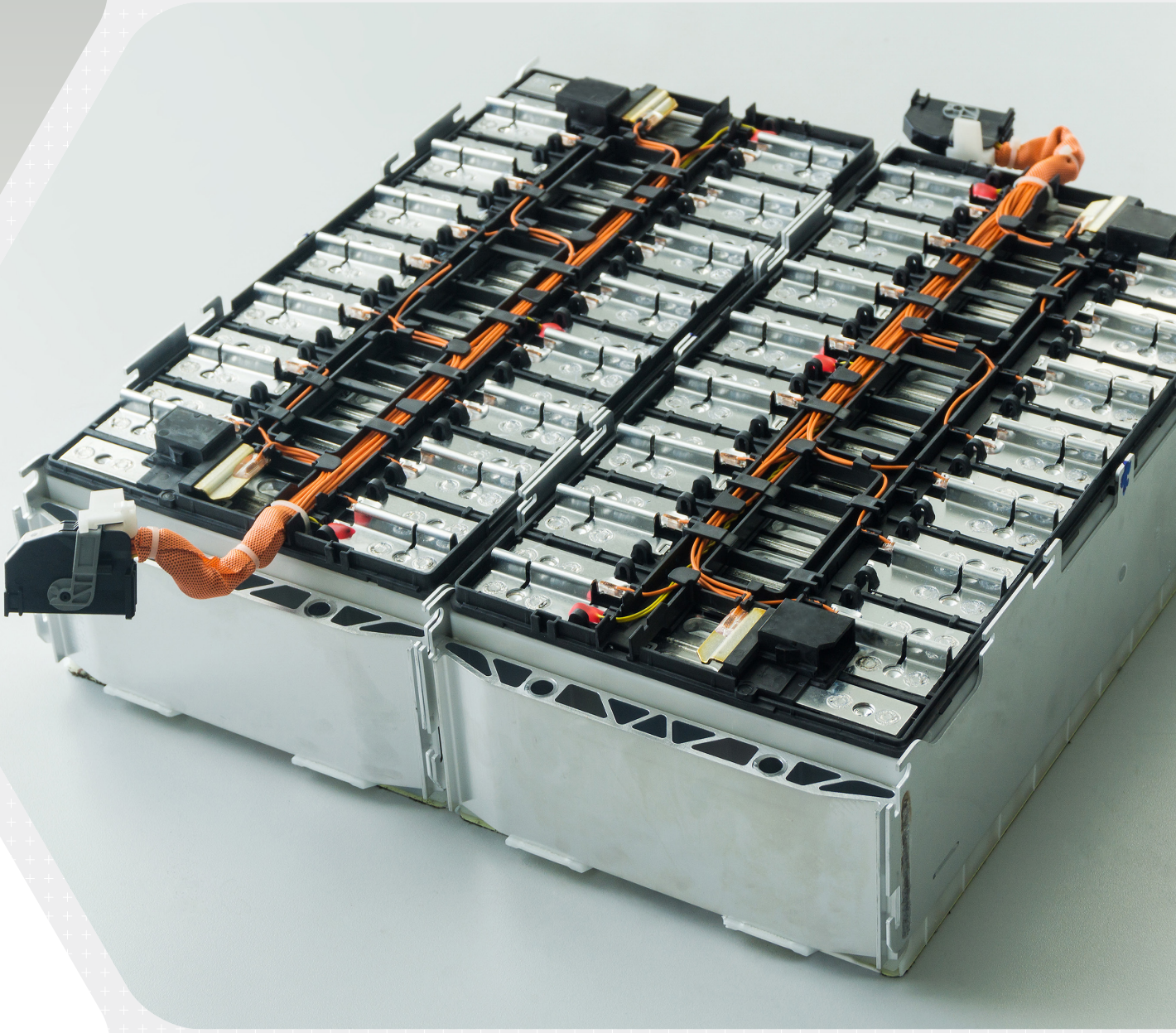

DV power

HOW TO USE BATTERY LOAD UNITS ? IN PROCESS OF REPAIR OR RECYCLING OF EV BATTERIES

It is becoming critical to recycle batteries to ensure environmentally friendly battery production, prevent human health risks due to inadequate disposal of certain types of batteries, as well as to secure very scarce and valuable raw material for production (nickel, cobalt, lithium, etc), which reduces the costs of new batteries.

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A rapidly increasing demand for batteries, especially in automotive industry and energy storage solutions, combined with more stringent battery usage and disposal regulations, is putting pressure on battery manufacturers to optimize their waste management.

It is becoming critical to recycle batteries to ensure environmentally friendly battery production, prevent human health risks due to inadequate disposal of certain types of batteries, as well as to secure very scarce and valuable raw materials for production (nickel, cobalt, lithium, etc), which reduces the costs of new batteries. Increased electrification of the transport sector will probably require automotive industry to make close partnership with the recycling sector.

