Altris

Altris-Simba

State of technology & Industrialization

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Content

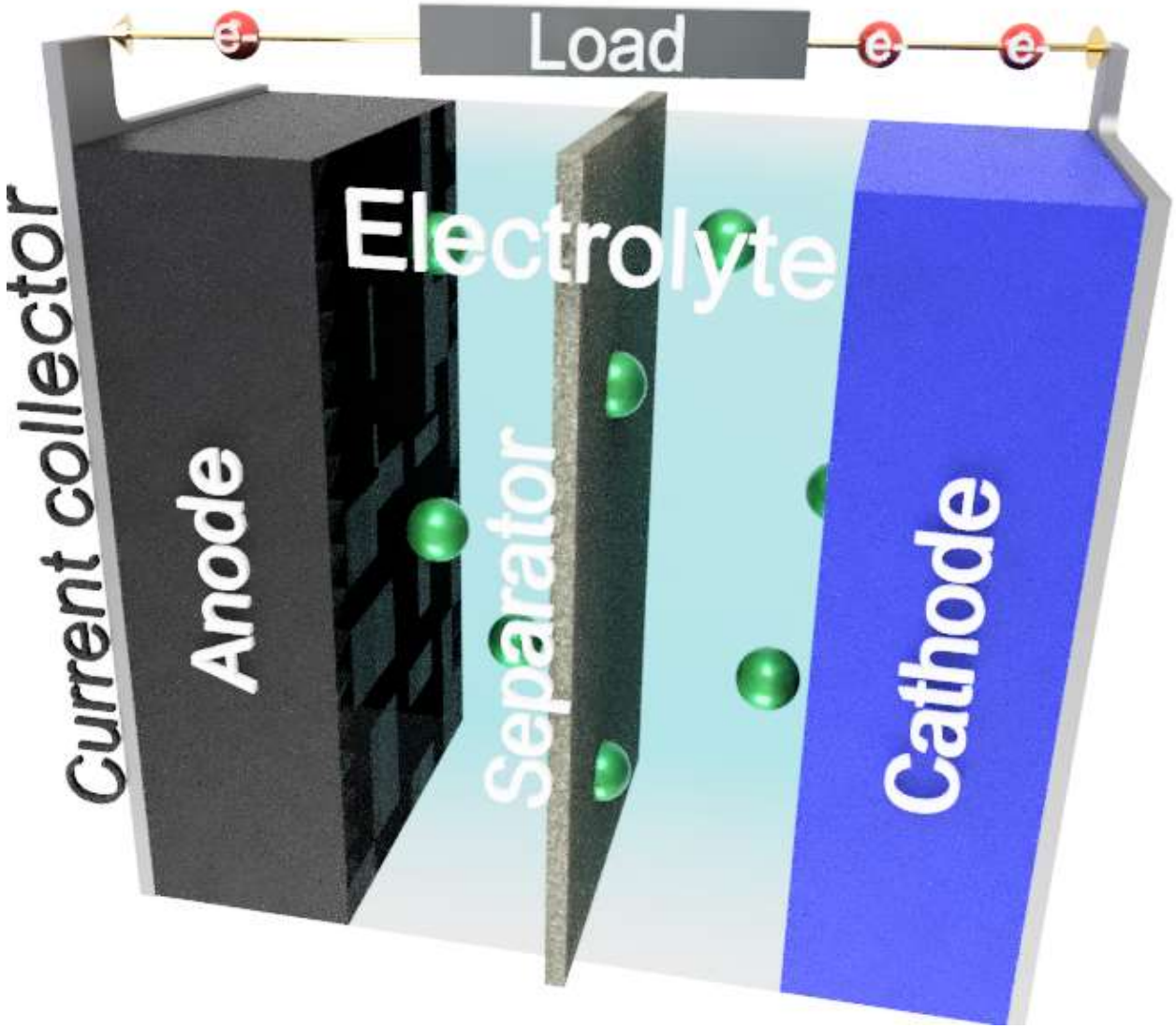
- Introduction Altris AB
- Materials development focus
  - Prussian White,
  - Hard carbon
  - Electrolyte
- Cell production upgrades
- Cell development strategy & Current state performance
- Applications – Where are Altris sodium-ion batteries best suited

Altris AB

- Started 2017 – spin off from ÅABC
- Primarily a CAM producer and cell technology developer for sodium-ion batteries
- Currently building CAM by building capacity
- Operates one small pilot line for cell development (Vaksala Eke) and just finished a larger industrial cell production facility (A-line)
- Grew from 25 to almost 50 employees last year

