



# Battery Innovation Days BATTERY HEROES CLUSTER

Advancing European Sustainable Production  
from Pilot to Gigafactory Scale

Dec 3, 2025



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# Agenda

**01.** Cluster Introduction

Battery Heroes Introduction

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**02.** Project Overview

Projects involved across the value chain

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**03.** Cell Production Process

Overview of potential energy and cost reduction

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**04.** Technical Highlights

Selected results of the projects: e.g. high Si Anodes, Aqueous and dry electrode processing and drying conditions

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**05.** Summary & Outlook

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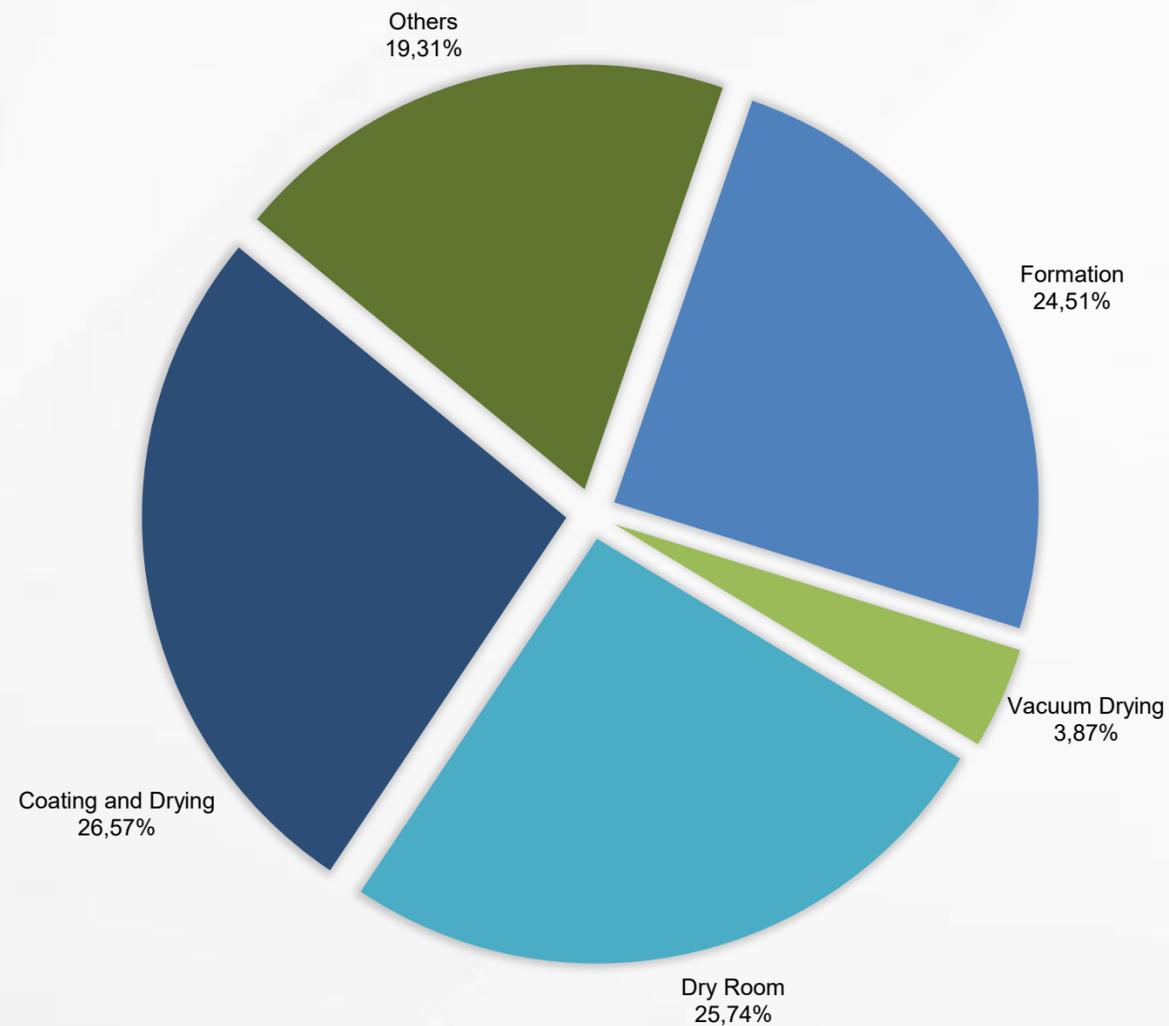
# Cluster Introduction

