www.calbatt.com

CalBatt™
premium charging technology

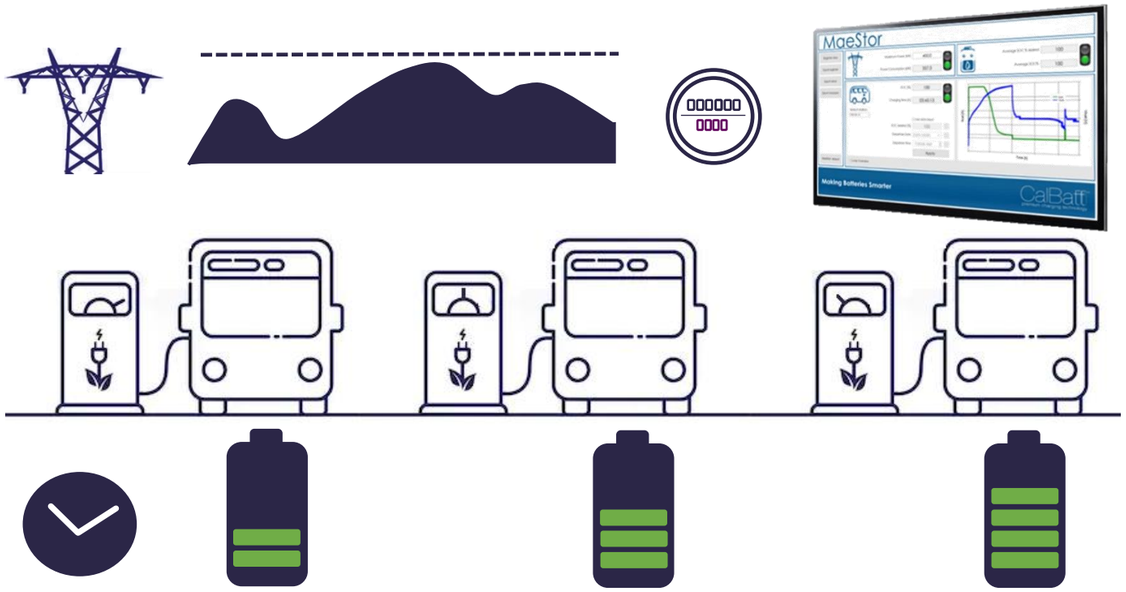
MaeStor

The smartest charging for e-bus fleets

BEST-IN-CLASS EMS PLATFORM FOR SMART E-BUS CHARGING

MaeStor Energy Management Systems (EMS) **modulates the charging power** of the different e-buses in order to perform **dynamic charge optimization** according to:

- **Number of buses** in simultaneous charging
- **State of charge** of each bus
- **Available charging time** for each bus



MAESTOR PLATFORM IS BASED ON THREE DIFFERENT MODULES

DYNAMIC CHARGE OPTIMIZATION

CHARGING INFRASTRUCTURE INTEGRATION

USER INTERFACE

FLEXIBLE HARDWARE FOR PERFECT INTEGRATION

MaeStor platform is based on a very flexible hardware architecture implemented by an Industrial PC supporting several communication ports and standards over Ethernet and Wi-Fi.

HARDWARE CHARACTERISTICS

RAM	Up to 8 GB
Embedded Hard Disk	Up to 128 GB
Operating System	Windows IOT/Linux
Communication ports	• 1x RJ45 • 1x HDMI/ 1x DP • Up to 4x USB
Supported protocols	• MODBUS TCP/RTU • OCPP • HTTP (API) • RS232/RS485

CHARGING INFRASTRUCTURE INTEGRATION MODULE

Thanks to its flexible hardware architecture and communication protocols supported, MaeStor can be integrated with third-party devices:

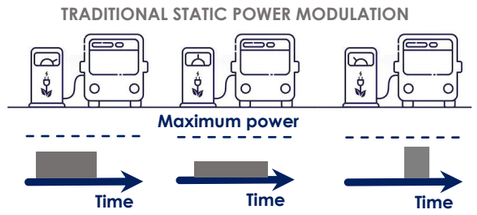
- Charging stations;
- HMIs, PCs and servers, etc. implementing SCADA systems or other charge balancing platforms;
- On-board E-bus devices for monitoring in real-time battery parameters;
- Energy storage systems.

