**INFORMATION FOR FIRST AND SECOND RESPONDERS**

**RESCUE AND TRAINING MANUAL**

# HIGH VOLTAGE (HV) LITHIUM-ION BATTERIES

**TYPE VEHICLE**

**BRAND VEHICLE**

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EXAMPLE

Version ../../.. ENG

# INFORMATION FOR FIRST AND SECOND RESPONDERS

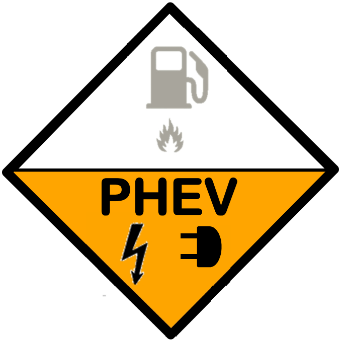
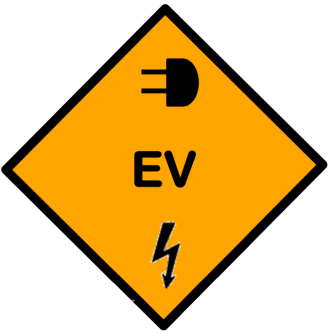
**RESCUE AND TRAINING MANUAL**

# HIGH VOLTAGE (HV) LITHIUM-ION BATTERIES

# IN AN HYBRID (HEV), PLUG-IN HYBRID (PHEV) , FULL ELECTRIC VEHICLE (EV)

**AND FUEL CELL ELECTRIC VEHICLE (FCEV)**

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Note:

**First responders**: Fire Fighters, Police, Medical personal, Emergency Medical Transporters.

**Second responders**: Towing and maintenance personnel,…

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| INFORMATION FOR FIRST AND SECOND RESPONDERS **RESCUE AND** **TRAINING MANUAL** HIGH VOLTAGE (HV) LITHIUM-ION BATTERIESIN AN HYBRID (HEV), PLUG-IN HYBRID (PHEV), FULL ELECTRIC VEHICLE (EV) **AND FUEL CELL ELECTRIC VEHICLE (FCEV)**  BRAND/TYPE OF VEHICLE | |
| **Manufacturer vehicle :** XXX Info in case of emergency: **XXX** | Version: **17/08/2014** |
| GENERAL INFORMATION | |
| 1.1 Picture and information:Image: minimum 1 MBScanned image: minimum 300 DPI  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | |  |  |  | | --- | --- | --- | | High voltage battery | Type of Li-ion battery | Info | | 1. High Voltage Battery   Type: **(e.g. Li ION)** | **XXX** | xxx Volt (nominal) battery pack consisting of xxx Volt cells connected in a series-parallel circuit.  **XXX** kg. | |  1.2 General considerations in the event of damage to or fire involving an electric vehicle (EV) or hybrid-electric vehicle (HEV):  * Always follow the “safety considerations” about the specific vehicle as supply by the car manufacturer. * Warn all responders and dispatch/inform that an Hybrid, Electric our Fuel-Cell Vehicle is involved. * Always assume that the high voltage (HV) battery and associated components are energized and fully charged. * Before handling battery cells or packs, remove all metal objects including rings, watches, belts, etc. * Exposed electrical components, (orange) wires, and HV batteries present potential HV shock hazards even when the battery is partially or fully discharged. * Physical damage to the vehicle or HV battery may result in immediate or delayed release of toxic and/or flammable liquids and gases with a risk of fire. * Venting/off-gassing HV battery vapours are potentially hazardous and flammable, and could contain hydrogen fluoride, carbon monoxide and carbon dioxide. * Leaking electrolyte from a Li-ion battery gives a typical sweet/ether-like odour. * A pungent sweet or acidic odor may be detected if casing is breached. * Parts of the battery (e.g. cells) may be ejected as projectile. When the inside cells of the battery are damaged flammable liquid may be expelled from the battery. * When Li-ion batteries have been mechanically damaged there is a risk of fire as a result of a rapid temperature elevation in the battery due to e.g. an internal or external short circuit. For battery fires involving packs with more than one lithium ion cell, the individual cell fires occur over a period of several seconds rather than simultaneously. * As with any vehicle fire, the by-products of combustion can be hazardous and all individuals should be directed to move to a safe distance upwind and uphill from the vehicle fire and out of the way of oncoming traffic. * When individual(s) are trapped in a vehicle with fire or leaking electrolyte, it is necessary to give them, immediately fresh air coming from a SCBA gear. | |
| **1.3 Classification**  Lithium-Ion Batteries are classified as Dangerous Goods for Transportation under UN 3480  http://www.qorpak.com/vimages/nfpa.gifClass of Hazard: Class 9 (Miscellaneous).  NFPA Code: XXX | |
| 1.4 General first aid measures: **Cell/Electrolyte Mixture:** The following actions are recommended if direct contact occurs with electrolyte  mixture due to damage of battery pack or cells  **Always contact medical assistance**     |  |  |  |  | | --- | --- | --- | --- | | **Inhalation** | **:** | High vapour concentrations may cause respiratory tract irritation. Leave area immediately and seek medical attention if irritation occurs. |  | | **Eye contact** | **:** | Eye contact may cause severe irritation and possibly a burning sensation or corneal tissue injury. Rinse eyes with water for 30 minutes and seek medical attention immediately. |  | | **Skin contact** | **:** | Skin contact may cause irritation. Prolonged contact with electrolyte mixture may result in more severe irritation. Wash area thoroughly with soap and water and seek medical attention if irritation occurs. |  | | **Ingestion** | **:** | Swallowing electrolyte mixture may cause gastrointestinal tract burns. May cause nausea and vomiting. Do not give anything by mouth to a victim who is either unconscious or is losing consciousness. If swallowed, rinse mouth with water and have victim spit the wash water out. Repeat. Do NOT induce vomiting. If vomiting occurs naturally, have victim lean forward to avoid aspiration. Call poison control centre immediately |  | | |
| |  |  |  | | --- | --- | --- | | **1.5 Content of chemical products:**   * The battery contains the following substances (in % by weight of the battery: **XXX** % ). * Total weight battery : **XXX** | | | | **NAME:XXX** | **UN Nr: XXX** | **CAS #:XXX** | | **NAME:XXX** | **UN Nr: XXX** | **CAS #:XXX** | | **NAME:XXX** | **UN Nr: XXX** | **CAS #:XXX** | | **NAME:XXX** | **UN Nr: XXX** | **CAS #:XXX** | | **NAME:XXX** | **UN Nr: XXX** | **CAS #:XXX** | | |

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| Danger by spills/leaks (absence of fire) | |
| Under normal conditions of use, the battery does not present any risk of exposure to its content. | |
| SPILLS | |
| http://www.qorpak.com/vimages/nfpa.gif**[Gevaar](http://www.pictogrammenwinkel.nl/waarschuwingen-c-203/bordjes-c-203_204/gevaar-c-203_204_221/)**Specific Attention | 2.1 Inhalation in non-fire situations  * The electrolyte used in the Li-ion battery cells contains a flammable organic solvent and a corrosive substance. * Contact with organic electrolyte or acidic vapour caused by reaction of the electrolyte with moisture may irritate the eyes, nose, throat, and skin.      * The vapour may contain hazardous fluor-based substances! Hydrogen fluoride, carbon monoxide and carbon dioxide may be released from exposed electrolyte. |
| **7010-m0177010-m013**Safety Measures | **2.2 Recommended Personal Protective Equipment:**   * Safety glasses or face shield * Chemical resistant neoprene or nitrile gloves * Protective apron or coveralls * Air-purifying respirator equipped with acid gas cartridge or Self-Contained Breathing Apparatus (SCBA).     Absorption/neutralisation see chapter 4: **Environmental aspects** |