- Established in January 2023 by 4 projects funded under HORIZON-CL5-2021-D2-01-04
- Joined by GigaBat and BatMachine (HORIZON-CL5-2022-D2-01-04) as well as LiPlanet in December 2023





# Cell Production Process



Batteries 2024, 10, 64. <https://doi.org/10.3390/batteries10020064>

- **Why are we working on this topic?**
  - Sustainable and cost-efficient battery cell production
  - Reduction Carbo footprint and strength leadership in green battery manufacturing
- **Who benefits the results?**
  - European battery manufacturers
  - OEMs
- **What is the industrial need?**
  - Lower production costs and energy demands and ensure high performance cell quality



# Sustainable Production Processes in Focus



- Solvent-free processing of a Ni-rich cathode and pure Si anode
- R2R prelithiation from a high Si system
- Scale up pre.lith. process
- Optimized Current Collectore foils

- Electrolyte development for high Si anodes
- Demonstrator Cell 21700 / pure Si Pouch Cell
- Advanced formation protocolls



- Aqueous Processing of Anode and Cathode
- Dry Processing of Anode and Cathode
- Scaling of dry processing

- Cylindrical 18650 and Pouch Cells



- Optimized Cell Manufacturing Process with reduced dry room
- Aqueous Processing Cathode
- Electrode Drying Concepts
- Laser Structuring (3D Design of electrodes)

- Advanced formation Protocols



- Wet and dry processing
- Scale up of the manufacturing process
- Electrode laser texturing

- Recycling Process Development

# Ensuring Scalability of Si Technology

## Demand for Si anode production technology

### Prerequisite for Si technology

„Drop-in technology“:  
scalability on existing Li-ion  
plants

Industrial availability  
of materials and equipment:

- Ensuring material availability for ramp-up on production plants
- Definition of quality-related parameters and permissible fluctuations
- Ensuring „Freedom to Operate“



