BATTERY 2030+

At the heart of a green and connected society

A Large-Scale Research Initiative on Future Battery Technologies

Coordinator: Prof. Kristina Edström, Uppsala University, Sweden

Deputy Coordinator: Dr. Simon Perraud, CEA, France

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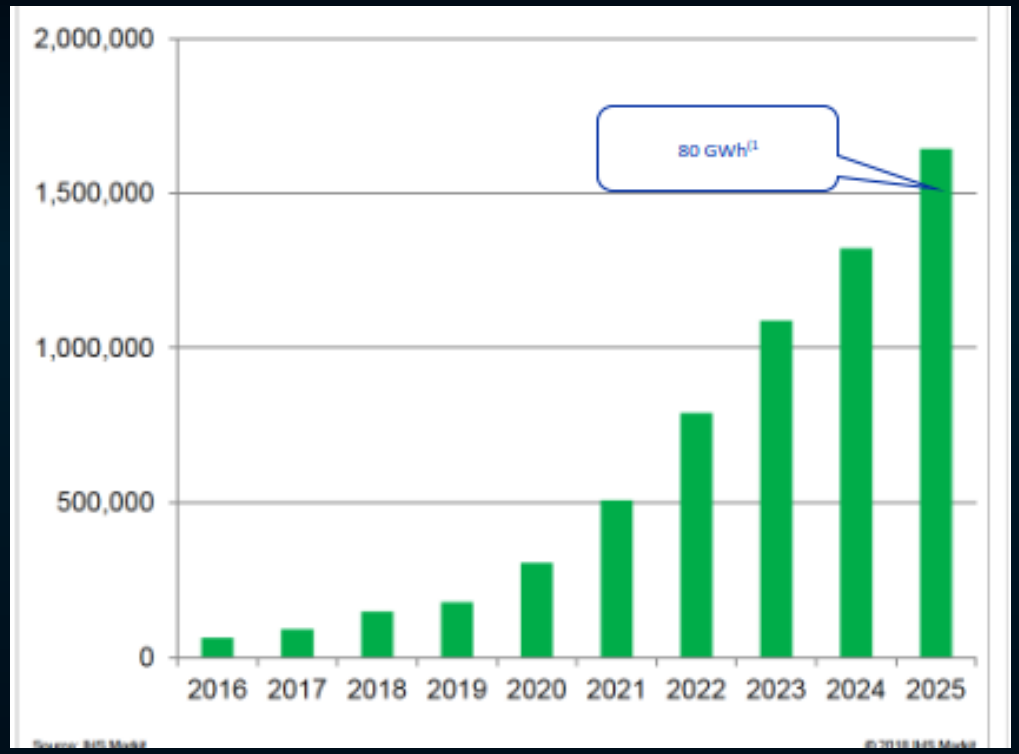
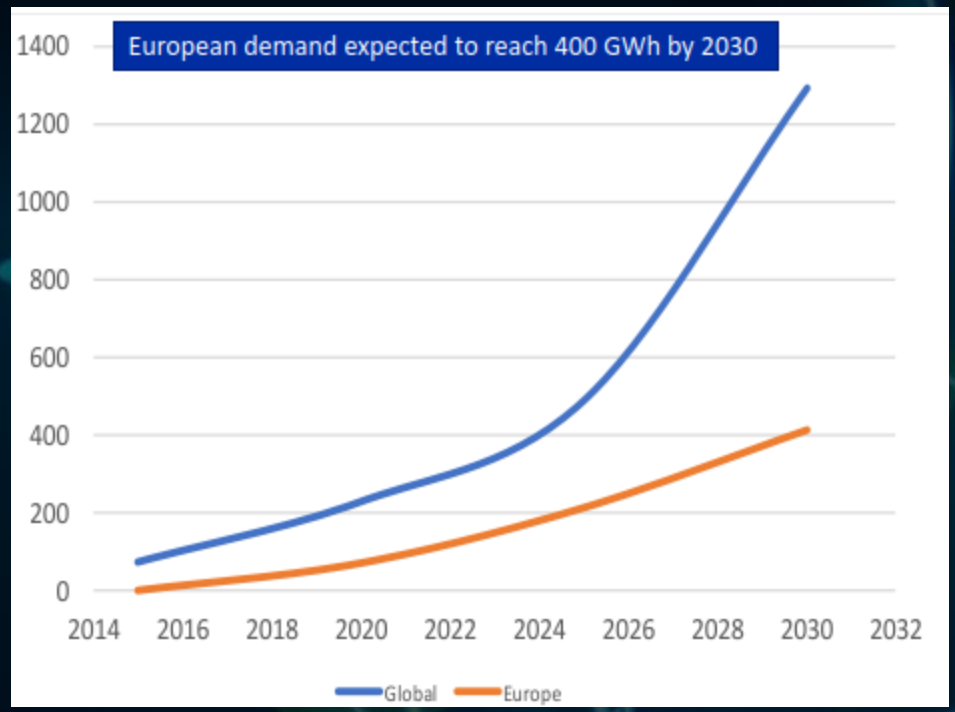
DRIVERS FOR BATTERY RESEARCH

Transport sector, large scale storage, UPS and grid quality



The expected increase in number of electric vehicles (EVs)



The cost of the Li-ion batteries is decreasing

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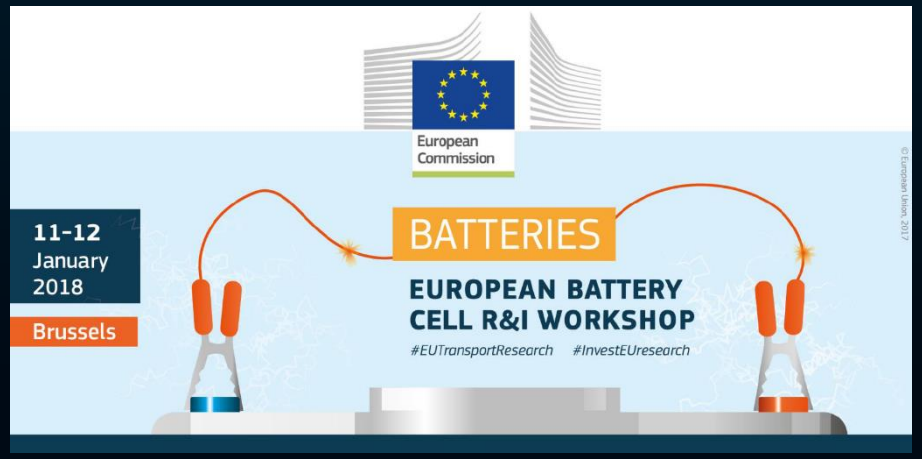
DRIVERS FOR BATTERY RESEARCH

BACKGROUND



October 11, 2017
Launch of the European Battery Alliance by Vice-President Maroš Šefčovič

January 11-12, 2018
Workshop organized by DG RTD

Short- & medium-term R&I priorities (market introduction starting from 2025):