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| Hazards Associated with a Lithium-Ion Battery Fire | | |
| **Under normal conditions of use the battery does not present any risk of exposure to its content.** | | |
| FIRE | | |
| http://www.qorpak.com/vimages/nfpa.gif**[Gevaar](http://www.pictogrammenwinkel.nl/waarschuwingen-c-203/bordjes-c-203_204/gevaar-c-203_204_221/)Sp****ecific Attention** | | * If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling or bubbling sounds from the HV battery compartment, assume there is a battery fire and ventilate the passenger area (roll down windows or open doors).  3.1 Fire in the HV Battery Assembly  * Be alert. There is a potential for delayed fire with damaged lithium-ion batteries. * When the inside cells of the battery are damaged flammable liquid may be expelled from the battery, * The battery contains a combustible organic solvent. * When one cell ignites there is a risk a propagation of the fire to neighbour cells   (Thermal runaway).  Parts of the battery(e.g. cells) may be ejected as projectile. 3.2 Inhalation in Fire Situations  * Hazardous gases are given off as by-products of combustion. * Vapour emitted in case of a fire contains CO, CO2 and hazardous fluorinated substances! * May rupture or explode in a fire, which could release hydrogen, hydrogen fluoride, carbon monoxide, carbon dioxide, aldehydes, and short chain hydrocarbons. |
| Safety Measures    Extinguish  Measures | | * Keep distance from the vehicle and evacuate people upwind from the immediate area. * Keep any person not involved in the rescue, 15 meters away from the fire zone,   **3.3 Recommended Personal Protective Equipment:**   * Wear always full Personal Protective Equipment suitable for organic solvents and Self-Contained Breathing Apparatus (SCBA). * **To avoid serious injury or death from severe burns or electric shock, never breach or remove the high voltage battery assembly cover under any circumstance.**   **3.3 Extinguish Fire** 1st Objective  * In case of a large fire cool down the battery with an overflow of water with in order to reduce the temperature of the battery.  2 nd Objective:  * Shutting off the oxygen supply to the fire: using if possible (dry) sand or other suitable mineral agent.   **Offensive attack**   * Recommended where exposures are present or the high voltage battery is not involved. * Copious quantities of water with 3% AFFF can be used to cool down burning Li-ion cells and batteries. * During application, caution should be exercised as flammable particles may be ejected from the fire.   **Defensive attack**   * Recommended if the high voltage battery is involved and no exposures are present. Due to the difficulty in reaching the burning cells inside the battery with the extinguishing agent, the Incident Commander may choose to allow it to burn itself out. Any individuals without SCBA should remain upwind of the fire an avoid inhalation, due to toxic compounds in the smoke. * Fire crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke. * Allow battery to cool to ambient temperature before approaching. Measure temperature remotely with an infrared temperature (IR) gun or similar device, if available. |
| Environmental Aspects | | |
| **IN ALL CASES** | | |
| **[Gevaar](http://www.pictogrammenwinkel.nl/waarschuwingen-c-203/bordjes-c-203_204/gevaar-c-203_204_221/)**Specific Attention  http://www.qorpak.com/vimages/nfpa.gif  7010-m017Safety Measures | **4.1 Absorbent materials.**   * To confine the spillage of liquids and the fire: use dry materials such as sand or mineral absorbing agents. * Cleanup all spills/leaks immediately using an absorbent material such as vermiculite or dry sand. Neutralization is not necessary. * Collect all contaminated absorbent material in a designated approved plastic waste container (non-conductive). * In case of abundant use of water, care should be taken to confine and neutralise the water outflow. * After intervention, rinse the affected areas with water adequately.   **4.2 Recommended Personal Protective Equipment:**     * Handle Li- ion spills using the following personal protective equipment (PPE) * Safety glasses or face shield * Chemical resistant neoprene or nitrile gloves * Protective apron or coveralls * Protective mask for acidic vapours or SCBA.   Perform gross decontamination by removing affected clothing. Wash skin with water and soap.  **4.2 Treatment of Waste Water.**   * Confine the effluent or the contaminated material and collect it as hazardous waste (water) for appropriate treatment. * Pick up and transfer to properly labelled containers. * Dispose of in accordance with local waste management legislation and emissions regulations. | |

