.dk/the-big-picture/recycling-ev-components.aspx

In this section, you will find examples of what to consider regarding EVs, if you are:

- a mon-OEM mechanic
- a parts clerk, or
- cargo handler, etc.

If your work brings you into contact with one of these occupational groups, please find useful information in this handbook or

Find more details on

http://greenemotion-project.dk/in-the-workshop.aspx

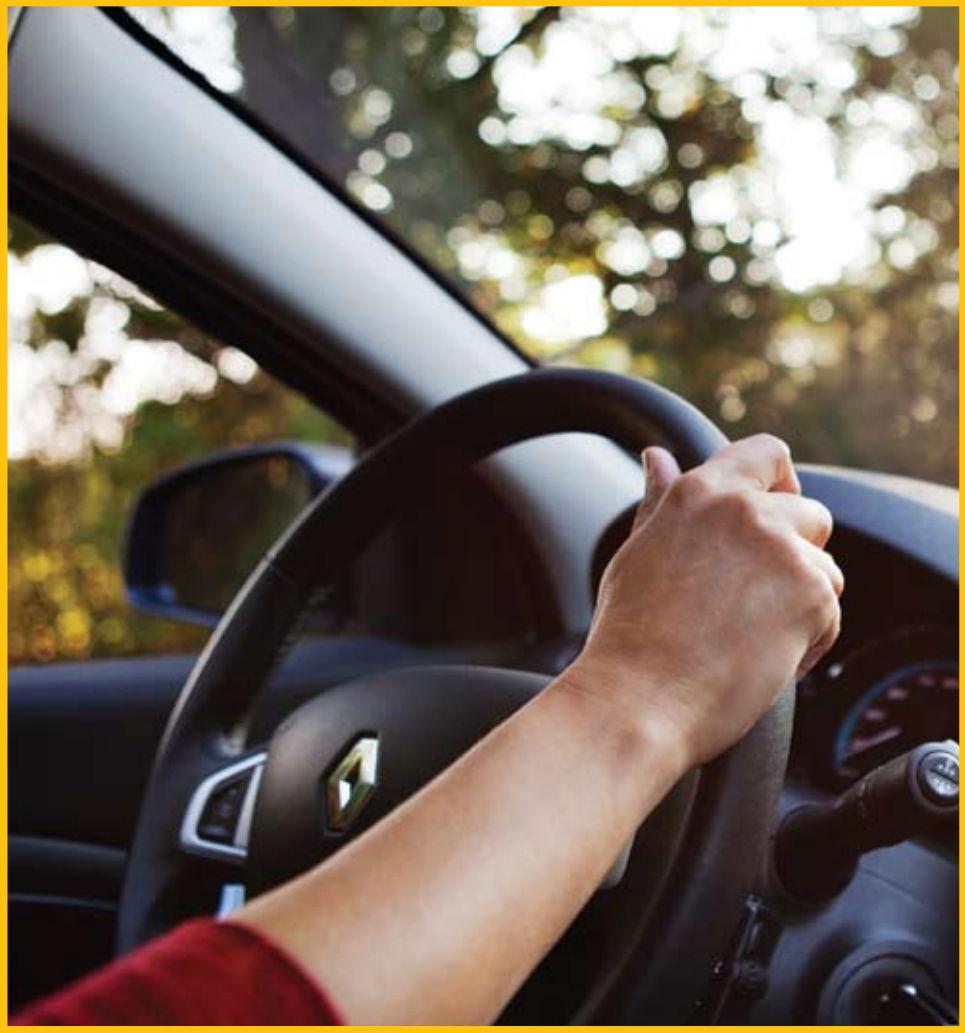
- Take note of the safety guidelines supplied by the vehicle manufacturer
- Energy stored in a battery can be harmful if discharged in an uncontrolled manner

Regarding EV repairs, you should familiarize yourself with the safety guidelines supplied by the vehicle manufacturer. There are a number of new risks and challenges associated with batteries and electricity in general.

The EV battery voltage is at a lethal level and it is enough to allow electricity to travel through thin air. Moreover, the EV battery stores a huge amount of energy, which can be very harmful if discharged in an uncontrolled manner, for example, if short-circuited by an ordinary steel wrench or electric arcing.

Find more details on

http://greenemotion-project.dk/in-the-workshop/safety-first.aspx



5.2 Charging levels and modes

- An EV charger's level and mode should correspond to the EV
- An EV charger should communicate with the EV
- The different levels and modes are on their way to be harmonized

Be aware that an EV charger has a certain charging level and a certain charging mode corresponding to the power level of the charger and the scheme that the charger uses to communicate with the EV and possibly the electrical grid.

The levels include standard charging with or without communication, and several high power charging levels. Charging at a high power level always includes communication.

These different levels and modes are on their way to be standardized to ensure safety in general with respect to the EVs and the electrical grid.

Find more details on

http://greenemotion-project.dk/in-the-workshop/charging-levels-and-modes.aspx

- Extreme temperatures should be avoided

Lithium ion batteries have a few enemies including extreme temperatures. It is therefore crucial that the temperature of an EV battery be managed properly to ensure that it can outlast the vehicle.

Find more details on

http://greenemotion-project.dk/in-the-workshop/maximizing-battery-life.aspx

5.4 Transportation of EVs and batteries

- EVs should not be towed for long distances
- Batteries themselves must be treated as dangerous goods when transported

When it comes to transportation, there are new challenges with EVs. For example, towing an EV can be harmful to its electric transmission, as an EV has no clutch.

Furthermore, batteries are potentially hazardous, and when they are not installed in EVs, they must be transported only in accordance with the legislation on transportation of dangerous goods.

When crash damaged, EVs still have their batteries and they have an increased risk of catching fire, therefore the batteries must be treated as dangerous goods.

Find more details on

http://greenemotion-project.dk/in-the-workshop/transportation-of-evs-and-batteries.aspx

5.5 Handling in non-OEM car repair shops

- Modern EVs contain parts, such as the battery, that cannot be serviced at regular car repair shops

Modern EVs contain highly sophisticated parts that cannot be serviced at regular car repair shops. This mainly applies to the high voltage battery, the power inverter and the charging system.

Other parts may be serviced and replaced in any car repair shop.

Find more details on

http://greenemotion-project.dk/in-the-workshop/handling-in-non-oem-workshops.aspx

DANISH
TECHNOLOGICAL
INSTITUTE

Prepared by:
Kim Winther – Danish Technological Institute
Morten Holst Johansen – Danish Technological Institute
Lene Skov Halgaard – Danish Technological Institute
Christian Gylling – Danish Technological Institute