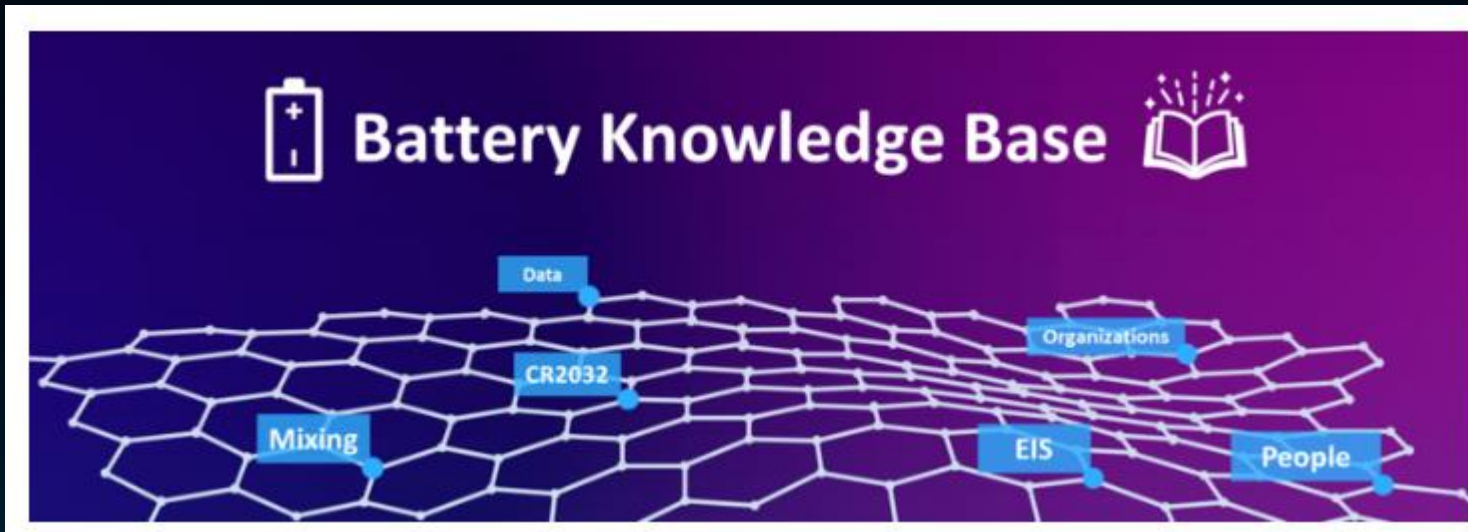




This project has received funding from the European Union's Horizon Europe research and innovation programme under grant number No. 101104022.



