BATTERY 2030+ - at the heart of a green and connected society

a large-scale research initiative

Future battery technologies

coordinator: Prof. Kristina Edström, Uppsala University, Sweden
Deputy coordinator: Dr. Simon Perraud, CEA, France

Large interest for batteries in Europe

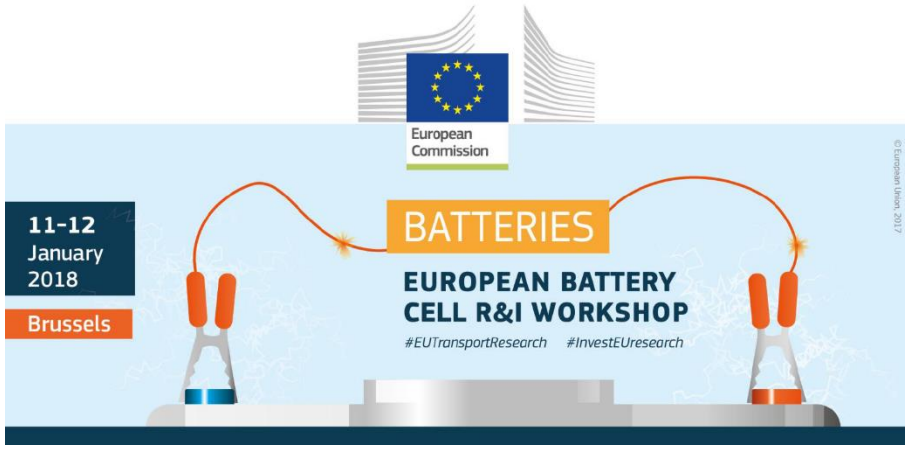
European Battery Alliance

Started October 2017

"*Batteries are at the heart of the industrial revolution and I am convinced that Europe has what it takes to become the world's leader in innovation, decarbonisation and digitisation*." - **Vice-President Maroš Šefčovic**

Background

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

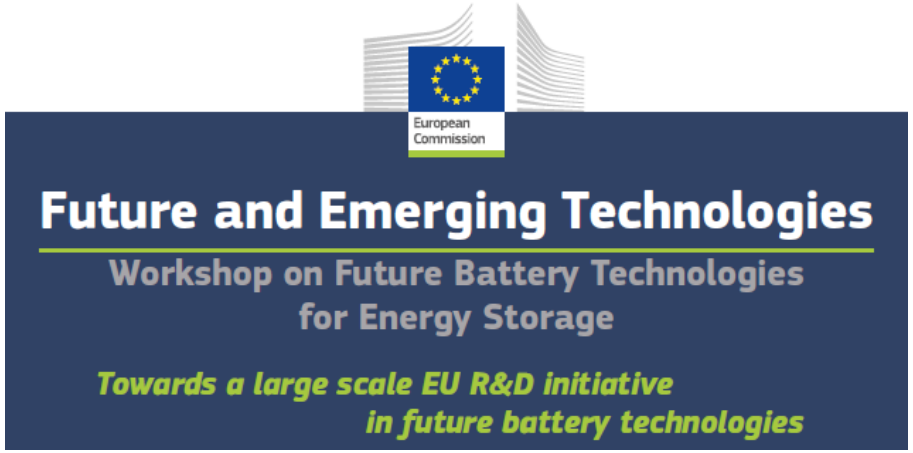


January 11-12, 2018
Workshop organized by DG R&I

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)

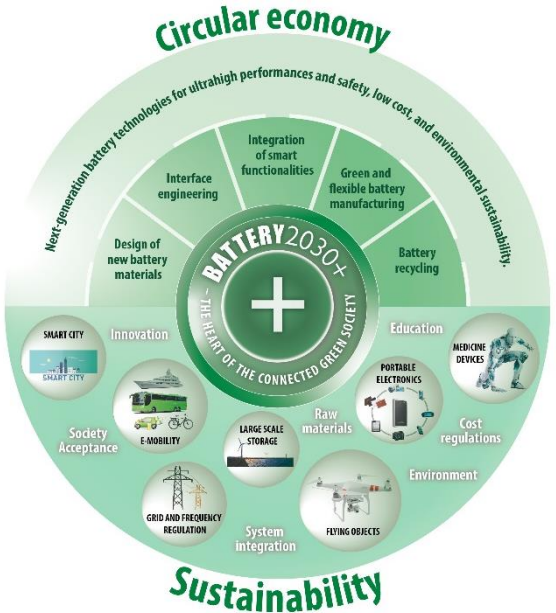
Background



January 10, 2018
Workshop organized by DG CONNECT, with the participation of DG R&I 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

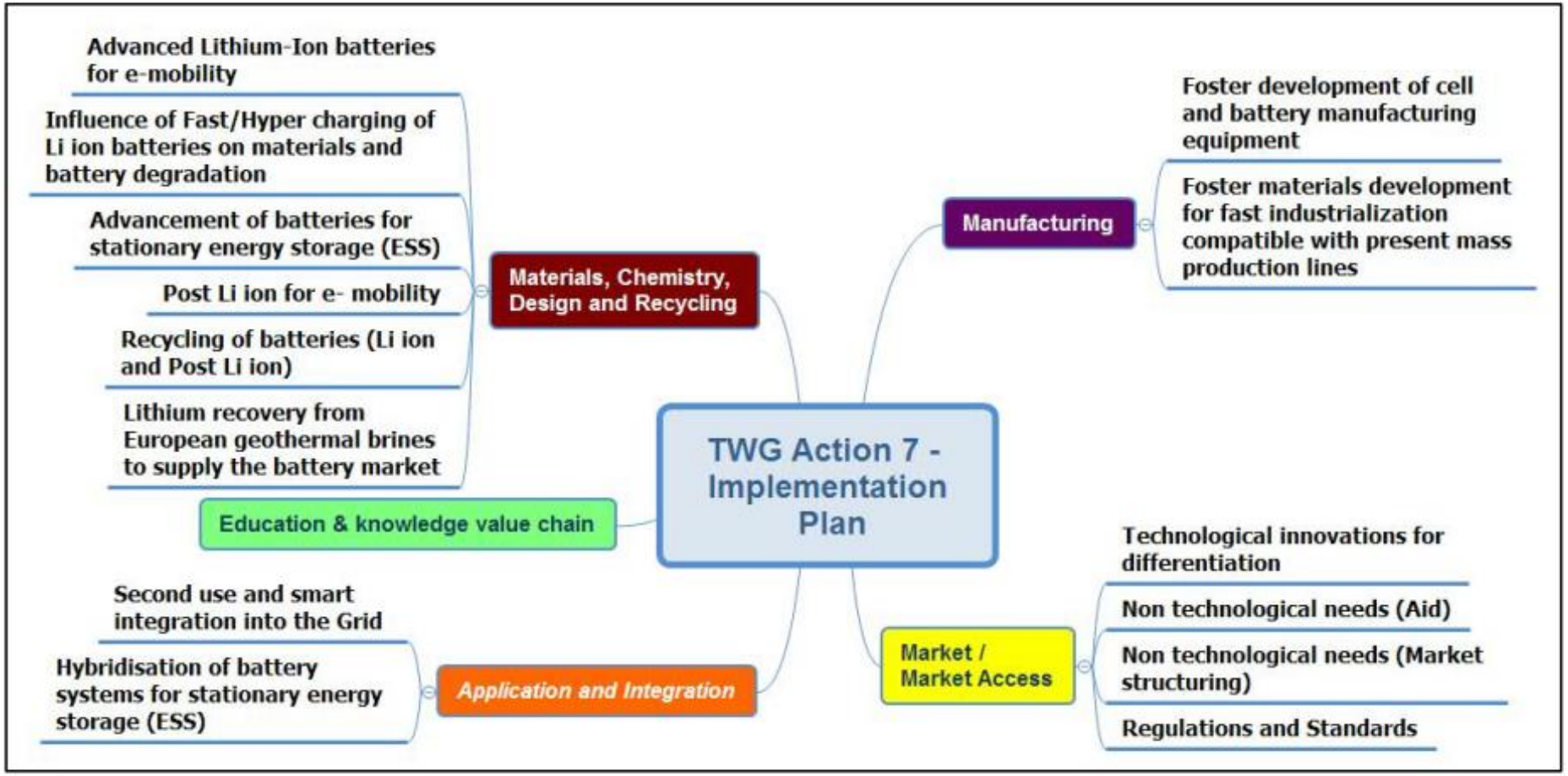
13 b solid state battery – short term program but also longer needed