- advanced Li-ion batteries
- solid-state Li-ion batteries
- > 400 Wh/kg, > 750 Wh/L (SET-Plan targets)

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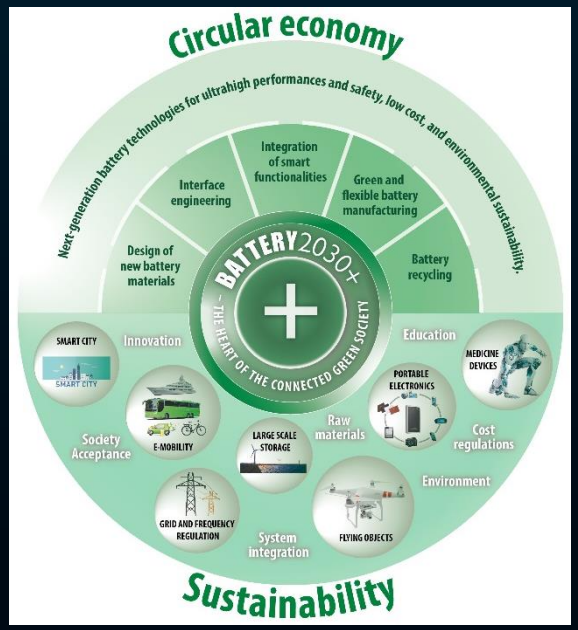
THE FIRST STEPS

European Commission

Future and Emerging Technologies

Workshop on Future Battery Technologies for Energy Storage

Towards a large scale EU R&D initiative in future battery technologies



January 10, 2018
Workshop organized by DG CONNECT, with the participation of DG RTD and JRC

Long-term R&I priorities (market introduction starting from 2035)

« *The EC called on all the research actors in Europe (…) to deliver a commonly agreed long term research agenda for such an ambitious large-scale research initiative* »

EBA: InnoEnergy work shop

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OVERALL GOAL – TO MEET THE UN SUSTAINABILITY GOALS

BATTERY 2030+

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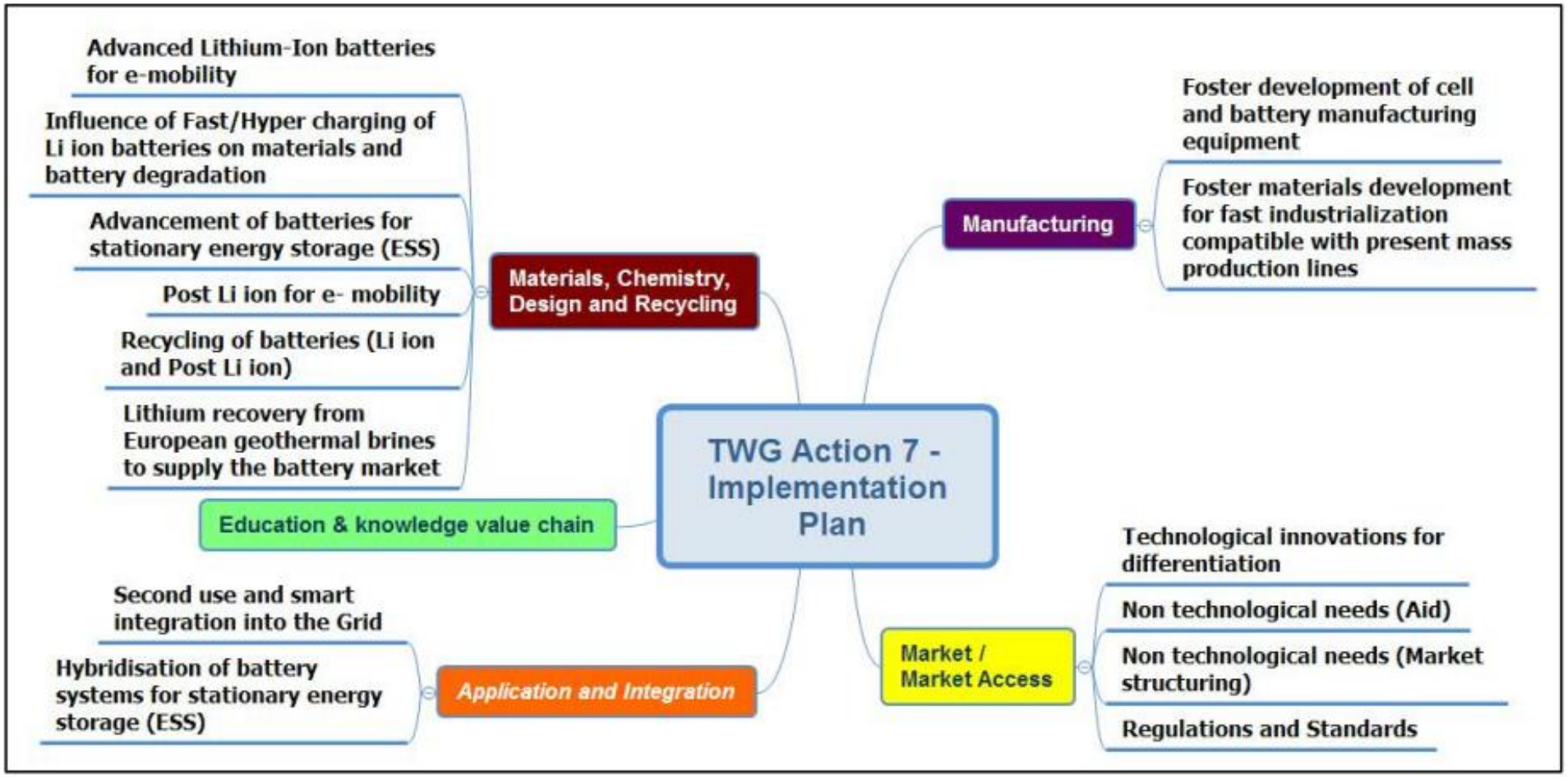
SET PLAN 7 IMPLEMENTATION



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The European b**attery R&I landscape**

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A LONG-TERM RESEARCH INITIATIVE IN THE BATTERY R&I LANDSCAPE

TRL 1 TRL 2 TRL 3 TRL 4 TRL 5 TRL 6 TRL 7 TRL 8 TRL 9

Scope	Long-term research	Short-to-medium term research	Industrialization
Actors	The European Battery Community	HORIZON 2020 / Horizon Europe	European Battery Alliance
Roadmap	**A long-term research roadmap (FETPROACT-04-2019 CSA)**	SET-Plan	Industrial roadmaps

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BATTERIES EUROPE

BATTERY 2030+

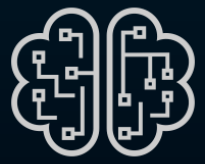
EXECUTIVE SUMMARY

The BATTERY 2030+ **initiative at a glance**

BATTERY 2030+ - A LONG-TERM RESEARCH INITIATIVE

- Inventing the batteries of the future
- Providing breakthrough technologies to the European battery industry across the full value chain
- Enabling long-term European leadership in both existing markets (road transport, stationary energy storage) and future emerging applications (robotics, aerospace, medical devices, internet of things, …)

