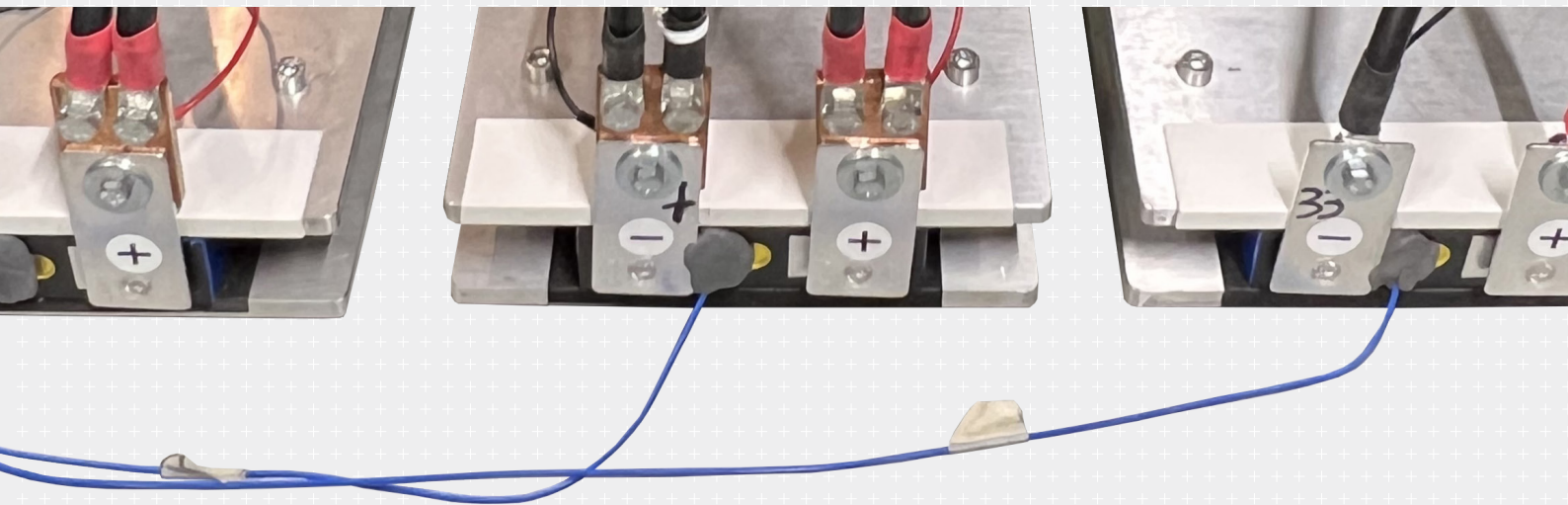


E-MOBILITY DEVELOPMENT REQUIRES
INTERDISCIPLINARY APPROACH, DEEP
KNOWLEDGE AND BATTERY TESTING

HOW CESI IS
CONTRIBUTING



A more sustainable approach to the use of electrical energy is widely spreading out in most sectors, ranging from stationary applications, such as energy storage systems both for domestic and for large plants, to e-vehicles, which are supposed to replace a big slice of the cars on our roads in the next years.

The use of energy in an electric vehicle must necessarily follow strategies different from those considered in combustion engine vehicles, given the different diffusion of the refueling systems which, for the electric vehicles, are the charging stations.

CESI

Shaping a Better Energy Future

All current and future EV models should be tested for homologation (at both full vehicle and component levels) to ensure safety and conformity.

CESI Group designed specific laboratories to test the different E-mobility aspects.

Test on storage solutions

Manufacturers focus on quality, safety and efficiency of the elements they produce; it is in this area that electric car battery testing and certification operates, ensuring that batteries, cells, chargers, and electrical components for use in e-mobility comply with global safety requirements and perform reliably.

Over the course of their service life, batteries, and their subsystems such as connections and cooling systems tend to deteriorate. This can result in a loss of battery performances, potentially leading up to a total failure. In addition, batteries in electric and hybrid vehicles come in a wide variety of sizes, shapes, weights, and chemical compositions. This makes it essential to carry out EV battery testing to verify durability, safety, and reliability of the components.

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Battery Cyclers for testing EV cells and battery modules

Whether Customers are seeking to bring new products to market or consolidating a developed technology, it is essential to be able to carry out non-destructive (pre-)testing of batteries, among which:

- Life cycle tests in conditioned environments
- Functional, climatic, and electromagnetic compatibility testing
- Performance measurements and modelling of new applications, including systems adjacent to the main energy storage system
- Failure investigation of energy storage systems.

CESI Battery Testing Laboratories lie in a context of increasing development, as batteries are more and more used, both in storage and vehicular applications. CESI tests samples of batteries with different technology, using different testing systems, thus gaining increasing experience and knowledge in this field.

The Battery laboratory is equipped with all the necessary instruments to perform battery testing, by guaranteeing a controlled environment, allowing the monitoring of the tests even remotely and providing a database in which to store the records of all the tests for later use and analysis.

Climatic chambers, Cyclers and Data Acquisition Systems, are the main tools available at their laboratories to simulate and reproduce the behavior of battery cells in the real world, where they power the vehicles and the storage plants.

