

Cleantron Products & Markets



Products

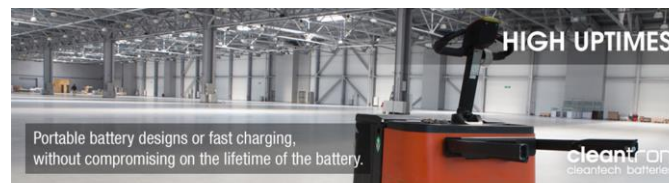
- Customizable Standard Battery Modules (24-72V)
- Tailored Li-ion Battery Modules (Low voltage and High voltage)

Markets

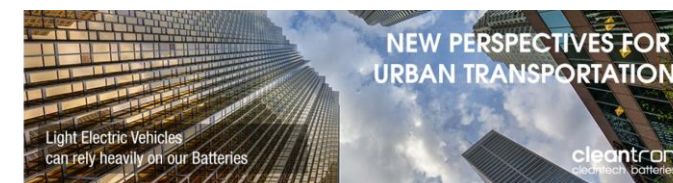
- Industry
- Light electric vehicles
- Automotive



Electric Scooters
Light Electric Vehicles
Special e-Bikes



Light Horizontal Industrial Transportation
Cordless Cleaning Equipment
AGV's / Terrestrial / Agricultural Systems
Greenhouse Robotics



Prototyping for OEM
Series Production Niche Vehicles

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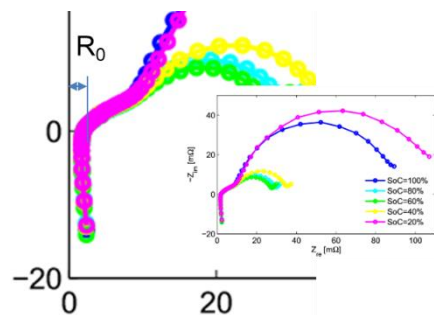
Business Proposition

Production

- Industrialized, ISO 9001 certified, qualifying for IATF16949
 - Highly atomized
 - Close loop QC system from cell testing to battery pack testing
 - Spotwelding
 - Laserwelding
- Responsive; short delivery times in EU27