# An interactive semantic battery wiki

Philipp Veit, Christian Punckt, KIT

Simon Stier, Lukas Gold, Fraunhofer ISC

Simon Clark, Eibar Flores, SINTEF



September 6<sup>th</sup> 2024

BATTERY  
2030+

# Agenda



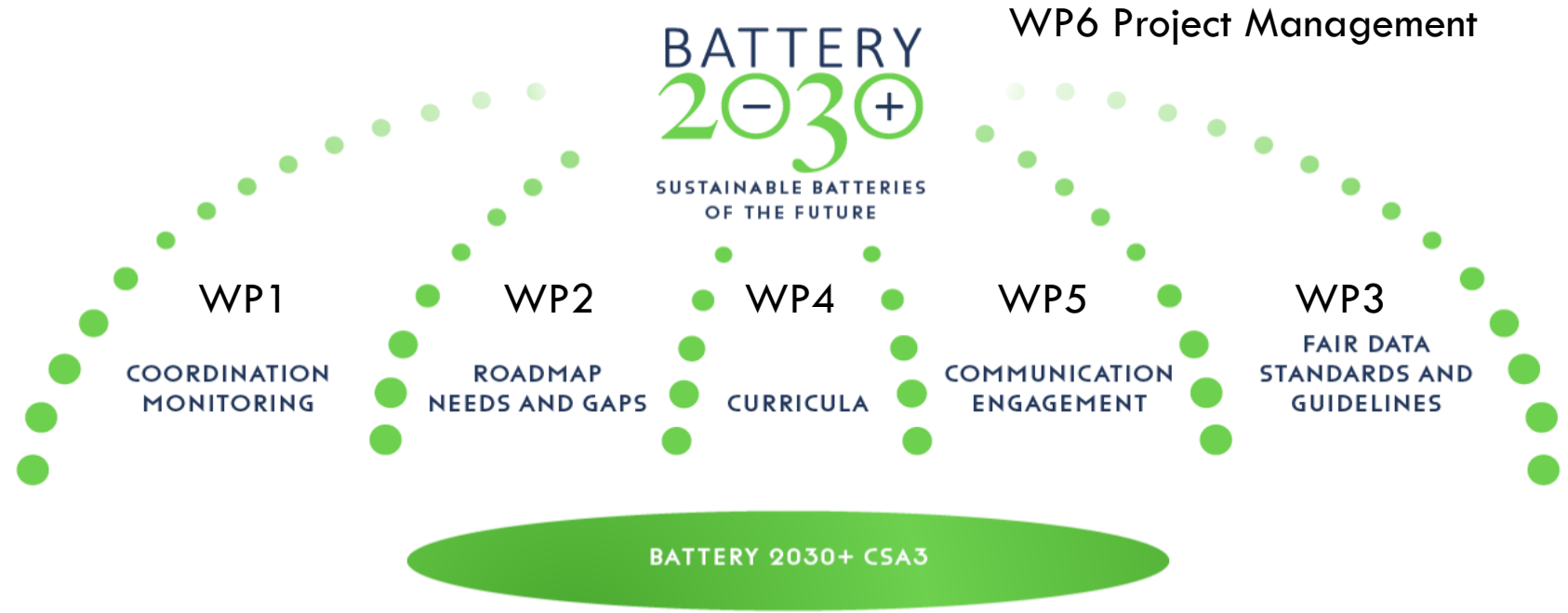
- **Introduction and housekeeping rules**
- **Menti warm-up**
- **Presentation: Background of the Knowledge Base**
- **Menti**
- **Live Demo: How to use the Knowledge Base**
- **Menti check-out**
- **Q&A**