Ultrahigh performances



Smart functionalities

Environmental sustainability

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A LONG-TERM BATTERY RESEARCH ROADMAP – SO FAR

- Long-term objectives:
  - Energy & power densities approaching the theoretical limits
  - Outstanding lifetime & reliability
  - Enhanced safety
  - Environmental sustainability
  - Cost effectiveness
- Specific research areas contributing to the objectives:
  - Accelerated battery material discovery & interface engineering
  - Smart sensing & self-healing functionalities
  - Open to ideas for new research areas!
- Cross-cutting research areas:
  - Manufacturability
  - Recyclability

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BATTERY 2030+ – A FULL RESEARCH ECO-SYSTEM

New battery cell designs and battery chemistries

Establish the "Battery Interface Genome"

Accelerate the materials discovery process with AI

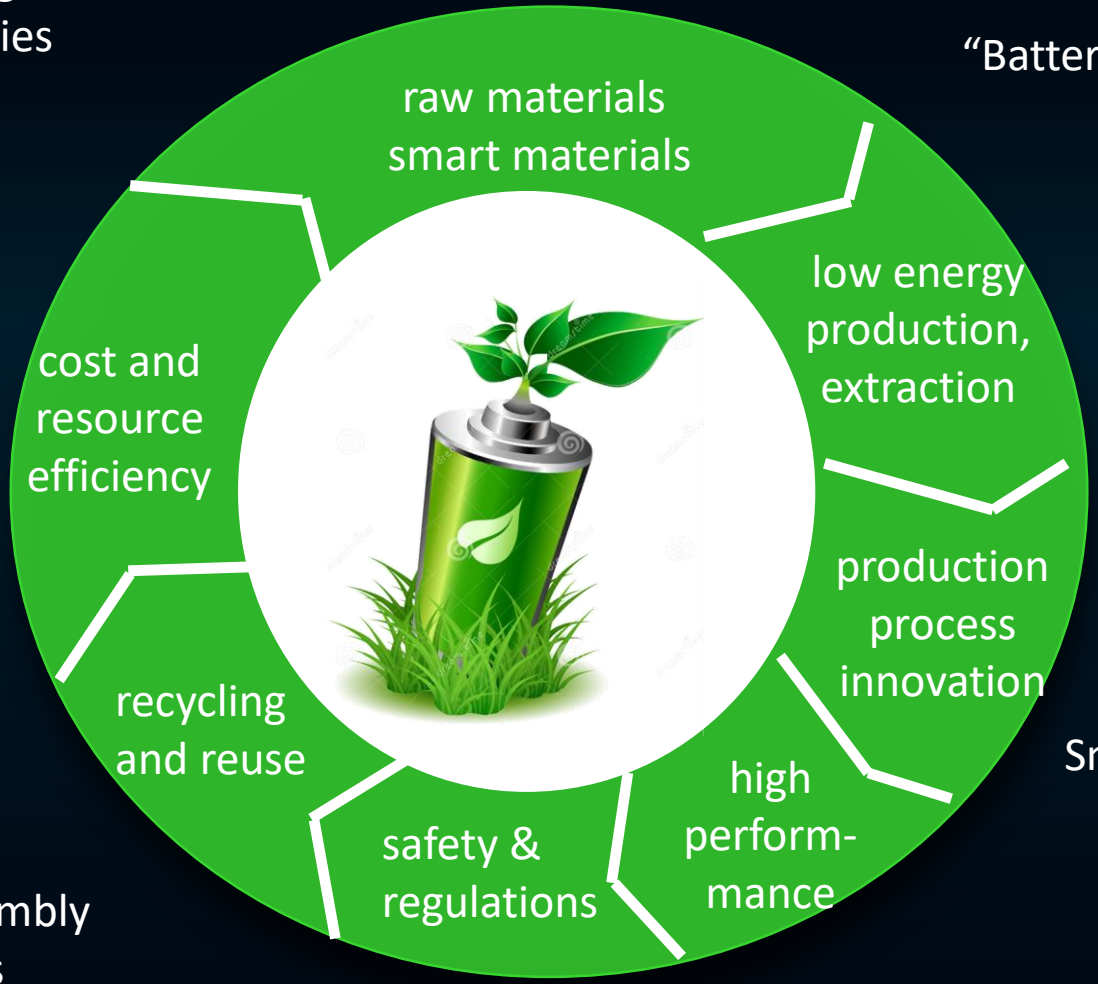
Green manufacturing w/ closed-loop material cycle