Services & innovation

- Mechanical Design
- Electrical Engineering
- Li-ion Cell Management



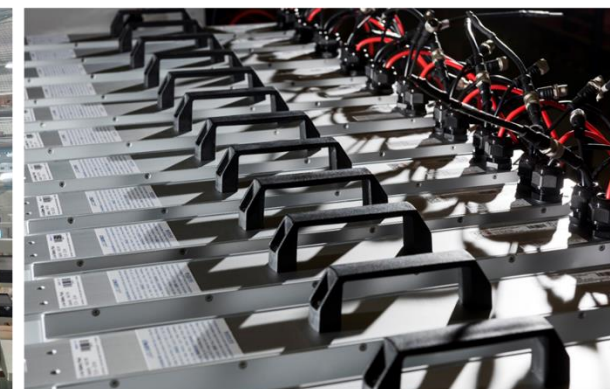
Electrical Engineering



100% In Line Cell Testing



Industrialised Production



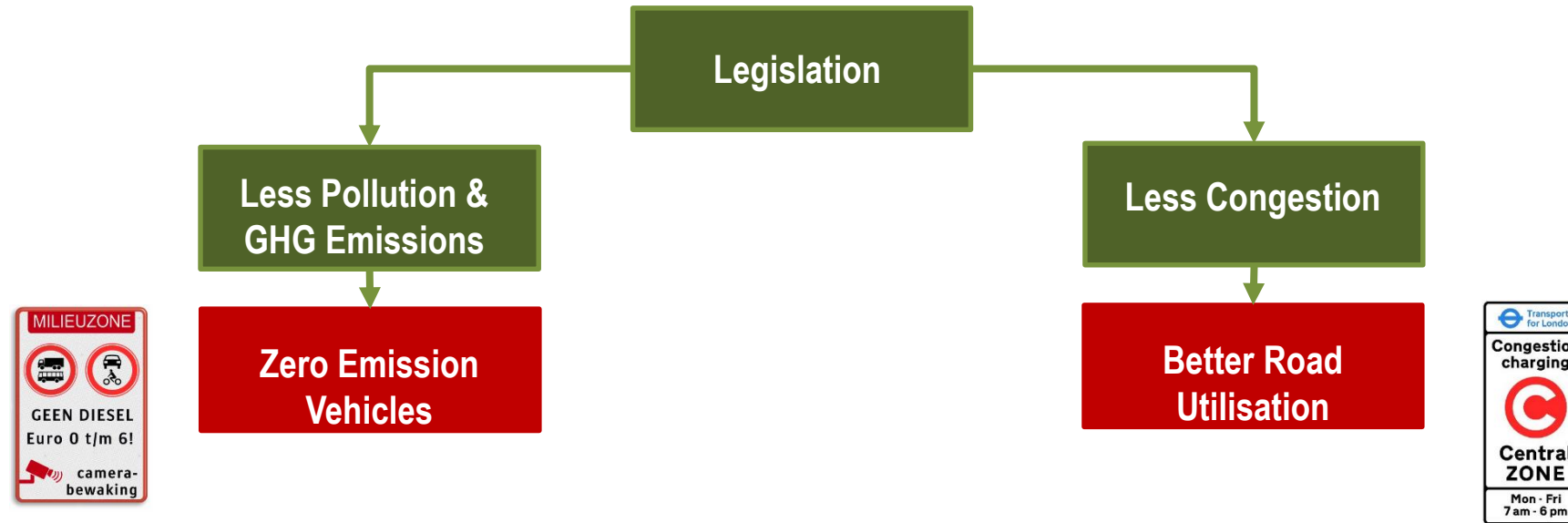
100% Module Testing

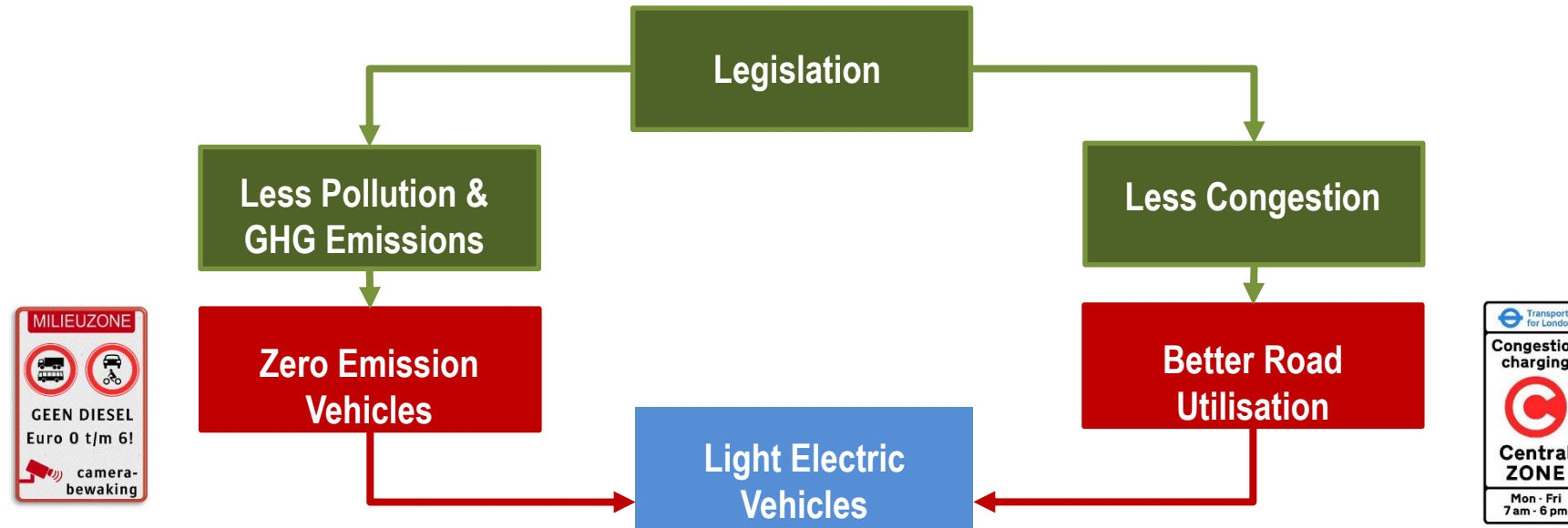
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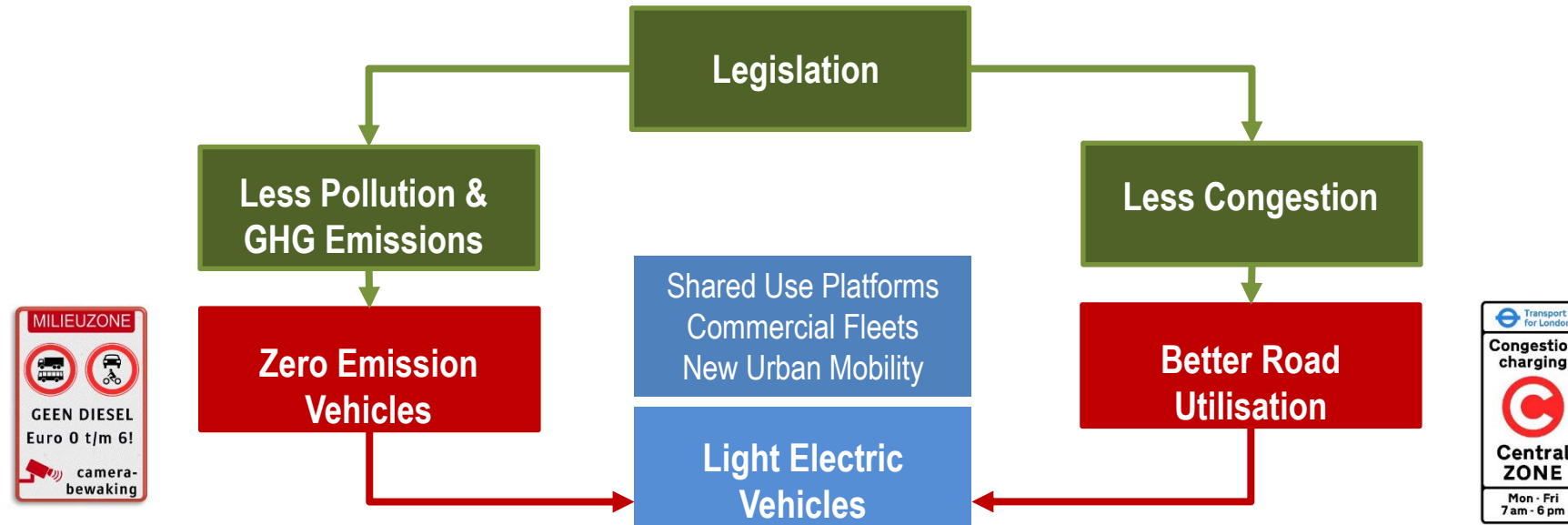
Lithium Ion Modular System for Light Electric Vehicles