# Structure of the initiative



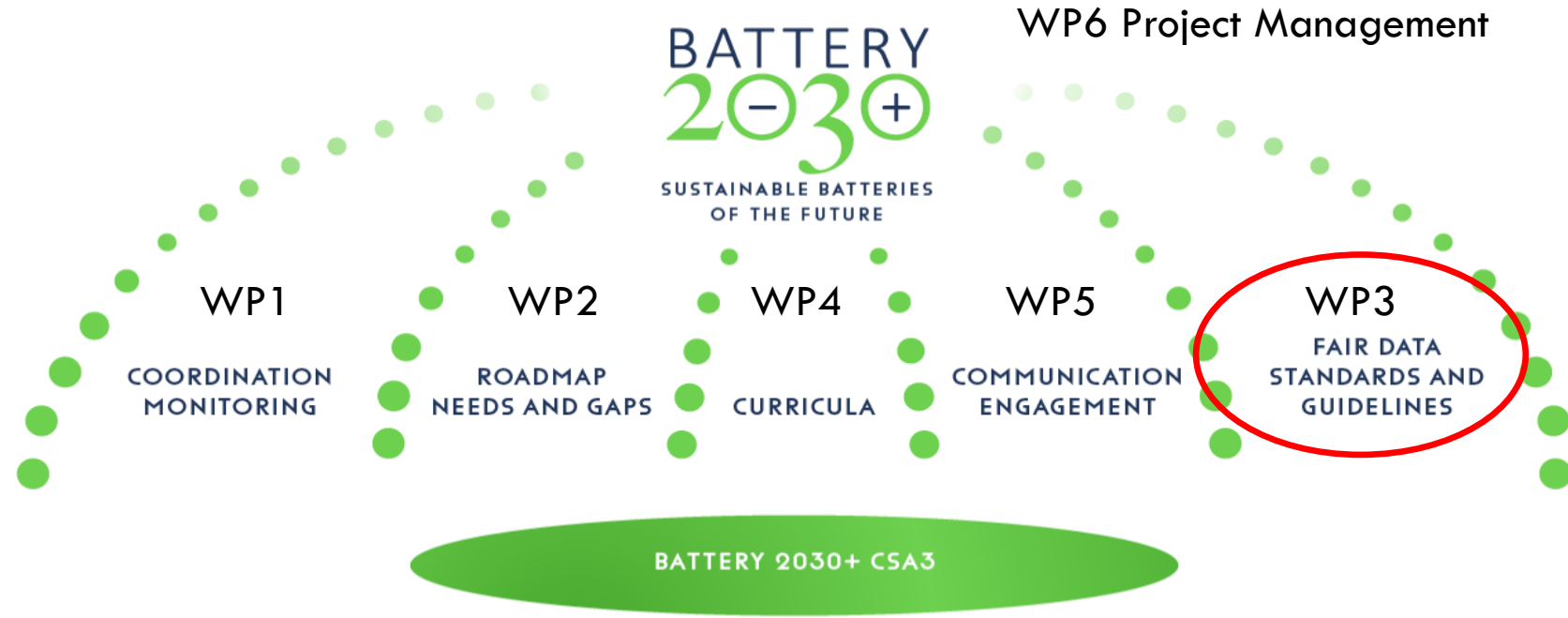
## LARGE-SCALE RESEARCH INITIATIVE



# Structure of the initiative



## LARGE-SCALE RESEARCH INITIATIVE

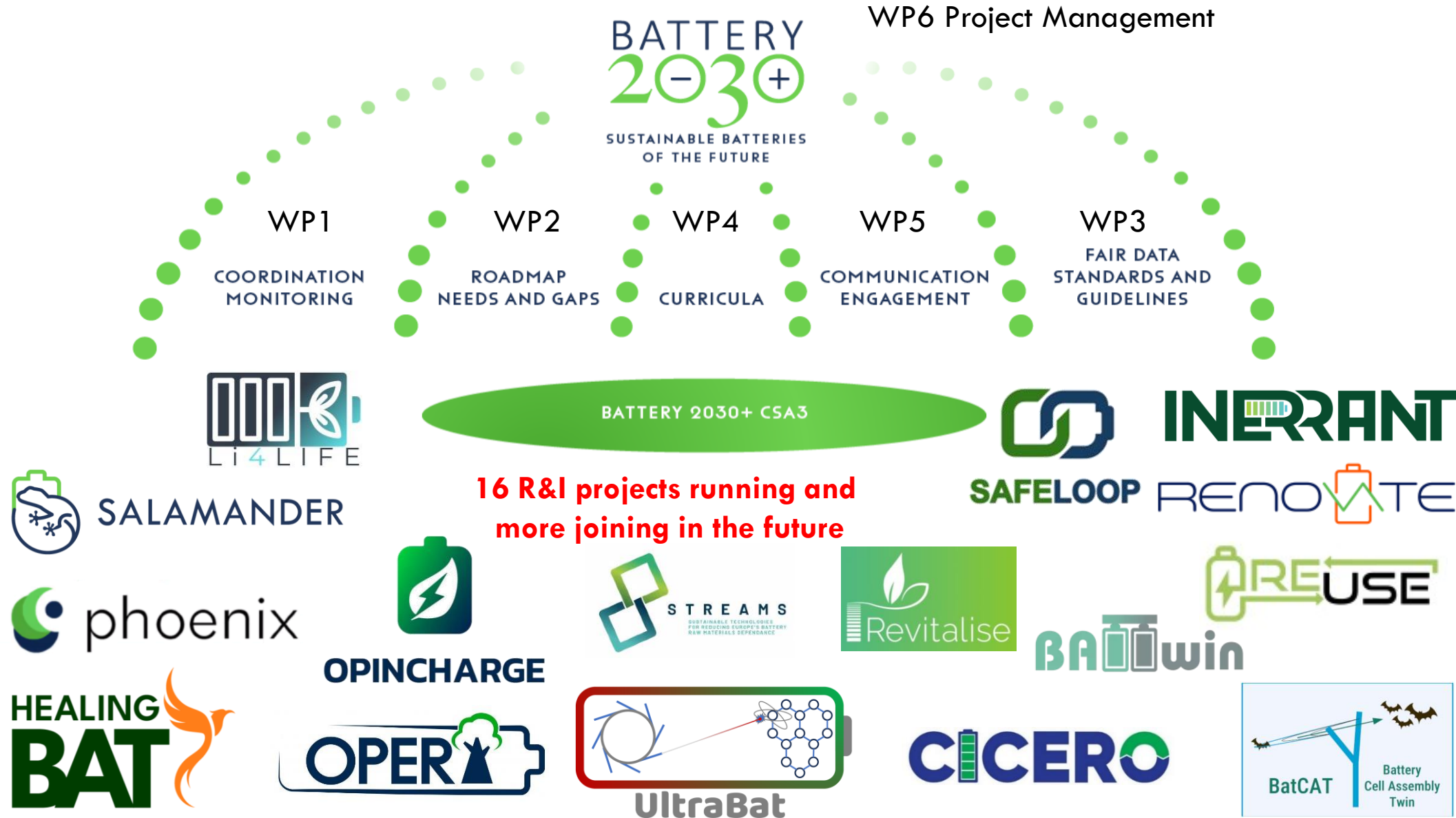


# Structure of the initiative



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant number No. 101104022.