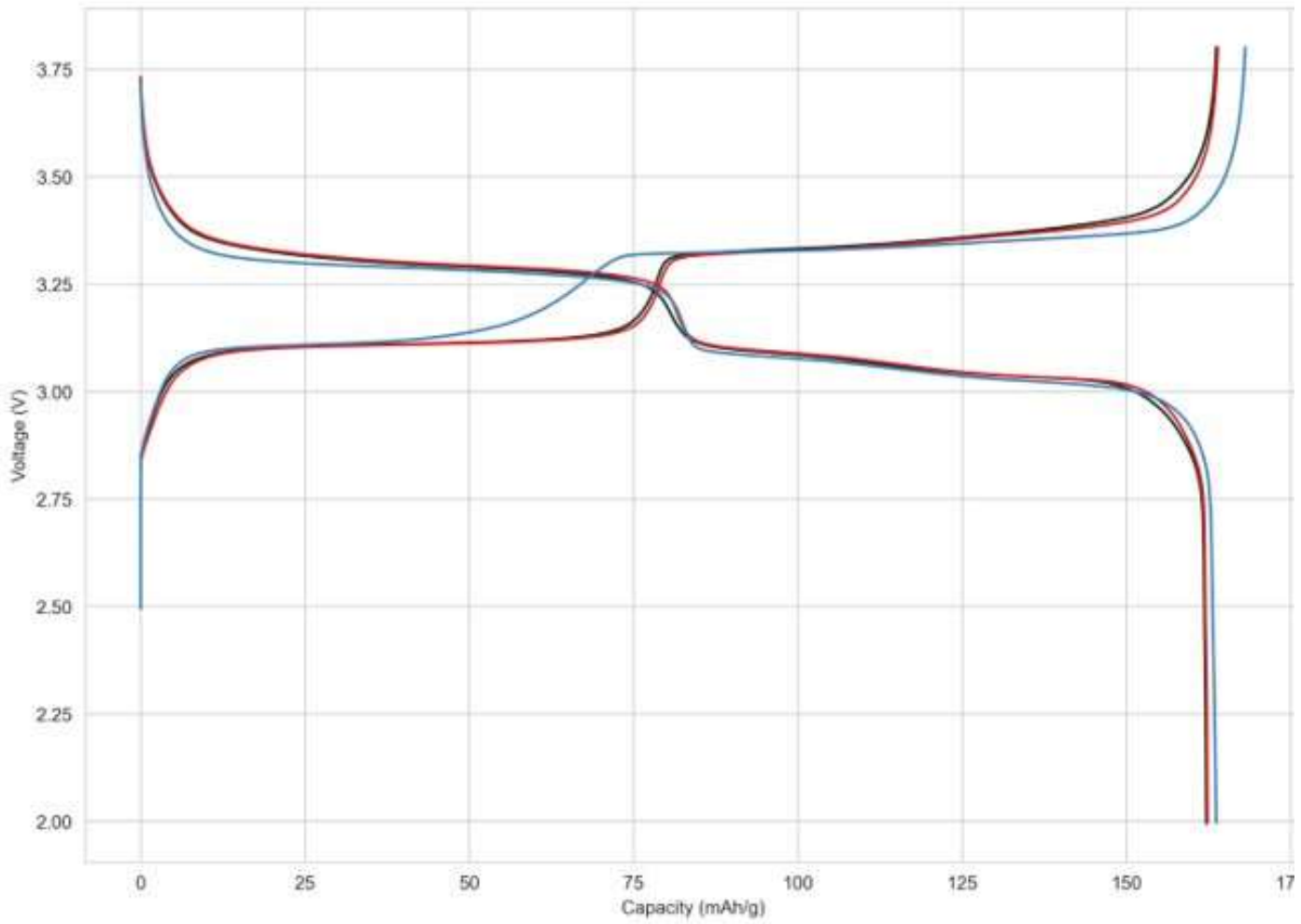
Sodium ion batteries

- Prussian White – Hard carbon technology
- Various electrolytes – From standard to exotic
- Abundant and green components kept as constraints in design
- Processing and material synthesis must be cost effective
- Manufacturing should comply as closely as possible with existing equipment and plants



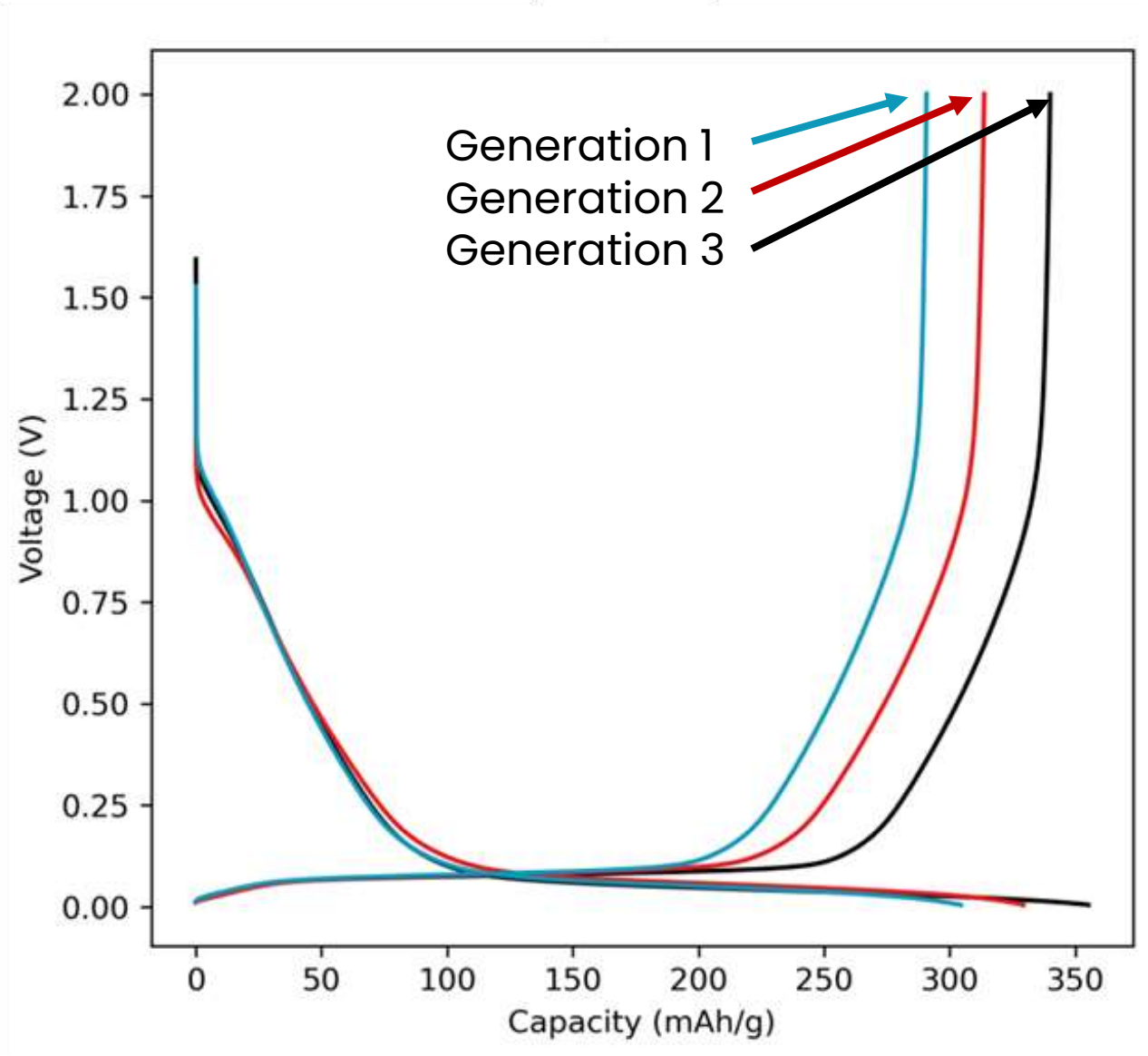
Cathode

- Cathode performance is close to theoretical, even with D50 values close to 20 µm
- Cathode performance in lifetime and rate capability is currently not an bottleneck
- Development is focused on
  - Processing and handleability
  - Repeatability and QC



Anode

- Bio-based hard carbon
- Capacity up to 350 mAh/g but rated capacity only slightly above 300 mAh/g
- ICE above 92% for best carbon-electrolyte combinations
- Low coating density and poor compressibility remains problematic for large scale manufacturability