BATTERY TECHNOLOGY



(no) Charging
Infrastructure

Fit for Purpose

Affordability

BATTERY TECHNOLOGY

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Urban Mobility, Commercial Fleet, Shared Use Platforms

using Cleantron Modular Battery Technology: Multi Pack Configuration (MPC)



Cleantron MPC System:

Scalable

Easy Maintenance and Allowing Battery Module Swapping

Safe & Redundant

User and Platform Information

(no) Charging
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Cleantron Multi Pack Configuration



<https://www.youtube.com/watch?v=iXy9rk9VgnA>

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Urban Mobility, Commercial Fleet, Shared Use Platforms

using Cleantron Modular Battery Technology: Multi Pack Configuration (MPC)



Allowing 1 till 16 Modules in Parallel to tailor the Battery Pack Capacity (from 2 up to 32 KWh)

- Reducing cost by allowing an optimised battery capacity for each application and each use case
- Plug & Play Module replacement for fast on-the-spot Maintenance

Inter-Module Communication via CANBUS

- no fixed Module Positions required
- no fixed module CAN-ID, allowing the user to Swap any Module at any Time at any Position in Vehicle

System Functions

- Managing Charging & Discharging of the MPC: Avoids uncontrolled Overcharge Currents between Modules
- Monitoring the SOC of the MPC
- Monitoring the Number of Active Modules and the SOF of the MPC
- Identification of the Modules that may require attention/maintenance



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Cleantron Multi Pack Configuration

Configuration Options

Parallel Discharge for fixed Battery Systems

- easy maintainable Battery Systems (easy module swap)
- allowing high Charge & Discharge Currents on System Level (up to 500A in a 16 module configuration)
- offering maximum Cycle Life

Sequential Discharge for Battery Swapping Systems

- Cycle Intelligent Charging
- Portable battery for easy charging avoiding the need for high cost charging infrastructures

cleantron
cleantech batteries



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Cleantron Multi Pack Configuration

Operational Advantages

Benefits:

Scalable

Easy Maintenance and Allowing Battery Module Swapping

Safe & Redundant

User and platform information

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BATTERY TECHNOLOGY

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Cleantron Multi Pack Configuration

Safety and redundancy



Safety on Battery Module level



Is the design of the module intrinsically safe?