New battery cell designs lead to new packs and modules

Smart batteries with self-healing and sensors

Cost effective disassembly of cells and packs

Regulatory issues



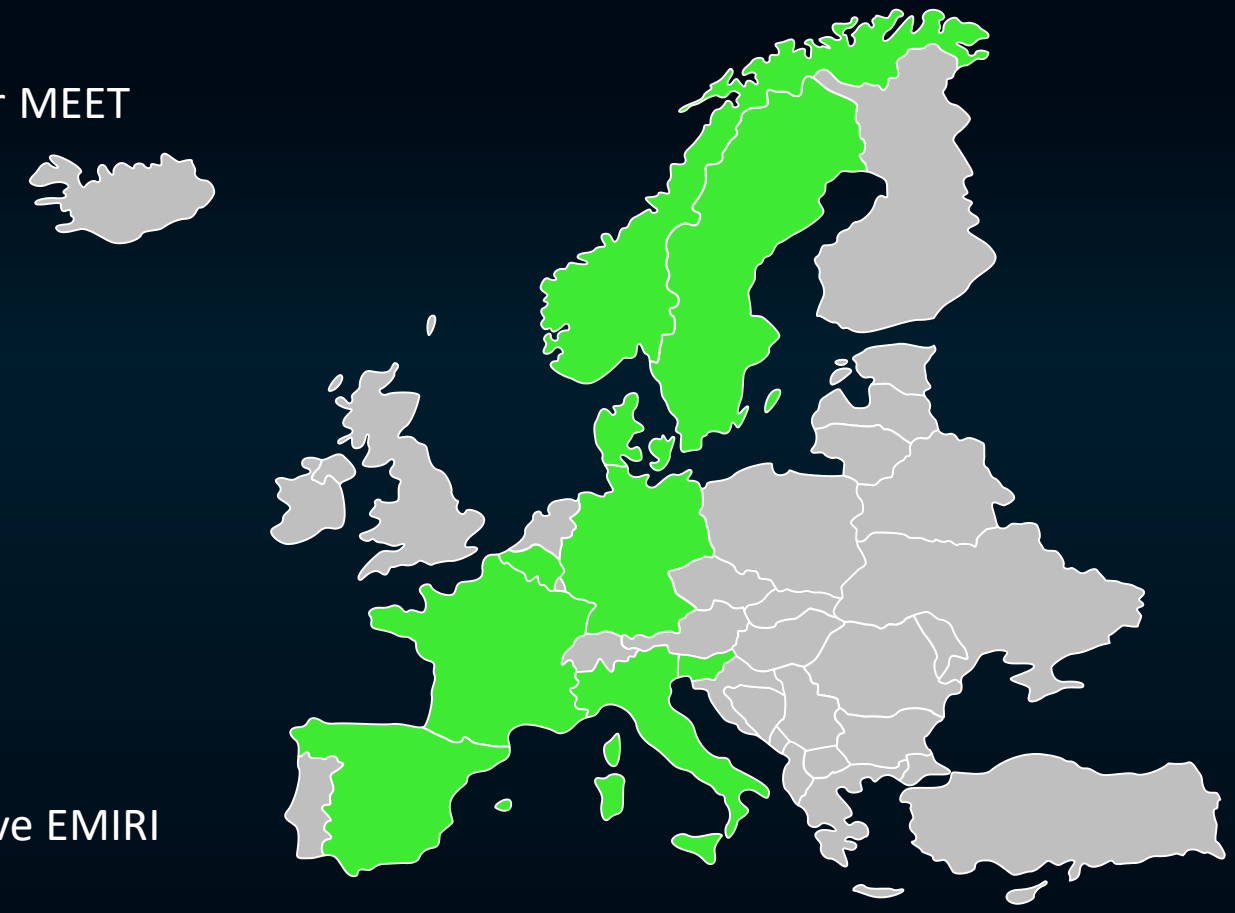
BATTERY 2030+

BATTERY 2030+

Core Group

CORE GROUP

- **Uppsala University, coordinator**
- Westfälische Wilhelms Universitaet Münster MEET
- Forschungszentrum Jülich GMBH FZJ
- Politecnico di Torino POLITO
- Kemijski Institut
- Vrije Universiteit Brussels VUB
- RECHARGE
- CEA
- Technical University of Denmark DTU
- Fundacion CIDETEC
- Sintef AS
- CNRS
- Energy Materials Industrial Research Initiative EMIRI
- Fraunhofer-Gesellschaft FhG
- Karlsruher Institut für Technologie KIT
- European Association for Storage of Energy EASE



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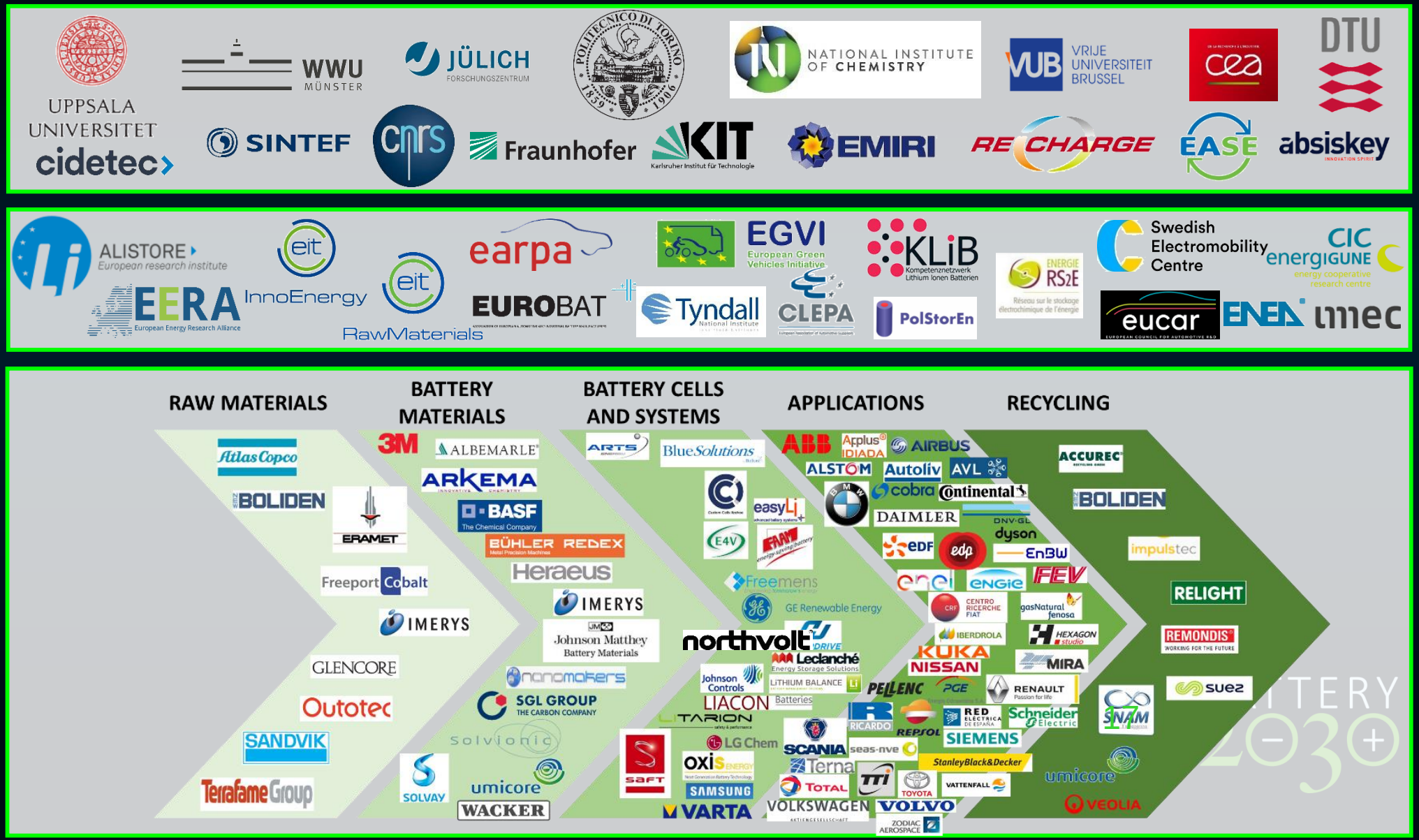
STAKEHOLDER SUPPORT

Core group

Supporting organizations

Industry (90+ companies belonging to the core or supporting organizations)



BATTERY 2030+

Coordination Support Action (CSA)

THE BATTERY 2030+ CSA

CSA kick-off meeting Tuesday, March 26th

BATTERY 2030+ CSA project global objective is to prepare a long-term research roadmap for disruptive, ultra-high performance, sustainable and smart electrochemical energy storage technologies, which will provide a competitive edge to the European battery industry value chain beyond 2030. The BATTERY 2030+ CSA project is based on coordinating efforts of the relevant stakeholders, notably academia, RTOs, and industry.

Objective 1: Establish the BATTERY 2030+ roadmap

Objective 2: Propose R&I actions

Objective 3: Get official stakeholder support for the BATTERY 2030+ roadmap

BATTERY 2030+

THE MANIFESTO

- Read the full Battery 2030+ manifesto at www.battery2030.eu
- Please go in and ENDORSE the initiative!