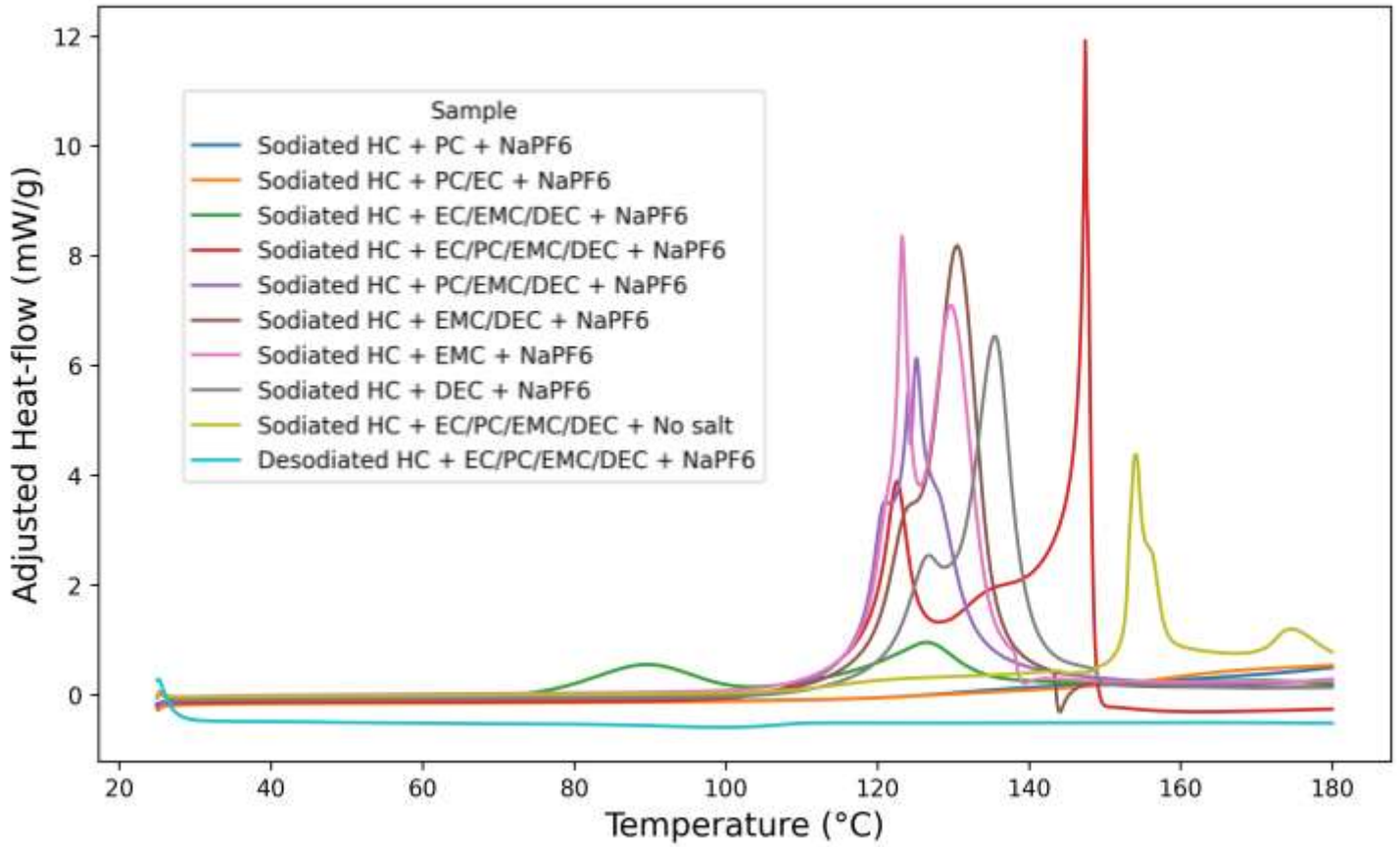


Electrolytes

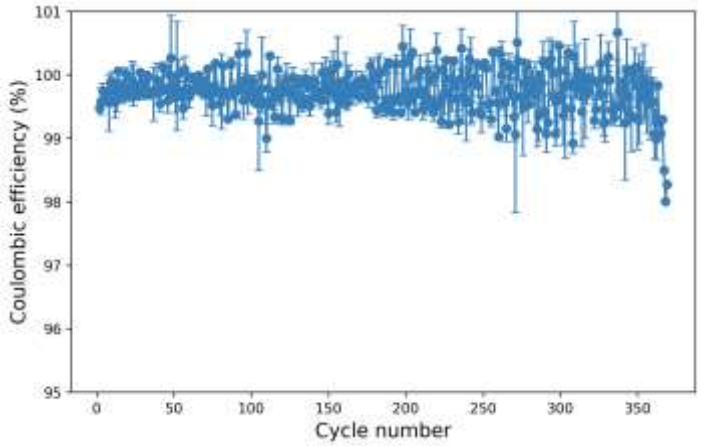
- Lifetime
- Rate capability
- Temperature performance
- Safety
- Separators
- Weight

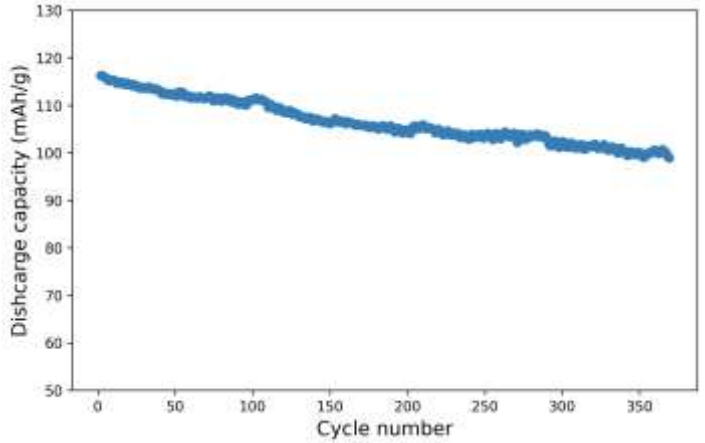
Electrolytes

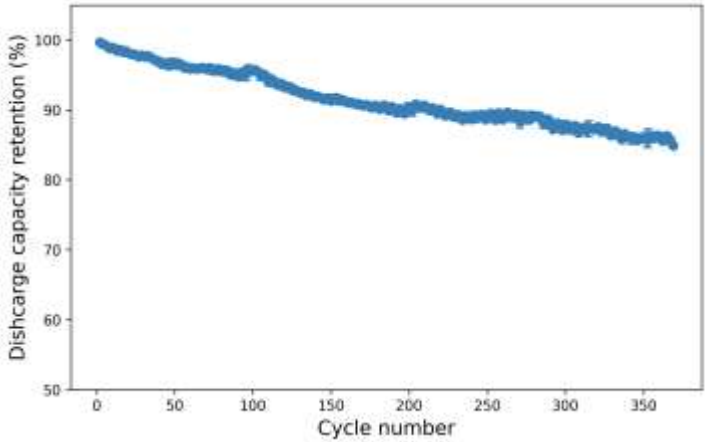
- Lifetime
- Rate capability
- Temperature limits
- Safety
- Separators
- Weight



TEP + Borate based salt + X

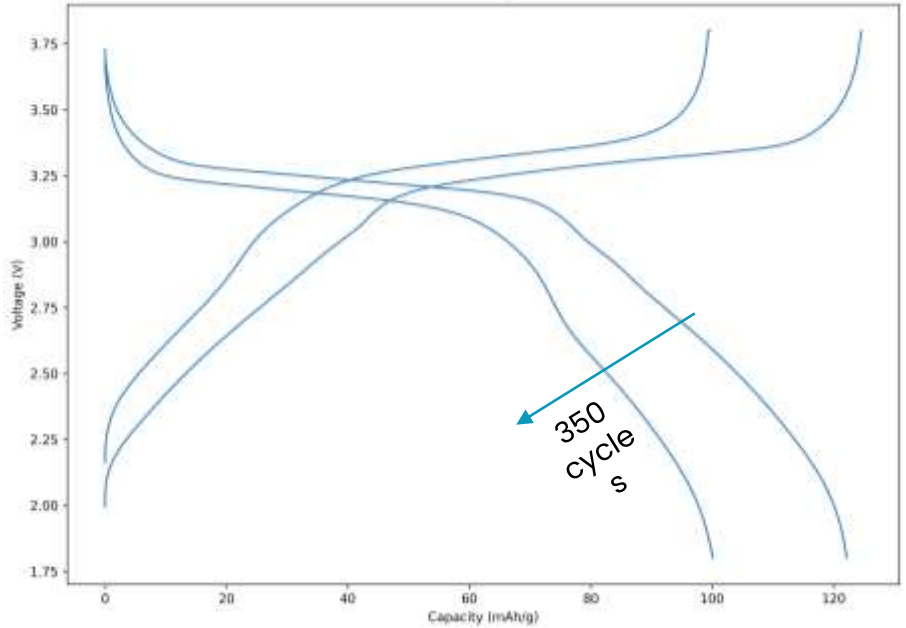






Cycling temperature: RT

Cycling protocol: C/3 charge and discharge and RPT every 50 cycles Between 2V and 3.6V.