## LARGE-SCALE RESEARCH INITIATIVE



# Why do we need standard protocols?

Comment | Published: 12 February 2024

## My cell is better than yours

[Nella M. Vargas-Barbosa](#) ✉

*Nature Nanotechnology* 19, 419–420 (2024) | [Cite this article](#)

4735 Accesses | 10 Altmetric | [Metrics](#)

Editorial | [Free Access](#)

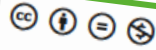
## Ten Ways to Fool the Masses When Presenting Battery Research\*\*

Prof. Patrik Johansson ✉ Dr. Sajid Alvi, Pedram Ghorbanzade, Martin Karlsmo, Dr. Laura Loaiza, Dr. Vigneshwaran Thangavel, Kasper Westman, Fabian Arén

First published: 01 October 2021 | <https://doi.org/10.1002/batt.202100154> | Citations: 9

\*\* Heavily inspired by and a homage to Ref. [1]. Editorial note: This Editorial article is written in a humorous tone and has been peer reviewed. It should not be taken as literal advice by the scientific community.

Research Article | [Open Access](#)

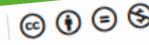


## Round-robin test of all-solid-state battery with sulfide electrolyte assembly in coin-type cell configuration

Alexander Beutl ✉ Ander Orue ✉ Pedro López-Aranguren, Andrea Itziar Pitillas Martinez, Maria Helena Braga, Ville Kekkonen, Artur Tron ✉

First published: 29 March 2024 | <https://doi.org/10.1002/elsa.202400004>

Research Article | [Open Access](#)



## Potential and Limitations of Research Battery Cell Types for Electrochemical Data Acquisition

Dr. Anna Smith ✉ Dr. Pirmin Stüble, Dr. Lea Leuthner, Dr. Andreas Hofmann, Dr. Fabian Jeschull, Liuda Mereacre

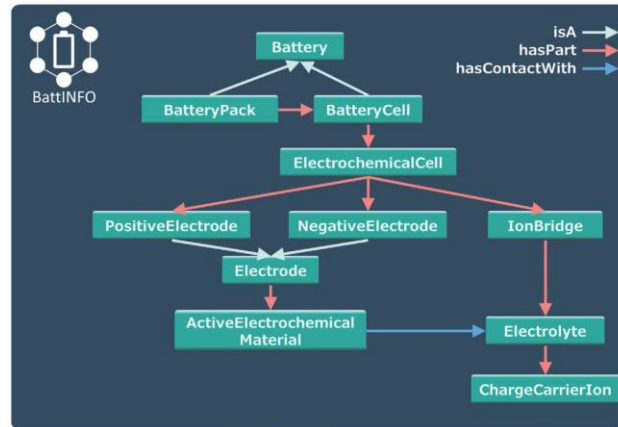
First published: 20 March 2023 | <https://doi.org/10.1002/batt.202300080> | Citations: 4

- Compare results from different “competing” labs
- Compare results from different collaborating labs
- **Boost collaboration & innovation**



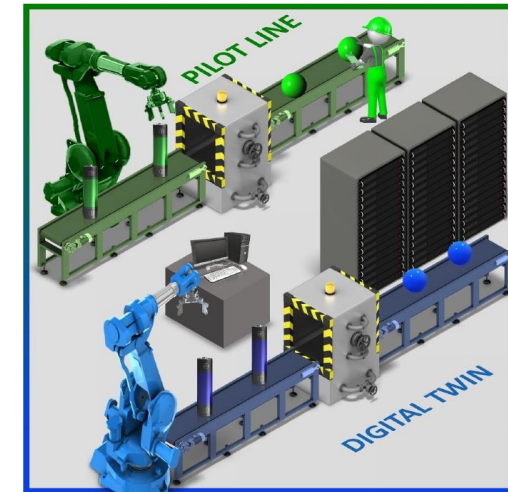
# Best Practices for standard protocols for theory and experiment