By endorsing you will be invited to influence the content in the roadmap and you will be invited to our roadmap workshop.

Make your own country visible!

BATTERY 2030

UPCOMING CALLS

1) Materials Acceleration Platform 20 M Euro for one project
2) Sensors 10 M Euro for several 2-4 M Euro projects
3) Self-healing 10 M euro for several 2-4 M Euro projects
4) **M-ERA NET 5M Euro from the commission and at least 10 M Euro from member states - A COMPLEMENTARY PROJECT**

Competences in materials, characterisation, modeling at different length-scales, sensors, AI, machine learning, polymer chemistry, recyling, BMS, how to adapt batteries in an application, etc…

BATTERY 2030+

ACCELERATED BATTERY MATERIAL DISCOVERY & INTERFACE ENGINEERING

MATERIALS ACCELERATION PLATFORM
Self-driving laboratory for autonomous discovery and optimization of materials and interfaces

10× acceleration of the development cycle

Energy & power densities approaching the theoretical limits

Outstanding lifetime & reliability

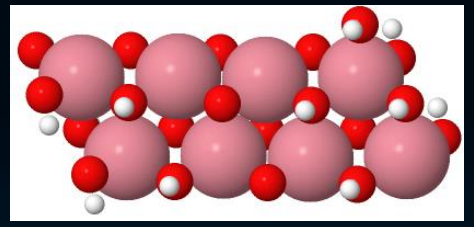
BATTERY 2030+

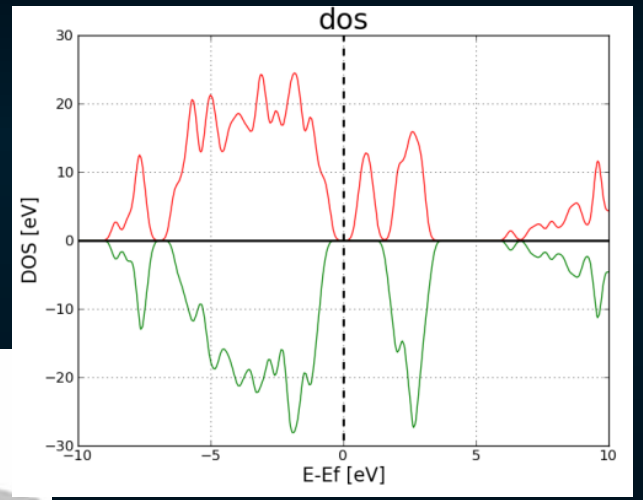
FROM DESCRIPTIVE TO PREDICTIVE ACCURACY

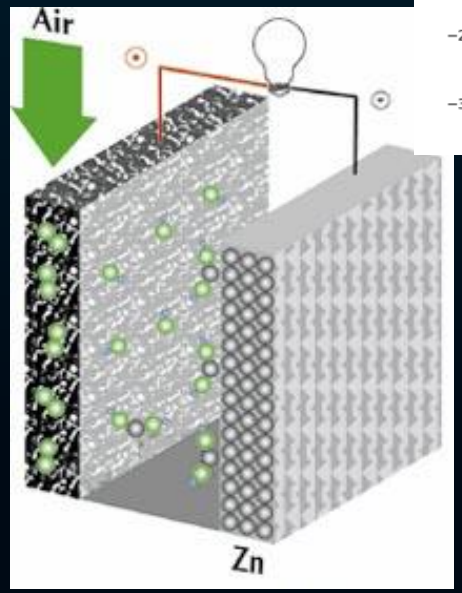