Improved **explosion protection**  
Adopted (sensitive) **mixing technology**



40% **improvement in precision**

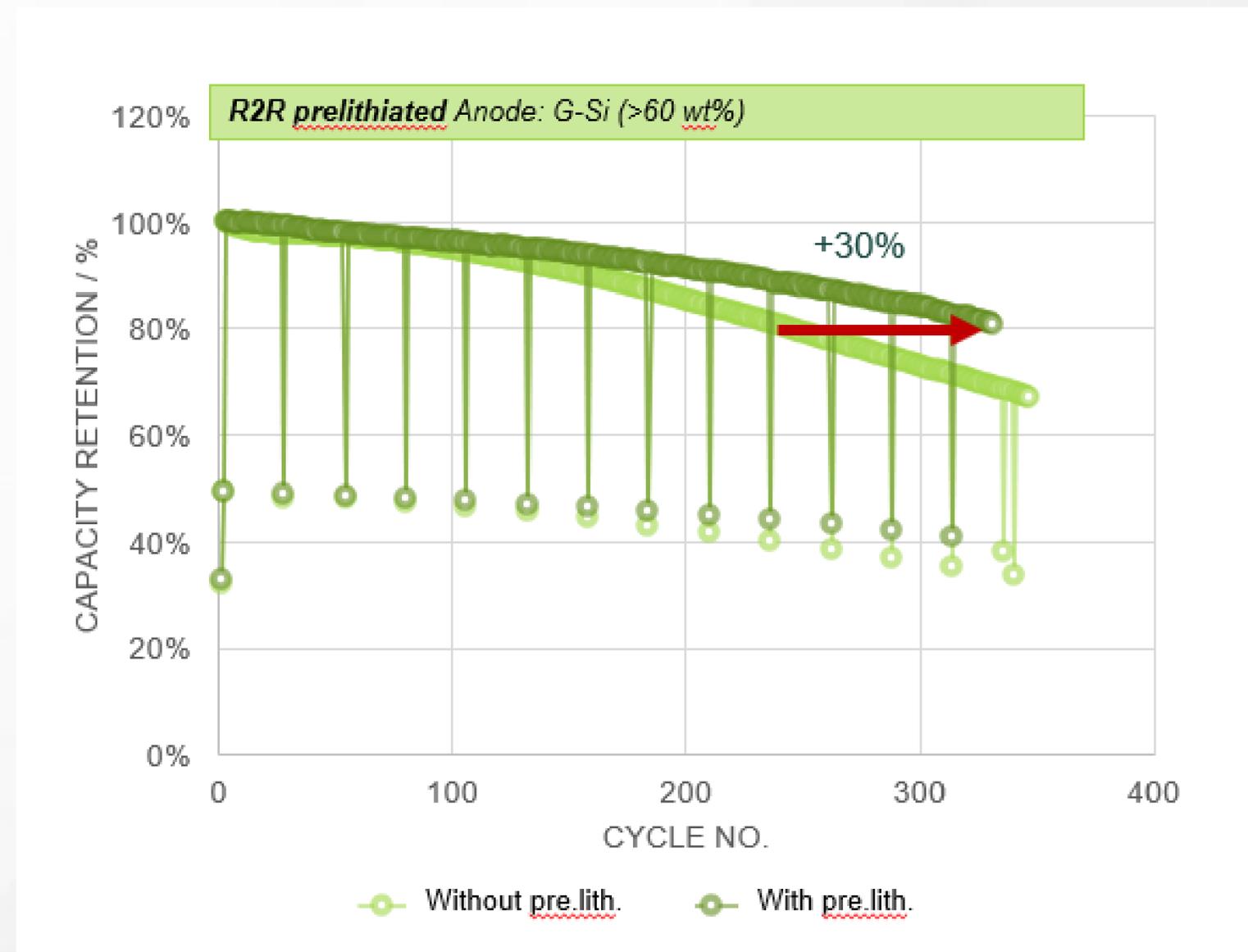
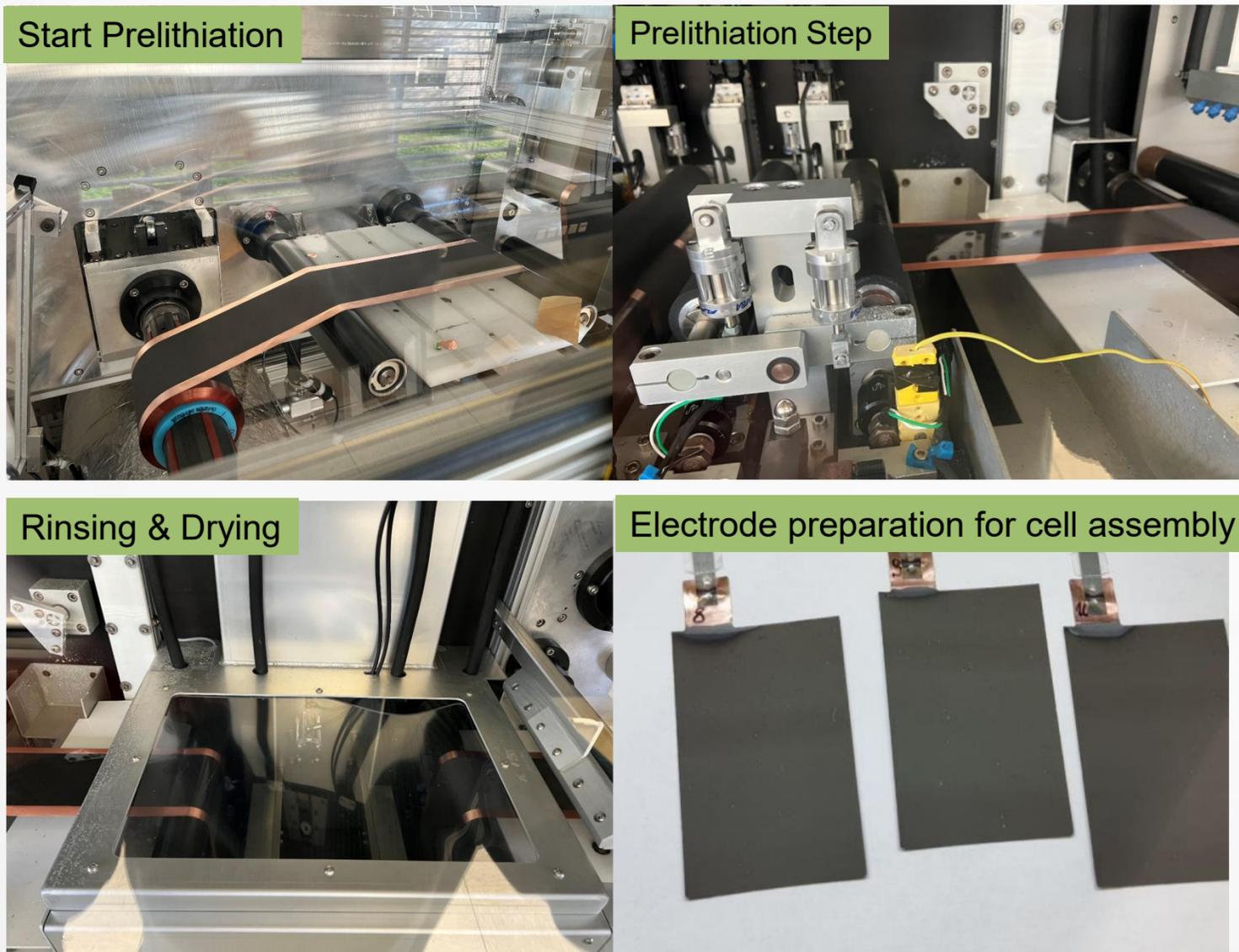


