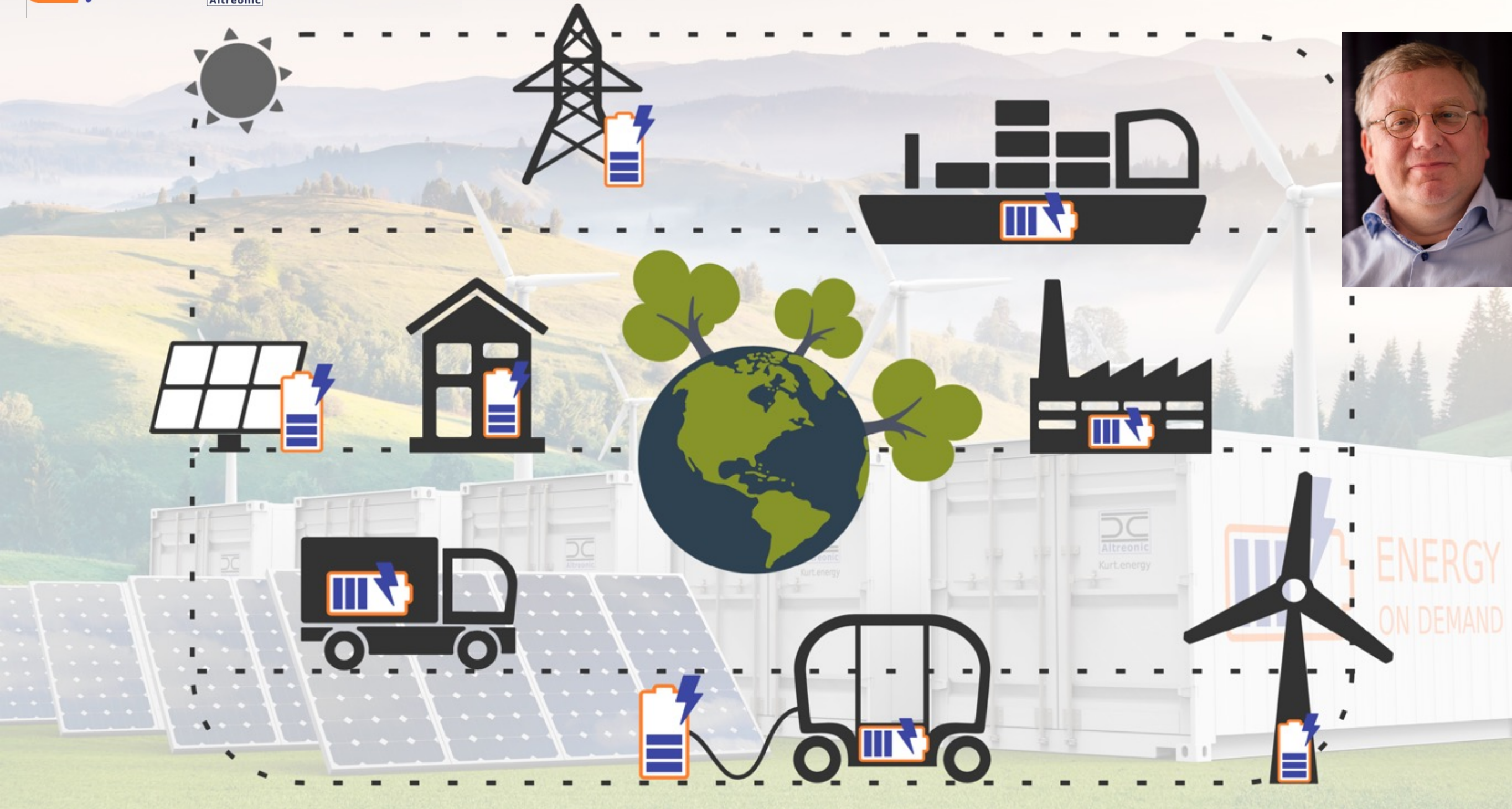


ENERGY FOR LIFE, BLUE CELL POWER



Eric Verhulst, CEO/CTO

**THE SHIFT TO CLEAN ENERGY NEEDS BETTER BATTERIES NOW:
We have them!**

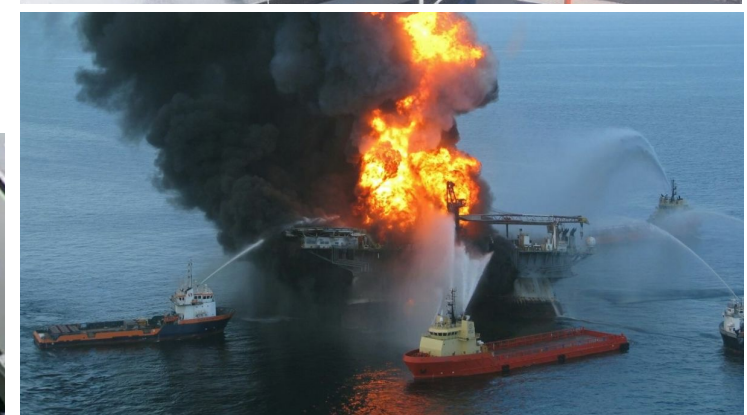
Lithium-ion: Sustainable? Practical? Cost-efficient?

GM asks Chevy Bolt EV owners not to charge overnight or park inside after 2 more fires

Sean Graham - Jul. 14th 2021 1:59 pm PT



Batteries are full of very inflammable products)



Recall will cost 2 billion US\$



Toxic smoke 10 km away

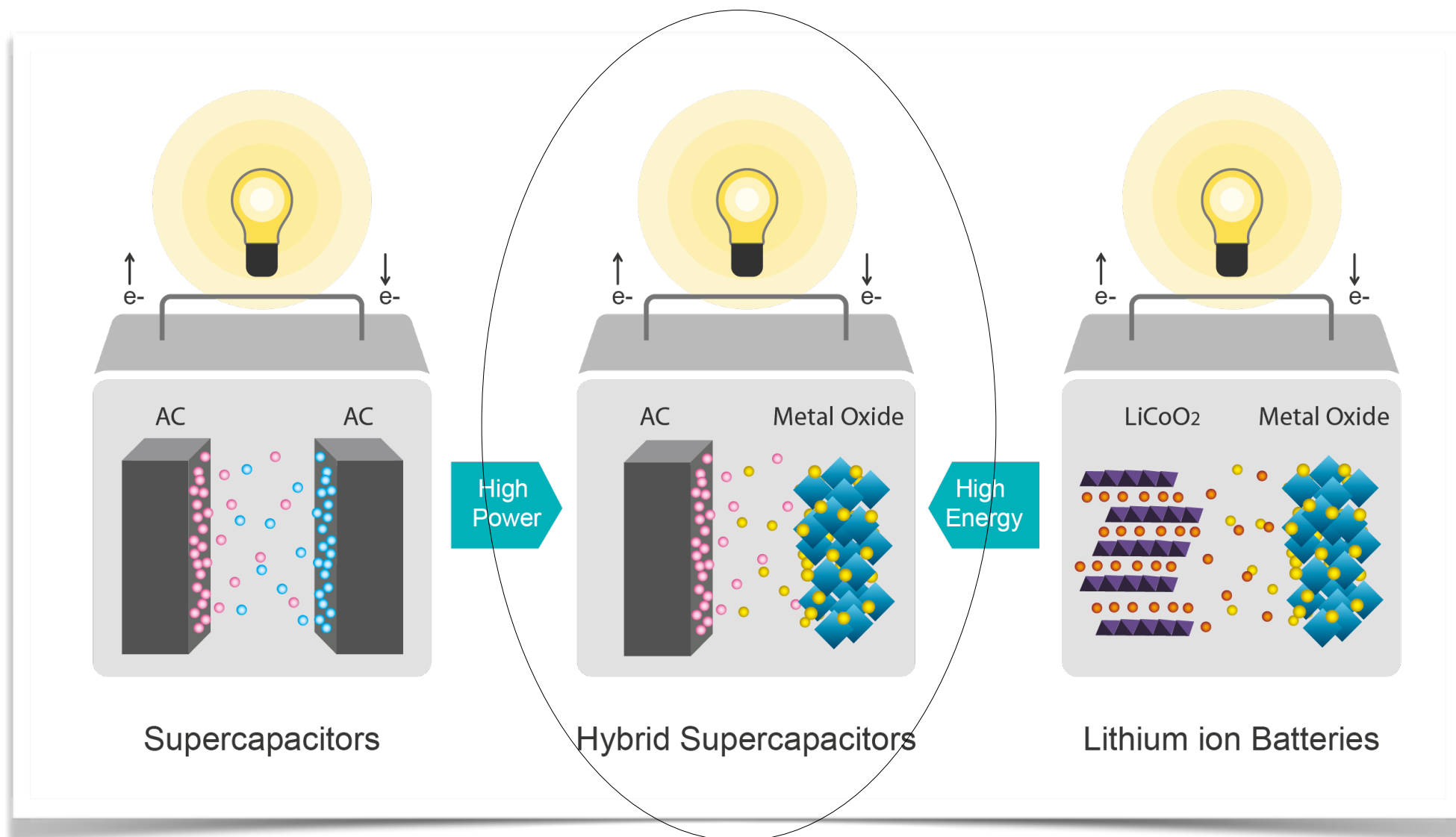


From smartphones to warehouses

Our Power Capacitors are safe, and more...

The step beyond Lithium-ion batteries

- First cells in 2018
- Unique carbon based hybrid super capacitors with energy of Li-ion
- Customer and volume production since 2 years



Game-changing hybrid carbon-based power capacitors

A practical and sustainable battery must meet many criteria combined

Lithium-ion battery cells

Fire risk

Complex to use

Active cooling/heating

Short time limited power

Energy, 60 to 80 % usable

Limited temperature range

Fast charging is problematic

Lifetime too short

Sustainable?