UN 38.3



IEC 62133

Safety on Battery System level



Applicable norms and requirements must be defined together with the customer



EN 506104

Safety on Application System level:



Strongly depends on the Application and must be done together with the end customer



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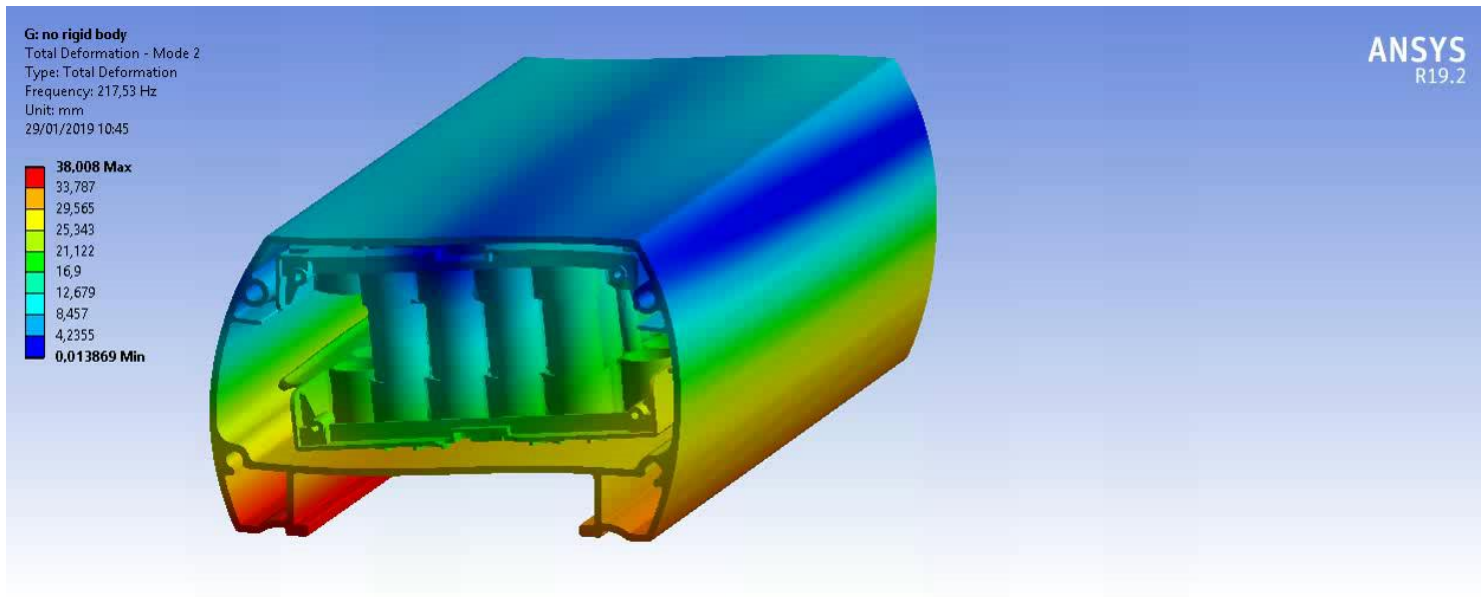
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Cleantron Multi Pack Configuration

Safety and redundancy

Safety on Battery Module level

- Simulating and physical mechanical abuse testing
- Simulation and physical Electrical abuse testing