Overall goal – to meet the UN sustainability goals


SUSTAINABLE DEVELOPMENT GOALS


3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
SUSTAINABLE DEVELOPMENT GOALS

SET PLAN 7 implementation



A long-term research initiative in the battery R&I landscape

BATTERY2030+

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	EERA, ALISTORE European research institute, EGVI European Green Vehicles Initiative, EMIRI, EUROBAT, RECHARGE, earpa, CLEPA, eucar, EASE, eit European Institute of Innovation & Technology, ...	
Roadmap	A long-term research roadmap (FETPROACT-04-2019 CSA)	SET-Plan	Industrial roadmaps

Coordination office

EBA@250: 4th September cumulative ecosystem

Going stronger and stronger

140 attendees

www.innoenergy.com

Raw materials	Active Materials	Battery Cells and Battery Packs	Applications			Recycling/2nd life
			E-mobility	ESS	Ind. applications	
EIT Raw Materials	Nanomakers	Magna Energy Storage	Akasol	VOLKSWAGEN	ENEL	Umicore
Leading Edge Materials	3M	Gigavaasa	Envites Energy	ABB	AVL LIST	Veolia
Outotec	Elkem	Saft	Continental	Ambibox	Cummins	Solvay
EUROMINES	Imerys Graphite & Carbon	Varta	LION Smart	FIAT/Chrysler	TERNA	EBRA
Eramet	Prince Erachem	Leclanché	BMZ	Renault/Nissan	EDF	Revatech- SUEZ
Albemarle	BASF	EAS Batteries	Sonnen GmbH	PKN Orlen	cyberGRID GmbH	
Terrafame	Arkema	Terra E	EoCell Inc	Honda	Epiroc	
Rio Tinto	NXP Semiconductors	Liacon	HE3DA	Jaguar-Landrover	Albufera	
Magnis /Allocate	SGL Carbon SE	Northvolt	Blue Solutions	Rafako	Toyota	
European Metals Holdings	BELENOS	CustomCells		BMW	Manz	
Finnish Minerals Group	CEFIC	KLIB		PSA Groupe	CNH Industrial	
Copperalliance	Heraeus			Ford Motor Company	Elring-Klinger	
Finnish Minerals Group	Nanomakers			Forsee Power	Stihl	
Gov. of Western Australia				VOLVO Car Group	Vattenfall	
Trafigura				Daimler	Total	
Keliber				Husqvarna		
Savannah Resources						
LOTOS						

- Attending company that has been previously engaged
- Attending company that has not previously been engaged
- Company that has been previously engaged, but not attending today

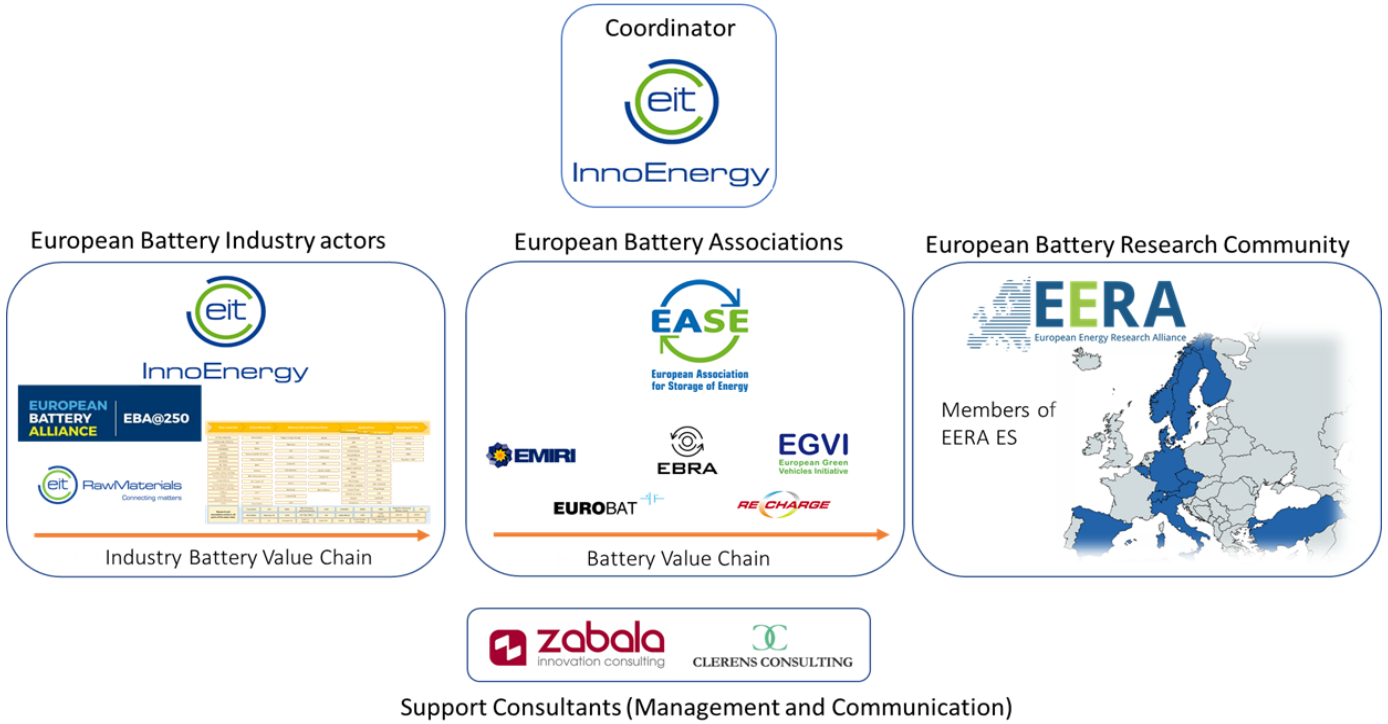
Research and associations active in all parts of the value chain

Fraunhofer	CEA	ENEA	T&E (Transport and Environment)	EASE	EUROBAT	EMIRI	ANIE	Ångström Advanced Battery Centre	E4V	
RECHARGE	Akkurate OY	CEPS	SET Plan TWG 7	AIT	CEN/CENELEC	CEEP	Credit Agricole	DNV GL	SINTEF	
EGVIA	ifu	Innovate UK	Invest in Lithuania	Smart EN	VDMA	Future Energy Consulting	Vrieje Universiteit Brussels	Catch	PFR	