Structure, composition

Electronic structure

Functionality

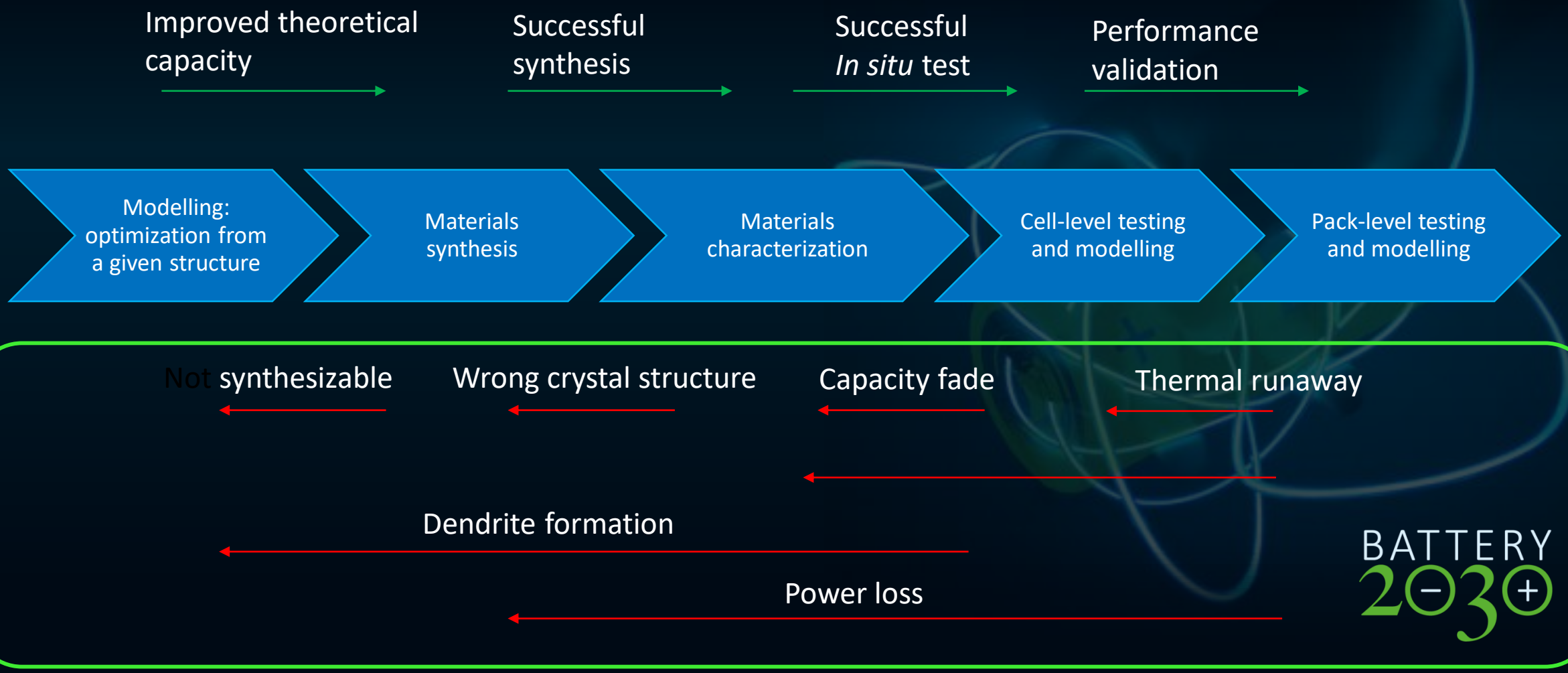




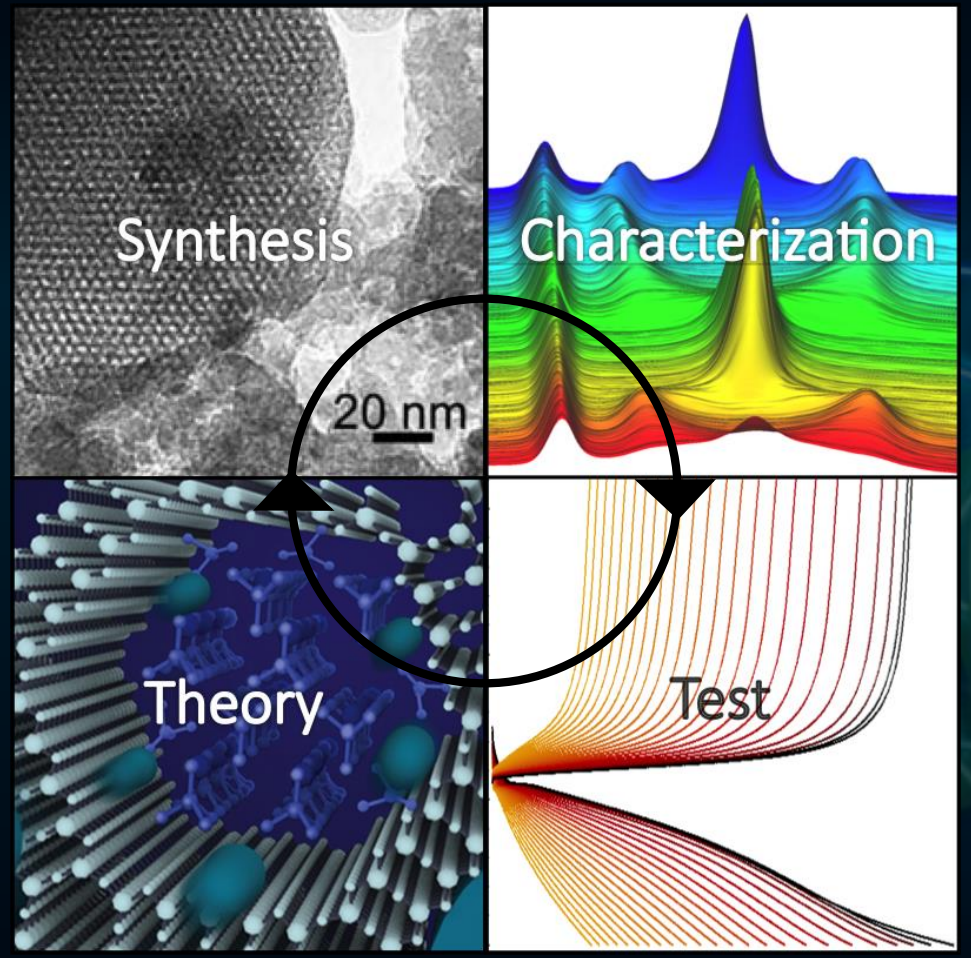


BATTERY 2030+

MODELLING IN TRADITIONAL BATTERY DEVELOPMENT



STATE-OF-THE-ART: A CIRCULAR DESIGN LOOP



BATTERY 2030+

INSTEAD IN BIG-MAP

- Transitioning from Edisonian and sequential battery development to autonomous discovery of ultra-high performance battery materials and interfaces
- Establish an autonomous battery Materials Acceleration Platform (BIG-MAP)
- AI-orchestrated acquisition and utilization of data from DFT and multi-scale simulations, automated synthesis, machine learning and high throughput experiments, sensors and tests to accelerate the discovery process
- Establish novel methodologies for inverse design of battery materials and interfaces/interphases, e.g. hybrid physics aware data-driven models using semi-supervised Deep Generative Learning
- Integrate European cross-sectorial strongholds in battery materials, computational modeling, AI, automated synthesis robotics, operando characterization, manufacturing and applications
- BIG-MAP should bridge across academia, research institutes, industry and end-users

