Januari 2019
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elincom presenteert:

# Leader of the Pack

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ENERGY STORAGE EVENT

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# Outline Cleantron

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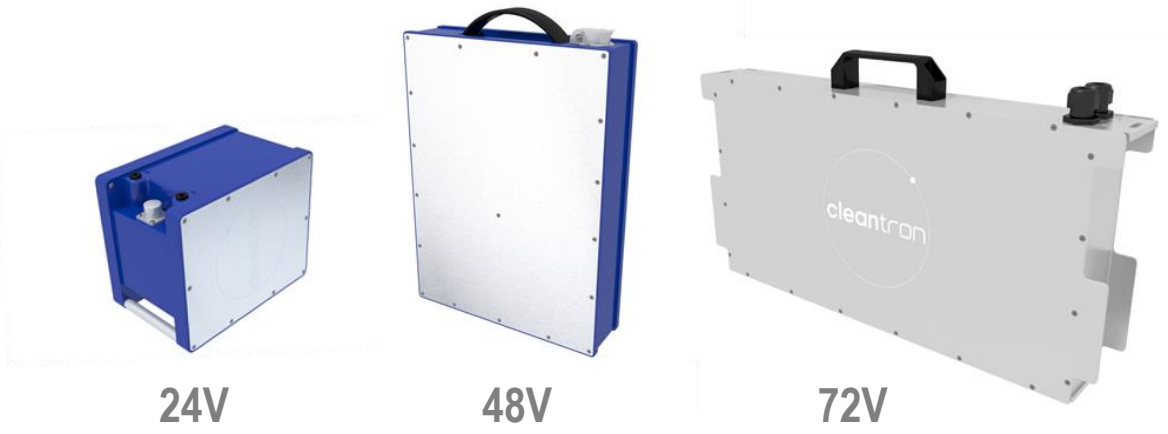


## Products

- Customizable Standard Battery Modules (24-72V)
- Tailored Li-ion Battery Modules
- Automotive

## Production

- Industrialized, ISO 9001 certified, qualifying for IATF16949

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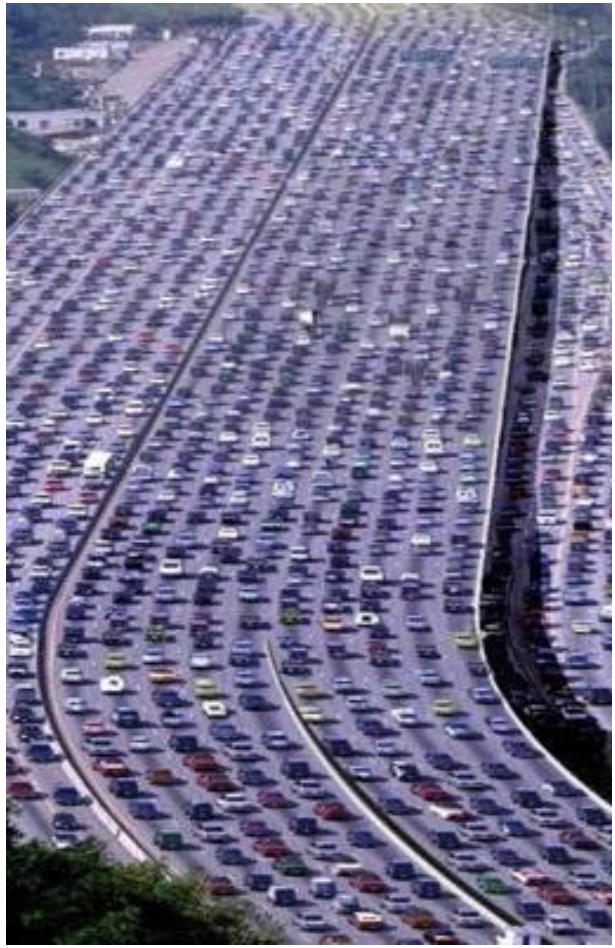

# Urban Mobility, Commercial Fleet, Shared Use Platforms

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

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## System Functions

- Managing Charging & Discharging of the MPC
- 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