Cost efficient

Many announcements

Hybrid Carbon-based Power Capacitors

NO fire risk

Simple and robust; NO BMS needed

NO need for active thermal management

Sustained high power capability (up to 20x)

Energy, 100% usable

Works from -40°C to +80°C

Fast charging in 5-10 min

1 million km or 20 years and more

10 to 20X lower environmental footprint

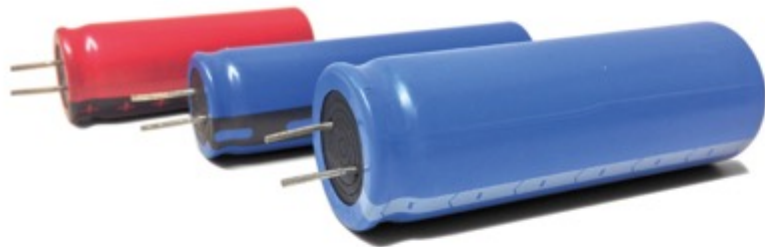
Lowest cycle life cost

In production since 2 years

Kurt.energy develops and delivers batteries world-wide

Small cells, enabling a high potential

CARBON BASED POWER CAPACITORS



www.kurt.energy 

*Hybrid
vehicles
application*



*Extreme
temperature,
lifetime
and power
requirements*

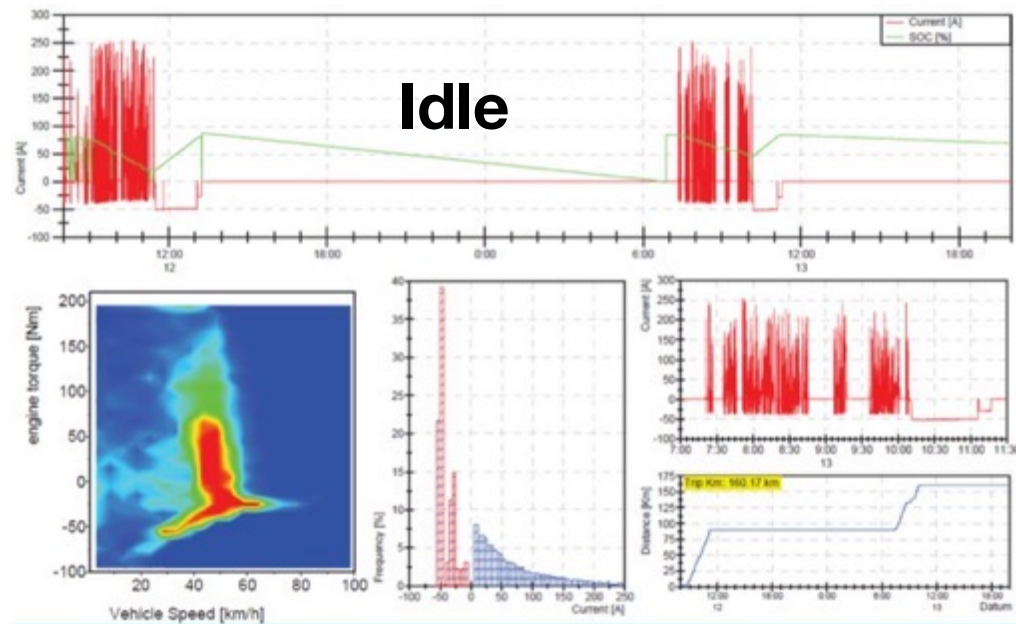
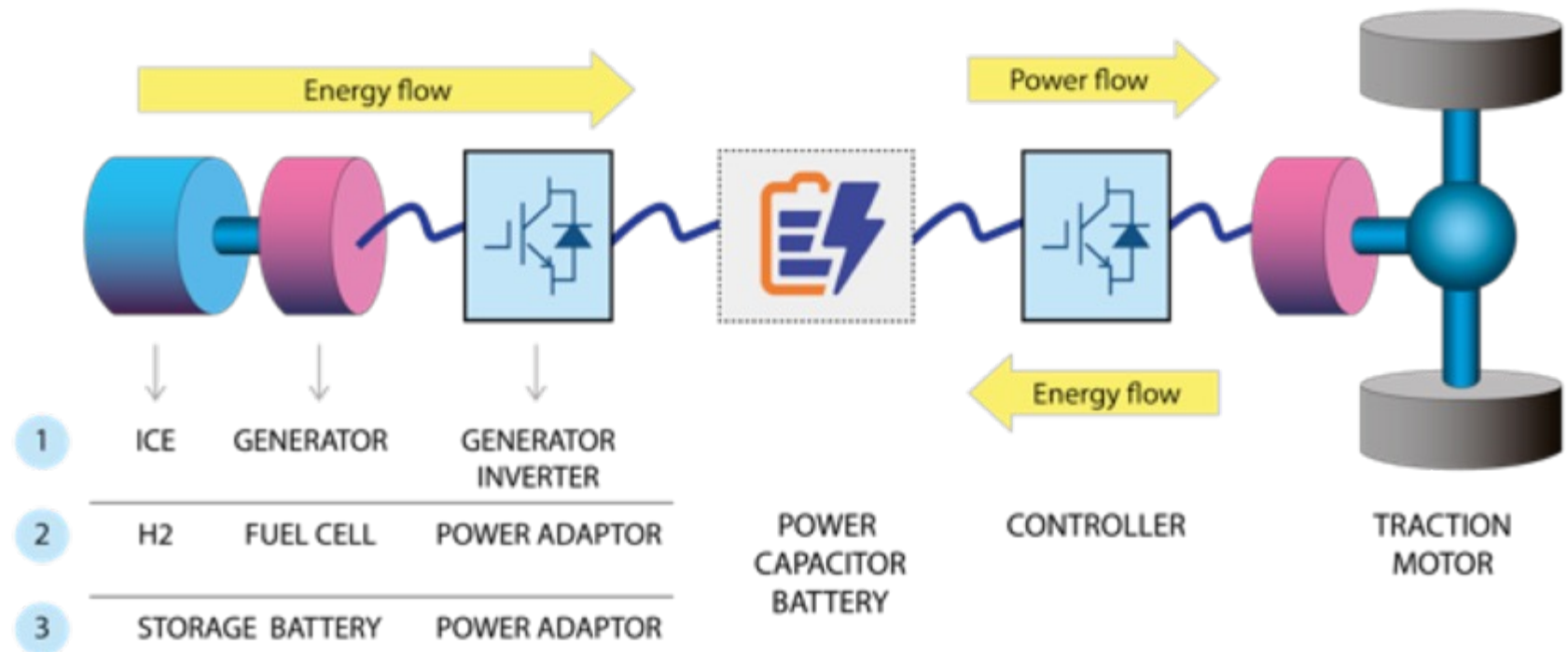


Hybrid carbon-based power and energy capacitors

Power capacitor = energy + power

charging
+
regen
braking

Pull-up



Unbeatable benefits in hybrid propulsion:

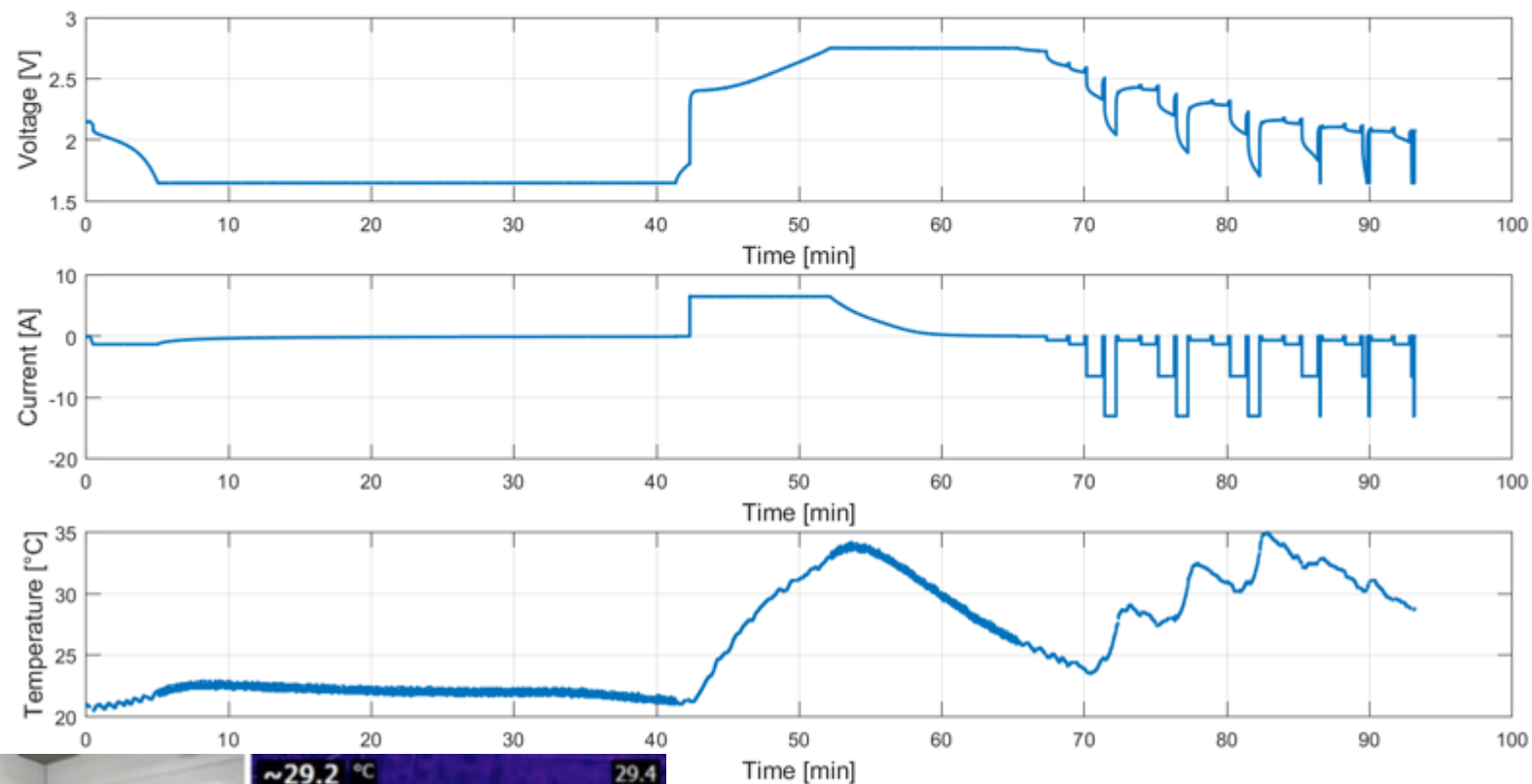
- Safe (H2 fuel cells!)
- Robust
- Power (upto 20C)
- Simple: no BMS, no active cooling
- Works from -40 to +80°C
- Lifetime: upto 30 years