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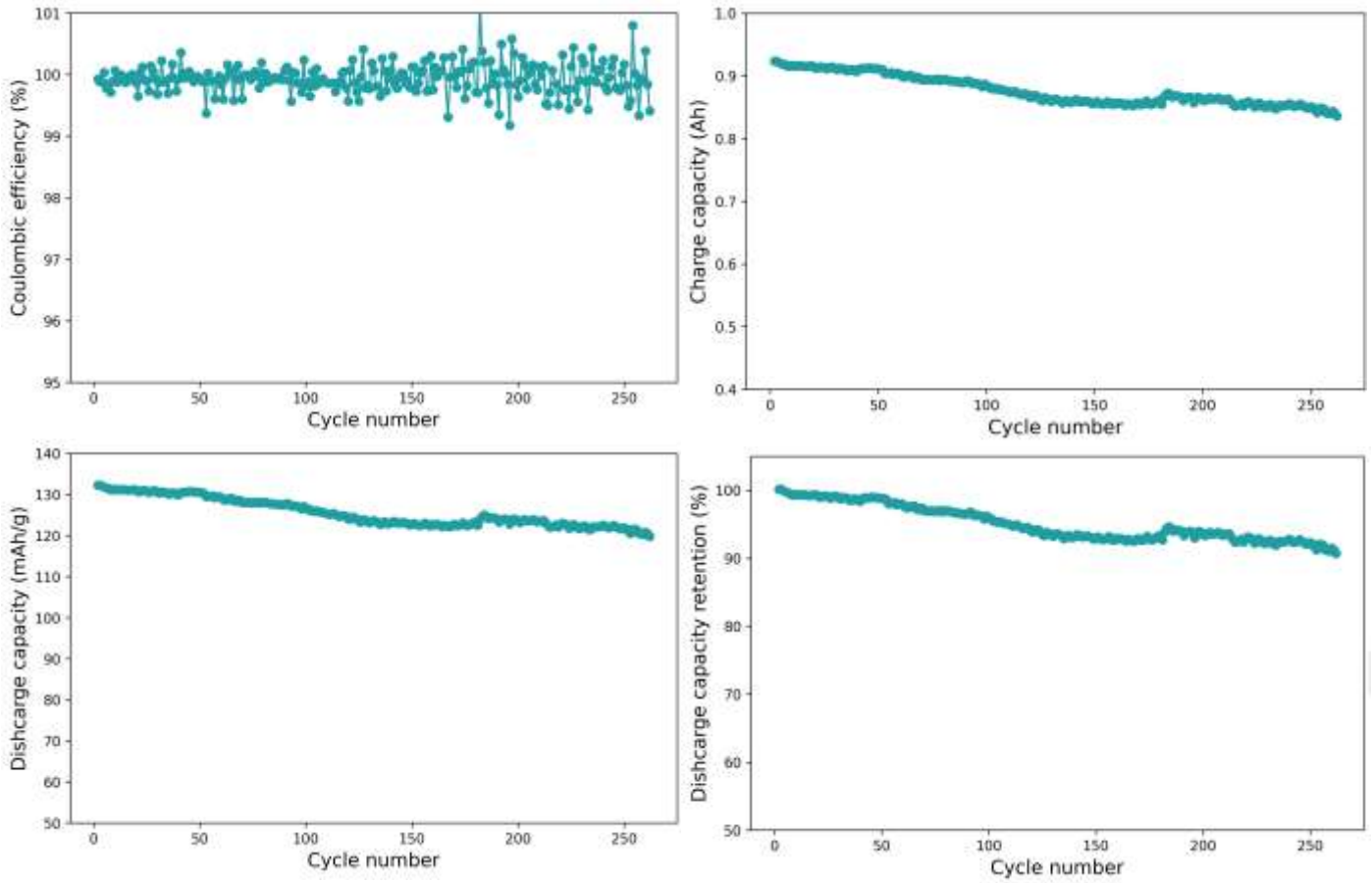
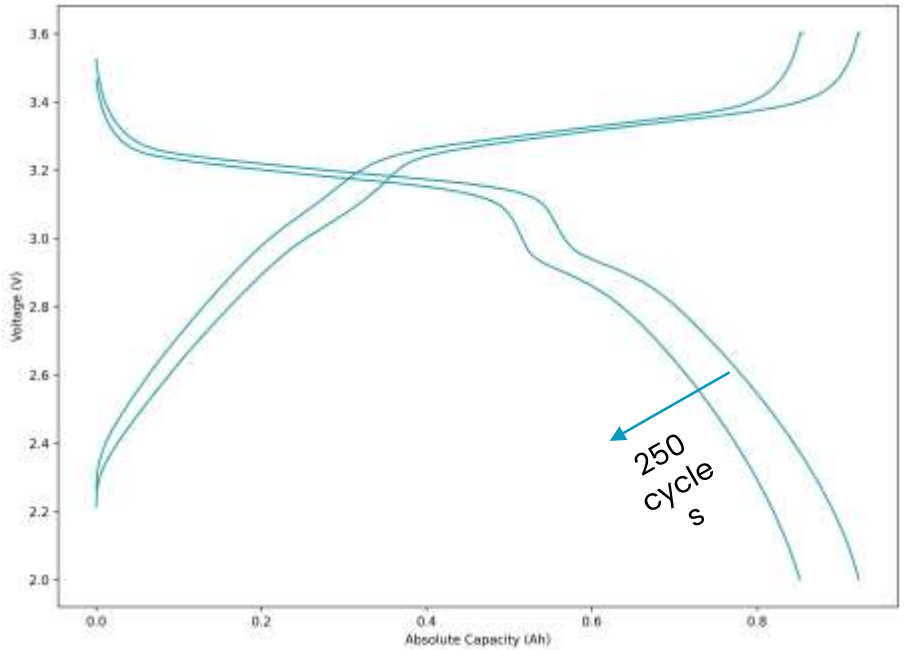
TEP + NaFSI + X





Stack: 13/14 cathode anode (A7 format)
Cycling temperature: RT

Cycling protocol: C/3 charge and discharge and RPT every 50 cycles Between 2V and 3.6V.