### Major impact

### Minor impact

- **Calendering**: less force but higher accuracy needed
- **Electrode slitting**: silicon-based materials are **notably harder / abrasive** and oxidation product is a solid (SiO<sub>x</sub>)

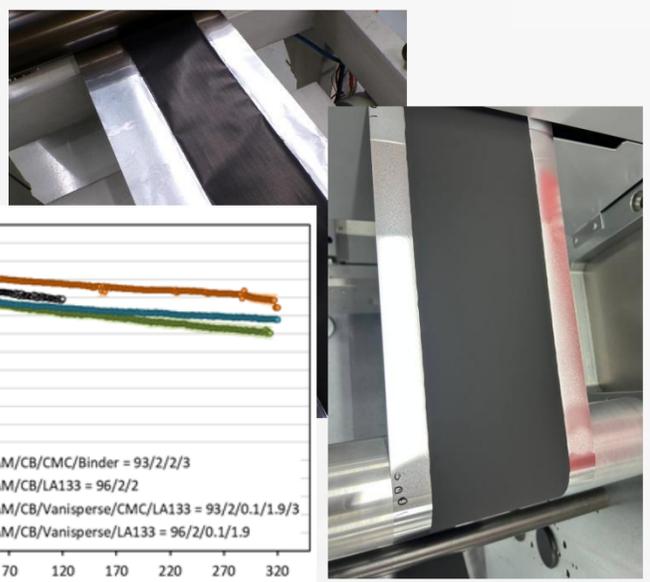
# R2R Prelithiation of a high Si Anode



# Challenges of Electrode Processing

## WET PROCESSING

- **Conventional** electrodes: Anode (aqueous) and Cathode (NMP-based)
- Viscous slurry coated on a current collector
- **Drying process:** solvent recovery adds additional costs and energy consumption
- **Aqueous processed Cathode-** reduction of NMP



**MAIN CHALLENGES**

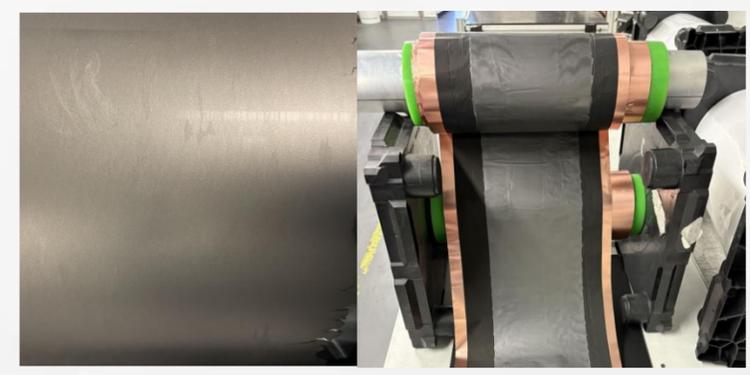
- Active material degradation
- Increased pH value
- Binder selection
- Optimum drying times

## DRY PROCESSING

- **Shear Mixing** to mix a fibrous network the binds the electrode materials
- **No need of NMP**, drying and solvent recovery
- Reduction of **energy consumption**, reduces carbon footprint