Power needs happen in bursts: the killer for Li-ion



Stress and abuse tests at Flandersmake

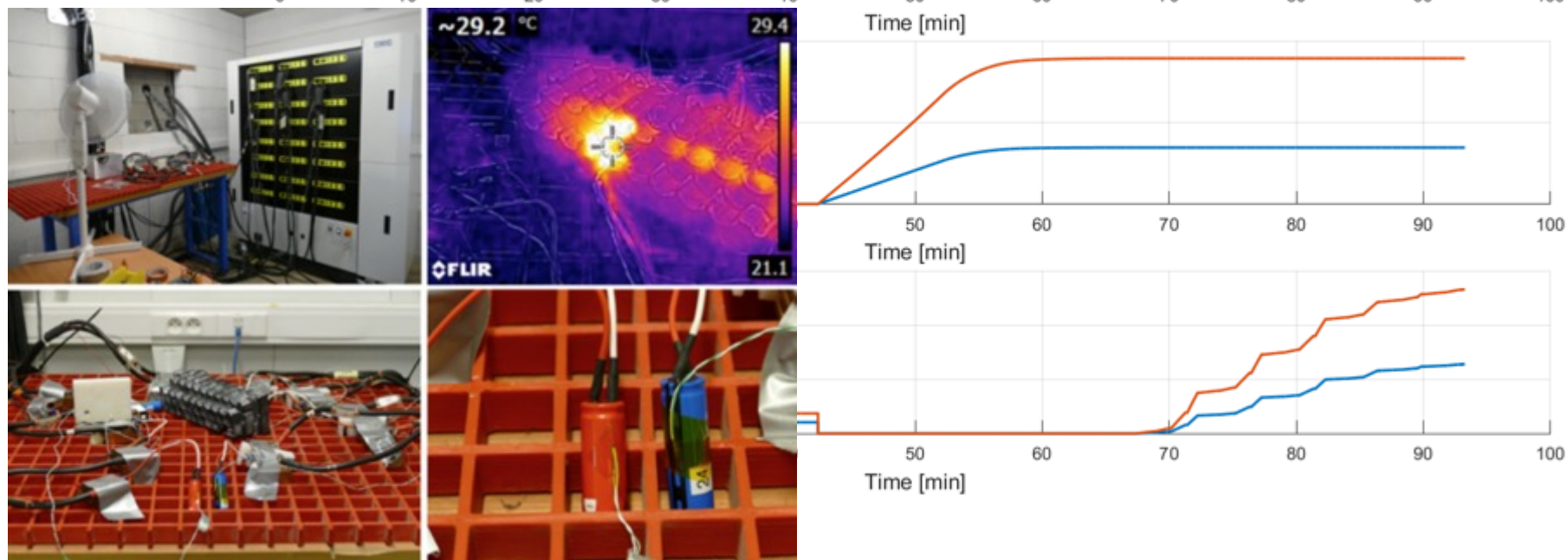
Test 4773 | 18650 | Cell 22 | WLTP test



Charging in 5 minutes to 75%

Discharging at 0.5, 1C, 5C, 10C

$T < 35^{\circ}\text{C}$ in ambient air



3.4 Wh charged & discharged

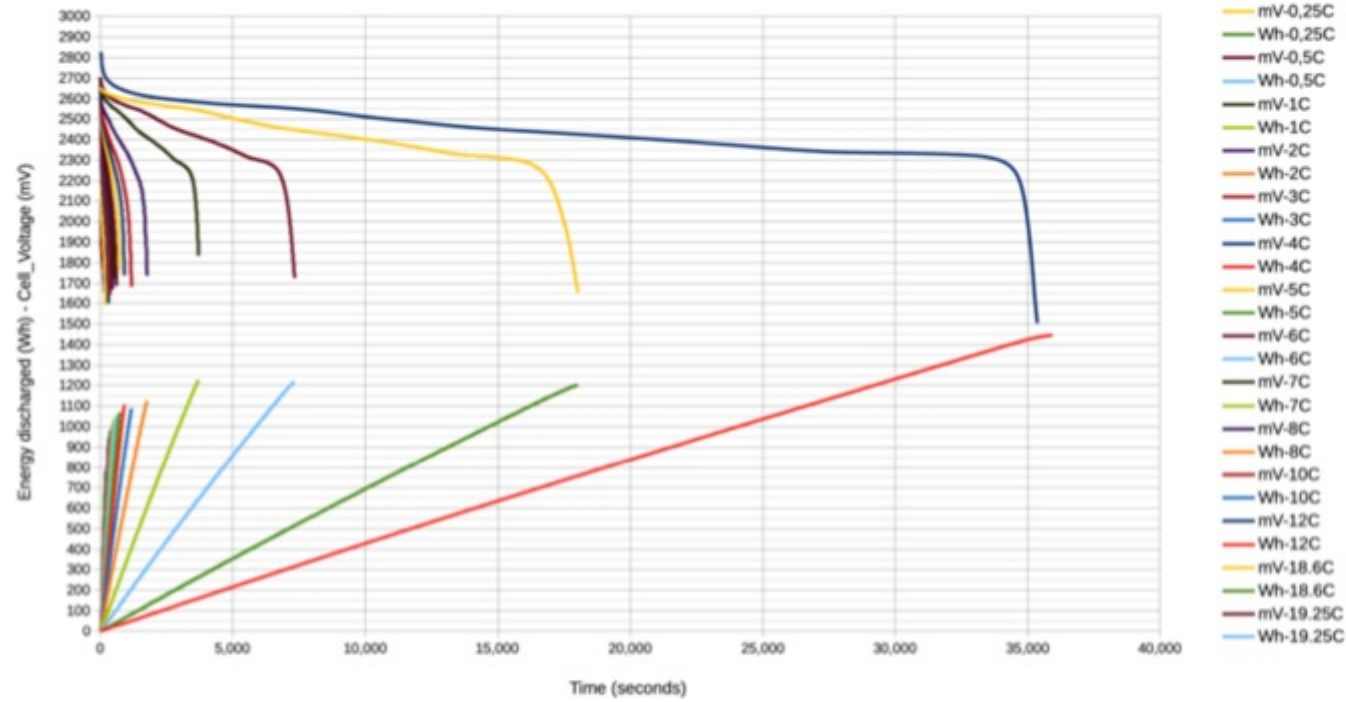
Charging at 5C (6.5 A), discharging at 0.5C, 1C, 5C, 10C, simulating WLTP cycle

Discharging at 2x max. C-rate (40C), overcharging, short-circuit show extreme robustness

From 3A to 488A on a non-cooled battery

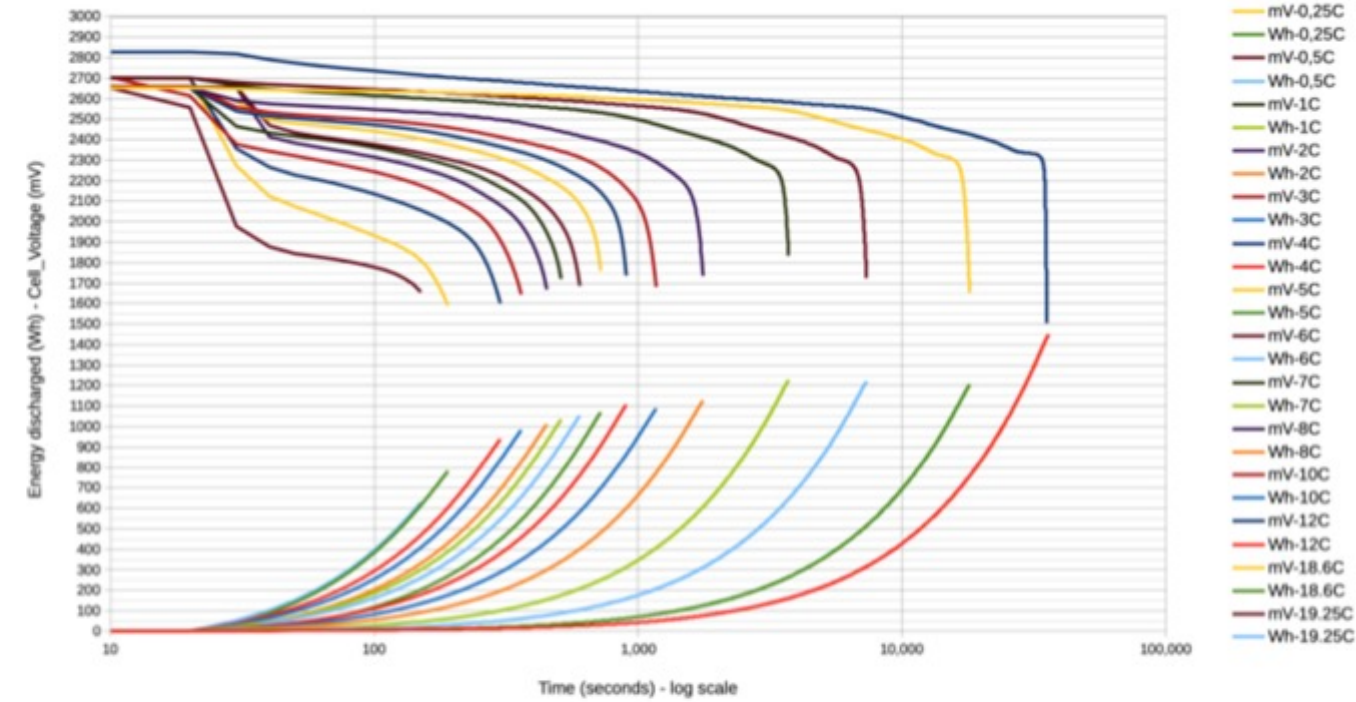
20Sx20P 18650 Powerpack (25Ah/50V)

Discharging curves 0.1C-19.5C (3A - 488A) (linear scale)



