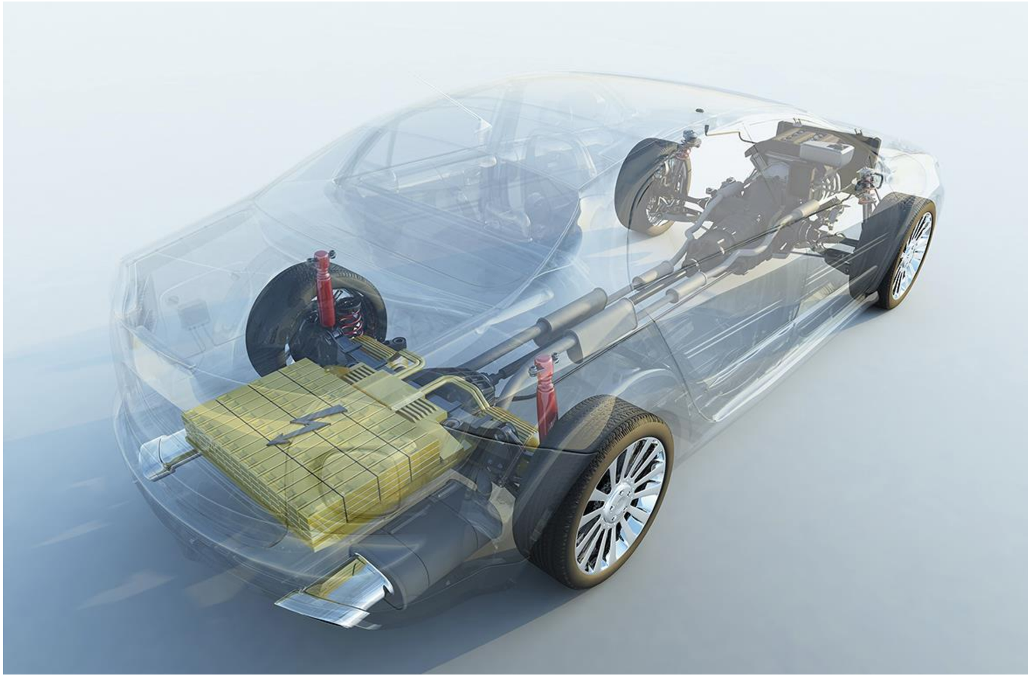
European Commission

Battery Energy Storage Testing

for Safer, Better Batteries



Why Batteries?

Safe and high performance batteries have been globally recognised a key enabling technology for the successful transition to electrified vehicle drive trains. More recently, the potential of energy storage, including batteries, for increasing the renewable energy share in the power generating mix has received increasing attention.

International competition is hard and as a result Europe faces big challenges to sustain competitiveness of its battery manufacturing, automotive and stationary energy storage industries.

How does JRC-IET contribute to the safe use of batteries?

The BATTEST (BATtery TESTing) project focuses on independent performance and safety assessment and includes experimental battery testing and modelling for transport and energy storage applications. The project executes pre-normative research supporting the deployment of batteries for vehicle traction and energy storage to achieve European Union policy goals pertaining to low-carbon, safe and sustainable transport and transitioning of the EU energy system. Traction batteries are a Key Enabling Technology in electric vehicle (EV) drive trains for enabling electrification of transport.

Since 2012, scientific and technical policy support is provided within the UNECE WP.29 Informal Working Group tasked with developing a Global Technical Regulation (GTR) on Electric Vehicles Safety (EVS). This global technical regulation addresses safety hazards unique to EVs to attain an equivalent level of safety for vehicle occupants as for conventionally powered vehicles. Global players involved in the development of the GTR, are EU, US, China, Japan, Korea and Canada.

Horizon 2020 funding of battery research

Battery research currently focuses on new and improved materials and manufacturing processes as well as on the operating conditions for batteries. Within Horizon 2020, EU (European Union) battery-related research projects are funded through different instruments, the most important being:

- NMP programme (funding research and Innovation in the Nanotechnologies, Advanced Materials and Advanced Manufacturing and Processing) for research on battery materials
- European Green Vehicles Initiative (EGVI) for energy storage systems for electric vehicles. EGVI is a contractual public-private partnership (PPP) dedicated to delivering sustainable vehicles and mobility system solutions and focuses on energy efficiency of vehicles and alternative powertrains.

JRC cooperation with industry

A Collaboration Agreement on pre-normative research and the development of fit-for-purpose testing methods and harmonised standards for EV battery testing was signed between the Joint Research Centre (JRC) and the European Green Vehicles Initiative Association as the representative of the private partner in the EGVI PPP (public private partnership).