European Technology and Innovation Platform

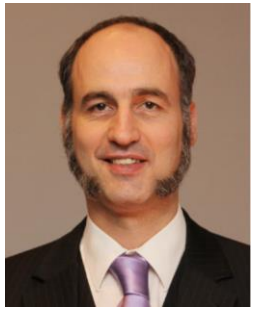
Coordination office

Secretariat Team

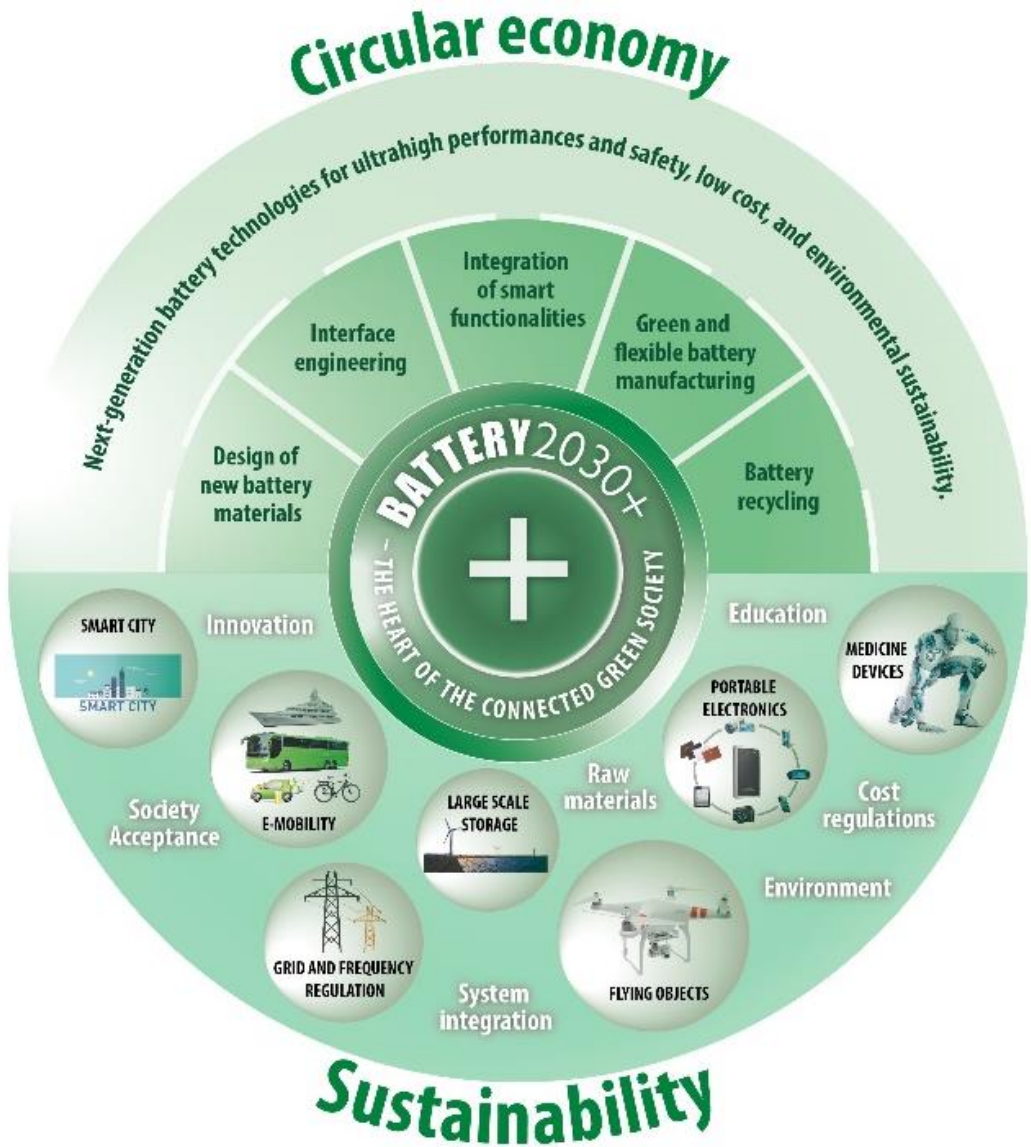


Ilka Von Dalvigk
InnoEnergy

Edel Sheridan
EERA/SINTEF



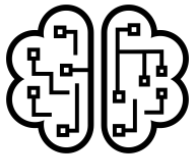
Patrick Clerens
(EASE)


Circular economy
Next-generation battery technologies for ultrahigh performances and safety, low cost, and environmental sustainability.
Interface engineering
Integration of smart functionalities
Green and flexible battery manufacturing
Design of new battery materials
Battery recycling
BATTERY2030+
THE HEART OF THE CONNECTED GREEN SOCIETY
Innovation
Education
SMART CITY
MEDICINE DEVICES
PORTABLE ELECTRONICS
E-MOBILITY
LARGE SCALE STORAGE
Raw materials
Cost regulations
Society Acceptance
Environment
GRID AND FREQUENCY REGULATION
FLYING OBJECTS
System integration
Sustainability

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

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!

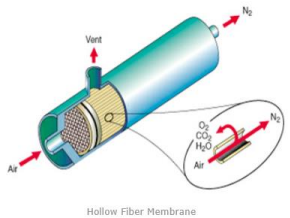
- **Cross-cutting research areas:**
  - Manufacturability
  - Recyclability

BATTERY 2030+ a full Research Eco-System

Cost effective disassembly of cells and packs

New battery cell designs lead to new packs and modules

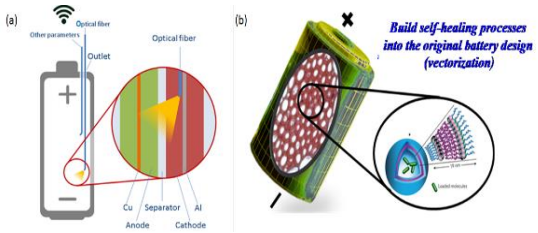
New battery cell designs and battery chemistries



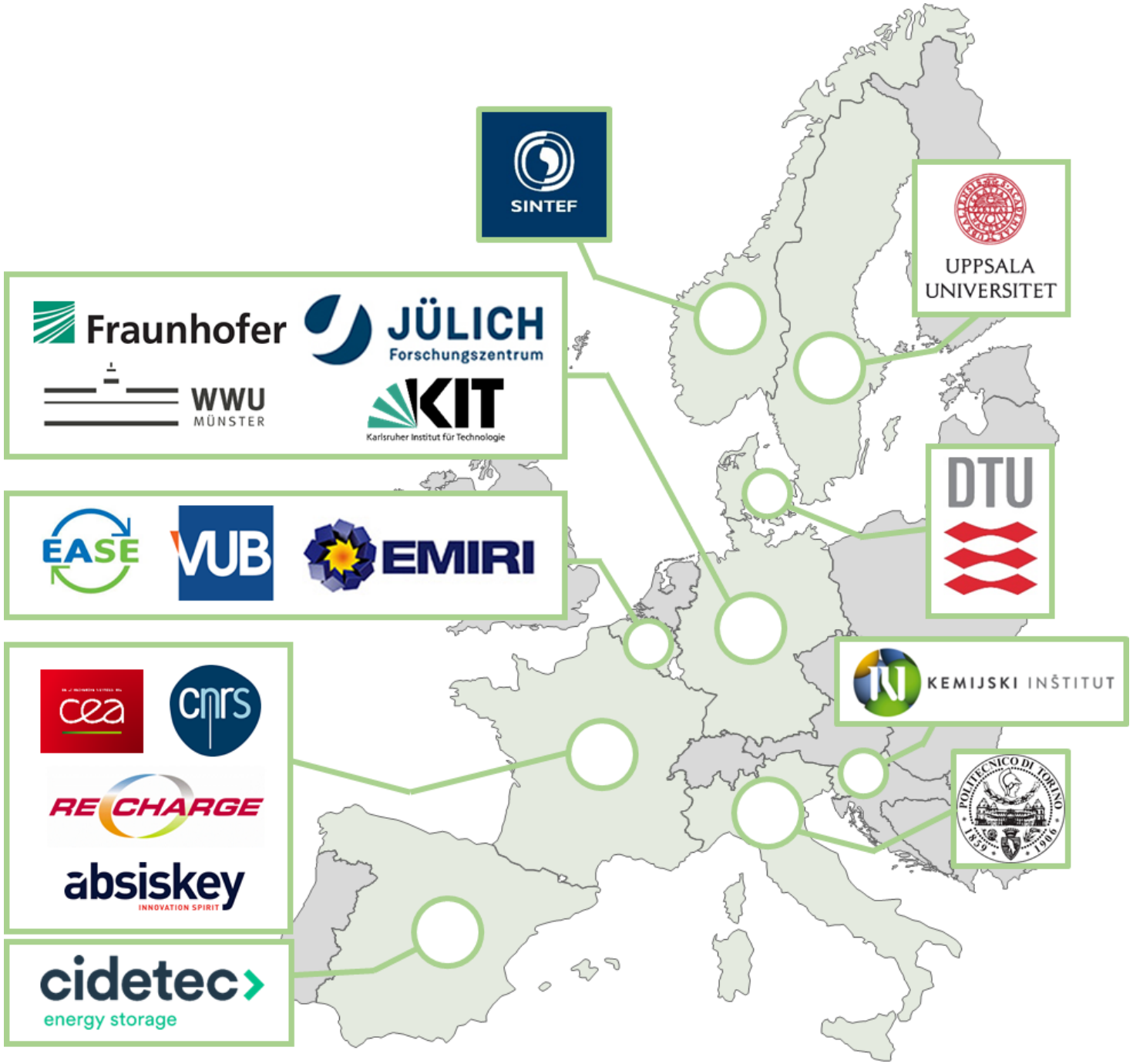
Regulatory issues

Establish the computational "**Battery Interface Genome**": Artificial Intelligence Machine learning