BATTERY 2030+

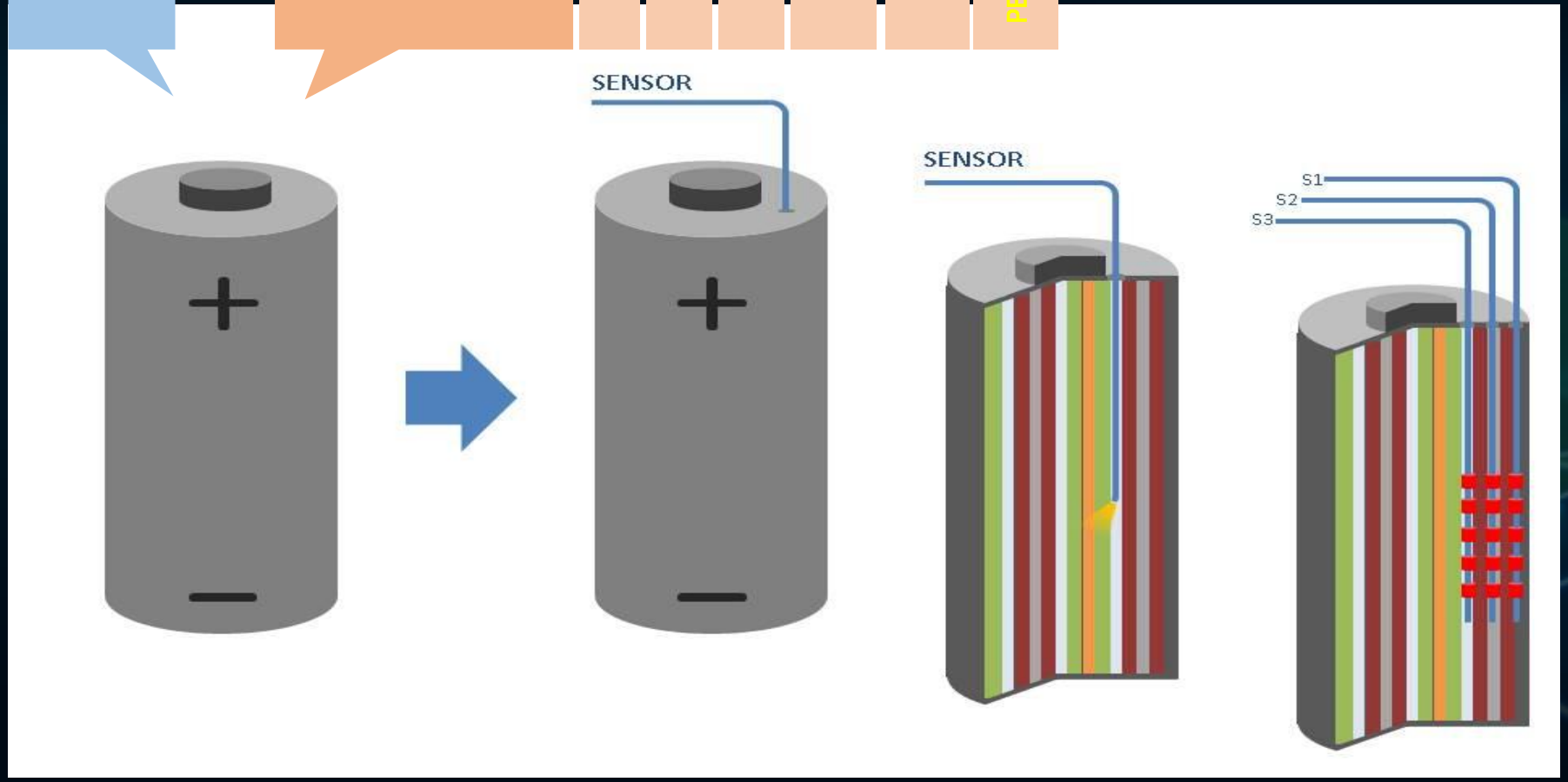
SMART SENSING

E, i, R

What else?

T | ε | σ | [x] | SEI | PERCOLATION

Spatially and time resolved sensing down to the battery cell level



- Outstanding lifetime and reliability
- Enhanced safety
- Environmental sustainability (second life)

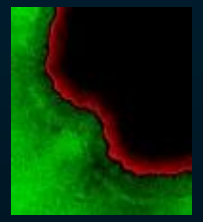
BATTERY 2030+

SELF-HEALING

Sensors also serve to identify defective components and local spots in the cell that need to be repaired

→ Develop self-healing processes

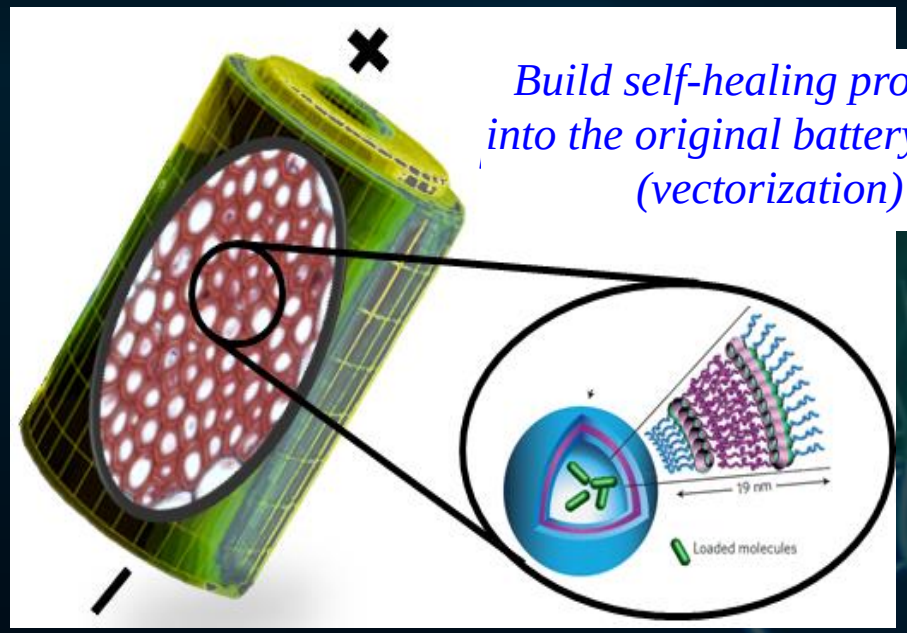
Electrode recovered by an SEI



(Prevents the crossing of Li^+)

Clogged artera by cholesterol

(Prevents blood circulation)



Build self-healing processes into the original battery design (vectorization)

Batteries 2030+ could be the driver to launch this revolutionary era of rechargeable batteries taking advantage of self-healing via the use of proper chemical processes

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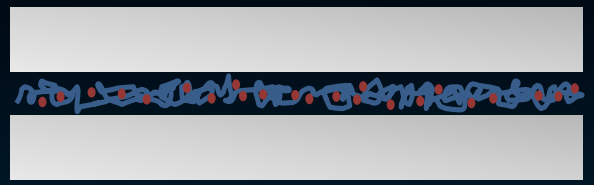
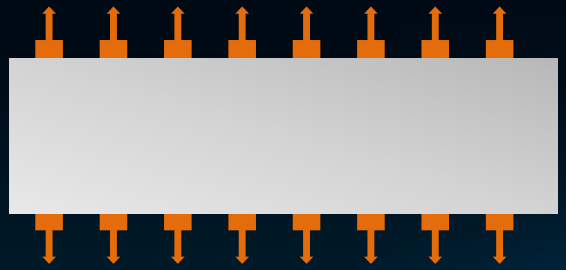
SELF-HEALING AND SENSING