## Ontologies & Dynamic DMPs



Clark et al., *Adv. Energy Mater.* (2021) 2102702

## Modelling & Digital Twins



DEFACTO / LiPlanet

Underlying data must be not only FAIR but FAIR<sup>4</sup>

# Best Practices – Battery2030PLUS

## FAIR<sup>4</sup> Data:

- F - Findable
- A - Accessible
- I - Interoperable
- Reusable
- R<sup>4</sup>** - Reproducible
- Reliable
- Relevant



Data  
„Quality“





# BATTERY 2030+ Memorandum on Research Standards and Guidelines

**120 Signatures from  
56 Affiliations**

**Read and Sign the  
Memorandum today:**



Combined, RDM tools and standardisation will not only improve the general quality of research within BATTERY 2030+ and enable the FAIR\* data principles. More importantly, the collaboration will be possible on entirely new levels, allowing for a novel, autonomous research approaches, accelerated materials discovery, and data-based research in a field that has thus far mostly adhered to classical trial and error research.



Read [BATTERY 2030+ Memorandum on Research Standards and Guidelines](#).

Endorse BATTERY 2030+ Memorandum by sending an email to [battery2030@uu.se](mailto:battery2030@uu.se) including your full name and affiliation or fill out this form below.

Your name

Your email

Affiliation

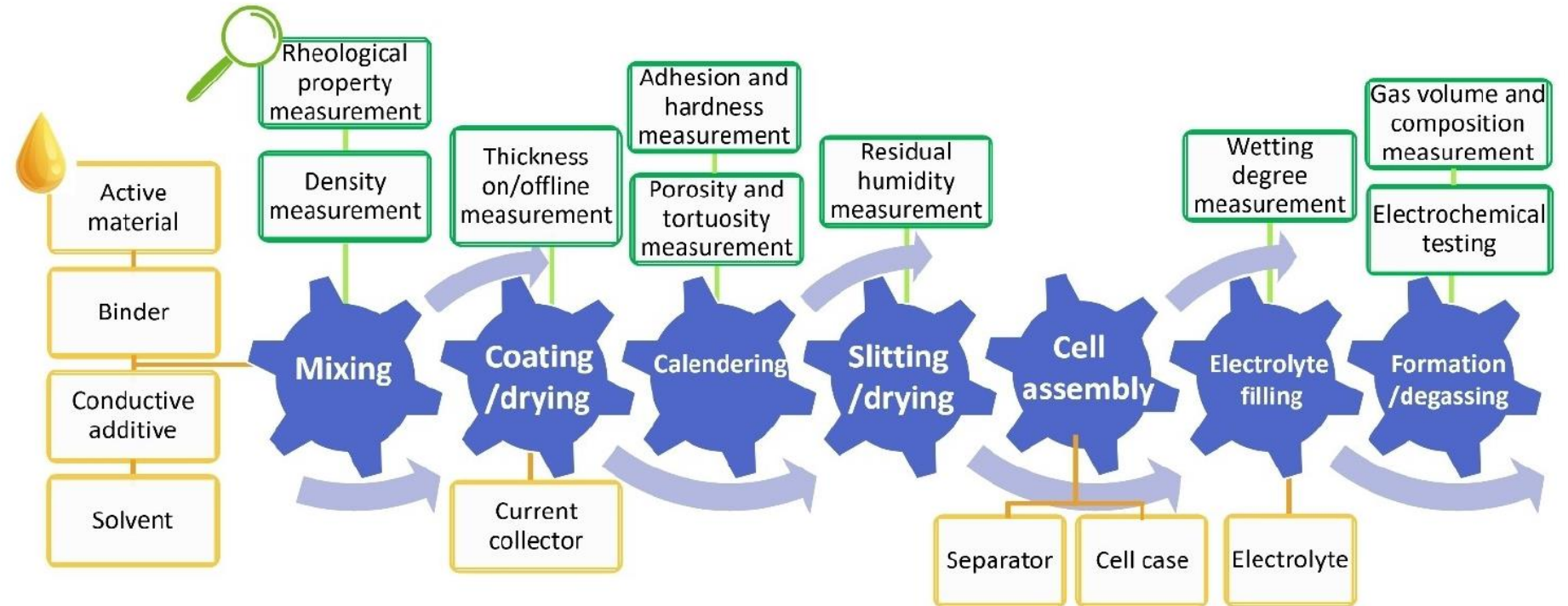
Submit

\*FAIR data stands for **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

<https://battery2030.eu/research/research-data-management-rdm-standards/>

# Protocols & Standards

- Key Performance Indicators (KPIs) & Process Parameters (PPs) along the R&D process chain for batteries – FOCUS ON CELL FABRICATION