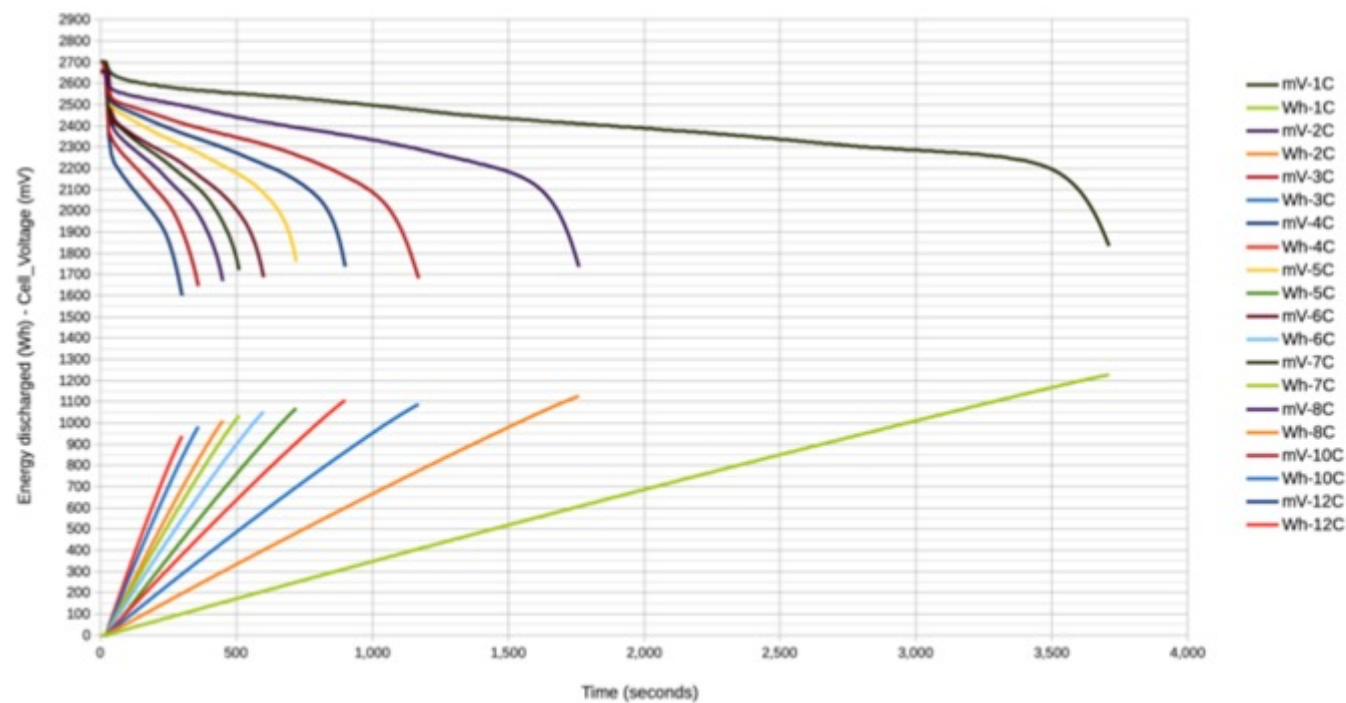
20Sx20P 18650 Powerpack (25Ah/50V)

Discharging curves 0.1C-19.5C (3A-488A) (Log scale)



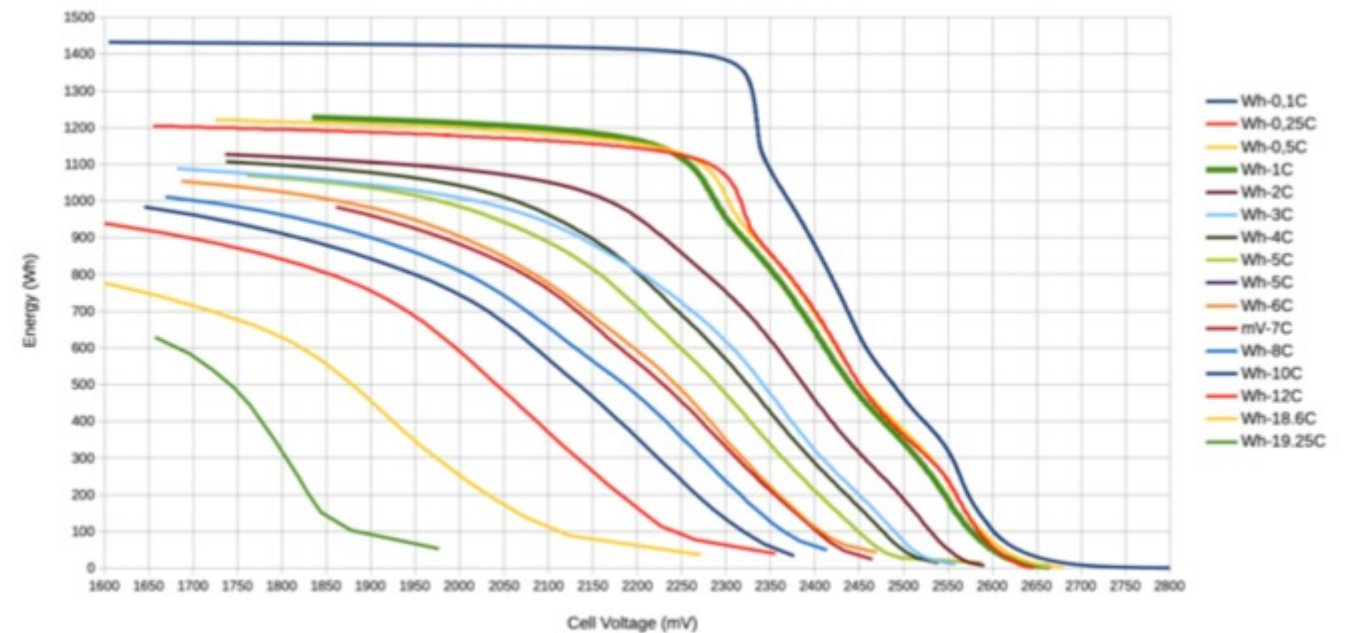
20Sx20P 18650 Powerpack (25Ah/50V)

Discharging curves 1C-12C (25A - 300A) (linear scale)



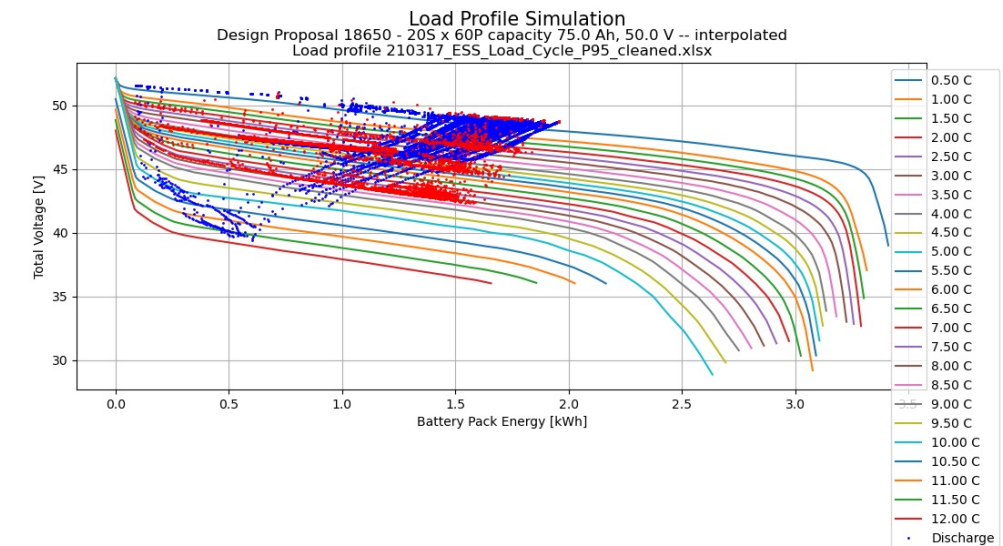
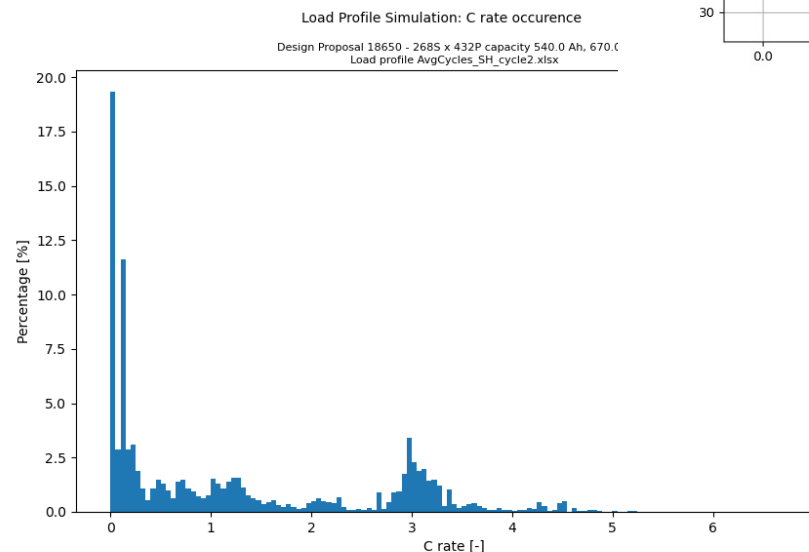
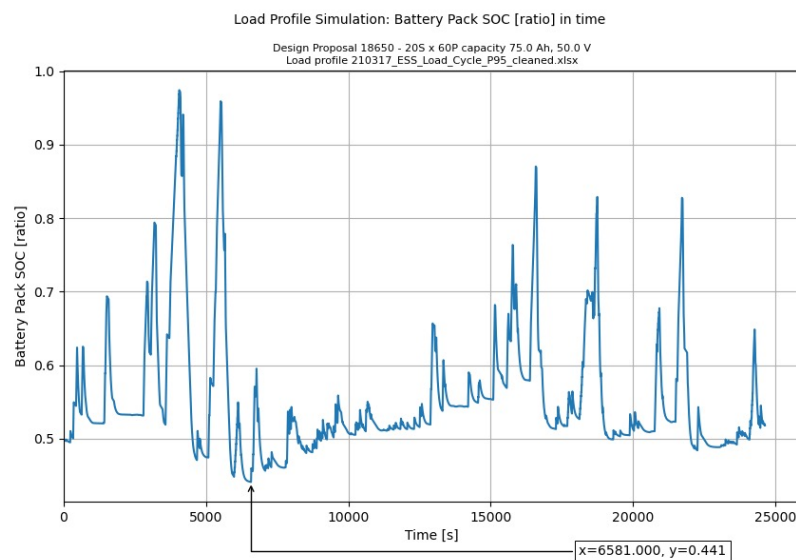
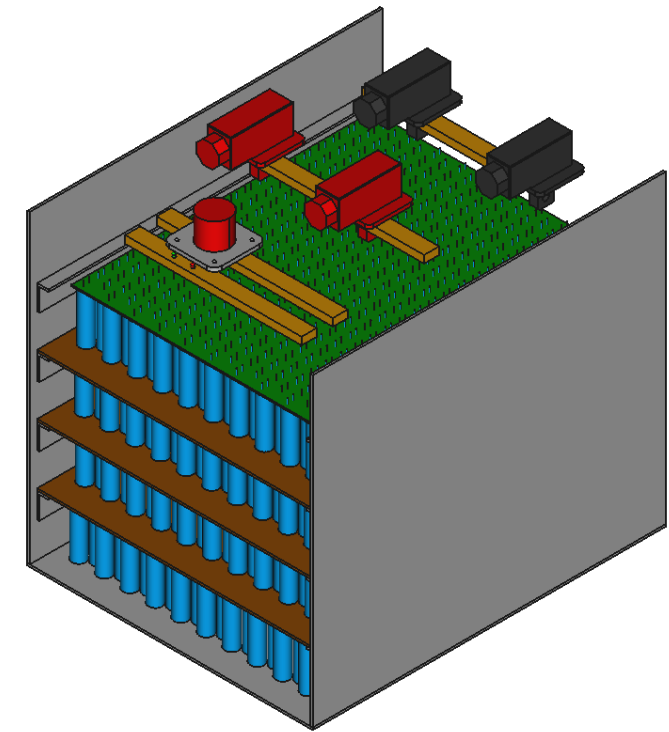
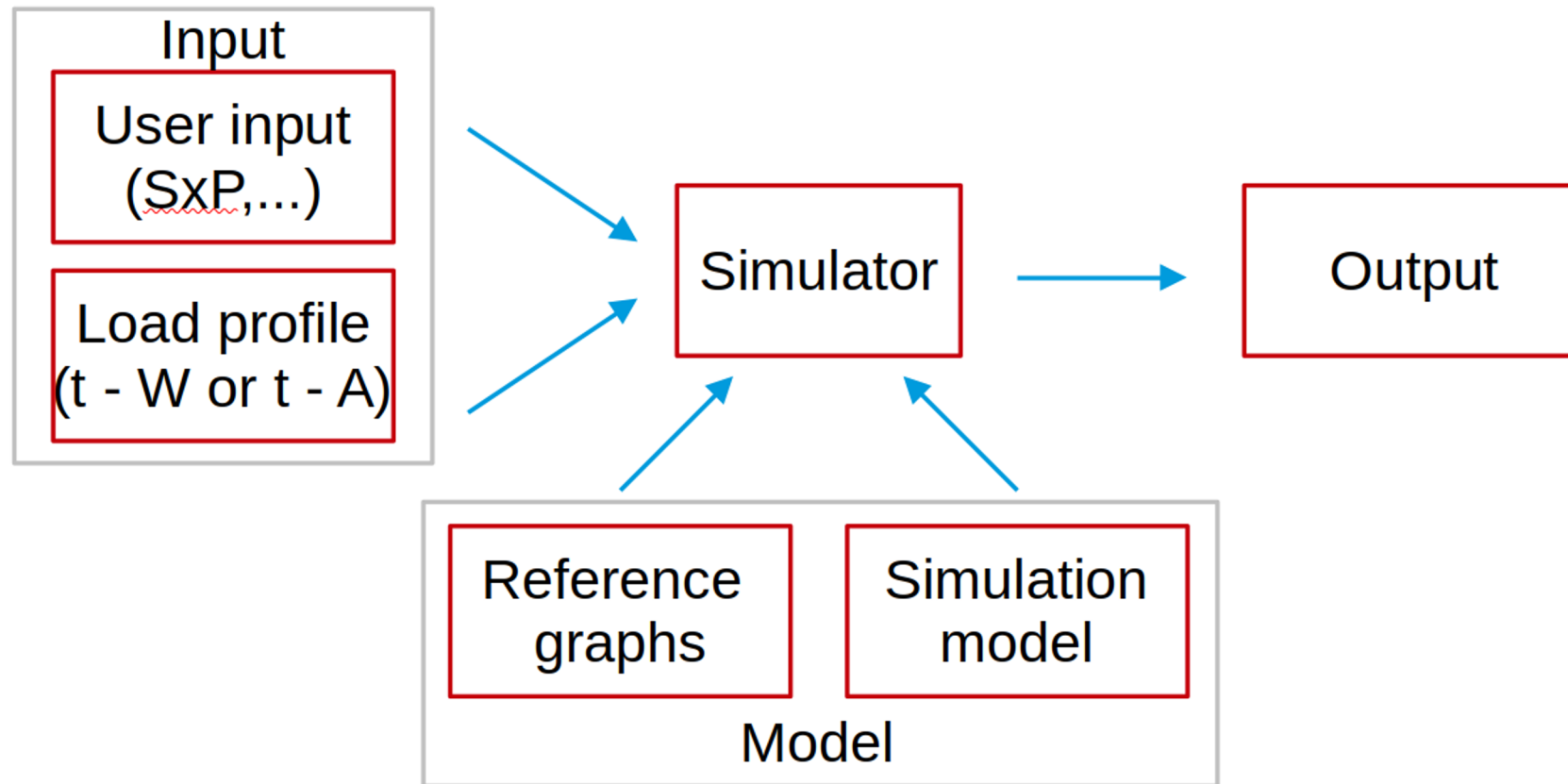
20Sx20P 18650 powerpack (25Ah/50V)