## Inter-Module Communication via CANBUS

- Each Battery Module gets a unique CAN ID each time the Module is connected:
  => creates an extremely flexible System Configuration:
    - 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

# Urban Mobility, Commercial Fleet, Shared Use Platforms

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

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**Benefits:**

**Scalable**

Easy Maintenance and Allowing Battery Module Swapping

Safe & Redundant

User and Platform Information


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# Cleantron Multi Pack Configuration

Scalable

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## Allowing 1 till 16 Modules in Parallel to tailor the Battery Pack Capacity

- 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

## Avoids uncontrolled Overcharge Currents between Modules:

- Preventing Overcharge Currents as a result of Voltage Differences in the System:
    - in case a Module is exchanged during maintenance
    - in case a Module is shut down due to an Abuse Condition inside the Module (e.g. Over-Temperature)
    - in case of growing Impedance Differences
    - ….

# Cleantron Multi Pack Configuration

## Operational Advantages

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**Benefits:**

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# Cleantron Multi Pack Configuration

## Configuration Options

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### Parallel Discharge for fixed Battery Systems

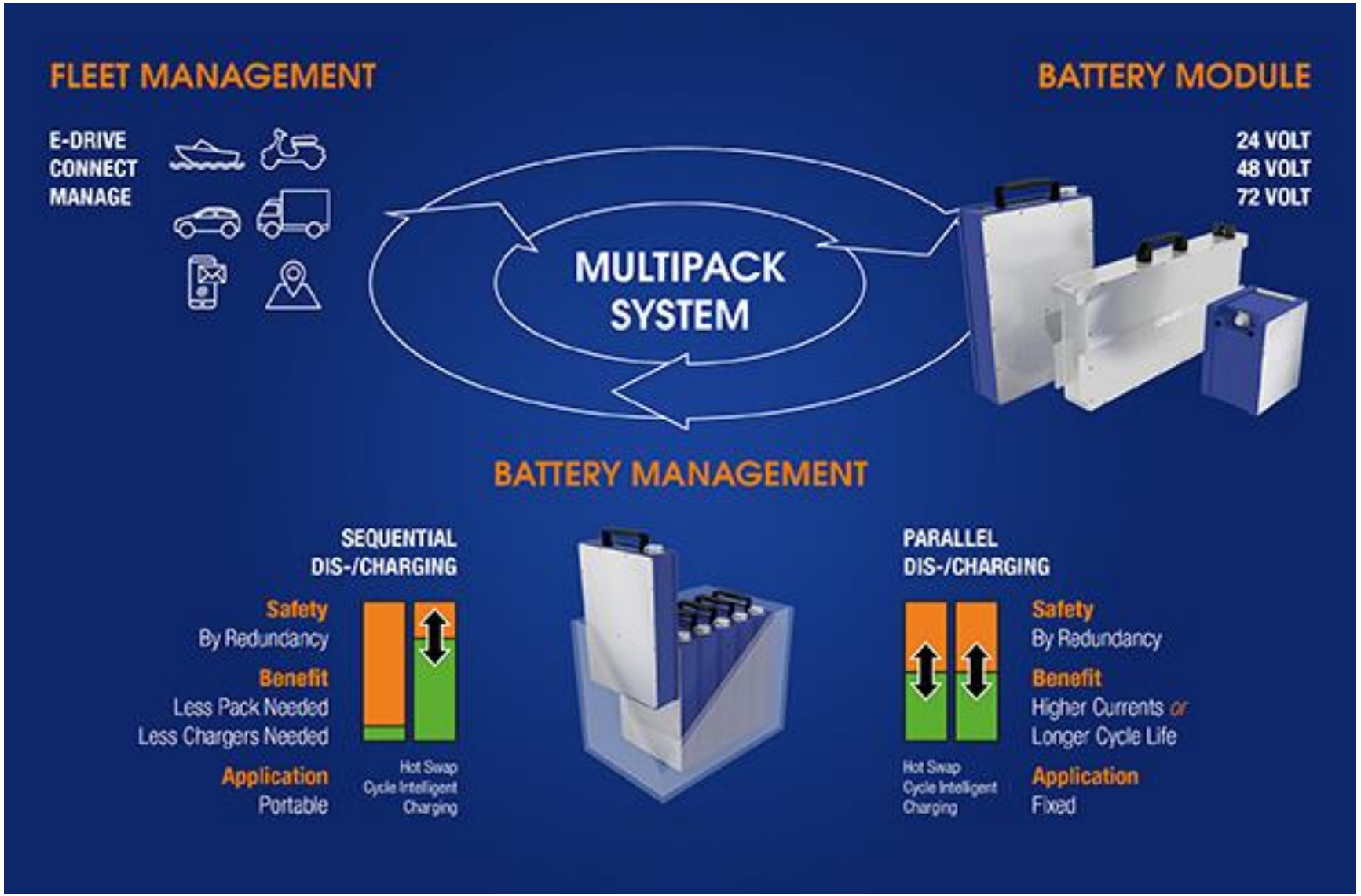
- easy maintainable Battery Systems (easy module swap)
- allowing high Charge & Discharge Currents on System Level (up to 500A in a 16 module configuration)
- offering maximum Cycle Life