**MAIN CHALLENGES**

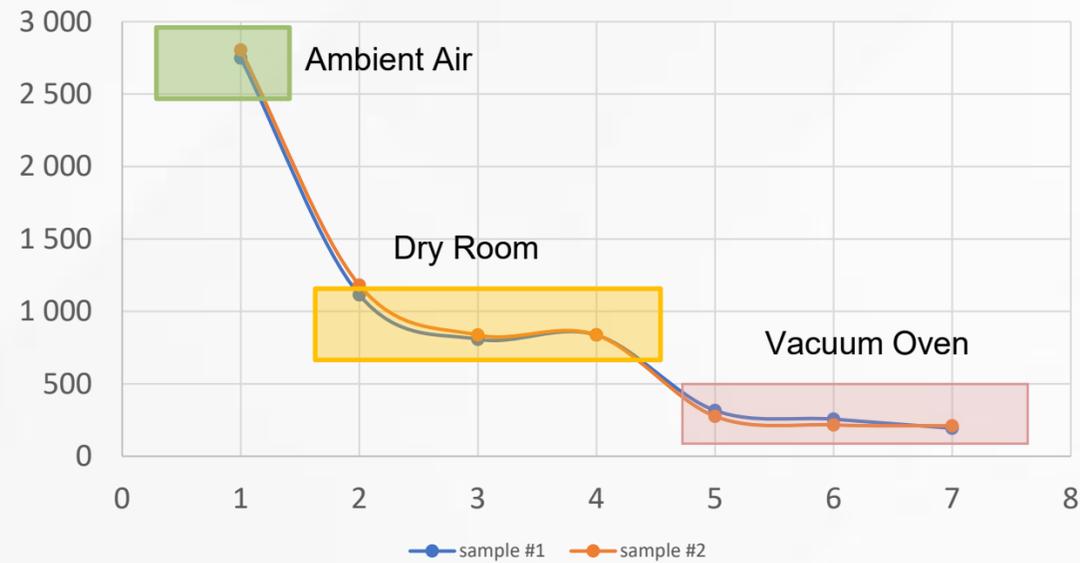
- Inhomogeneous dosing causes “ribbing”
- Edge quality
- Inhomogeneous granules is causing curling effect
- Challenges in freestanding anode electrode adhesion
- Mechanical stability



# Electrode Drying Concepts

Cathode CM068

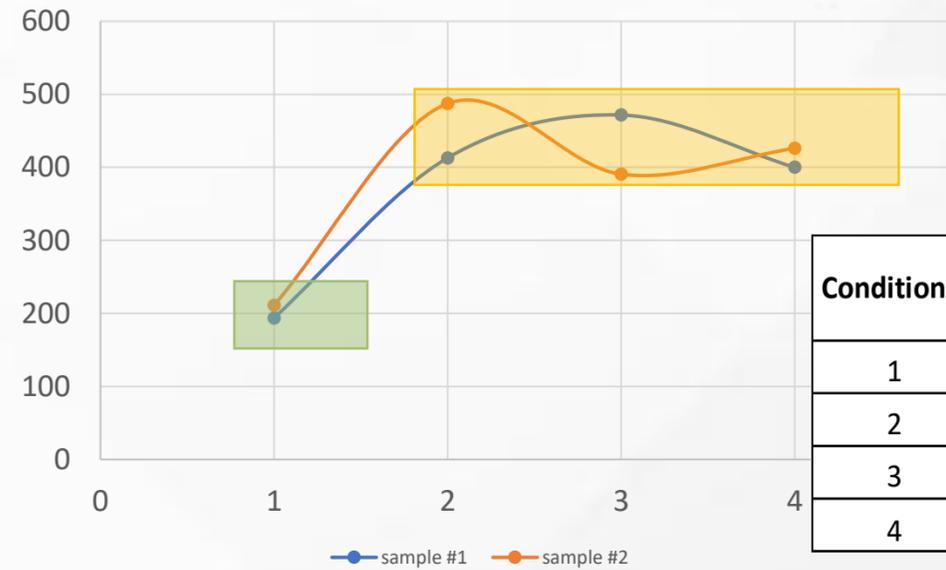
Cathode moisture content ppm at different storage conditions