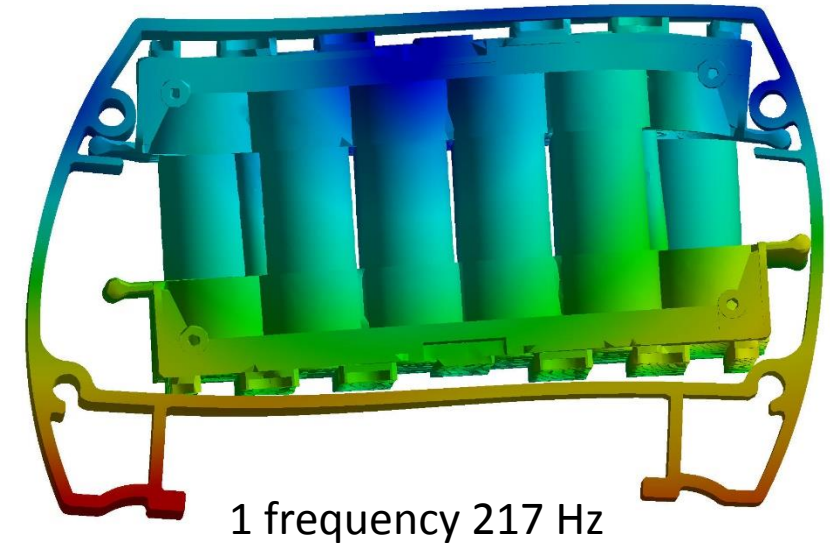


UN 38.3



IEC 62133

Test is a Sine Sweep: 7Hz – 200Hz – 7Hz in 15



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Safety and redundancy

Example Safety on a Battery System level:

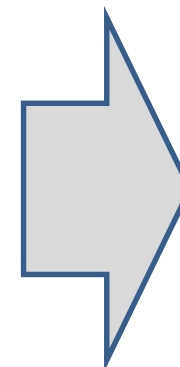
The **combined Currents of all Modules** in the System is much larger than the individual Current of each Module. These high Currents can result in **significant inductive effects**. This can result in an **Overvoltage on the BMS MOSFETs resulting in a Failure of the BMS Safety System**:

Cleantron safety solution:

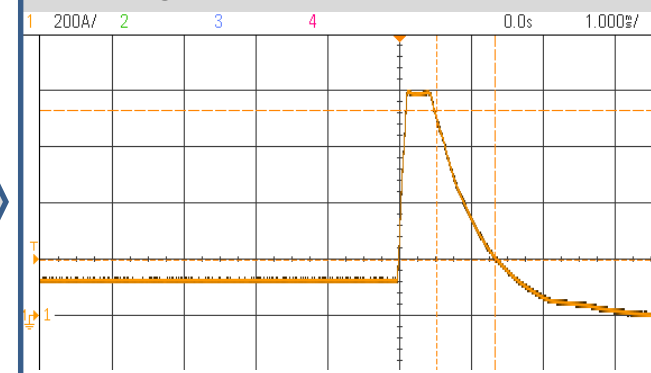
- A fast acting BMS with MOSFETs in combination with an additional Path to safely drain Inductive Energy avoiding a fatal Overvoltage on the BMS MOSFETs
- An additional Passive Fuse

Cleantron validation test:

- **Highly loaded system (20 KW / 400A discharge)**
- **Significant System Induction**
(1 m cable from module to central Hub)
(4m between hub and loads)
- **Full short circuit applied (0-10 mOhm)**
(+/- 1700 A)



The Short Circuit is triggered of all Modules and the MOSFETs of all Modules are successfully opened creating a safe and fast Shut Down



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Cleantron Multi Pack Configuration

Safety and redundancy

Safety on a Vehicle System level:

Full integration in the vehicle drive line and user interface:

- Warning messages via CAN Bus interface before a system shut down:
 - Over temperature
 - Under voltage
 - Over voltage
 - Over current
- System Health Indication for Maintenance
 - Impedance differences between modules

System Redundancy:

- No Shut-Down if One Module fails



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Cleantron Multi Pack Configuration

Operational Advantages

Benefits:

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Safe & Redundant

User and platform information

BATTERY TECHNOLOGY

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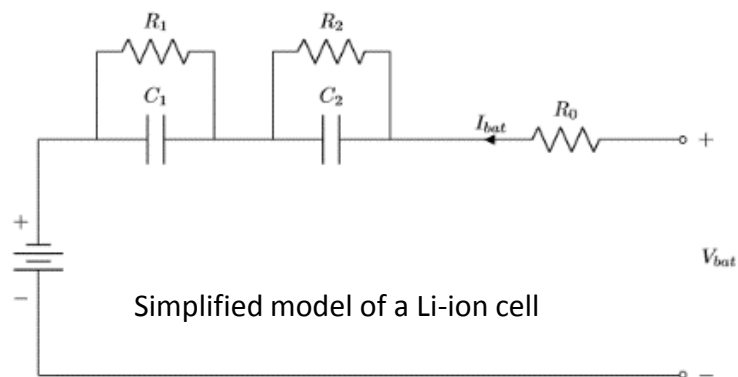
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Battery Technology