Smart batteries with self-healing and sensors



Core group


SINTEF
UPPSALA UNIVERSITET
Fraunhofer
JÜLICH Forschungszentrum
WWU MÜNSTER
KIT Karlsruher Institut für Technologie
DTU
EASE
VUB
EMIRI
KEMIJSKI INŠTITUT
cea
cnrs
RECHARGE
absiskey
INNOVATION SPIRIT
POLITECNICO DI TORINO
cidetec
energy storage

Stakeholder support

Core group

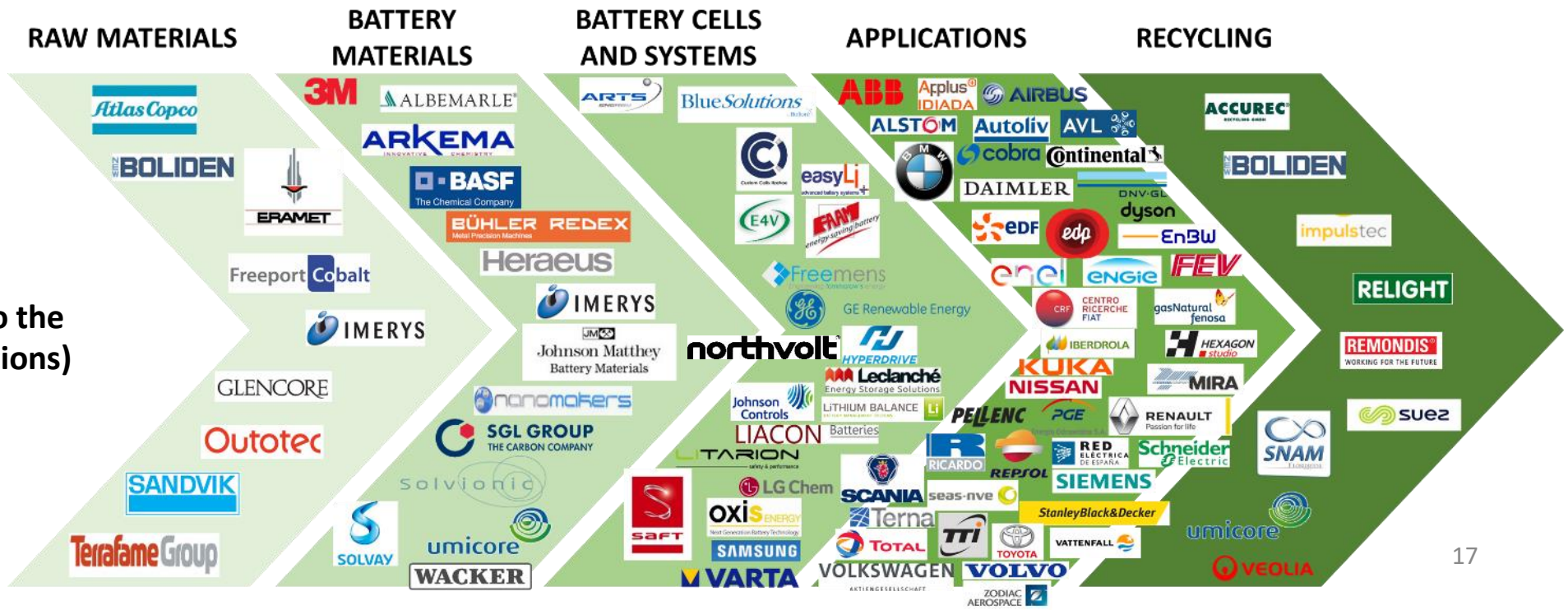
UPPSALA UNIVERSITET · WWU MÜNSTER · JÜLICH FORSCHUNGSZENTRUM · POLITECNICO DI TORINO · NATIONAL INSTITUTE OF CHEMISTRY · VUB VRIJE UNIVERSITEIT BRUSSEL · cea · DTU · cidetec · SINTEF · cnrs · Fraunhofer · KIT Karlsruher Institut für Technologie · EMIRI · RECHARGE · EASE · absiskey

Supporting organizations

ALISTORE European research institute · EERA European Energy Research Alliance · eit InnoEnergy · eit RawMaterials · earpa · EGVI European Green Vehicles Initiative · EUROBAT · CLEPA · KLiB Kompetenznetzwerk Lithium Ionen Batterien · ENERGIE RS2E Réseau sur le stockage électrochimique de l'énergie · Swedish Electromobility Centre · CIC energiGUNE energy cooperative research centre · ENEA · imec

Industry

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



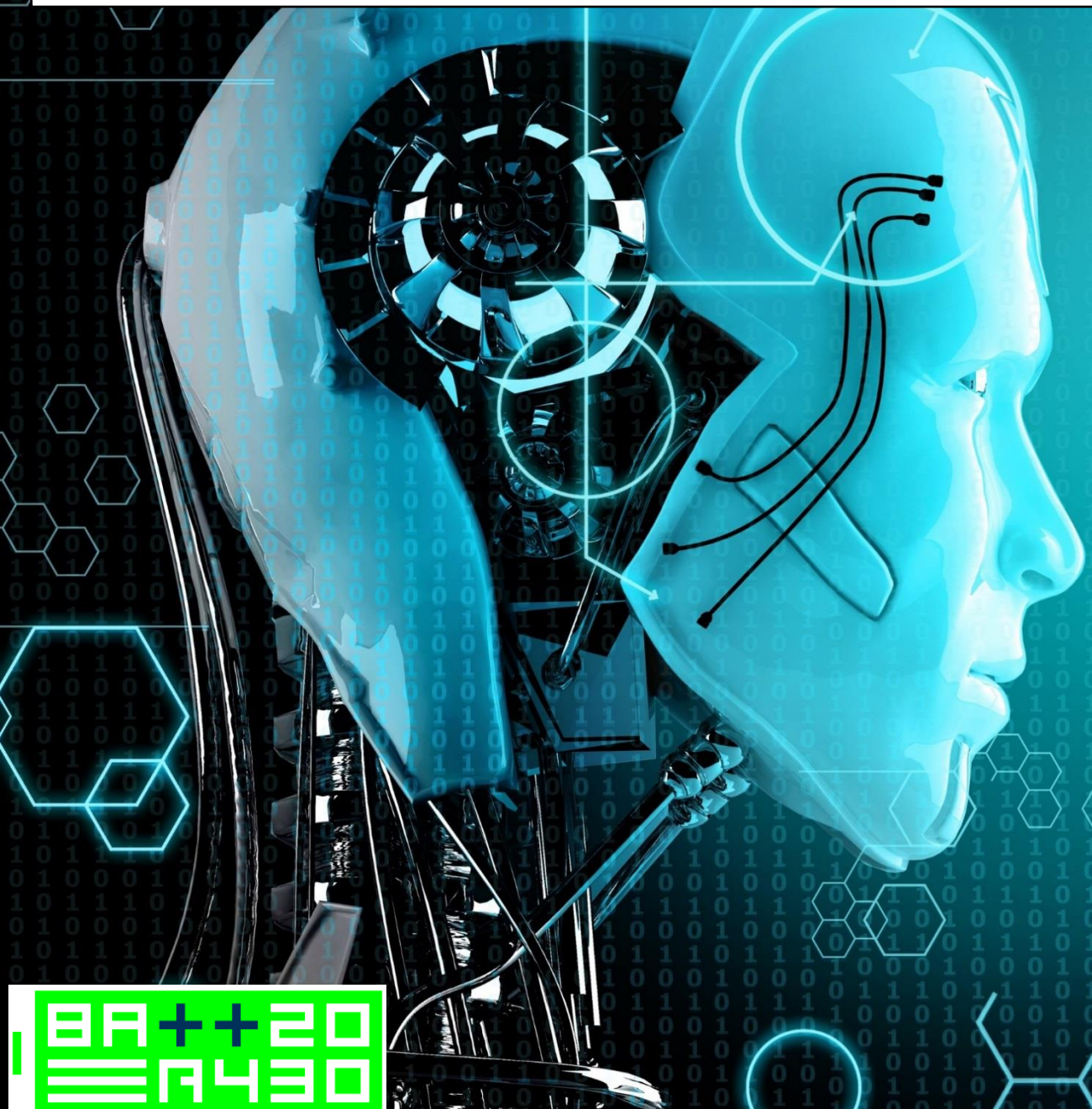
Three RIA calls and one M-ERA-net coming up