Dry room storage



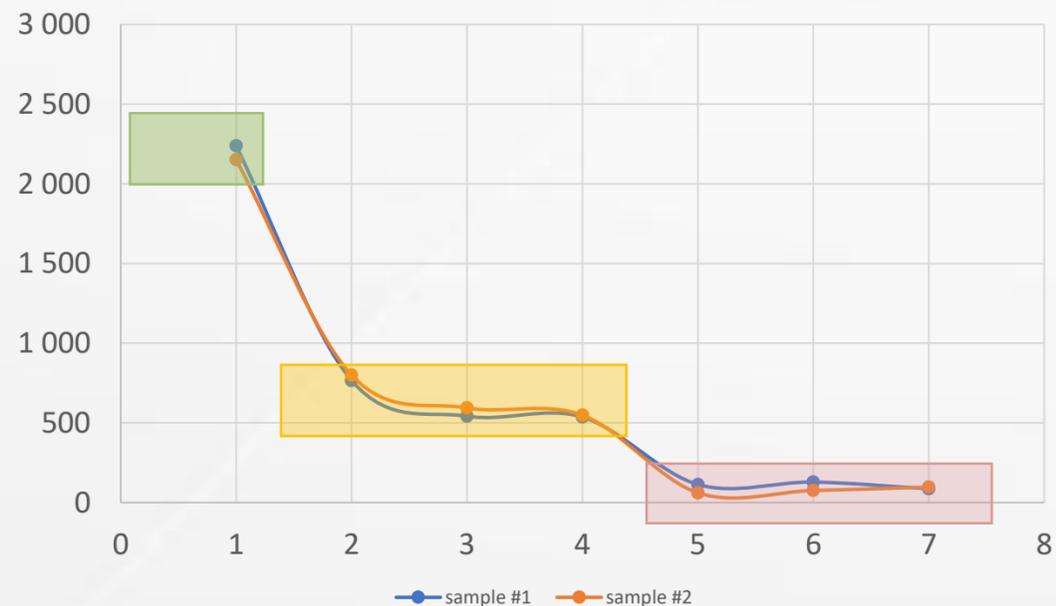
Cathode moisture content after vacuum drying



Condition #	Condition	ppm	
		sample #1	sample #2
1	Vacuum O. 80°C 90m	193,68	211,04
2	Stored in D.room 1h	412,90	487,32
3	Stored in D.room 2h	471,66	390,61
4	Stored in D.room 3h	400,01	426,09

Anode S126

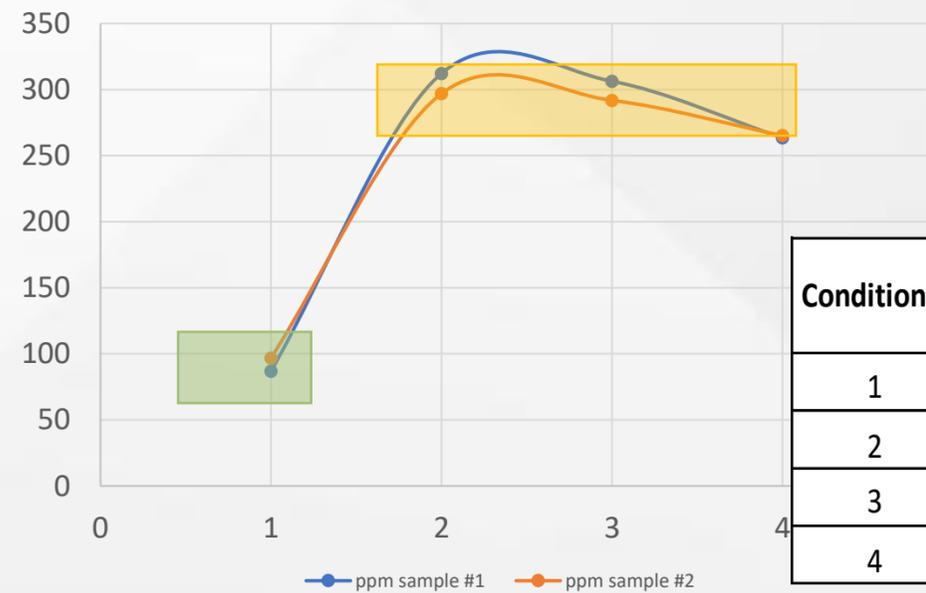
Anode moisture content ppm at different storage conditions