Several climatic chambers, with volumes ranging from **1000 to 2000 liters**, are used to create and reproduce the environmental conditions, regulating both temperatures, from **-35°C to 180°C**, and humidity, from **10 to 98%**.

They are equipped with safety devices, to prevent and mitigate risks associated to Lithium battery operation. Climatic chambers have completely independent systems and are user configurable according to the needs.

The laboratories are also equipped with "cyclers", which impose charge and discharge currents on the batteries. These devices are built following the principle of modularity with independent channels, which can be parallelized to obtain currents even very high, up to 1200 A. The wide range of voltages makes them flexible in terms of possible applications.

Our specific laboratories investigate charging stations potential and behavior, carry out tests to assess battery lifetime, performs automotive EMC tests define semi-empirical models of battery associated to E-vehicles.

Test on charging stations

CESI is developing studies and technical/economic models to analyze how cars parked – and especially their batteries, if properly managed – could represent an invaluable "reservoir" in which to pour energy produced in excess during some hours of the day, so that they can return energy back to the electricity grid in case of necessity.

For years, CESI has been committed to the study and test of the best technologies for charging stations infrastructure. CESI/KEMA laboratories can test and verify e-vehicles power components which deal with remarkable current peaks circulating in a system of limited dimensions.



Water tightness test on charging column



Dust tightness test on charging column

When talking about E-mobility, safety requirements is extremely important, one of the most striking and easy-to-understand examples may be the water and dust tightness tests on the charging columns. These tests are not conducted in live-circuit, as the risks of electric discharges would be hard to manage.

CESI laboratories are also equipped to evaluate how much stress the charging infrastructure is subjected to. The column is literally 'hammered in', using specific tools, to check its resistance.

Automotive EMC tests

Electromagnetic Compatibility (EMC) disturbances arising from the proximity of other electromagnetic devices could potentially interfere with the proper use and operation of the equipment for automotive. This leads to the most complex communication problems between the vehicle charging system and the station itself, for example.

In their labs, CESI uses anechoic chambers to test components and auxiliaries connected to e-mobility and their interactions. Anechoic chambers offer a controlled and reproducible environment to measure electromagnetic compatibility phenomena, such as the generation of electromagnetic fields by the devices and the effect of these fields on their operation.

Electric batteries are “a core component” of an EV, affecting the quality of the entire vehicle.

Developing of semi-empirical battery aging model

An accurate battery model can provide information about battery behavior, in conjunction with data coming from the working conditions.

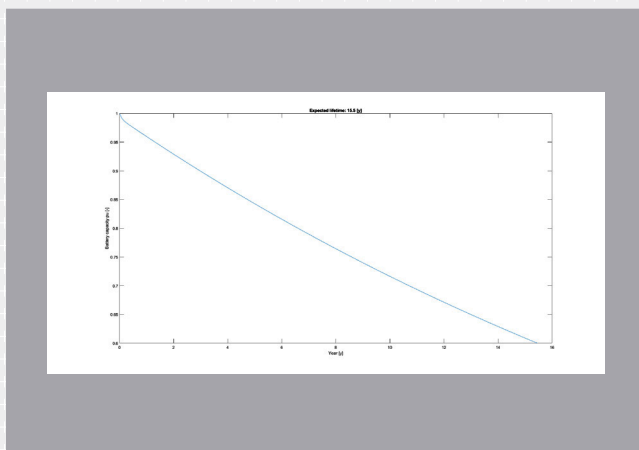
Some examples:

- Long term horizon, such as the degradation model of expected life.
- Short term horizon, such as predicting battery performances during the route of the vehicle.

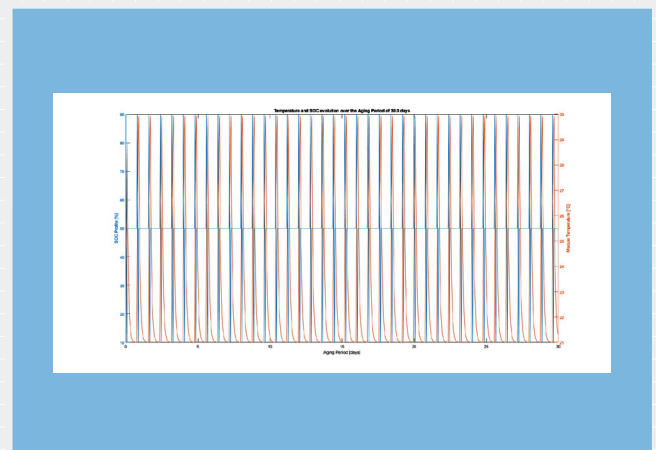
Battery cells model can be initially designed considering the physics and chemistry, using the “Analytical approach”. This aprioristic knowledge suggests the proper selection of the data set for refining the model. A “Big data approach” will be used in combination with the analytical modelling when the complexity of the environment increases and interactions with exogenous factors and variables must be also considered.

Data both from the experimental tests and from the real-world flow into the model, improving it.

In the following images, you can find an example of the output of one aging model developed by CESI.



*Aging model Output
Progressive capacity degradation of a battery module, depending on the operating conditions over its whole life*



*Aging model Output
Module temperature in relation with SOC profile*