Energy discharged (Wh) vs. Voltage at 0.1C to 19.5C



Simulation before building:

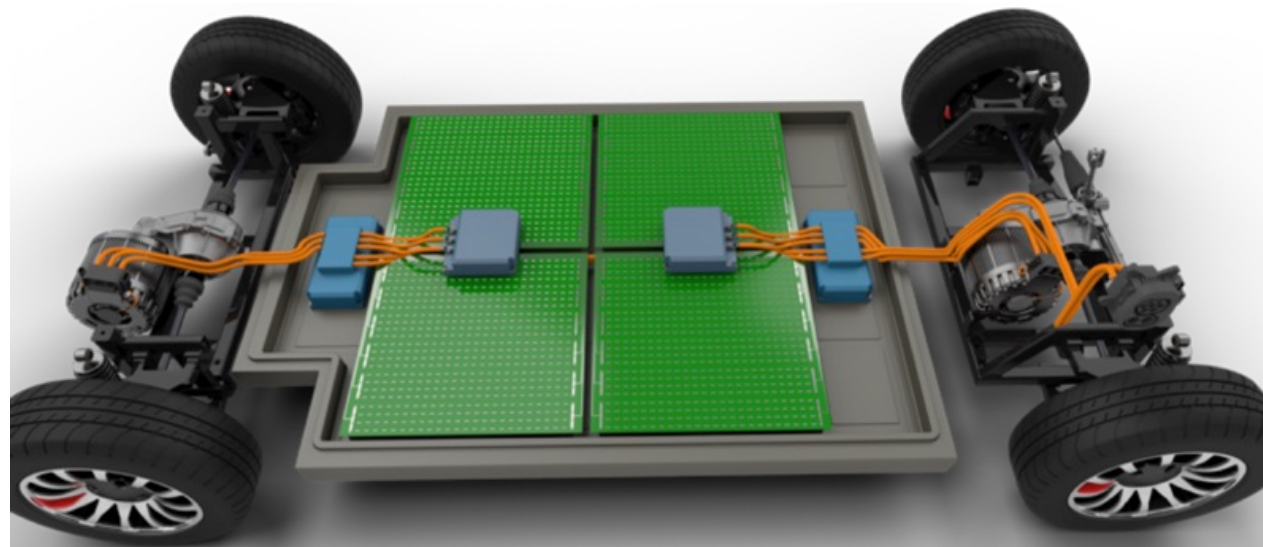
<https://batterybuilder.kurt.energy>





Seal of Excellence: Recognition by external experts

- Multi-Moby EU H2020 project: a novel modular and autonomous urban class e-vehicle
- Can be charged in 5 to 10 minutes

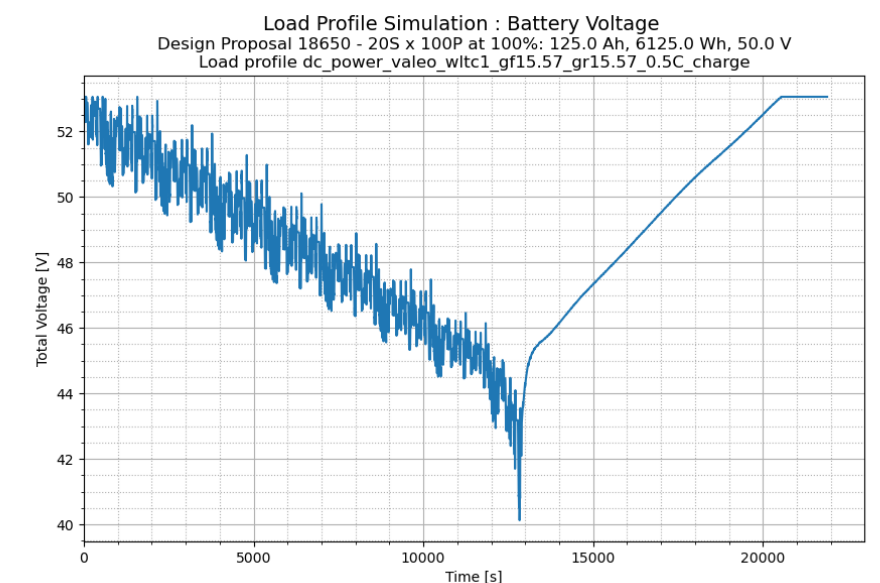
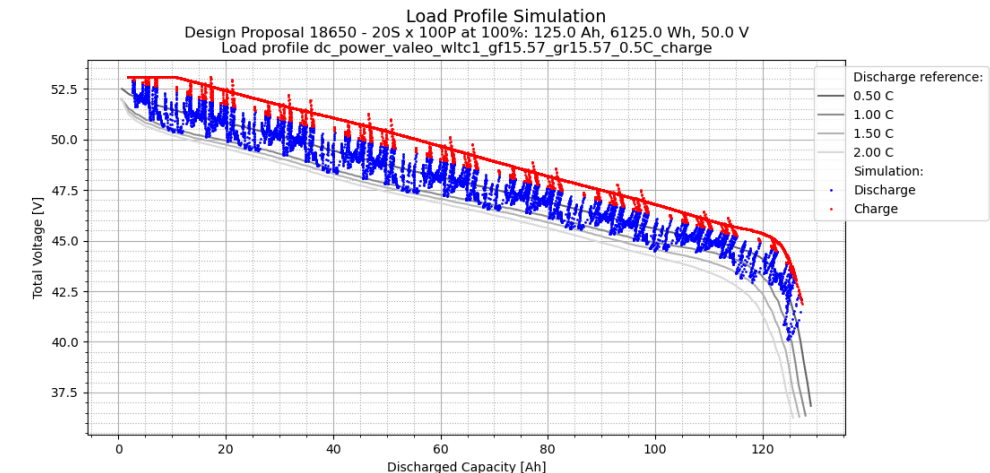
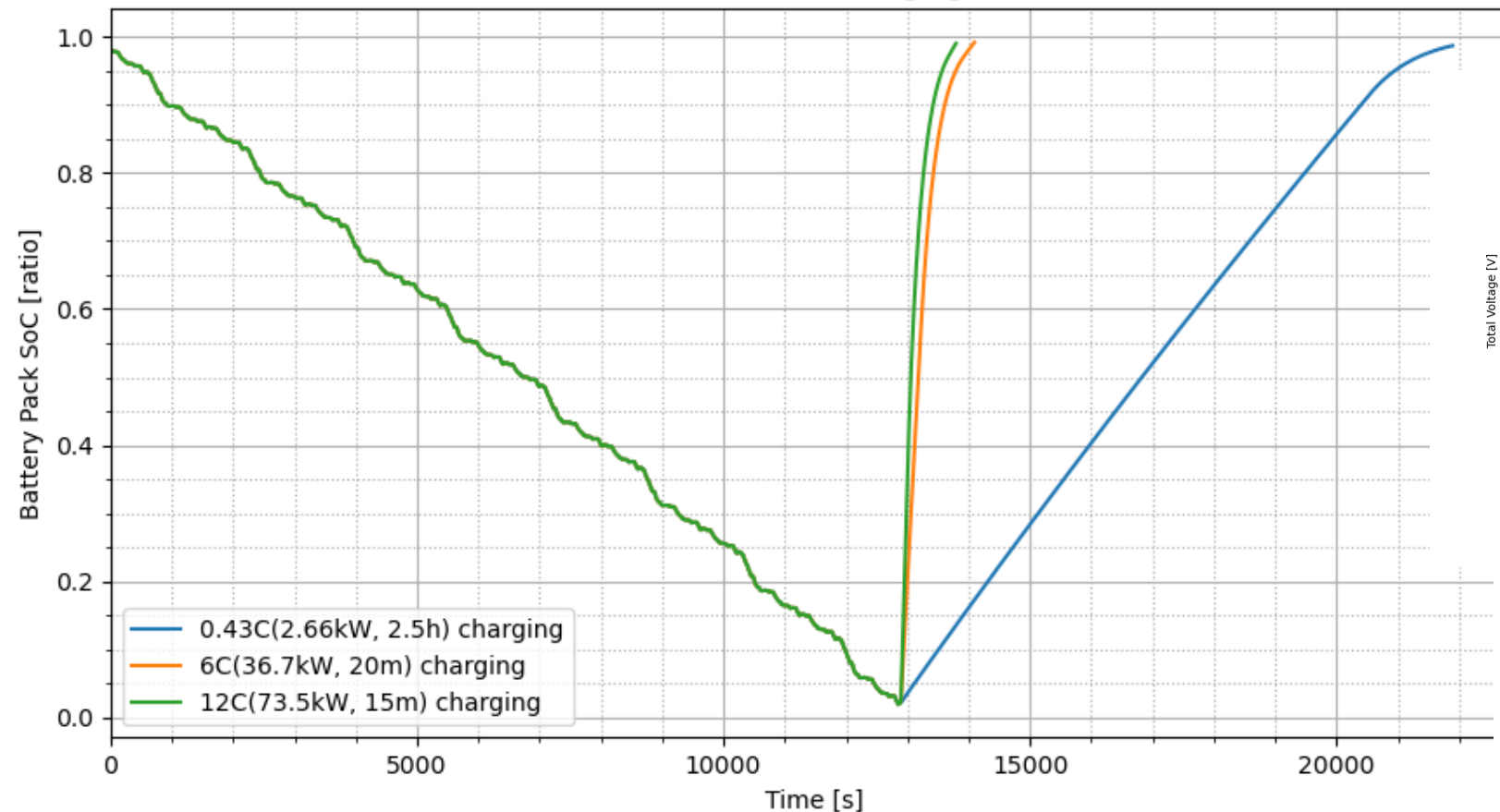