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

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…

Accelerated battery material discovery & interface engineering



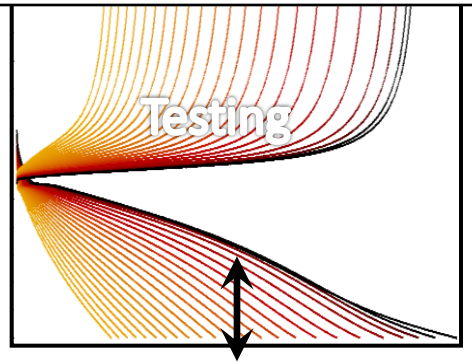
MATERIALS ACCELERATION PLATFORM
Self-driving laboratory for autonomous discovery and optimization of materials and interfaces

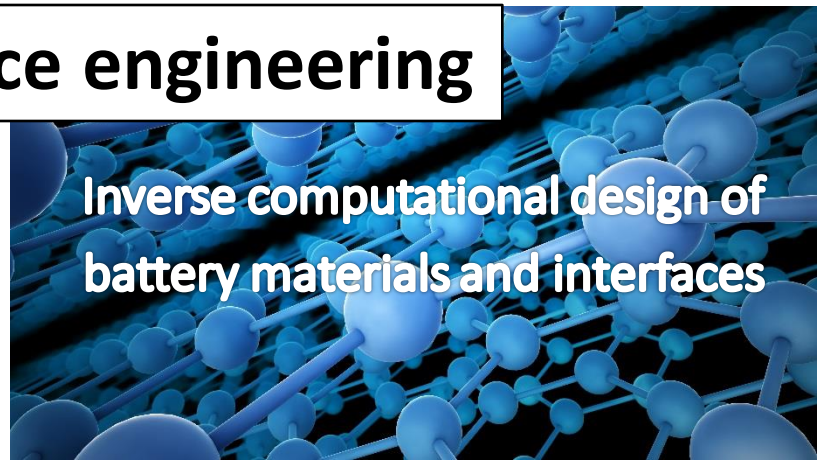
10× acceleration of the development cycle

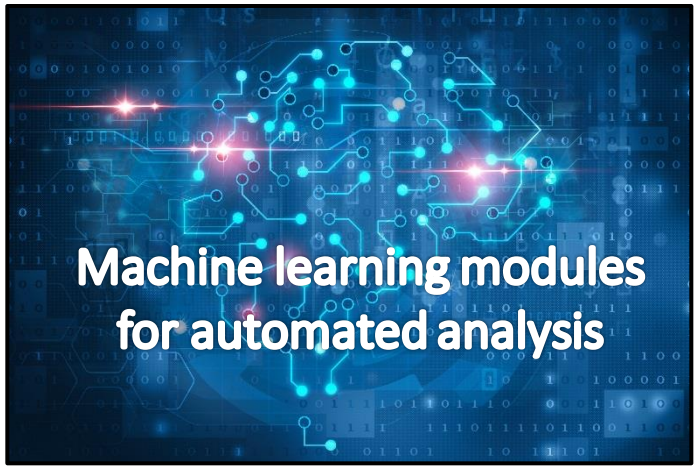
Energy & power densities approaching the theoretical limits

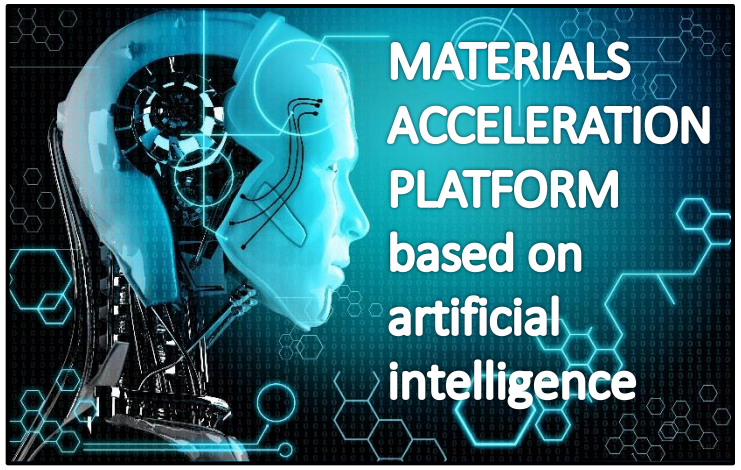
Outstanding lifetime & reliability

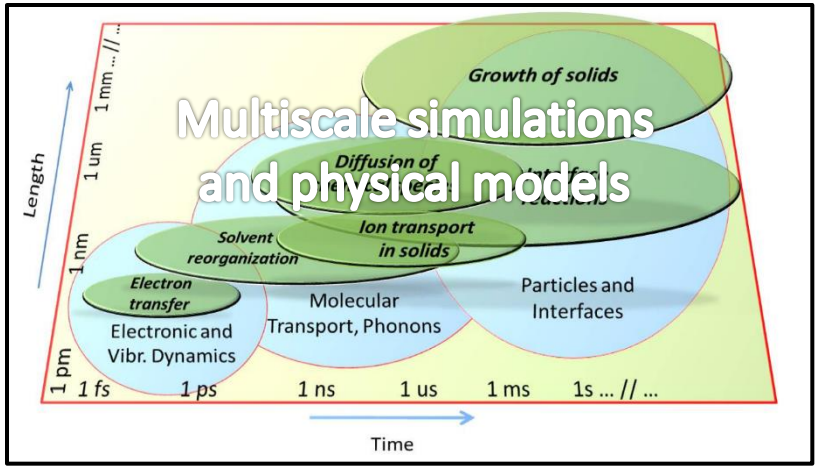
Accelerated battery material discovery & interface engineering