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Testing stages

Testing in many scales is useful

- Half cells tot test active material capacities
- A7 to investigate stacking precision, defect control, welding, overlap effects etc.
- A5 to find electrolyte loading/fill factor, thermal behavior, cell swelling, soaking time, energy density

Circular electrodes; 1 anode & cathode:
⌀ 13 mm cathode; ⌀ 14 mm cathode

Coin-cells / Lab-scale testing
Cell capacity: **3-4 mAh**
Used for:

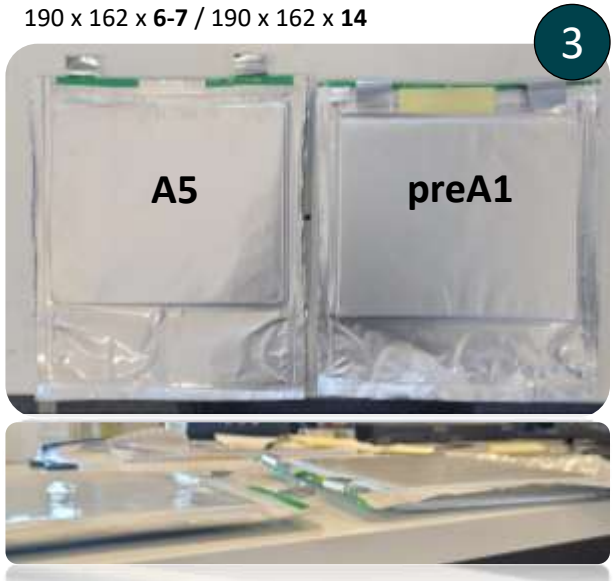
- Material QC
- Rough screening

Anode measures:
45 x 58 x 6-7

A7-Format
Cell capacity: **1-2 Ah**
Used for:

- Cell optimisation
- Component testing
- Gas evaluation
- Stack pressure
- etc

Anode measures:
A5-Format / PreA1
190 x 162 x **6-7** / 190 x 162 x **14**



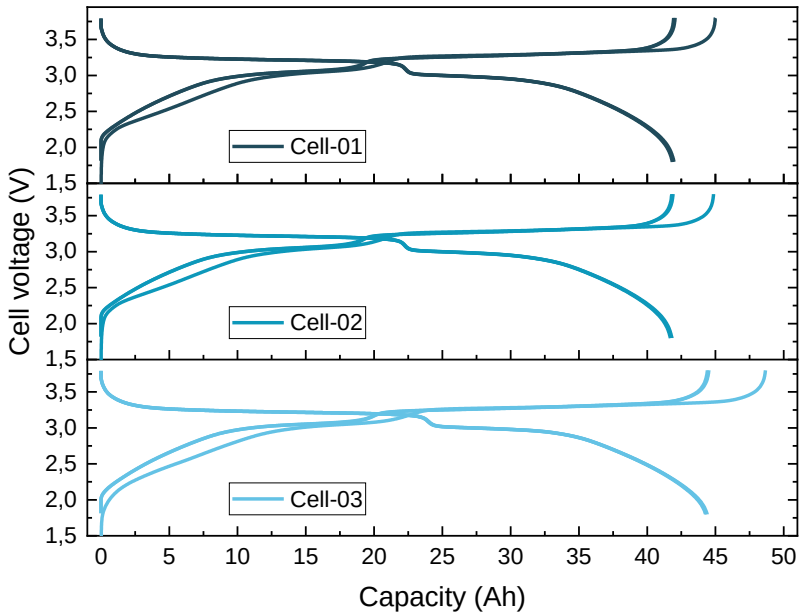
A5-Format / PreA1
Cell capacity: **ca. 18 Ah / 40 Ah**
Used for:

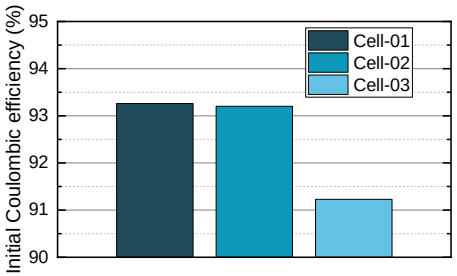
- Proof of concept
- Safety tests
- Thermal behaviour
- Electrolyte loading

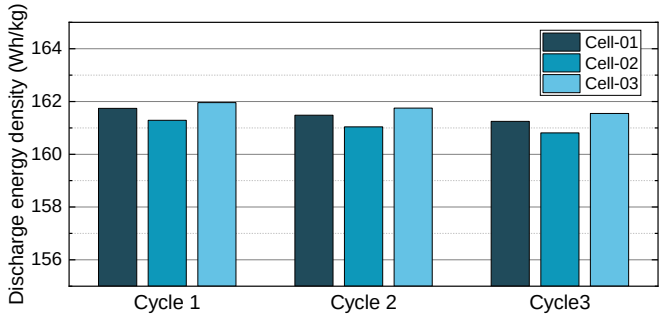
Altris 160 Wh kg^{-1} demonstration – god & bad

Prussian white anode & cathode designed for lower C-rates and minimized cost

- Water based coating – PFAS free
- Aluminum current collector
- >92% active content
- High mass-loading
- Wood based hard carbon







BESS 40Ah Prototypes

- >160 Wh/kg, >265 Wh/L
- 3 V average voltage
- Designed for C/3 max, capable of C/2 charge and 1C discharge
- 97% energy efficiency at C/10

Small coating facility, Vaksala EKE

- 5 Liter mixer
- 6 m Coater
  - Typical coating length 20-30 meter
  - 20 cm width, 0.2 m/min speed
- Small diameter roll hot-roller
- Laser engraver used for electrode cutting
  - 1 minute per electrode speed
- Injection as manual operation in glovebox
  - Ca 10-30 minute per large cell

A-line

- Our new facility aims to produce high quality cells in sufficient number to be able to demonstrate functional packs in kWh-MWh range
- The facility should be able to be flexible both in terms of cell format and of process flow
- Automation is limited since flexibility is prioritized before mass-production