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| Damaged Lithium-Ion batteries: additional precautionary measures – reactivation of the battery. | |
| RE-ACTIVATION OF LI-ION BATTERY | |
| Specific Attention | 5.1 Heat evolution and fire  * When the car with a damaged Li Ion battery needs to be transported/ stored be aware of the possibility of a reactivation of the fire within a damaged battery. * During overhaul, immobilize and disable the vehicle if not already done. * Keep the damaged car with a battery or the damaged battery under supervision and control.   WARNING: There is a possibility for delayed ignition or re-ignition of a lithium-ion battery fire even after it is believed to be extinguished. This may remain an issue until the lithium-ion battery is properly handled/ managed/ conditioned by a qualified person.  Re-ignition may appear even after a few days.  **The HV battery assembly cover should never be breached or removed under any circumstances including fire. Doing so may result in severe electrical burns, shock, or electrocution.** |
|  | |
| Specific requirements for packaging, storage and transportation of damaged Lithium-Ion batteries. | |
| Safety Measures  During Storage and Transport  **[Gevaar](http://www.pictogrammenwinkel.nl/waarschuwingen-c-203/bordjes-c-203_204/gevaar-c-203_204_221/)**  **7010-m013**  **7010-m017**  .. | * 1. **When the battery is left in the car.**   Damage to the high voltage battery or high voltage system can create a risk of electric shock, overheating, or fire.  If the vehicle is damaged from a moderate to severe crash, flood, fire, or other event, the vehicle should be inspected as soon as possible.  Until the vehicle has been inspected, store it outside at least (15m) 50 feet from any structure or anything that can burn. Ventilate the vehicle by opening a window or a door.  Contact **XXX** as soon as possible to determine whether an inspection is needed.   * 1. **When the battery has been removed from the car**   6.2.1 Recommended Personal Protective Equipment:   * Safety glasses or face shield * Chemical resistant neoprene or nitrile gloves * Protective apron or coveralls * Protective mask for acidic vapours or SCBA.   6.1.2 Other requirements   * Place and store the battery in a remote area, 15 meters (50 feet) away from a building where there are human activities. If possible, store on a floor made of concrete. * Before being offered for transport, the cells or batteries shall be inspected by a qualified person to determine if the batteries are damaged. Damaged batteries may include, but are not limited to:   + Cells or batteries identified as being defective for safety reasons;   + Cells or batteries that have leaked or vented;   + Cells or batteries that cannot be diagnosed prior to transport; or   + Cells or batteries that have sustained physical or mechanical damage. * Damaged or defective batteries can only be transported according to the UN Regulation for the transport of dangerous goods (UN 3480). * Only trained persons are allowed to offer a damaged or defective battery for transport. * Alternatively place the battery in a metal container, * Fill the container to the top with a non-combustible and non-conductive thermal insulation material (sand, vermiculite, glass, mineral agent…) * Store the container with the battery in a safe place for several days.   **Remark:** Trained personnel (for fire) should always accompany the transport of the damaged vehicle/battery to the safe place. |