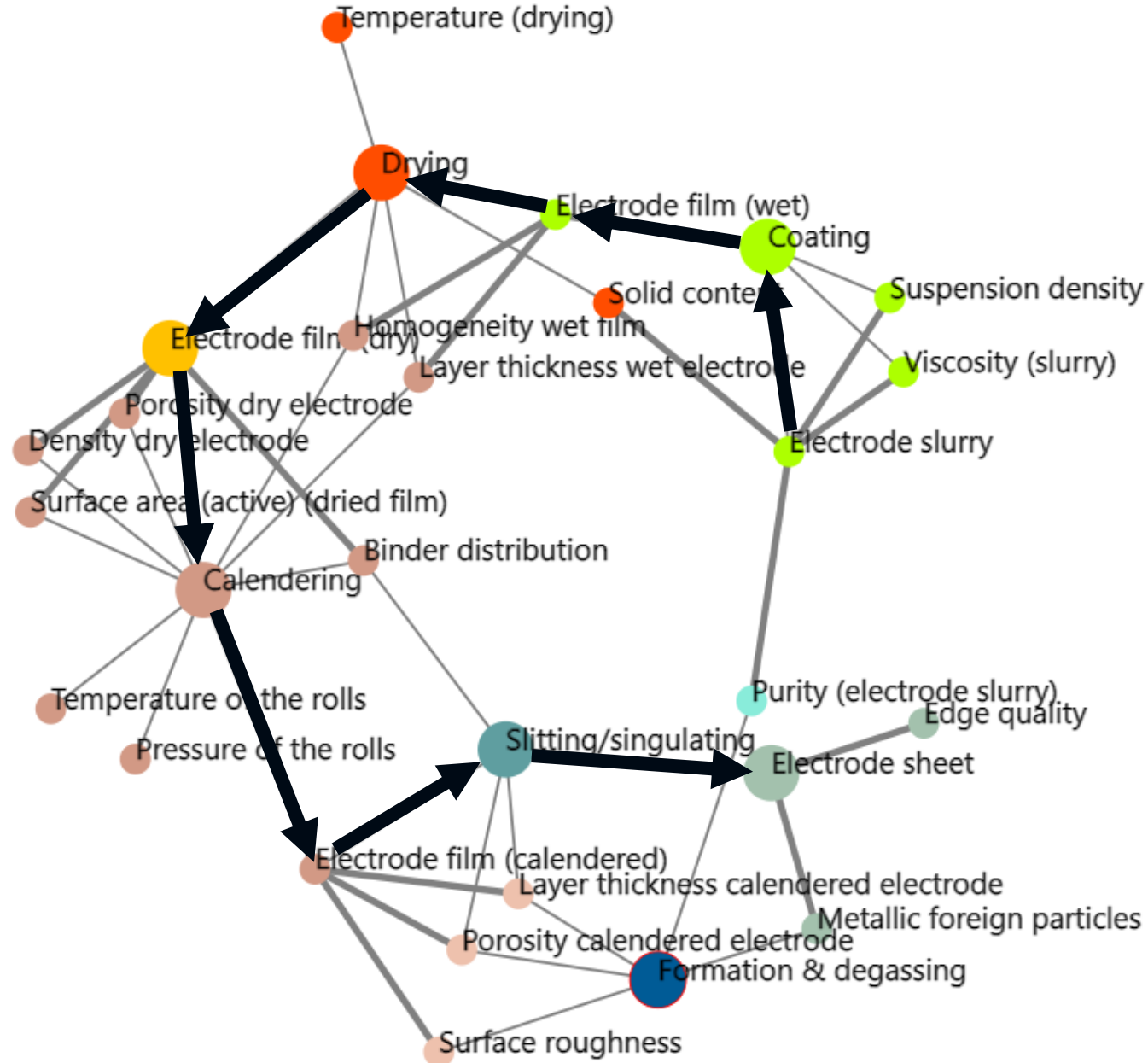


From: F.M. Zanotto et al. "Data Specifications for Battery Manufacturing Digitalization", Batteries & Supercaps (2022) e202200224