DYNAMIC CHARGE OPTIMIZATION MODULE

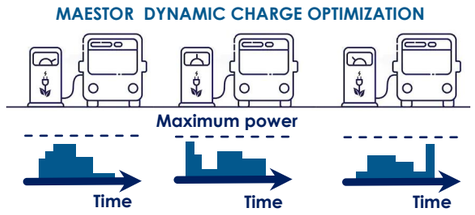
Standard EMS perform a static modulation, "spreading" the recharge of each vehicle on the available time window, thanks to the use of power values lower than the maximum usable.

PROBLEM OF STANDARD EMS

The power profile for each vehicle is fixed according to **predetermined charging curves** which do not take into account the real efficiency characteristics of the specific charger/battery set, leading to non-optimal charging performance



MaeStor is able to perform an optimized **dynamic modulation** of the charging power for each vehicle in the fleet according to the specific efficiency characteristics of the battery/charger set.



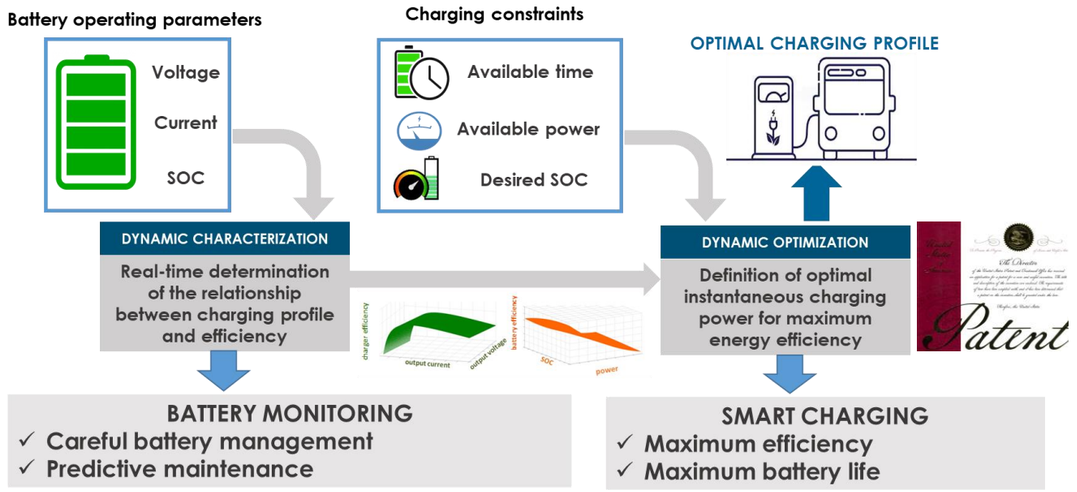
MAESTOR DYNAMIC CHARGE OPTIMIZATION

MaeStor EMS minimizes the costs of vehicle recharging through a **dynamic optimization of the charging power** of each vehicle based on the relationship between energy efficiency and the operating charging parameters of each specific charging station/vehicle bundle, determined in real-time through a **dynamic characterization of energy efficiency**.

The dynamic charge optimization algorithm takes into account:

- the relationship between energy efficiency and charging operating parameters;
- power available for charging;
- maximum current and voltage constraints for the battery of each vehicle;
- time available for recharging each vehicle;
- desired state of charge for each vehicle at the end of the recharge;
- possible variable electricity tariffs;
- possible renewable sources and/or storage systems present in the plant.

A TWO-STAGE PATENTED ALGORITHM



STAGE 1: DYNAMIC CHARACTERIZATION

The **dynamic characterization** phase consists in determining in real time the **relationship between the overall energy efficiency and the charging operating parameters** (current, voltage, state of charge, etc.) of the specific charging station/battery of each vehicle, taking into account the energy losses on both the battery and the charger, which vary during the life of the system due to the aging of the components and during the charging process, due to the change in the battery state of charge.