### Sequential Discharge for Battery Swapping Systems

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

# Cleantron Multi Pack Configuration

## Configuration Options



# Cleantron Multi Pack Configuration

Operational Advantages

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# Cleantron Multi Pack Configuration

Safety and redundancy

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## 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

EUROPEAN NORM
EN

EN 506104

## Safety on Application System level

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

# Cleantron Multi Pack Configuration

Safety and redundancy

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## Example Safety on a Battery System level:

**The combined Currents of all Modules in the System is much larger that 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:**

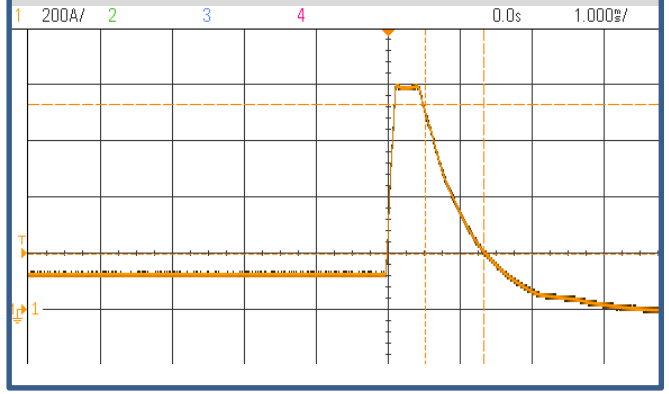
## Cleantron safety solution:

- 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**



# Cleantron Multi Pack Configuration

Safety and redundancy

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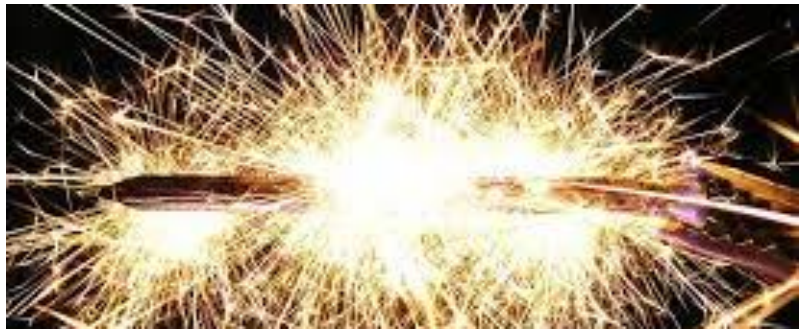
## Safety on a Vehicle System level:

Full integration in the vehicle drive line and user interface:

- Warning massages 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



What to do in area's of conflicting Safety Requirements:

- Example: Direct Short Circuit Intervention
  vs. Traffic Safe Intervention

# Cleantron Multi Pack Configuration

## Operational Advantages

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**Benefits:**

Scalable

Easy maintenance and Allowing battery swapping

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**User and platform information**

# Battery Technology

Battery Modelling for better End User Data

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## Cell and System Modelling

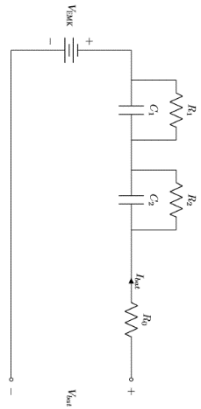
## Advanced Sensing en sense making Technology