Dry room storage

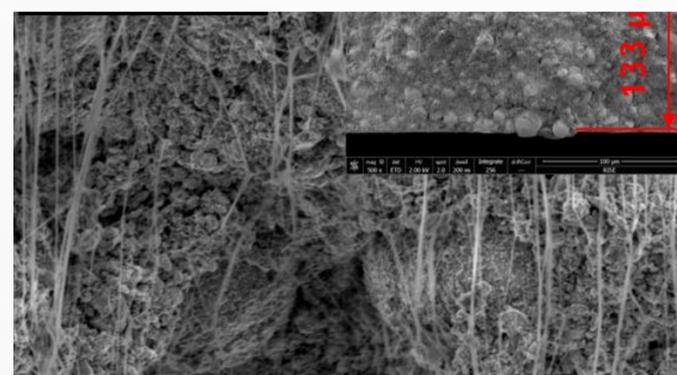
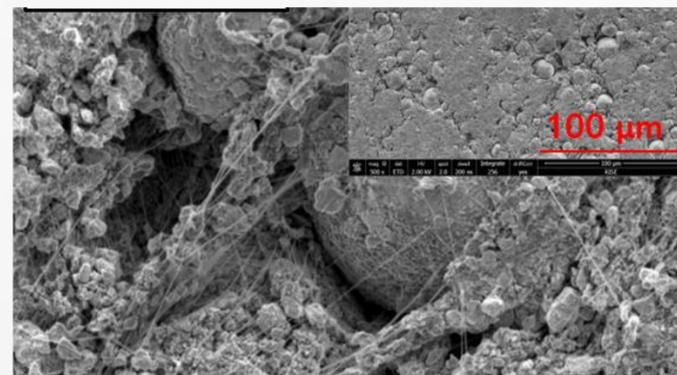
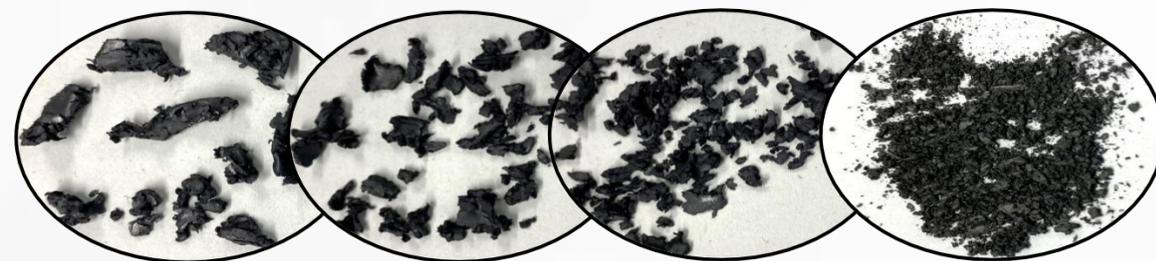


Anode moisture content after vacuum drying



Condition #	Condition	ppm	
		sample #1	sample #2
1	Vacuum O. 80°C 90m	86,83	96,81
2	Stored in D.room 1h	312,23	296,96
3	Stored in D.room 2h	306,30	291,83
4	Stored in D.room 3h	263,52	265,19