STAGE 2: DYNAMIC OPTIMIZATION

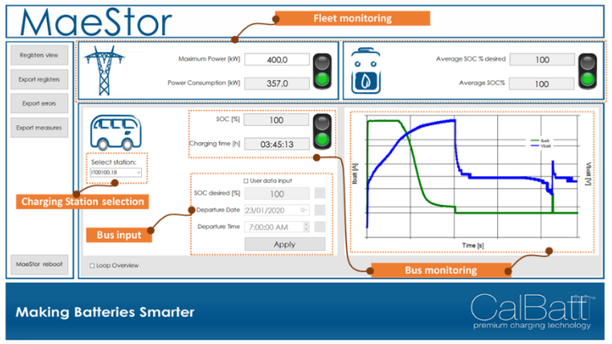
Depending on the output of the dynamic characterization phase, the **dynamic optimization** phase is carried out to determine **the instantaneous optimal charging power set-point** to be set for each vehicle in order to maximize the energy efficiency of the recharge, taking into account the constraints on the power available, on the time available for charging each vehicle, on the desired minimum state of charge at the end of charge and on the maximum voltage and current values that can be set for the battery of each vehicle. In the presence of variable tariffs for electricity, dynamic optimization is carried out to determine the optimal power set-point which allows to minimize the overall cost of charging based on the trend of both energy efficiency and energy cost as a function on the charging power.

The dynamic charge optimization module is available upon request also through APIs for integration with third-party charge balance platforms.

USER INTERFACE MODULE

RUNTIME GUI

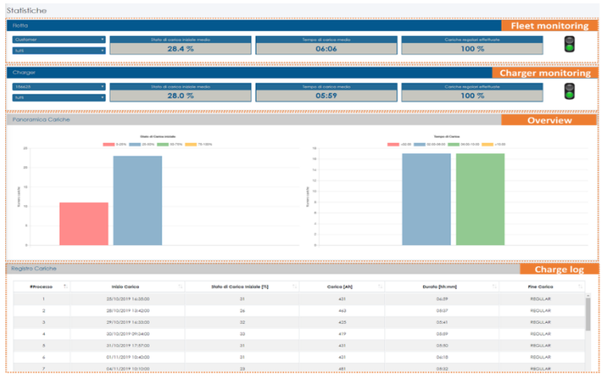
The Runtime Graphical User Interface (GUI) allows to visualize the operating parameters of the buses during charging and to input charging constraints.



- Charging station section allows to select the charging station for which user wants to visualize operating parameters and enter charging constraints;
- Bus input section is dedicated to the input by the user of charging constraints for the bus connected to the selected charging station
- Bus monitoring section allows to visualize the instantaneous trend of bus charging parameters:
- Fleet monitoring section allows both to enter the constraint about maximum power available for charging, and to view the overall trend of the fleet charging in terms of average state of charge and absorbed power.

STATISTICS GUI

The Statistics GUI allows diagnostics by visualizing statistics about the operating charging parameters of the e-bus fleet.



- Fleet monitoring section allows to monitor the initial state of charge of the batteries and the average charging time, as well as the percentage of charges regularly carried out for the entire fleet;
- Charger monitoring section shows the initial state of charge of the battery and the average charging time, as well as the percentage of charges regularly carried out for each charging station in the fleet;
- Overview section presents the statistical distribution of the initial battery state of charge and the charging time of the charging station selected in the "Charger monitoring" section;
- Charge log section reports the parameters of each process carried out by the charging station selected in the "Charger monitoring" section (starting time of charge, initial battery state of charge, charge supplied, charging time and end of charge condition).

ABOUT CALBATT

CalBatt develops solutions for smart charging of electric vehicles, based on its proprietary technology born in internationally recognized labs of University of Calabria. Since its beginning, the Company has always been fully committed to R&D, receiving several **awards** for its innovation.

Awarded by Enel for its disruptive technology validated on-field

In the **top 10 most innovative** European companies at Munich Cleantech Conference

Recognized as one of the Italian excellence in green technology at **COP 21 Paris Conference**

Awarded by Eu Commission with "**Seal of Excellence**" for Companies with most innovative technologies in the world

The smartest charging for e-bus fleets calbatt.com

Making batteries smarter

CalBatt™
premium charging technology

CalBatt srl
Technest Technology Hub-Rende (CS), Italy
Website: www.calbatt.com
Email: info@calbatt.com
Phone: +39 0984 494273