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

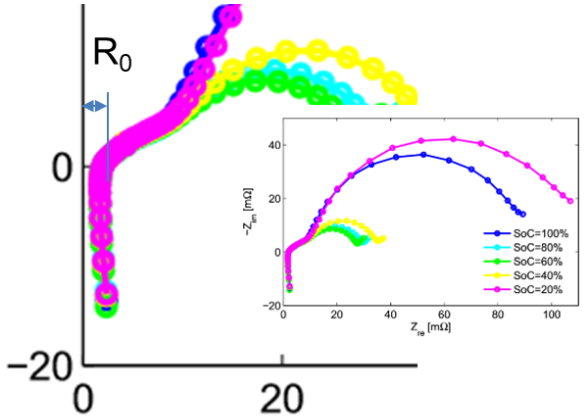
## Algorithm Development

- SOC, SOH & SOF determination
- Advanced Balancing Algorithms for Capacity optimisation and Lifetime Extension
- Temperature controlled Charging and Discharging Algorithms
- Fast Charge Algorithms

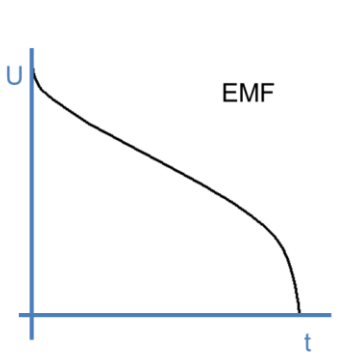
**USER & FLEET OWNER INFORMATION**



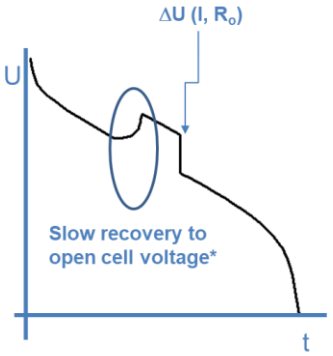
Simplified model of a Li-ion cell



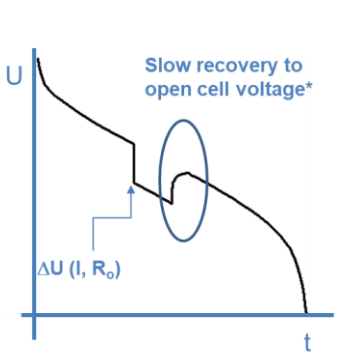

Nyguist plot of a Li-ion cell




EMF 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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# Fast Charging Algorithm

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# System Integration

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# MAKING GREEN AFFORDABLE


**Thank you for your Attention**

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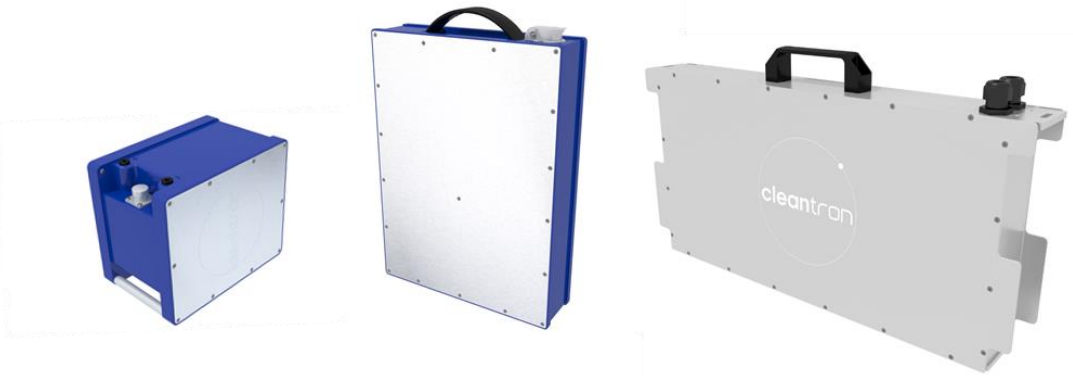


**More info at the Elincom booth**

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