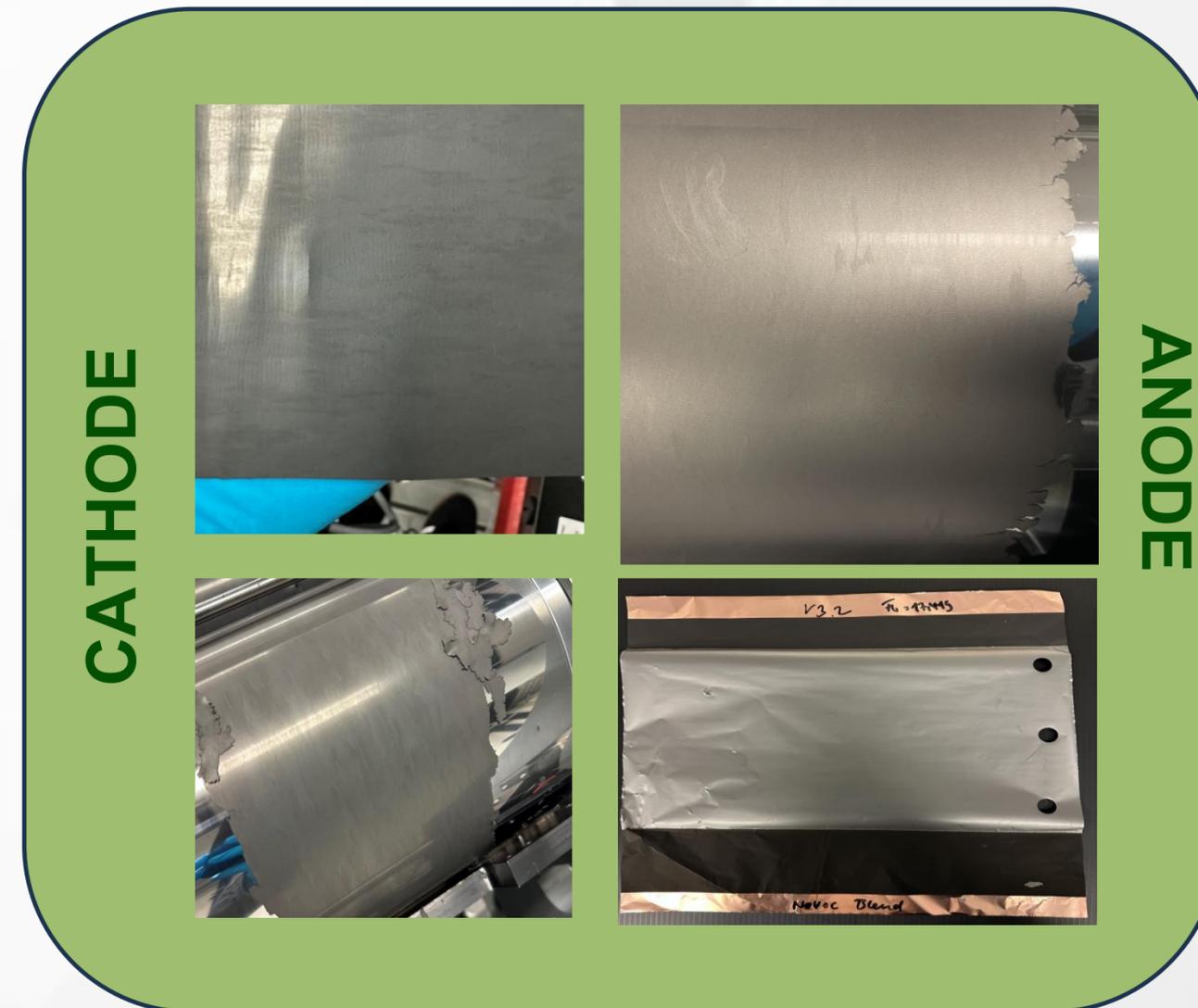
# Dry Processing & Scale up



Anode composition: 97.5 (graphite):1.5 (C65):1 (PTFE)  
 Cathode composition: 95 (NMC811): 2.5 (C65): 1.5 (PTFE)

**MAIN FINDINGS:**

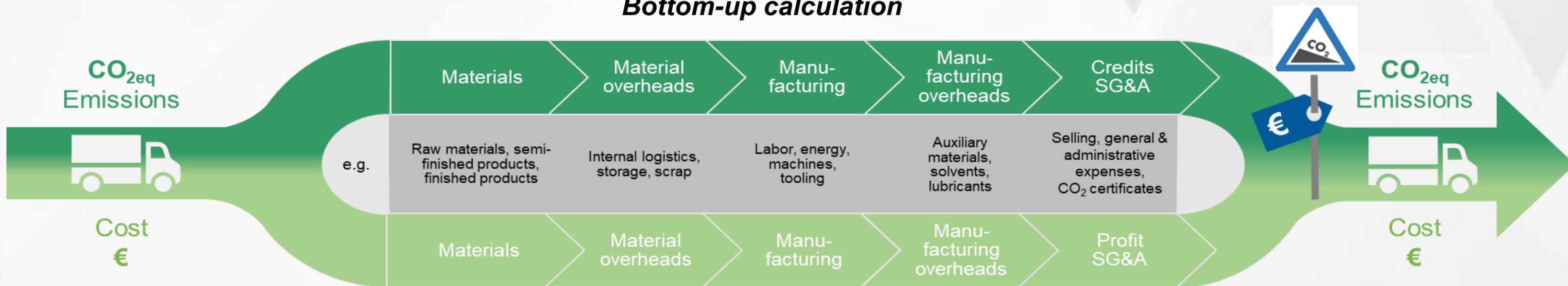
- 1) Inhomogeneous dosing causes “ribbing” of electrode in subsequent calendar gap.
- 2) Inhomogeneous size of extruded granules is causing curling effect.
- 3) Challenges in freestanding anode electrode adhesion.





# Assessment- Cell Production Processes

## Bottom-up calculation



Energy Reduction on Cell level	Cost Reduction on Cell level



# Summary & Outlook on Cluster

tbd

Thank you for your time  
and interest!



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