Fast charging @ 6C after 8 WLTC1 cycles

18650: fast charging

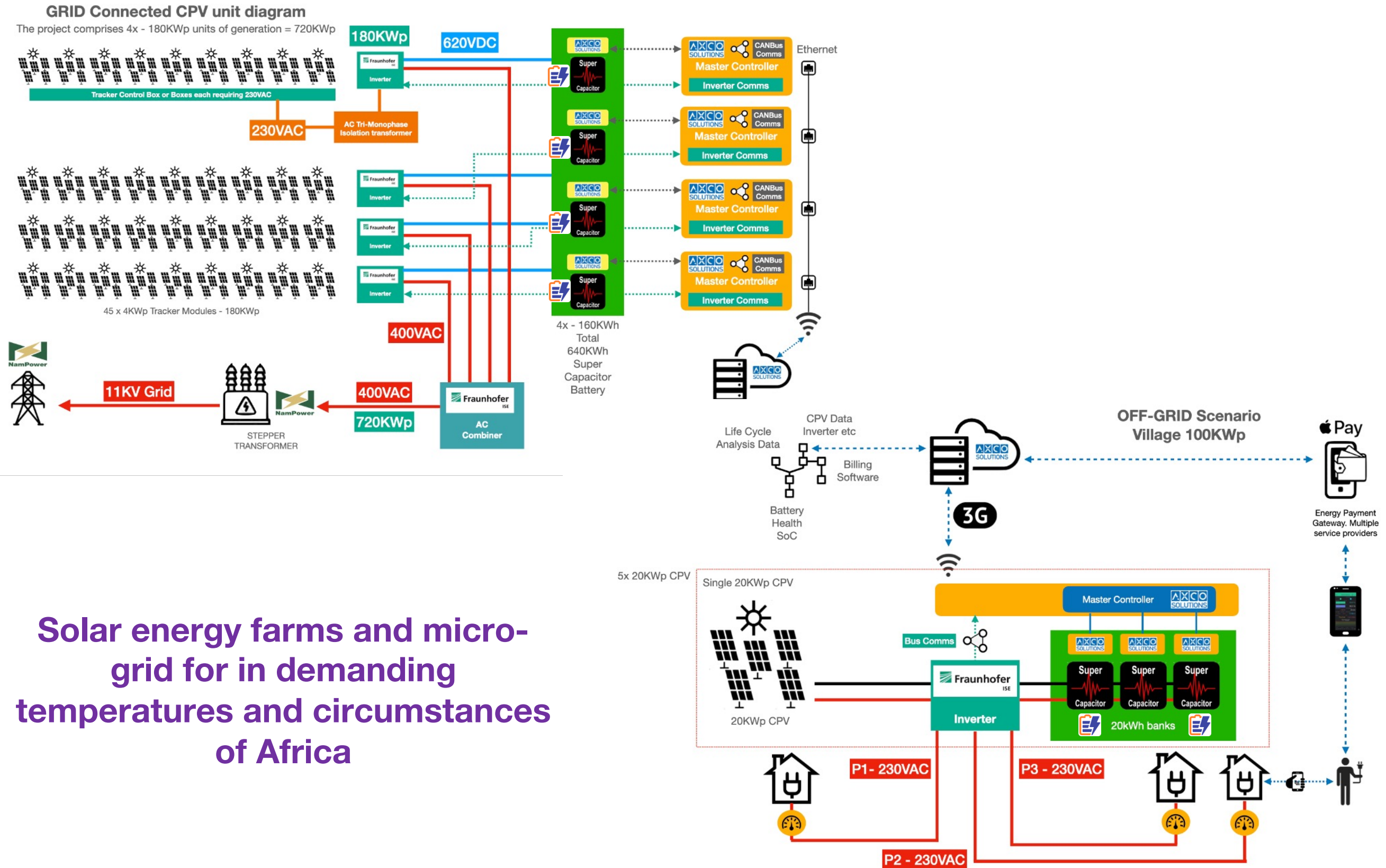
Design Proposal 18650 - 20S x 100P: 125 Ah, 6125 Wh, 50V

Load Profile Simulation : SoC, charging at 0.43C, 6C, 12C



- **0 – 75%: 5 min @ 12C, 8 min @ 6C**
- **0 – 100 % SoC: 2.5 hrs @0.5C, 20 min @ 6C, 15 min @ 12C**

H2020 Green Deal project with Fraunhofer



Excellent choice for hybrid energy generation



Use case:

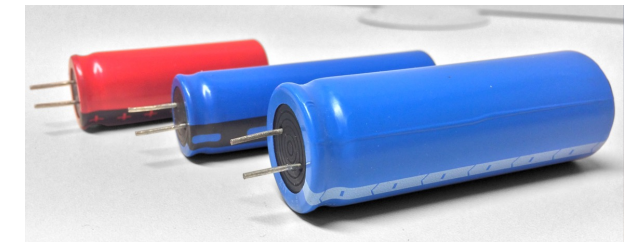
- 250 KWh hydrogen fuel cells
- 30 kWh / 800V powercapacitor battery
- Delivers 250 kW at cold start
- Absorbs 300 kW upon load disconnect

Use with hydrogen fuel cells:

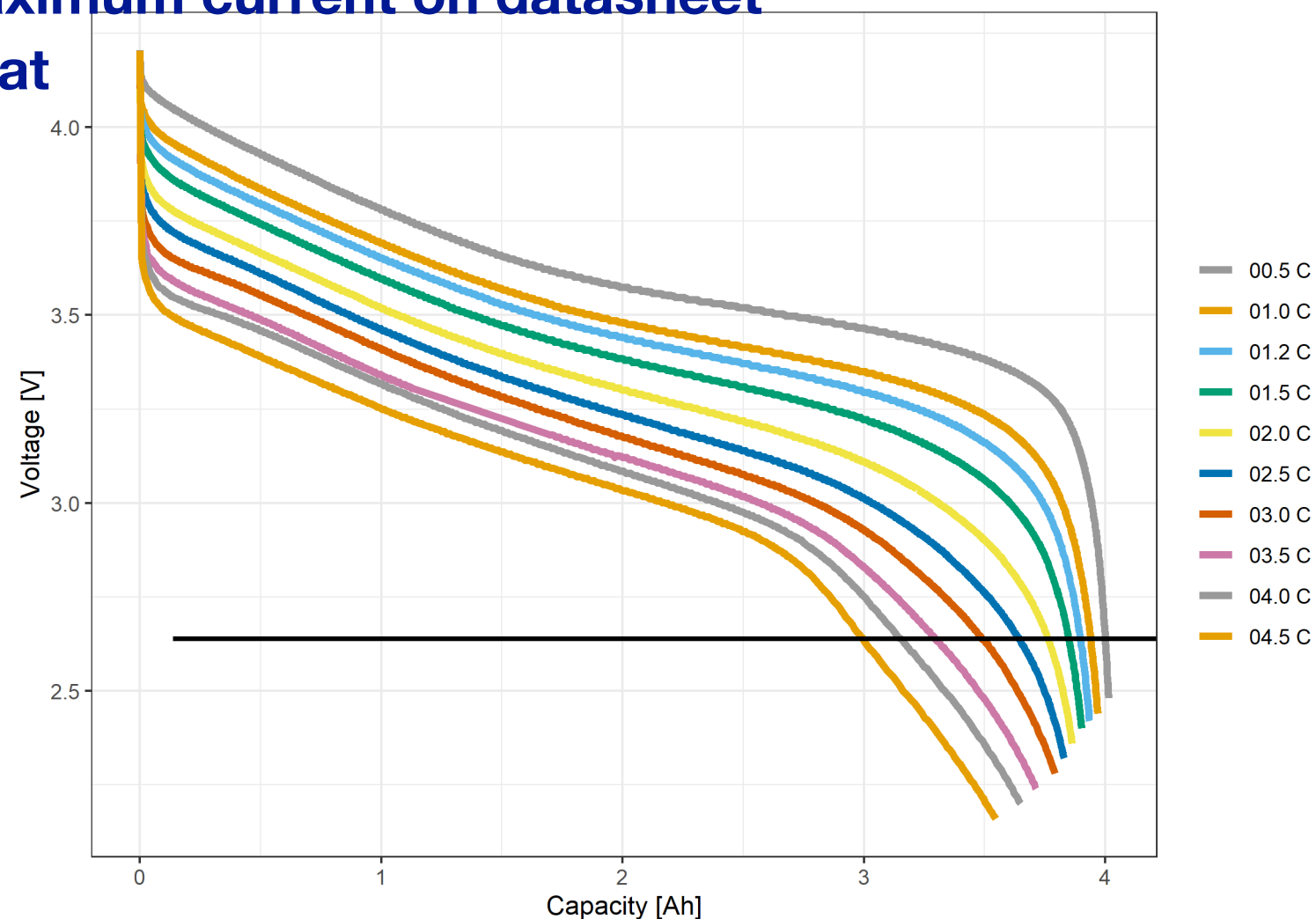
- Safety: no spontaneous fire risk
- Handles high power demands (e.g. cold start)
- Absorbs excess energy
- Robust: no BMS, no active cooling, 20000 cycles, zero maintenance
- Similar with ICE generators, liquid air, ... also for traction