A Memorandum of Understanding with the goal of cooperation on pre-normative research and standardisation activities was signed between the Joint Research Centre and Eurobat, whose mission is to promote the interests of the European automotive, industrial and special battery industries.

Contact:

Lois Boon-Brett
European Commission • JRC Petten
Tel.: +31 (0)224 56 5065
Email: JRC-PTT-BATTERIES@ec.europa.eu

https://ec.europa.eu/jrc/

Joint Research Centre

Dedicated state-of-the-art testing facilities at JRC

Battery cell performance/material testing – cell cycling and performance evaluation under normal, but varying, environmental operating conditions.

Two additional facilities will extend testing capabilities in the future:

Battery pack performance testing – battery pack (up to 160 kW) and battery module cycling and performance evaluation under normal, but varying, environmental operating conditions, including in-situ X-ray computed tomography of battery packs and modules.

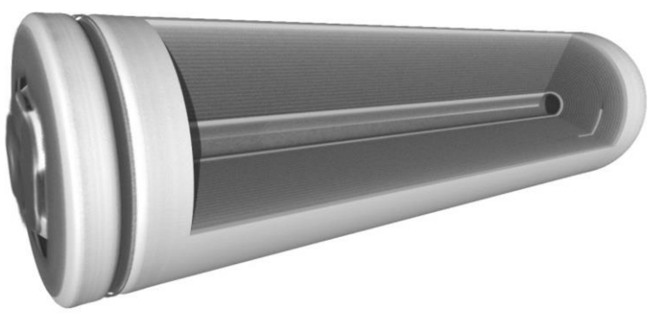
Battery cell abuse testing – mechanical, electrical and thermal abuse testing of battery cells including high speed video-recording, thermal imaging and gas detection.

In collaboration with international and European partners, the facilities are used in experimental programmes aimed at evaluating the safety and performance of batteries and emerging battery materials in addition to their ageing and performance degradation. Selected testing capabilities include:

Battery cycling at controlled temperature

The key test for assessing performance and degradation thereof is battery cycling. The battery or cell is charged and discharged repeatedly following a pre-defined protocol, which ideally should be representative of the battery use in the foreseen application. As temperature plays an important role for battery performance, temperature needs to be controlled. Currently more than ten temperature and climate chambers are available to perform battery cycling and degradation studies with high accuracy. Electrochemical impedance spectroscopy – which gives additional insight into cell functioning and degradation – can be applied in parallel. Additional related analytical techniques and setups include:

- **3-electrode cells** –the addition of a third electrode allows, in contrast to standard cells, the determination of half-cell potentials for improved understanding of electrochemical processes.
- **Transparent side-by-side cell** – such a cell allows the visual or IR observation of the electrodes/separator assembly in operation.
- **Dilatometer** – integrated into a 3-electrode cell, a dilatometer allows the measurement of the mechanical expansion of one electrode as a factor influencing performance and ageing (e.g. for Si alloy-based anodes with high expansion during operation).
- **IR camera** – for the imaging of surface temperature of a cell during operation (e.g. for the determination of hot spots).
- **Accelerated Rate Calorimeters (ARC)** – currently available for non-abusive investigation of thermal properties of cells.



18650 cell as imaged by X-ray computed tomography

Cell assembly/disassembly

Three glove boxes are available for handling cells and materials under controlled environment. A glove box allows the assembly of coin cells or 3-electrode cells, but also the disassembly of cells for further investigation. Materials harvested from a used cell can also be reintroduced into a new cell e.g. for evaluating remaining capacity of one electrode.

One of the glove boxes accommodates equipment for Simultaneous Thermal Analysis (STA) of battery components with subsequent analysis of emitted gases by FTIR (Fourier Transform Infrared spectroscopy) and GC/MS (Gas Chromatography/Mass Spectroscopy). This combination of analysis techniques provides insight into the battery components' thermal degradation.

Structural Analysis

The structure of batteries and battery materials is evaluated by multiple analytical techniques which include optical microscopy, porosimetry, Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD) and micro X-ray Computed Tomography (CT).

Numerical Modelling

Experimental activities are supplemented by numerical modelling of cell/battery performance, which allow also a better evaluation of the potential of new battery materials and design approaches. Further the degradation of performance can be modelled (e.g. by considering impedance spectroscopy data), which can provide better insight into degradation mechanisms.

Movie **Interactive tool**

https://www.youtube.com/watch?v=6u2Gjiudcas

www.tdh-interactive.nl/bestest/