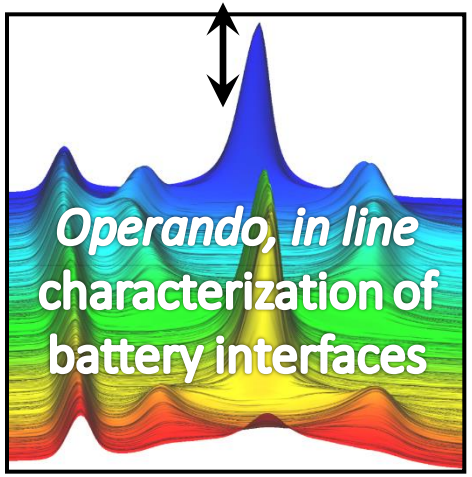


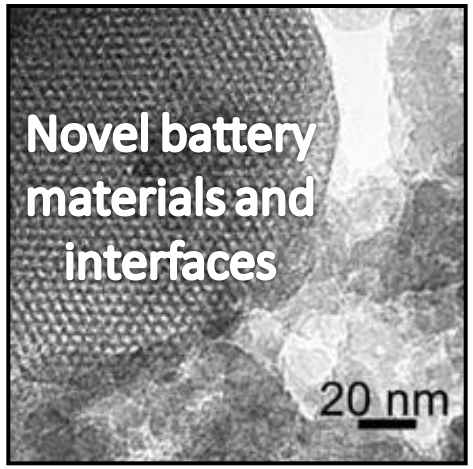












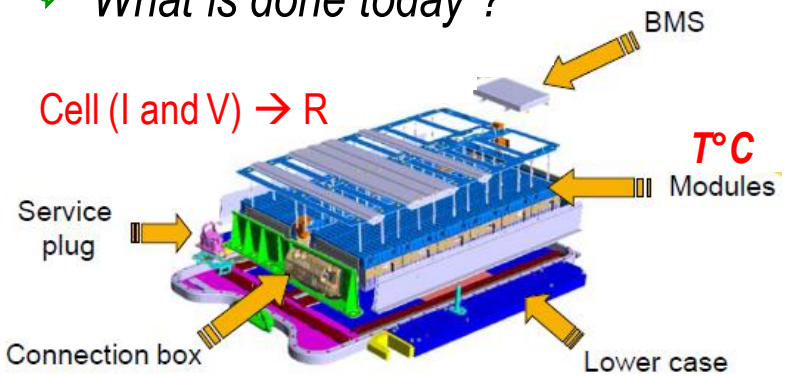
WHY sensing-monitoring ? A few examples

Temperature is very critical

Battery usage is not well optimized
(reduced life-time, limited ageing, enhanced safety risks)

Electric vehicles:

What is done today ?



Grid applications

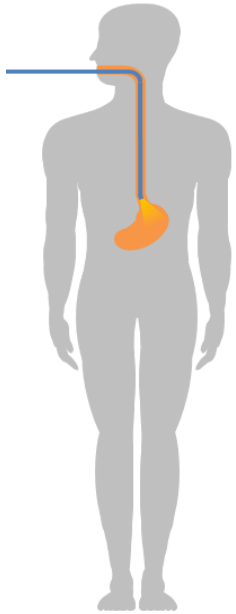
Battery second life

Double functionality

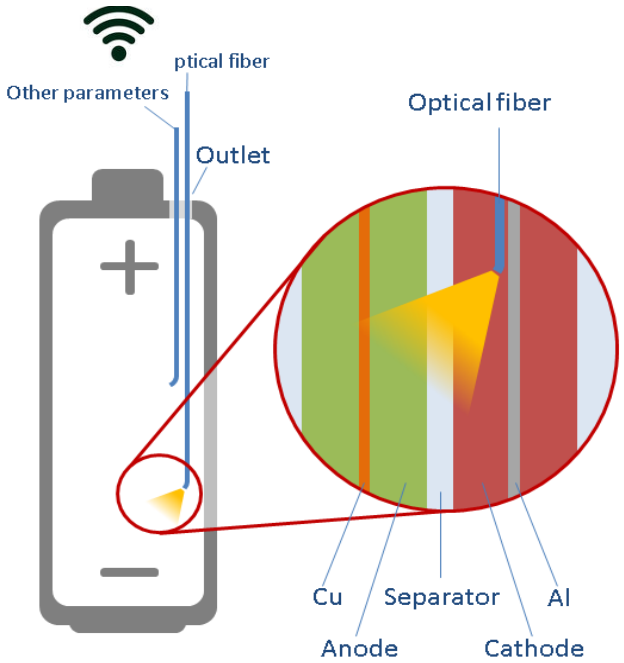
Better traceability

Looking ahead: New research challenges

Establish the state of health record of the battery just like for humans



Efforts towards instrumental miniaturization for real time monitoring of the batteries in the field



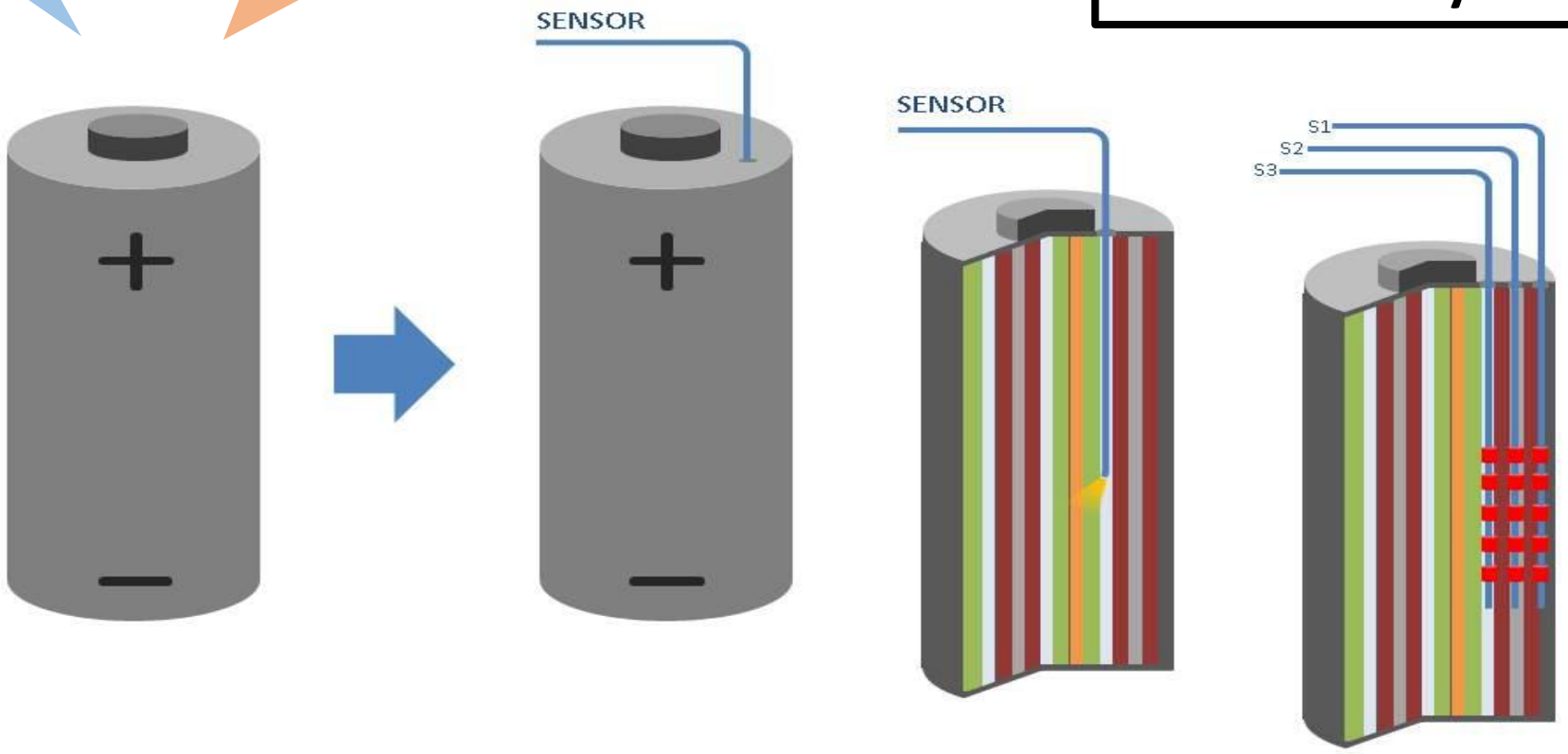
Need to introduce smart sensing functionalities within the cell