Task 4.2 New 23680 cells

- 4V / 4 Ah 23680 cell, 1.5C / peak 4C / 200 Wh/kg / hybrid AC+NMC
- Tests done:
 - Capacity measurement @ room temperature (1C) with air circulation
 - Charging/discharging at higher C-rates
 - ESR: 13-15 mOhm
 - Temperature increase: 6.5 °C at 1.25C, 22 °C at 4C
 - Abuse test: discharging > maximum current on datasheet
 - Also in small pouch cell format



Discharged capacity 23680G



Test in ventilated room air
At 22 – 25°C air temp,
36.6 °C on skin at end of 4C test

Task 4.2 New 21700 cells

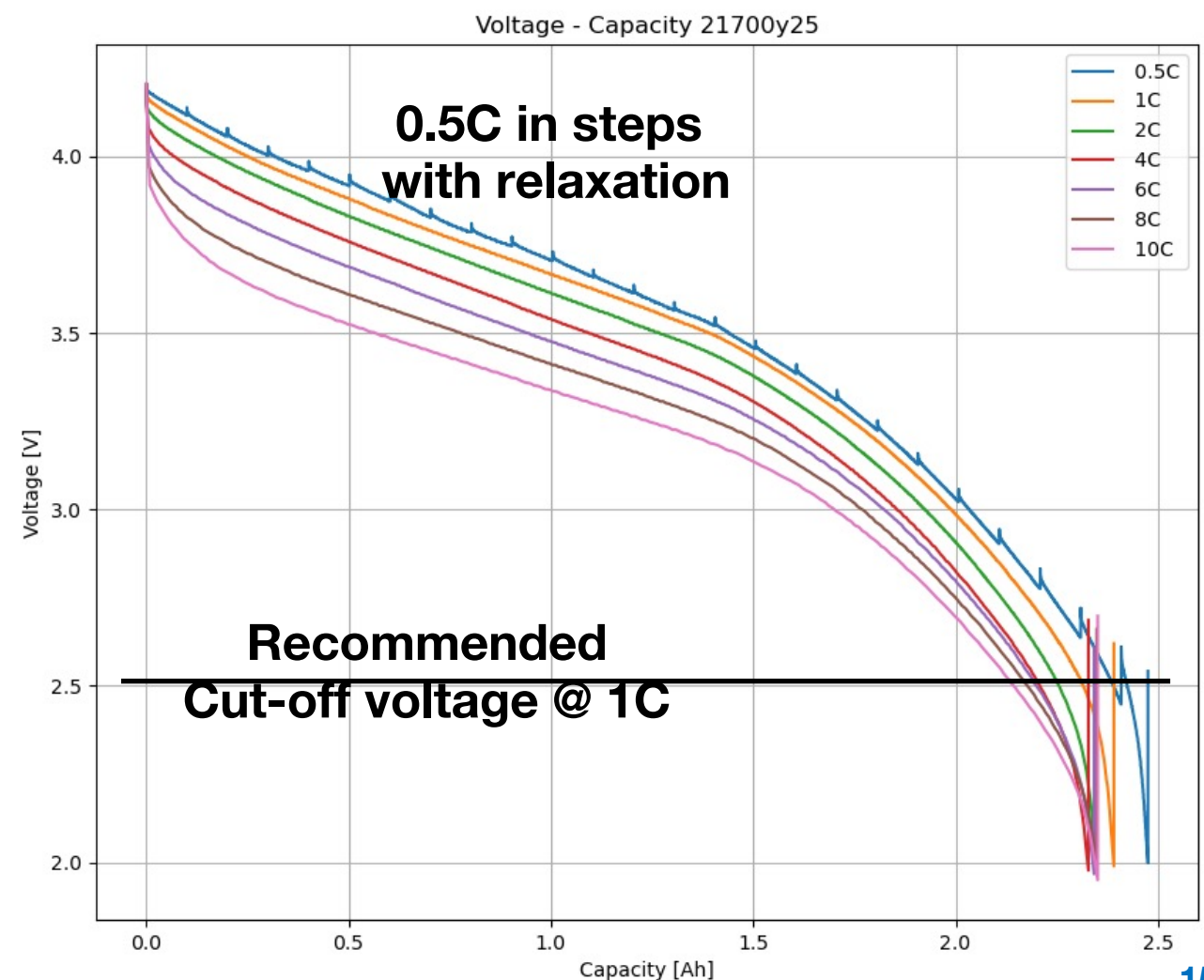
4V / 2.5 Ah 21700 cell, 10C / peak 14C / 140 Wh/kg - hybrid AC+NMC

Tests done:

- Capacity measurement @ room temperature (1C)
- Charging/discharging at higher C-rates
- ESR: 8 – 10 mOhm
- Temperature increase: 6.5 °C at 1.25C, 22 °C at 4C
- Abuse test: discharging > maximum current on datasheet
- Hard short-circuit test: pass



**Test in ventilated room air
At 22 – 25°C air temp.
41.1°C on skin at end of 10C test**



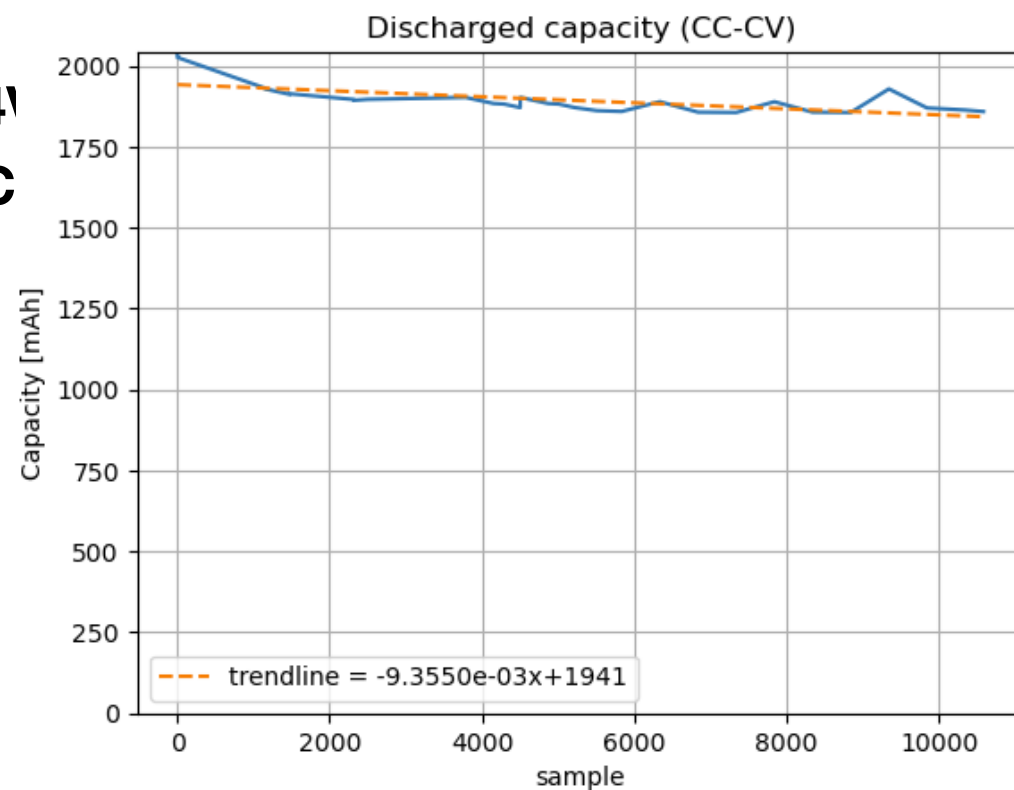
Task 4.2 New 21700 cells cycle life testing