# Protocols & Standards



## OVERALL NETWORK:

- 150+ KPIs and PPAs
- Each associated with method of measurement
- Data & Metadata
- Protocols and procedures
- Blank Detail Specifications

## HUGE TASK!

- Focus on pilot activities and best practice examples



# Protocols & Standards

**Extract from full data base:**

**Calendering process, KPIs of calendered electrode**

Selection of 3 KPIs w/ connection to several subsequent steps

| KPI   | PP 1 for                      | PP 2 for              | PP 3 for         | Measurement technique                     |
|---|-------------------------------|-----------------------|------------------|---|
| <b>Layer thickness calendered electrode</b> | Slitting/singulating          | Post Drying           | Electrochemistry | Thickness gauge, SEM, Laser triangulation |
| <b>Porosity calendered electrode</b>        | Electrolyte filling & sealing | Formation & degassing | Electrochemistry | Laser triangulation, mercury porosimetry  |
| <b>Surface roughness</b>                    | Formation & degassing         | Electrochemistry      |                  | SEM, Reflectometer                        |

Let's take a look at the complete network of process steps, KPIs and PPs...





# BATTERY 2030+ Knowledge base (1.0) for standards and protocols in battery research & development



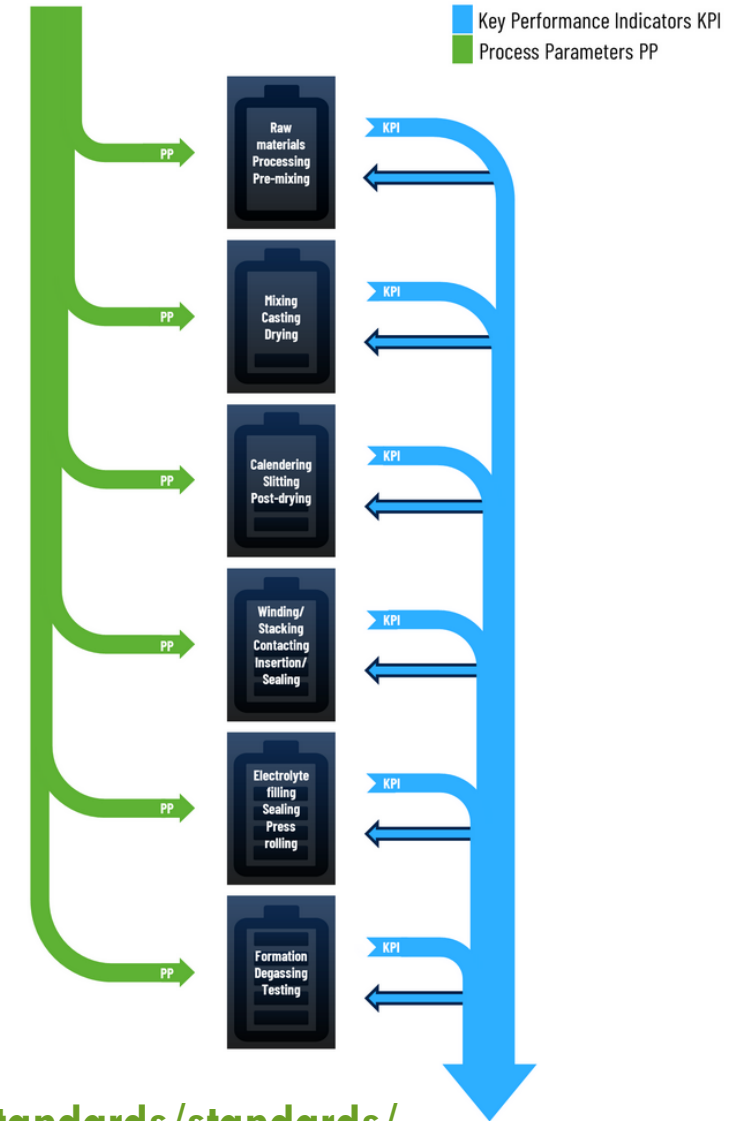
- Only desktop version running at the moment

<https://www.celest.de/en/or/layer1>

<https://battery2030.eu/research/research-data-management-rdm-standards/standards/>