The increased presence of electric cars nowadays (e.g. in Norway and Sweden) leads to increased demands for battery workshops and recycling facilities. Typical activities for electric cars workshops are:

- Replacement of bottom boxes on the battery base due to damage or rust,
- Replacement of one or more modules with deviations in cell voltage/ capacity,
- Replacement of high-voltage contacts that were mechanically damaged (e.g. hit by some object, stone, etc.).
- Replacement of springs and contractors after an overload in an AC compressor or a PTC heating element.

The battery module which has one or more weak cells cannot be replaced with a brand new module, since the other modules are not in a new condition. It is required to work with used parts and modules with the same residual capacity as other modules in the battery pack. Hence, it is required to use battery load units (e.g. BLU-800C) and to balance and measure the capacity of the module which is intended to fit into the battery. This is done in the following way:

- Both modules (one which needs to be replaced and one which will fit instead of the malfunctioning one) are charged to 90% SOC.
- With use of battery load unit, both modules are discharged up to 30% SOC.
- Deviations in battery cell voltage are being monitored during this process and compared with the specification given in the technical data from car suppliers (Typically 10 mV to 0.50 mV results between the different cells in a battery).

The replaced module is usually very suitable for the second lift application such as a battery for solar panels, etc.

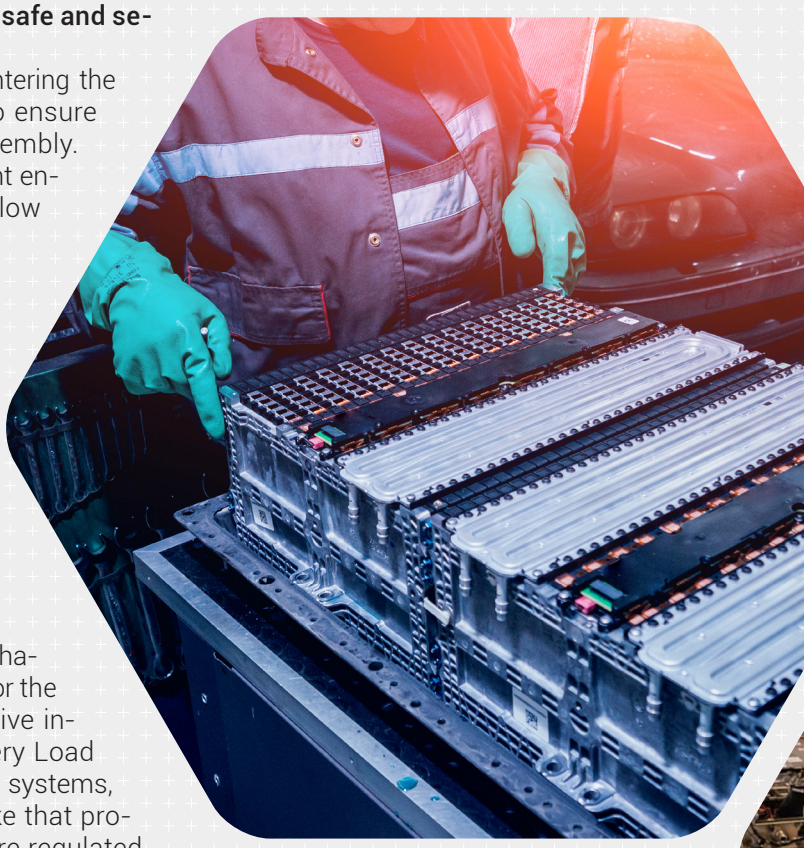
However, in some cases it is impossible to repair the battery pack, due to many modules damaged by water or some other cause. The damaged battery packs and modules needs to be prepared for the transport and recycling process in a safe and efficient way.

A few examples of damaged battery modules are presented in the following figure:

Figure 1.
Damaged battery packs

When it is decided that the battery has reached its end of life, the main question is: **How to prepare the battery for the recycling process in a safe and secure way?**

Fully discharging batteries before entering the recycling process is a crucial step to ensure safe and secure transport and disassembly. It is necessary to remove any remanent energy even from batteries with a very low State of Health (SoH).



Battery systems with nominal voltages of 400 Vdc or 800 Vdc are commonly used in newer generations of electric vehicles (e.g. Porsche Taycan, Audi e-tron GT, Lucid Air, Hyundai Ioniq 5, and the Kia EV6). There are some predictions that most of the EV industry is going to shift to 800 V by 2025, but this will depend on the decisions of the main manufacturers in the industry.

Considering the fact that we already have 400 V and 800 V systems available, for the recycling of batteries in the automotive industry it is important to have a Battery Load Unit capable of fully discharging such systems, from 800 Vdc down to 0 Vdc. To make that process more efficient, it is vital to ensure regulated current that is closely monitored during the entire discharge.

To avoid such uncontrolled temperature rise, besides monitoring the battery voltage and discharge current during the entire process, it is important to ensure temperature monitoring as well.