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| **Author: XXX**  **Sources: XXX**  **Following text may never be deleted!**  Template made by CTIF Commission for Extrication and New Technology.  Designer Kurt Vollmacher project leader.  This template is developed as an “example of good practice” in cooperation with RECHARGE, CTIF Hazmat Commission, Ing Jetty Middelkoop Hazmat Officer The Netherlands.  This document is not legally binding. It is prepared with the best information available to the authors at the time of its preparation.  The information contained in this template rescue and training manual may be updated without notice.  The information on this template must be further filled in (XXX) and specific adapted to the type of battery by the car manufacturer!  The information in the template has to be approved by the car manufacturer before distribution of this specific document.  The manufacturer is always the final author of the “filled in training and rescue manual” and it relays always under his responsibility.  This template is built for fire fighters/rescue workers/towing and maintenance, **as free information source** at the scene and after.  Also usable for training purposes.  Misuse of this document, containing specialized and lifesaving information, in any form or shape is punishable by law.  All rights reserved, Copyright protected. © |

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| Used Symbols |

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| **Important: only mention the used symbols in these list**  **Remove the details: E.G: ISO 7010 Blue R/G/B: 77/77/255, Red R/G/B: 255/0/0** | |
| **LI­ ION** | **High voltage battery pack with indication type of battery**  *Draft*  Orange R/G/B: 255/165/0  Black  Text: Arial rounded MT Bold |
|  | **NiMH battery, high voltage**  *Draft*  Orange R/G/B: 255/165/0  Black  Text: Arial rounded MT Bold |
|  | **Lithium ion battery, high voltage**  *Draft*  Orange R/G/B: 255/165/0  Black  Text: Arial rounded MT Bold |
|  | **Ultra capacitor, high voltage**  *Draft*  Orange R/G/B: 255/165/0  Yellow R/G/B: 255/255/0  Black |
| http://upload.wikimedia.org/wikipedia/commons/thumb/4/4b/Inductor.svg/150px-Inductor.svg.png | **Induction power (magnetic field)**  Draft  Orange R/G/B: 255/165/0  Black |
|  | **Use water to extinguish**  *Draft*  Blue R/G/B: 56/93/138  White |
|  | **Don’t use water to extinguish**  *Draft*  Red R/G/B: 255/0/0  White |
|  | **Use CAFS**  *Draft*  **Compessed Air Foam System**  Blue R/G/B: 56/93/138  White |
|  | **Do not break open**  *Draft*  Red R/G/B: 255/0/0  White |
|  | **Use heat Camera**  *Draft*  Blue R/G/B: 56/93/138  White |
|  | **Disassembly only allowed**  **by qualified persons**  *Draft*  Blue R/G/B: 56/93/138  White |
| 7010-w012 | **Danger electricity/electric shock**  *ISO 7010*  Yellow R/G/B: 255/255/0  Black |
| Batterij lekkage (bordje) | **Battery hazard**  *ISO 7010*  Yellow R/G/B: 255/255/0  Black |
|  | **Magnetic field** (e.g. induction power)  *ISO 7010*  Yellow R/G/B: 255/255/0  Black |
| 7010-m008 | **Wear safety boots**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
| 7010-m009 | **Wear safety gloves**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
| 7010-m010 | **Wear protective clothing**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
| 7010-m013 | **Wear face shield**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
|  | **Wear protective mask**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
|  | **Wear breathing apparatus**  *ISO 7010*  Blue R/G/B: 56/93/138  White |
|  | **Wear Splash suit/protected gas suit**  *ISO 7010*  (indicate preference type of suit)  Blue R/G/B: 56/93/138  Whit |
| http://www.qorpak.com/vimages/nfpa.gif | **NFPA 704 Hazard Identification System (USA)**  Hazard rating of 0 to 4,  The higher the number the greater the hazard  Flammability: red R/G/B:255/0/0 (0-1-2-3-4)  Health: blue R/G/B: 0/0/145 (0-1-2-3-4)  Reactivity: yellow R/G/B: 255/255/0 (0-1-2-3-4)  Special warnings: white  **Information:**  http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=704 |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/GHS-pictogram-explos.svg/120px-GHS-pictogram-explos.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-explos.svg) | **Explosive**  *(Globally Harmonized System of Classification and Labelling of Chemicals = GHS)*  Red R/G/B: 255/0/0  Black |
|  | **Flammable** *(GHS)*  Red R/G/B: 255/0/0  Black |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/6/6a/GHS-pictogram-bottle.svg/120px-GHS-pictogram-bottle.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-bottle.svg) | **Gases under pressure** *(GHS)*  Red R/G/B: 255/0/0  Black |
|  | **Oxidizer** *(GHS)*  Red R/G/B: 255/0/0  Black |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/a/a1/GHS-pictogram-acid.svg/120px-GHS-pictogram-acid.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-acid.svg) | **Corrosives** *(GHS)*  Red R/G/B: 255/0/0  Black |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/c/c3/GHS-pictogram-exclam.svg/120px-GHS-pictogram-exclam.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-exclam.svg) | **Caution harmful** *(GHS)*  Red R/G/B: 255/0/0  Black |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/5/58/GHS-pictogram-skull.svg/120px-GHS-pictogram-skull.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-skull.svg) | **Acute toxicity** *(GHS)*  Red R/G/B: 255/0/0  Black |
| http://www.gevaarsetiketten.com/components/com_virtuemart/shop_image/product/200508.gif | **Harmful** *(GHS)*  Red R/G/B: 255/0/0  Black |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/b/b9/GHS-pictogram-pollu.svg/120px-GHS-pictogram-pollu.svg.png](http://commons.wikimedia.org/wiki/File:GHS-pictogram-pollu.svg) | **Environmental hazard** *(GHS)*  Red R/G/B: 255/0/0  Black |
| **[Gevaar](http://www.pictogrammenwinkel.nl/waarschuwingen-c-203/bordjes-c-203_204/gevaar-c-203_204_221/)** | **General warning!** *ISO 7010*  **Hazard symbol has to be at beginning of the text!**  Yellow R/G/B: 255/255/0  Black |
| Stop (bordje) | **Indication of life threatening situation!**  *Draft*  **Hazard symbol has to be at beginning of the text!**  **Not acting on provided information can lead to life threatening consequences…**  Red R/G/B: 255/0/0  White |