Quick-access processes:

|                                   |
|-----------------------------------|
| 00. Mining/Recycling/Synthesis    |
| 01a. Processing                   |
| 01b. Processing                   |
| 01c. Processing                   |
| 02. Pre-mixing                    |
| 03. Mixing                        |
| 04. Casting                       |
| 05. Drying                        |
| 06. Calendering                   |
| 07a. Slitting/Singulating         |
| 07b. Slitting/Singulating         |
| 08. Post-drying                   |
| 09. Winding/Stacking              |
| 09L. Lab scale assembly           |
| 10. Contacting                    |
| 11. Insertion & Pre-sealing       |
| 12. Electrolyte filling           |
| 13. Sealing                       |
| 14. Press rolling                 |
| 15. Formation                     |
| 15L. Formation (lab scale)        |
| 16. Degassing                     |
| 17. Electrochemistry              |
| 17L. Electrochemistry (lab scale) |



## Work together with Fraunhofer ISC and SINTEF: BATTERY 2030+ Knowledge base (2.0)

### Previous Work:

- Open Semantic Lab: <https://github.com/OpenSemanticLab>
- KIproBatt Project Wiki: [https://kiprobatt.de/wiki/Main\\_Page](https://kiprobatt.de/wiki/Main_Page)
- EMMO Ontologies [https://onto-wiki.eu/wiki/Main\\_Page](https://onto-wiki.eu/wiki/Main_Page)
- BattINFO <https://github.com/BIG-MAP/BattINFO>



### Work together:

- Knowledge Base 2.0 on Open Semantic Lab:
- [https://battery.knowledge-graph.eu/wiki/Main\\_Page](https://battery.knowledge-graph.eu/wiki/Main_Page)

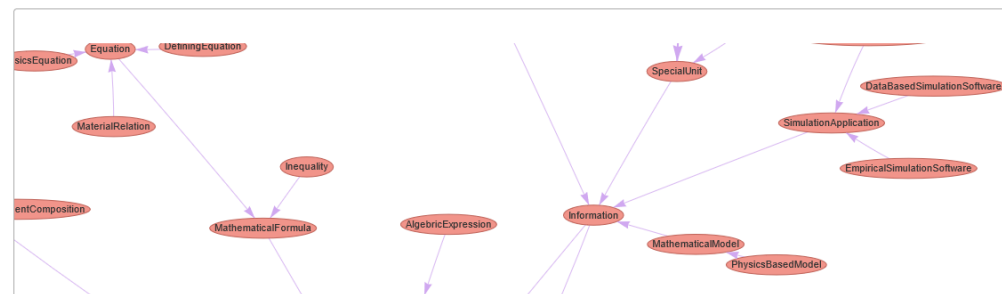
➔ **Live Demo**

#### EMMO Ontologies Overview

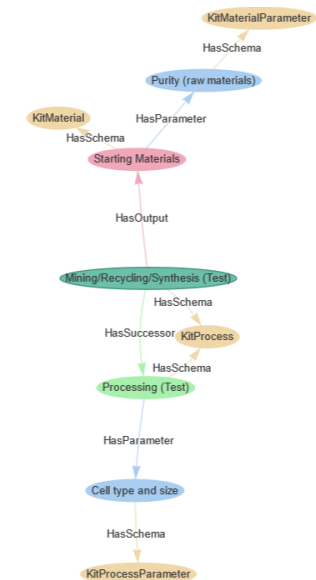
Subclass-Graph contains 8 levels of [EMMO \[1\]](#), [GPO \[2\]](#), [BattINFO \[3\]](#) and [BVCO \[4\]](#)

Use case for presentation and demonstration: [Battery Data Annotator](#)

**Right-click** on a node to navigate to its documentation page.



### Battery Knowledge Base





# What comes next?

- **Filling of the knowledge base with more content on measuring techniques**
  - **Including the BATTERY 2030+ community into the review process of the knowledge base**
    - Harmonisation with existing ontology work in BIG MAP and BATTERY 2030+
    - Link knowledge base to BIG MAP ELN, Kadi4Mat ELN, etc.
    - Direct input from research community
  - **Encouraging the BATTERY 2030+ community to use and further improve the knowledge base in a collaborative way**
    - Link relevant research papers
    - Link relevant standards
    - **Agree on common standards within the consortium**
    - Best practice guides, technical reports, technical specifications
- **Boost collaboration & innovation**



## Q&A

- **Add your questions in menti**
- **Raise your hand if you want to be unmuted**