Tests > 1 year

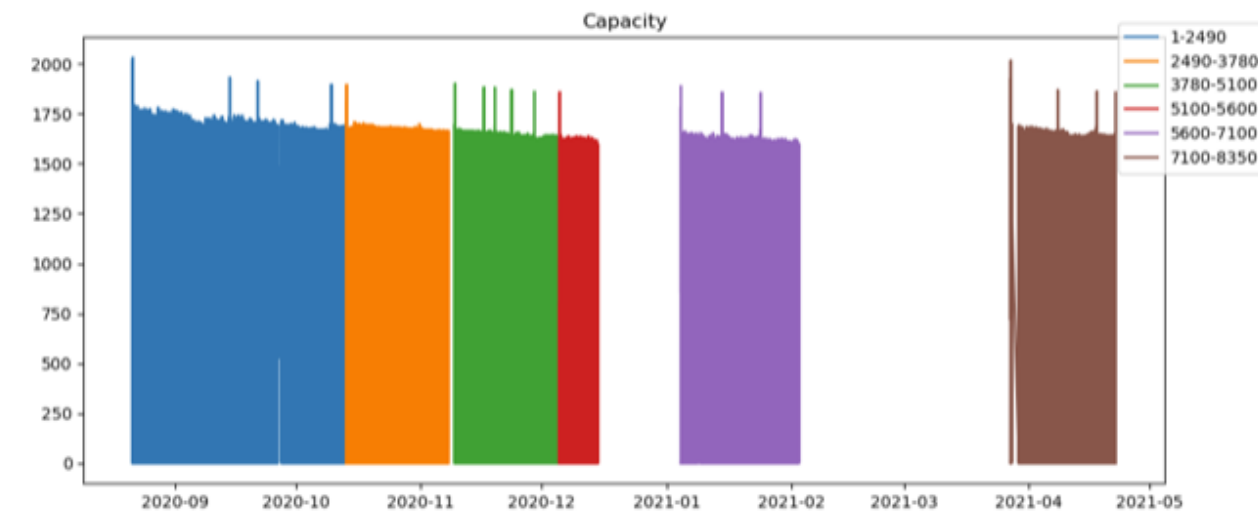
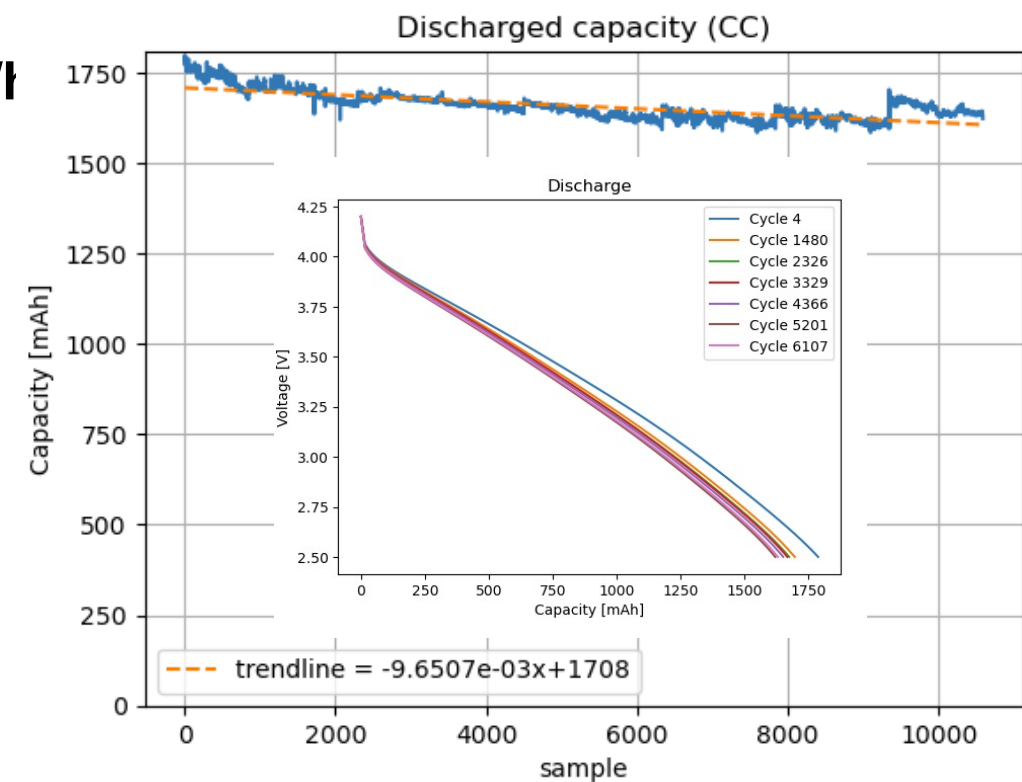
Shows some recovery due to rest time

Estimated cycle life: 20000 cycles

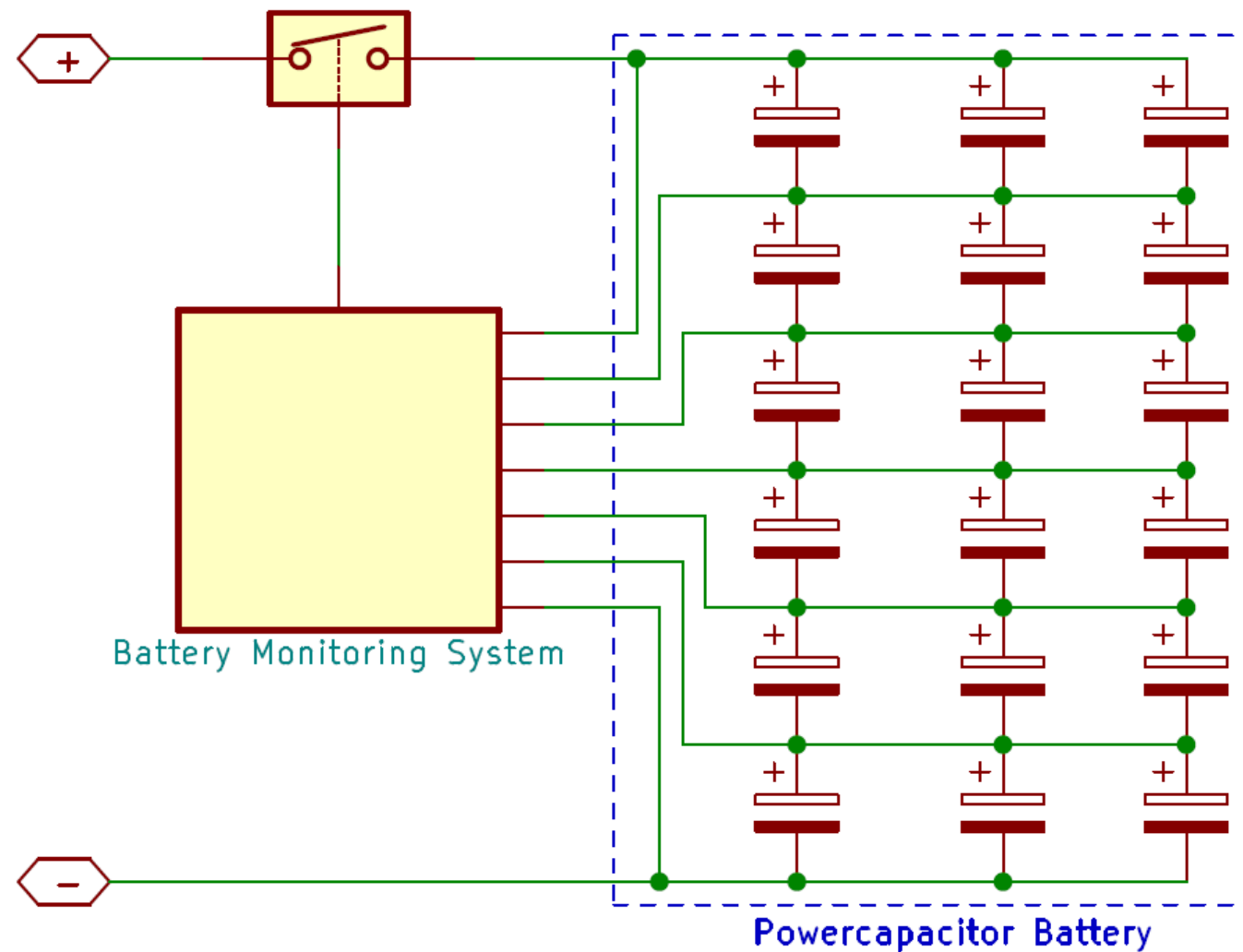
- 4
- C



W



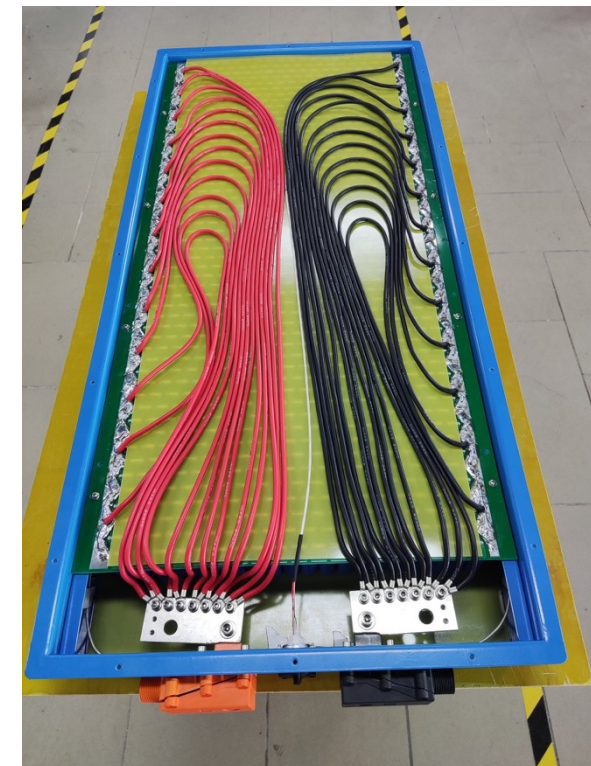
Battery construction



- Parallel first, then serial at module level
- BMS (active balancing) optional
- Battery Monitoring sufficient
- Parallel modules only at battery level to increase capacity
- Heat absorbing silicon gel inside



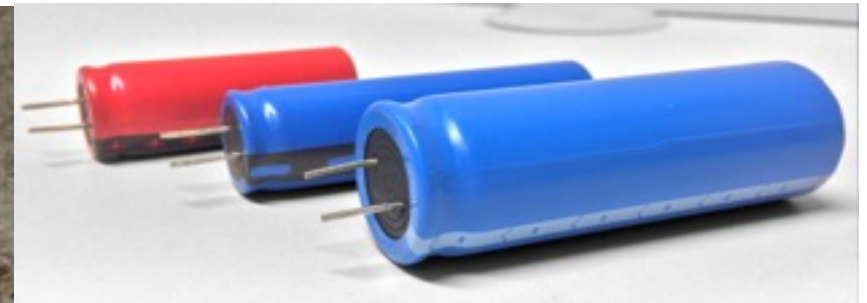
For illustration only





ETF Mining Truck D5

Payload 500 metric tons



**From small UPS to MWh hybrid, BEVs and energy storage worldwide:
medical, satellites, vehicles, trains, ferries, solar energy farms**

Battery-Electric All-Wheel-Drive with Energy harvesting
Zero GHG-Emissions & Low Noise (Average saving of 6.744 tons of CO₂ per year)



**Kurt.energy develops customer-specific power capacitor batteries
Our customers get trust and a sustainable investment**

Process flow for customer specific solutions

1. Requirements collection:

- Understanding the application and the system
- Understanding the boundary conditions

2. Feasibility study:

- Selecting powercapacitor cell types
- Initial battery configuration: (S xP), multi-module, ...

3. Load profile simulations

- Beginning of Life – End of Life
- Calendar lifetime calculations

4. CAD design

- Enclosure, safety devices, etc.

5. Assembly and test

Kurt.energy division of Altreonic

Questions?

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