Industrialization – focus areas

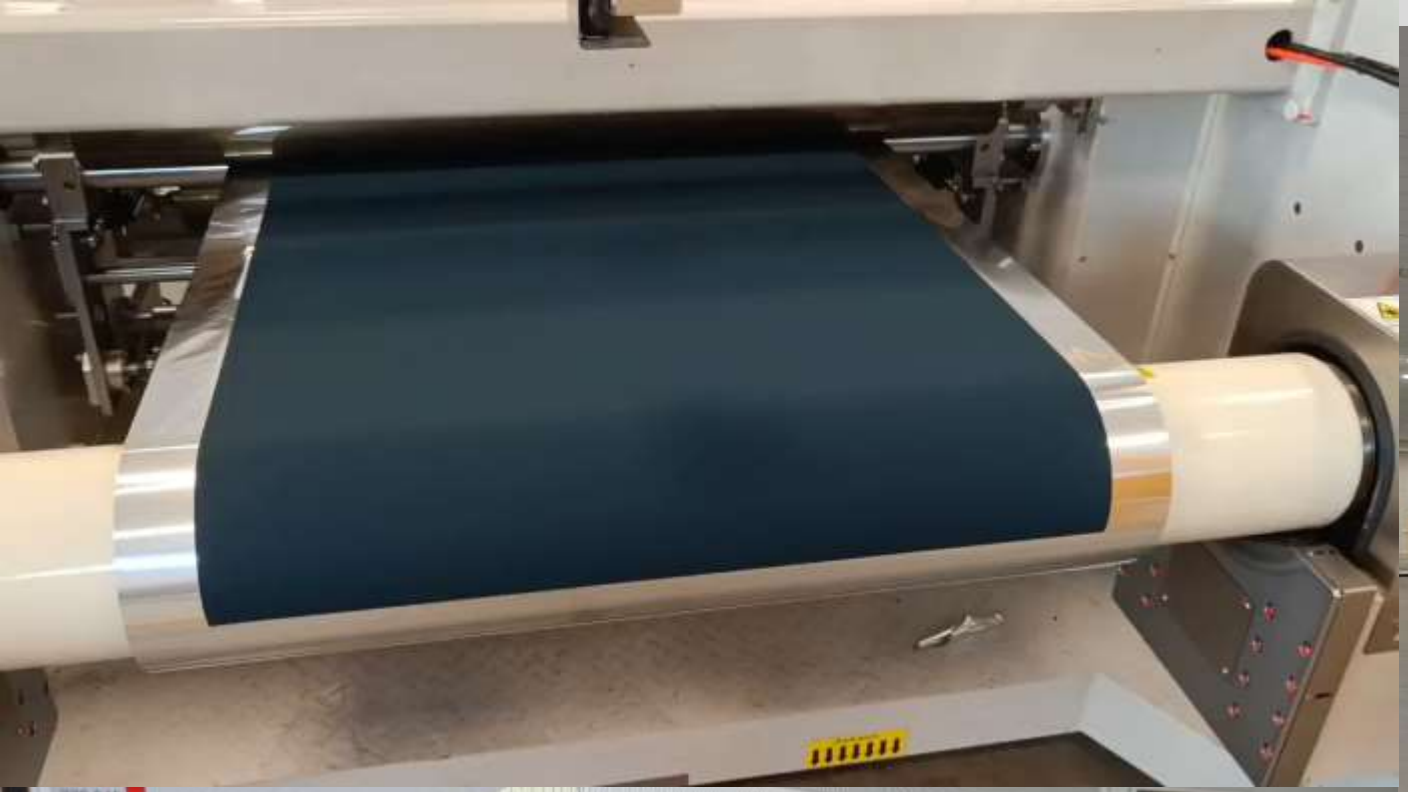
- Production capacity (15-100 MWh/year)
- IPC/QC (Beta-gauges, x-ray, CCD with machine learning)
- Supply lines
- Manufacturing know how

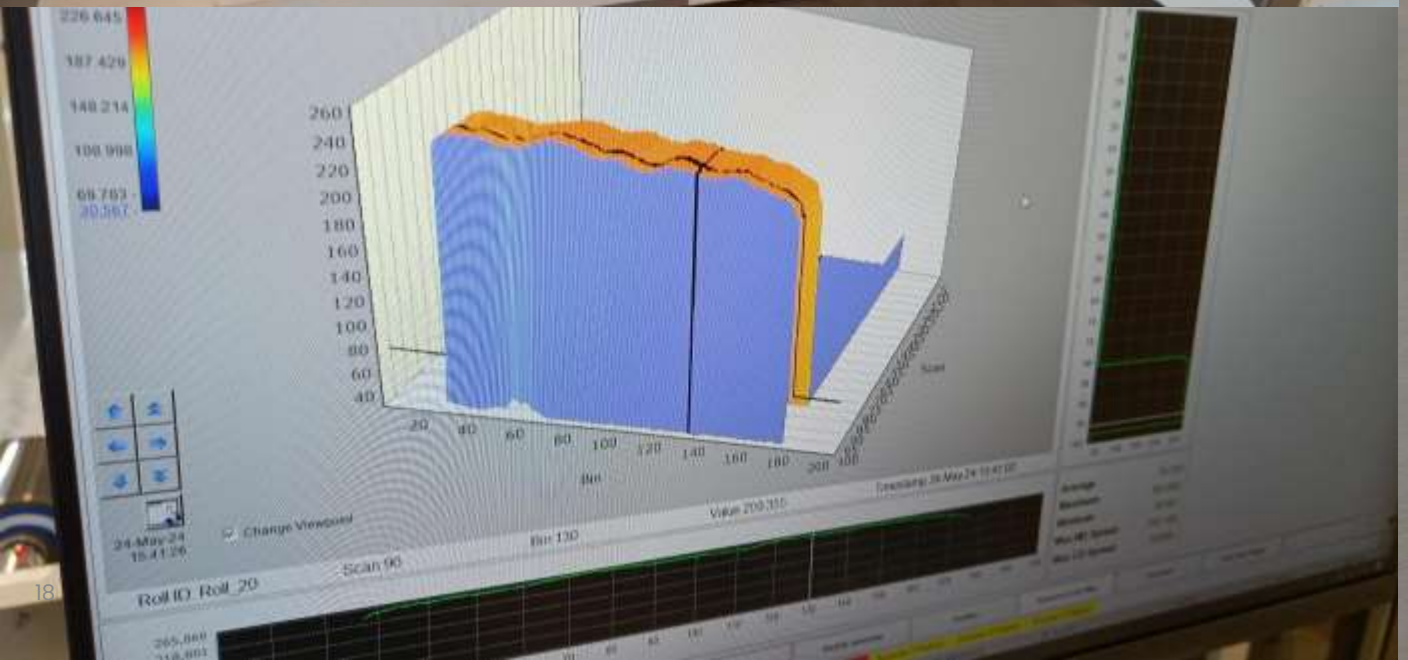
Slurry mixing

- 2x300 L mixing capacity with buffer tanks for psudo-continuous slurry feeding
- All water based
- Simple and of the shelf equipment
- Enclosed material handling for powders on second floor

Coating 1/2

- New slot-die coater 57 m in length with 30 m ovens
- Beta-gauge for mass loading control and profile calibration
- Up to 30 m/min speed and 108 cm width
- Possibility to treat foils in-line with coater