Due to specific battery characteristics, one deep discharge will not be enough for extracting all the remanent energy from the battery. Due to the *battery voltage rebound,* a rapid voltage increase will occur after the load is disconnected from the battery, even if the battery was previously discharged at 0 Vdc.

To prevent the *battery voltage rebound*, the Battery Load Unit should be used in combination with the Zero Voltage Discharge Module ZVD80. Besides enabling regulated (constant) current during the entire discharge process, the module drains remanent energy by short-circuiting the battery after the Battery Load Unit discharged it down to 0 Vdc.

The discharge current continues to be monitored and recorded and the battery is considered fully discharged and ready for recycling after the current drops to 0 A.

Figure 2.
Battery Load Unit BLU800C used for safe discharge of the batteries to 0 V

The most important demand in battery recycling preparation processes is

SAFETY!

Elevated demands on the battery recycling industry are challenging it to advance the processes in order to ensure shorter discharging times. This can be obtained by increasing the discharge currents, which can lead to an undesirable sharp rise of battery temperature or in extreme circumstances to temperature runaway and fire. In case of lithium batteries catching fire, toxic gases are released, life-threatening for the operating personnel.

Since the fire on lithium batteries cannot be suppressed with traditional fire extinguishers, special airtight containers with water tanks are used during the discharge process, as a safety measure. In case of fire, batteries are immediately immersed in water.

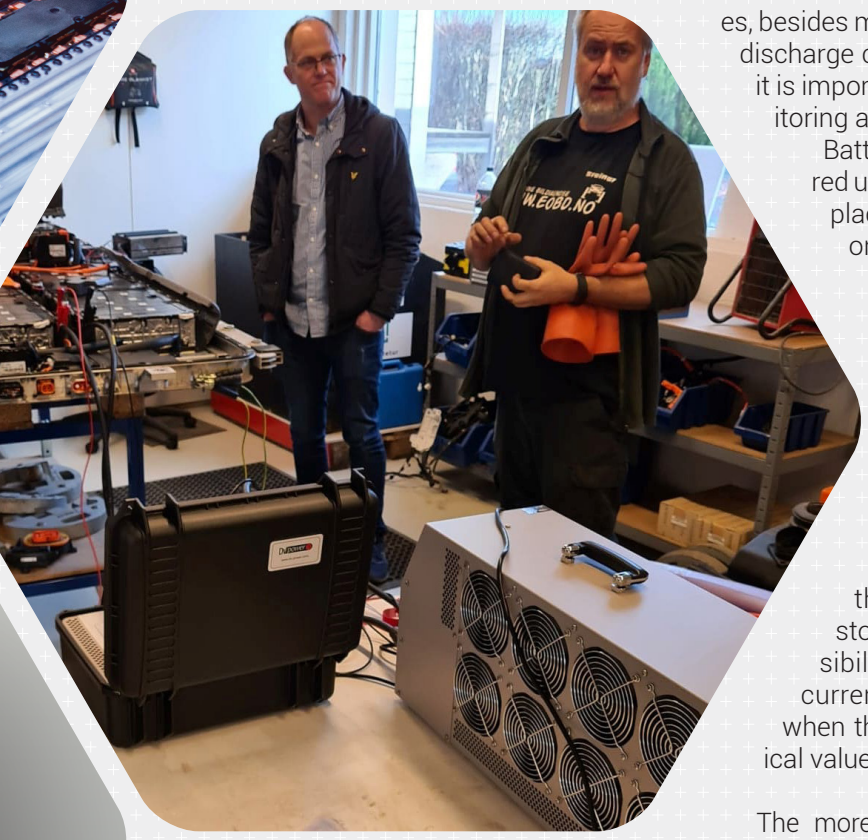


Figure 3.
Detached EV battery (left) and Battery load unit BLU360V (right)

To avoid such uncontrolled temperature rises, besides monitoring the battery voltage and discharge current during the entire process, it is important to ensure temperature monitoring as well.

Battery temperature can be monitored using several temperature sensors placed on chosen measuring points on the batteries or the thermal camera which have an alarm setting connecting to the BLU 800 remote control dry type, and the alarm indicates a dangerously high temperature over the entire battery and stops the discharge in a second. In case of a sudden temperature rise above the critical limit in any of those measuring points, the discharge process will be stopped. The operator has the possibility of decreasing the discharge current and continuing the discharge when the temperature is below the critical value.

The more advanced technical solution is to read measured parameters from the battery monitoring system (BMS) directly and control the discharge process accordingly. The BMS is usually an integral part of the batteries in electric vehicles, and it is possible to extract the necessary data important for the discharging process by using the CAN communication on BLU-C devices.

- Temperature of each individual battery cell or cell group
- Voltage of each cell or cell group
- Battery cell voltage deviation
- Isolation resistance

By monitoring the above- mentioned parameters, the operator can optimize the discharge profile for different battery types.

In case the BMS is not installed on the battery that is being discharged, or it is not available for any reason, BLU-C series can be used with its own battery supervising system, capable of monitoring battery cell voltages and temperatures, providing full control over the discharge process.

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