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| **DRIVE LINE SIGNS** | |
|  | **Hybrid Electric Vehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Diesel) and electric.**  Symbol description:  Fuel pump with  1 flame = flammable liquid.  High voltage symbol.  Colors:  Orange R/G/B: 255/165/0  Grey R/G/B: 127/127/127  Black  Text: Arial rounded MT Bold |
|  | **Plug In Hybrid Electric Vehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Diesel) and electric. Also power grid-connector to recharge battery.**  Symbol description:  Fuel pump with  1 flame = flammable liquid.  High voltage/plug in symbol  Colors:  Orange R/G/B: 255/165/0  Grey R/G/B: 127/127/127  Black  Text: Arial rounded MT Bold |
|  | **Plug In Hybrid Electric Vehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Gasoline ) and electric. Also power grid-connector to recharge battery.**  Symbol description:  Fuel pump with  2 flames = highly flammable liquid.  High voltage/plug in symbol  Colors:  Orange R/G/B: 255/165/0  Red R/G/B: 161/37/3  Black  Text: Arial rounded MT Bold |

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|  | **Fuel Cell Electric Vehicle: electric vehicle powered by a hydrogen fuel cell.**  Symbol description:  H2 hydrogen atom/high voltage symbol  The stored hydrogen is compressed. (C= compressed)  Colors:  Orange: R/G/B: 255/165/0  Blue: R/G/B: 0/176/240  White  Text: Arial rounded MT Bold |
| 7 | **Electric Vehicle: electric vehicle with power grid-connector to recharge battery.**  Symbol description:  High voltage/plug in symbol.  Colors:  Orange R/G/B: 255/165/0  Black  Text: Arial rounded MT Bold |
|  | **Super capacitor high-voltage**  Symbol description:  Capacitor/high voltage symbol  Colors:  Orange: R/G/B: 255/165/0  Black |