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KATOP

Electrode fabrication

- Standard hot-rolling
- Laser-notching

Cell assembly

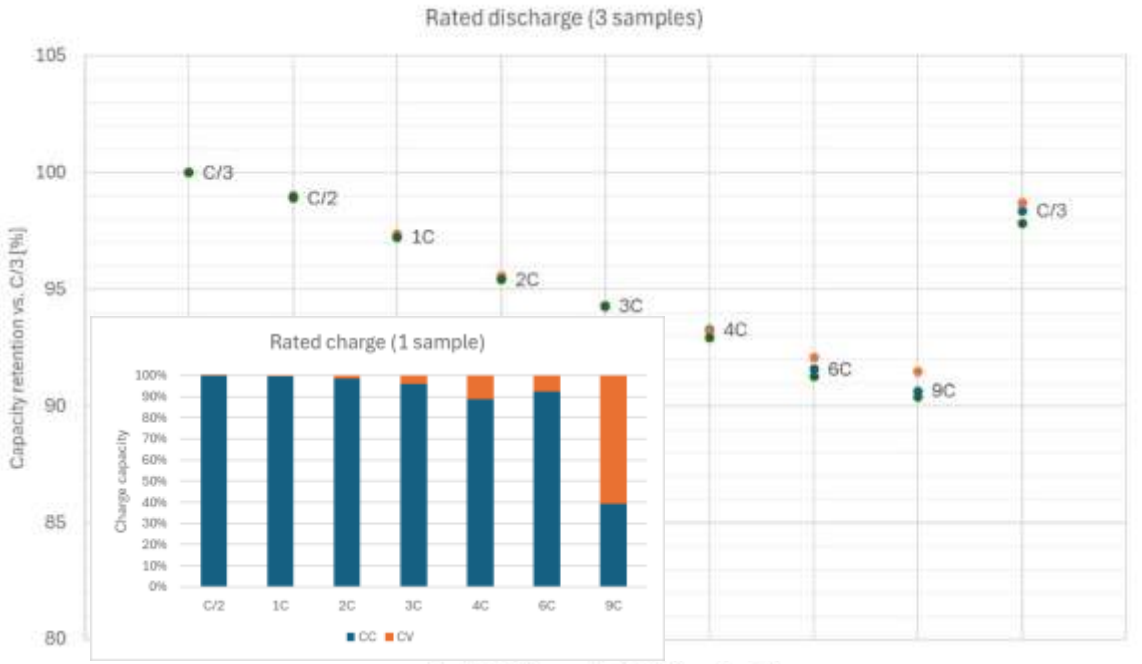
- Standard Z-stacking outside dry-room
- Heat resistant bio-based separator
- Large & small cell sizes possible

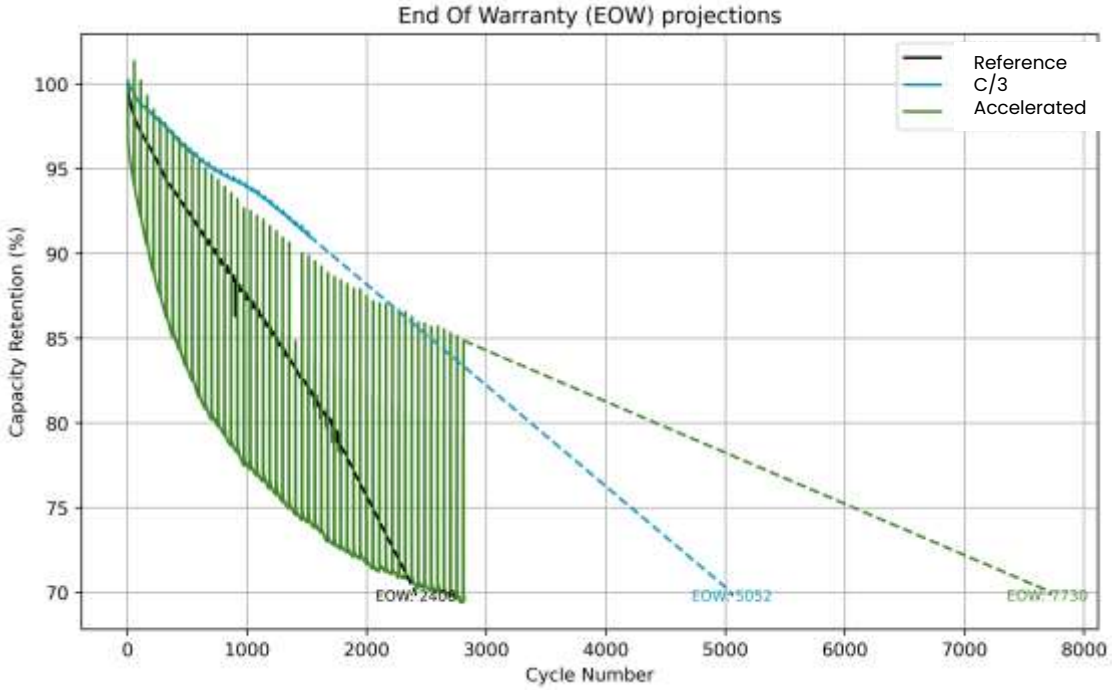
Finishing

- Dry-room capable of -70°C dew-point with two working
- Size is 100 sqm for drying, insertion, injection, and more
- Essential for performing experiments

Lifetime & rate

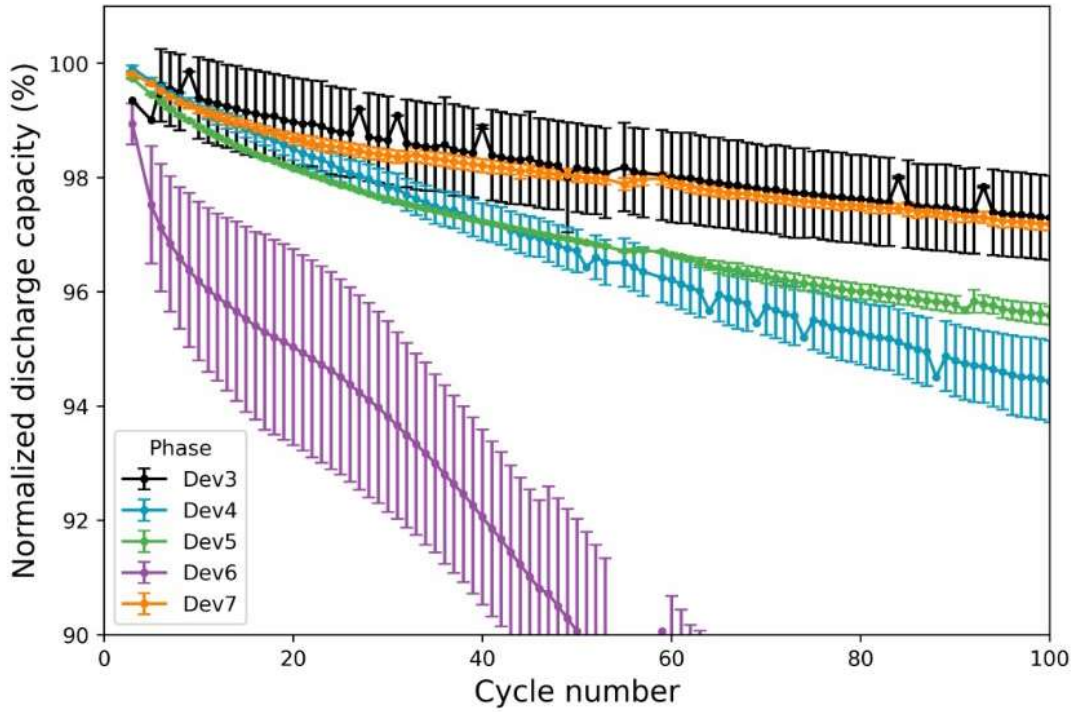
- Lifetime is promising but collection is slow
- Empirical data for C/3 100% DOD shows 1800 cycles above 80% retention
- Accelerated 0.5/1C data shows 80% retention at more than 2900 cycles
- Rate capability is more than adequate but high speed charging and/or low temperature cycling is being focused for improvement