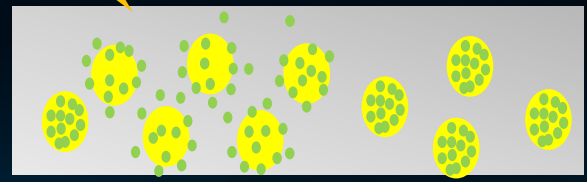
Multilayers



Surface functionalization

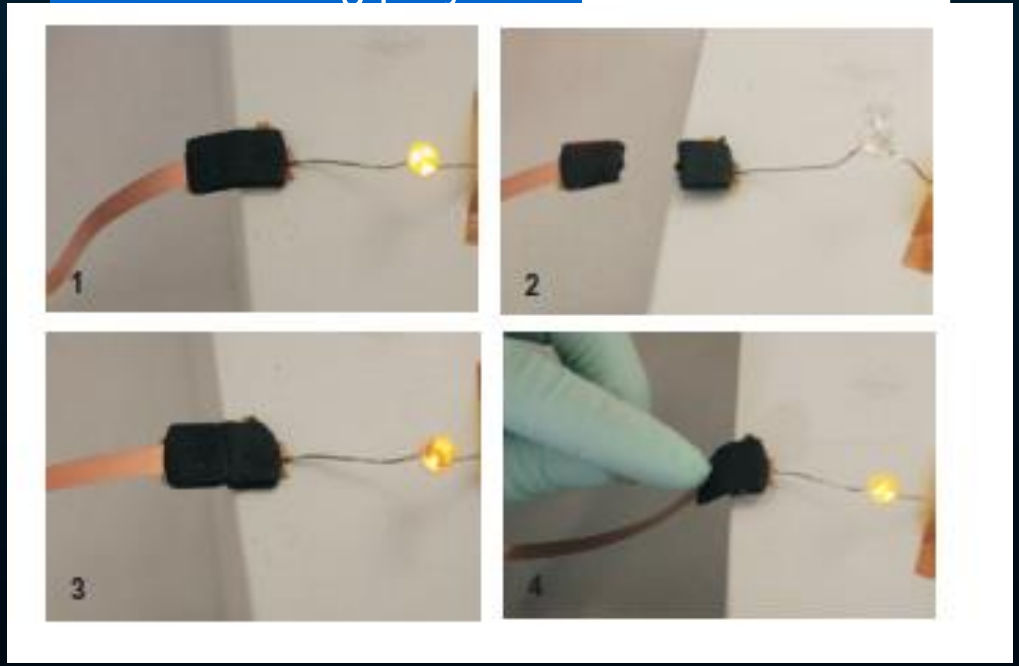


External or internal stimulus

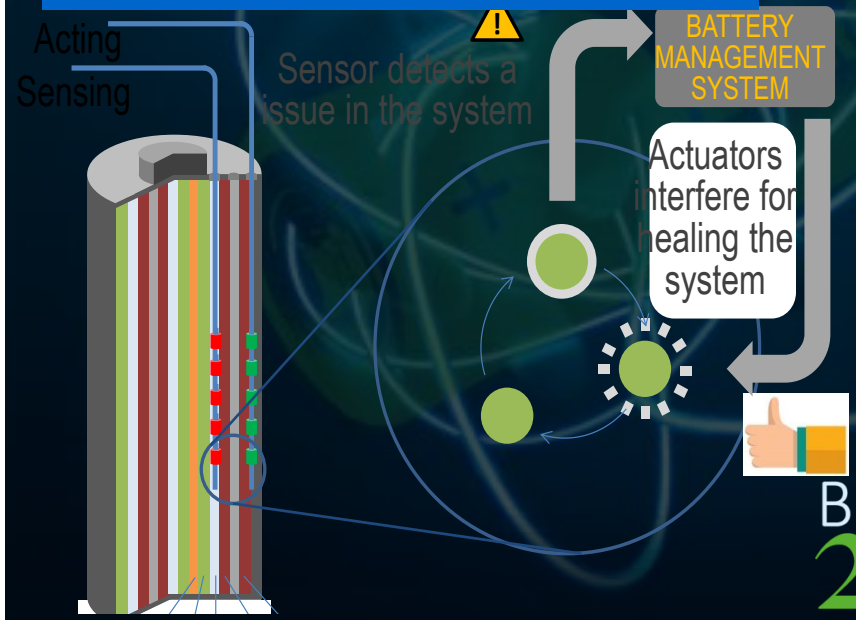


Encapsulated self-healing molecules

❑ Self-healing polymers



❑ Integrated sensing/self-healing



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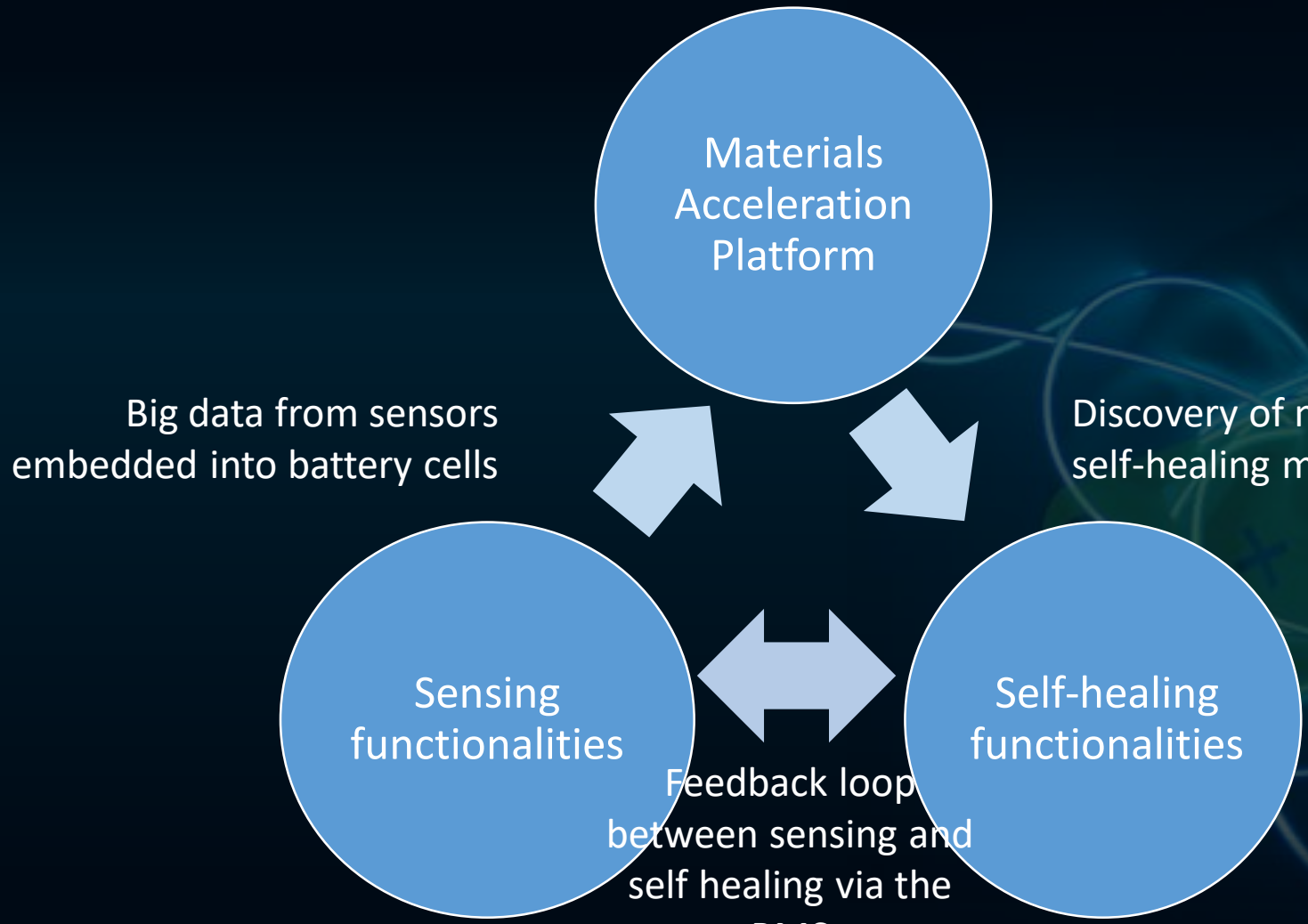
TOWARDS AN INTEGRATED APPROACH FOR THE BATTERIES OF THE FUTURE



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OUTLOOK

- You can influence the future battery research directions in EU
- Those who endorse Battery 2030+ will be invited to the workshops
- An opportunity to influence the roadmap since it will be the basis for future EU calls
- The three calls are open for whole Europe to apply
- There will also be an M-ERA-NET call coming later in 2020 and you are invited to influence the content

http://battery2030.eu

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