Smart sensing & self-healing functionalities

E, i, R

What else? T ε σ [x] SEI PERCOLATION

SMART SENSING
Spatially and time resolved sensing down to the battery cell level



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

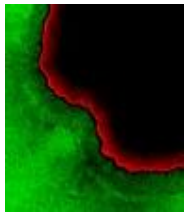
Looking ahead: new research challenges

Besides enhancing QRL, sensors also serve to identify defective components and local spots in the cell that need to be repaired

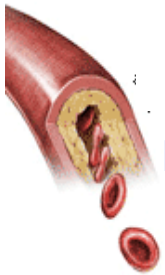
→ Develop self-healing processes

↓

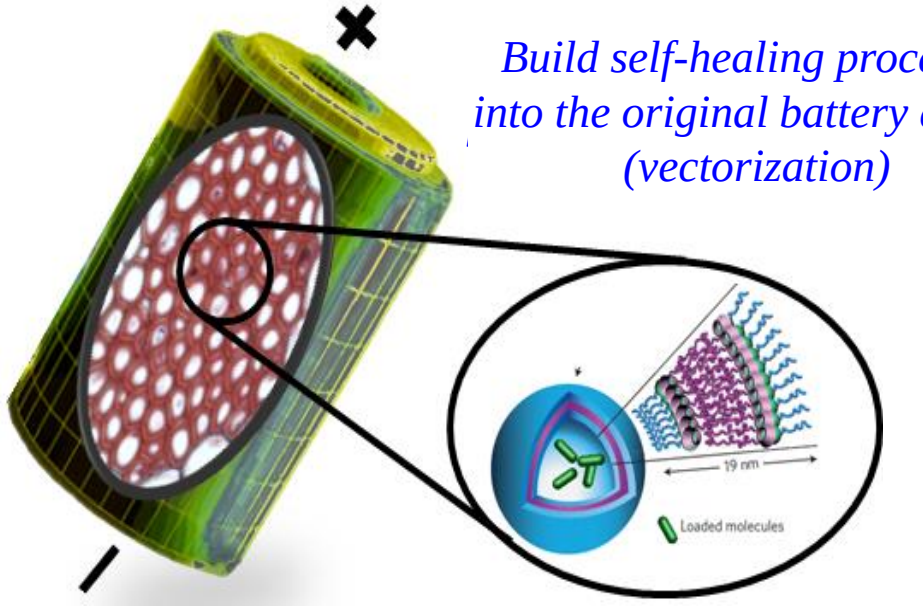
Electrode recovered by an SEI



(Prevents the crossing of Li^+)



Clogged artera by cholesterol (Prevents blood circulation)



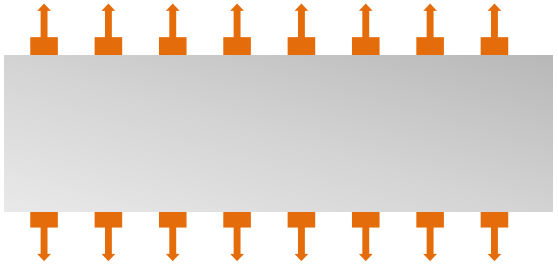
Build self-healing processes into the original battery design (vectorization)

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

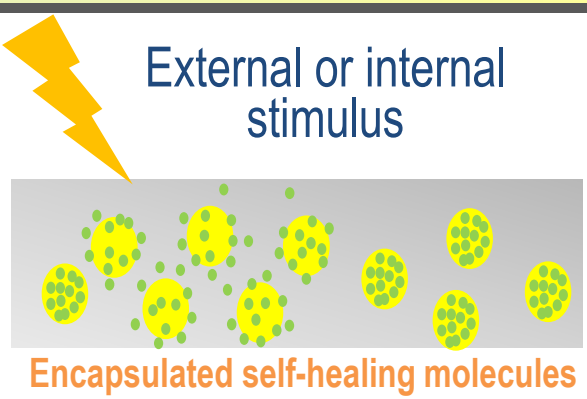
How to tackle this issue?
Innovative chemistry on the battery separator