Battery Modelling for better End User Data

Cell modelling



Simplified model of a Li-ion cell

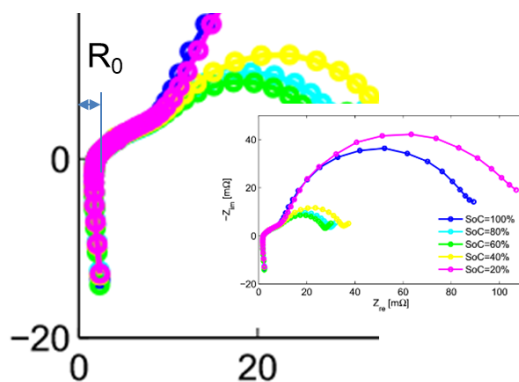


BMS in Service Sensing Technology

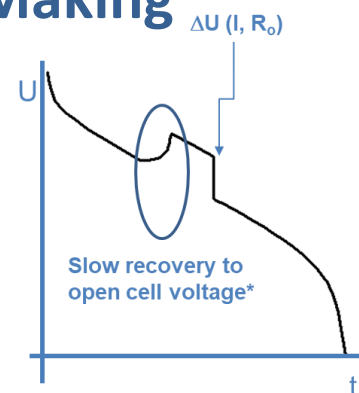
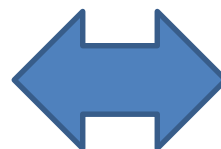
Determination of key parameters
($-V$ $-I$ $-R_0$ $-R_e$ & $-T$)



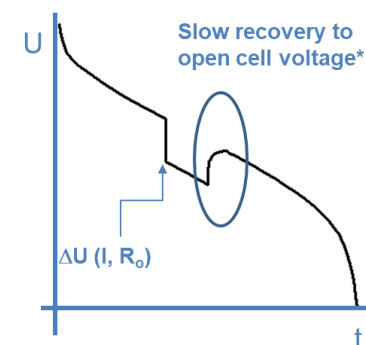
Advanced Sense Making



Nyquist plot of a Li-ion cell



U increases during Charge
depending on I and the R_0



U decreases during Charge
depending on I and the R_0

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Battery Technology

Battery Modelling for better End User Data

Algorithm Development for user data

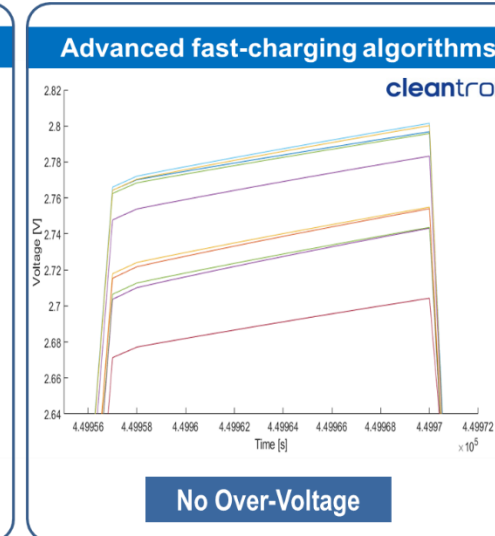
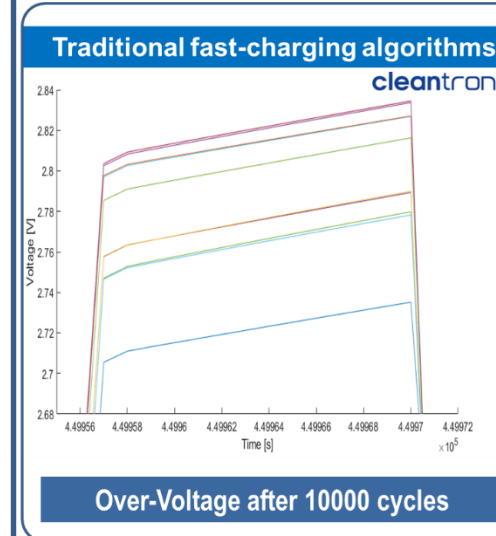
- SOC based on extended Kalman Filters
- SOH based on Impedance in combination with extended Kalman Filters
- SOF determination



USER & PLATFORM INFORMATION

Algorithm Development Battery management

- Advanced Impedance based Balancing Algorithms for:
 - Capacity optimisation
 - Lifetime Extension
 - Fast charging
- Temperature controlled Charging and Discharging Algorithms



Product performance reliability & lifetime

MAKING GREEN AFFORDABLE



Thank you for your Attention

Maarten Kelder

CTO Cleantron

maarten.kelder@cleantron.nl

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