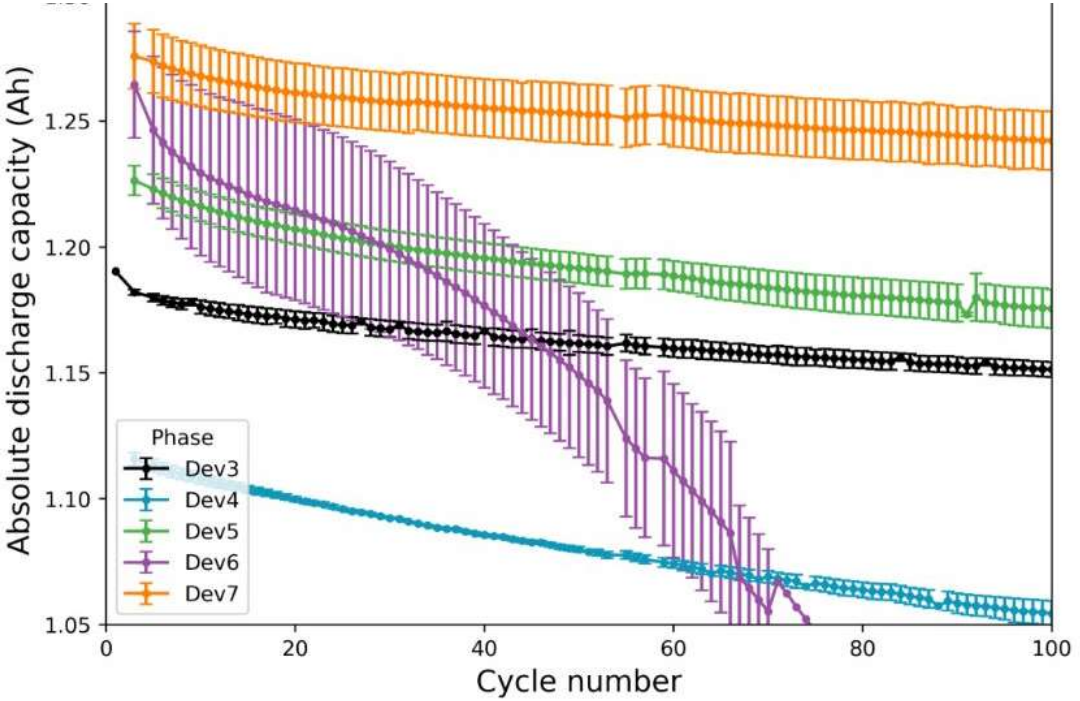




Full-cell development, behind the curtain

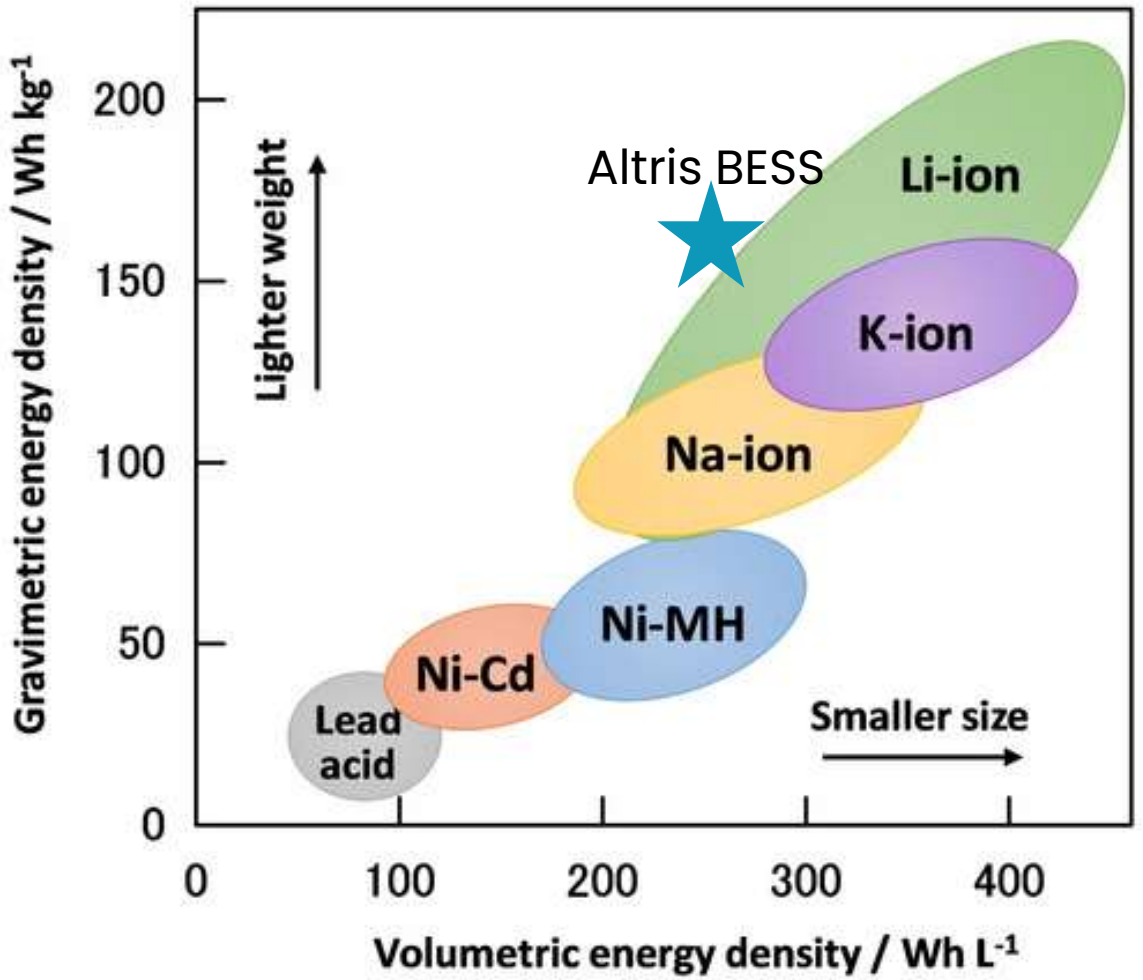
- Development cycles contain 3 essential components:
  1. Baseline/reference cells
  2. Isolated variations
  3. Combination of alterations to crosscheck interference between changes
- Just like when reading literature, parameters cannot be analyzed in isolation there are few alternatives
- Development is not always constant improvement





Applications

- Altris currently develops two distinct cell branches, Energy optimized & Power optimized
- Energy cells are meant to fit the need of stationary energy storage systems
- Power cells are designed to remove the last good arguments for lead acid cells and thus also include wide temperature range performance



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Final words

- Altris is extremely grateful for the diligent work performed by participants in the SIMBA consortium

- The project results have been instrumental for Altris to direct their work in SIB commercialization, including both cell design and equipment specification

- Altris is one of several SIB companies in Europe but we hope our and their development will ensure that Europe can be self-sustaining in energy storage technology

Special thanks to

UPPSALA
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Energy Agency

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