Multilayers

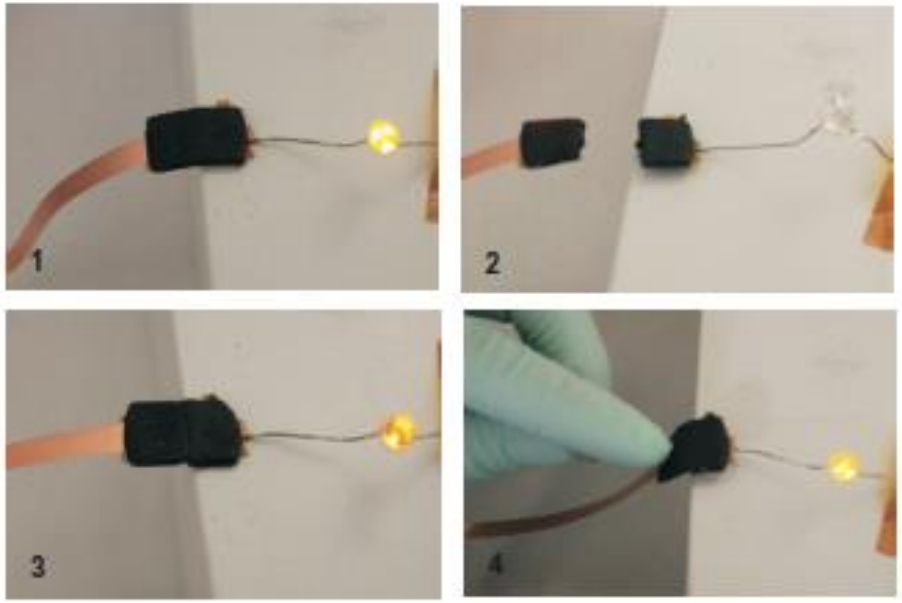
Surface-functionalization



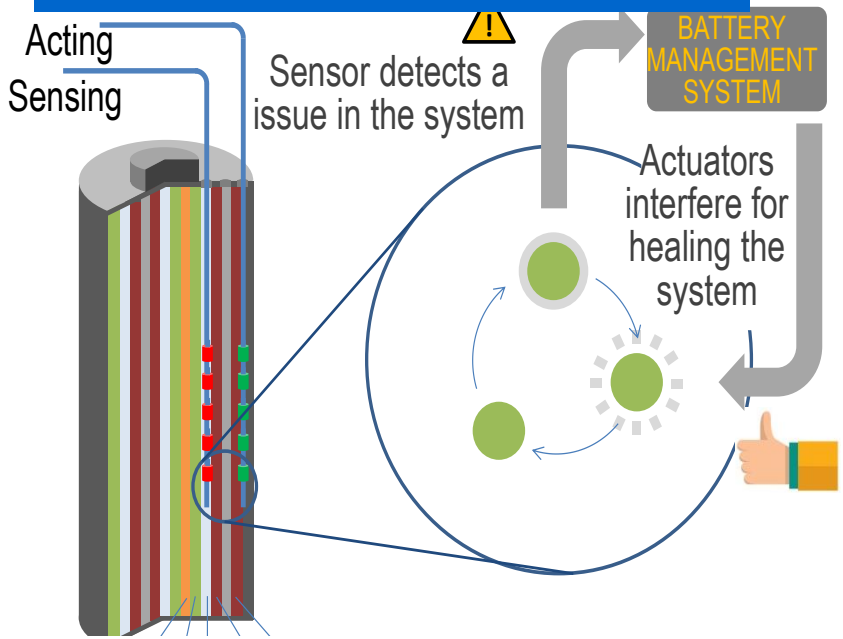
External or internal stimulus



❑ Self-healing polymers

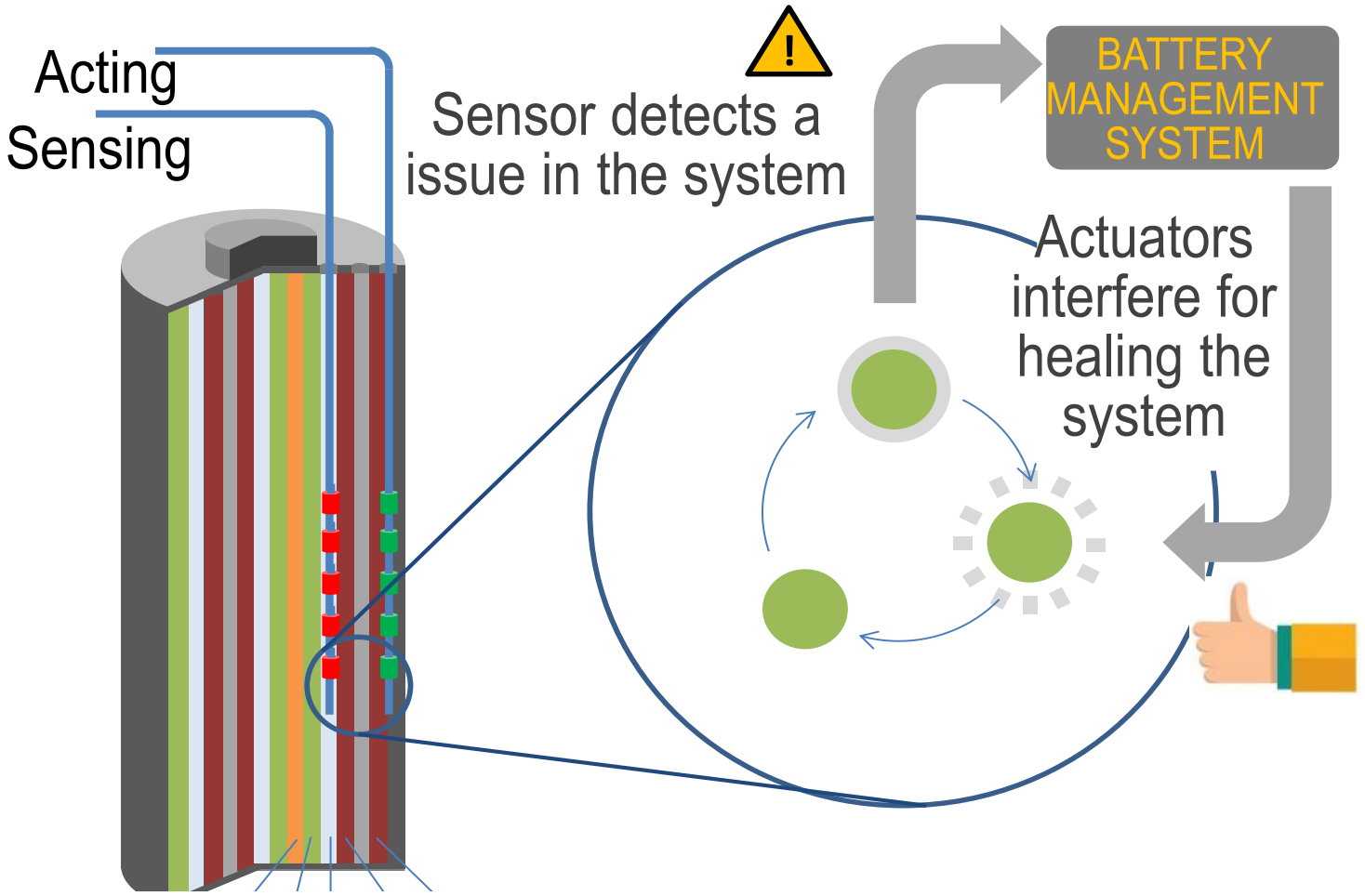


❑ Integrated sensing/self-healing

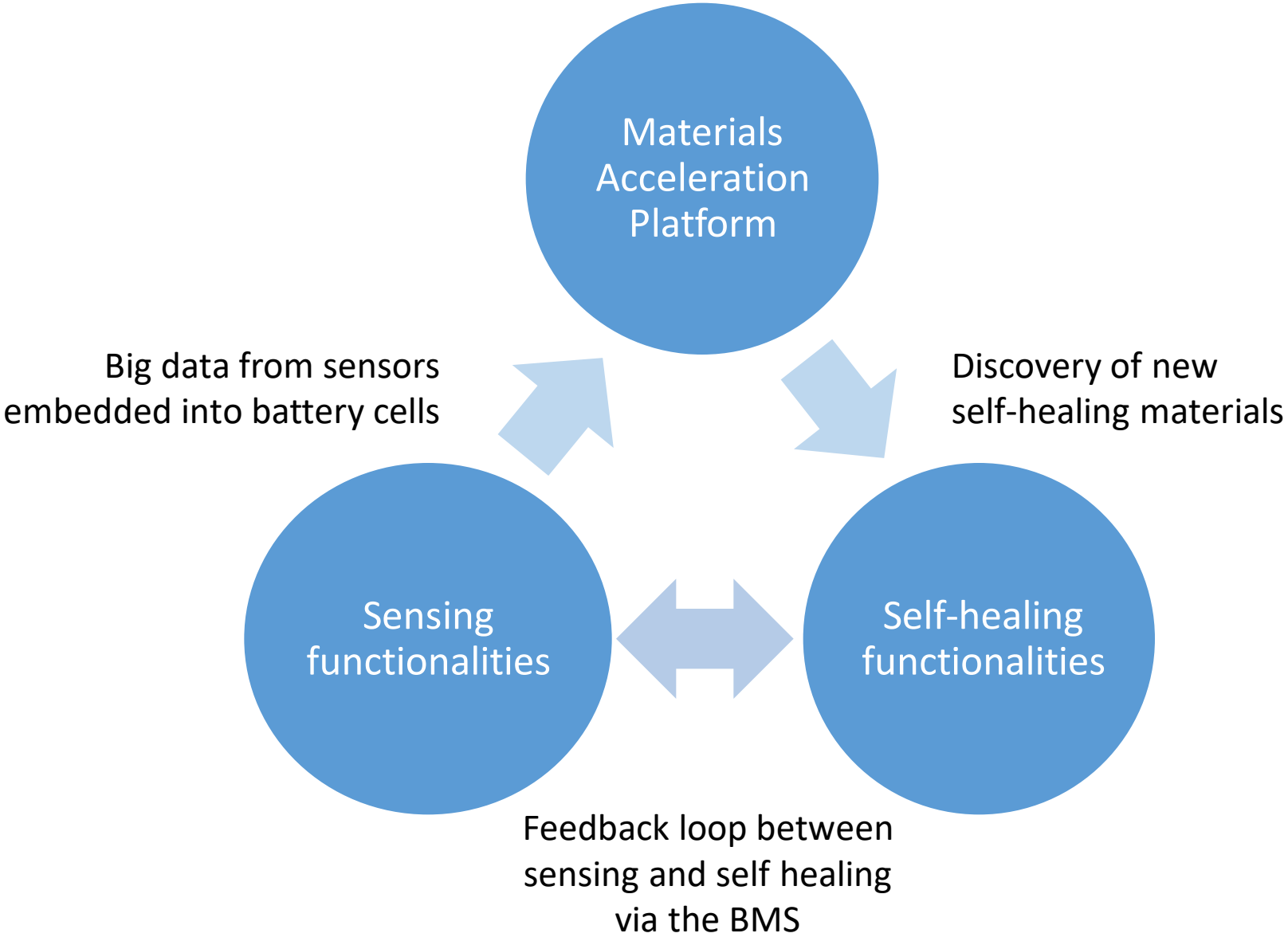


Complex but exciting science at the crossover of many disciplines

Smart sensing & self-healing functionalities



Towards an integrated approach for the batteries of the future



Work in progress

- CSA starting 1 March 2019
- Workshop in fall 2019
- ‘Road-map versions’ FEED BACK WANTED
- Full roadmap (FETPROACT-04-2019 CSA): March 2020

Endorse us on www.battery2030.eu

Thank you for your attention