

# BATTERY 2030+

## At the heart of a green and connected society

### A Large-Scale European Research Initiative on Future Battery Technologies

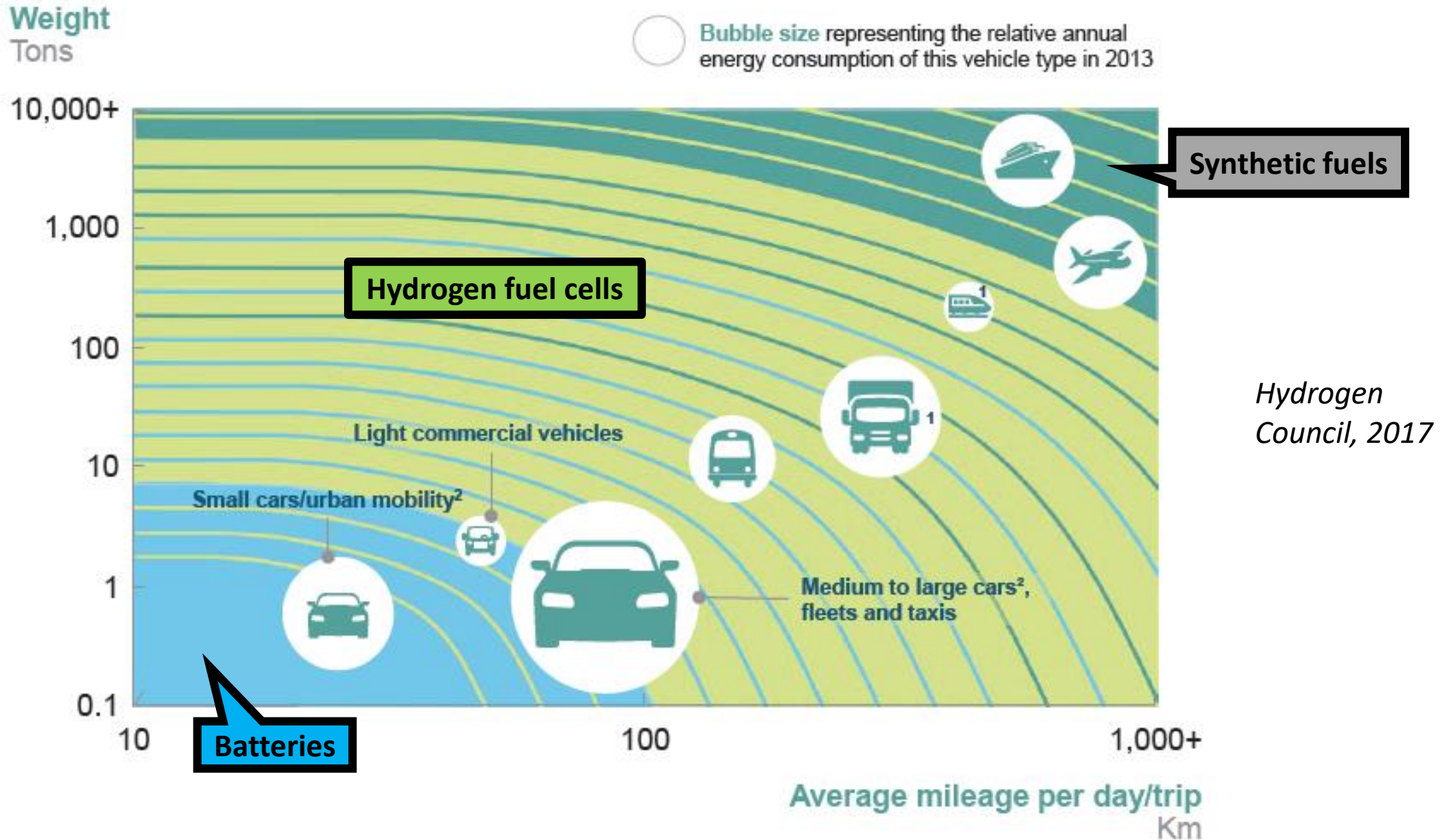
Dr. Simon Perraud, CEA

Prof. Jean-Marie Tarascon, Collège de France

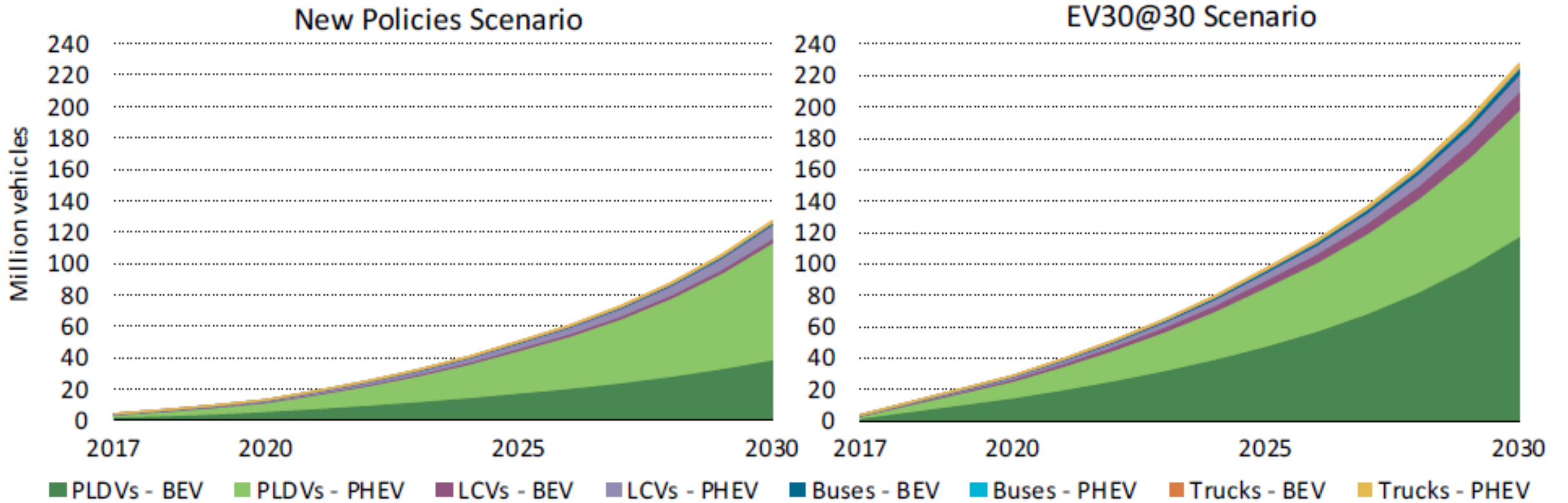


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# BATTERIES WILL CONTRIBUTE TO THE DECARBONIZATION OF THE TRANSPORT SECTOR

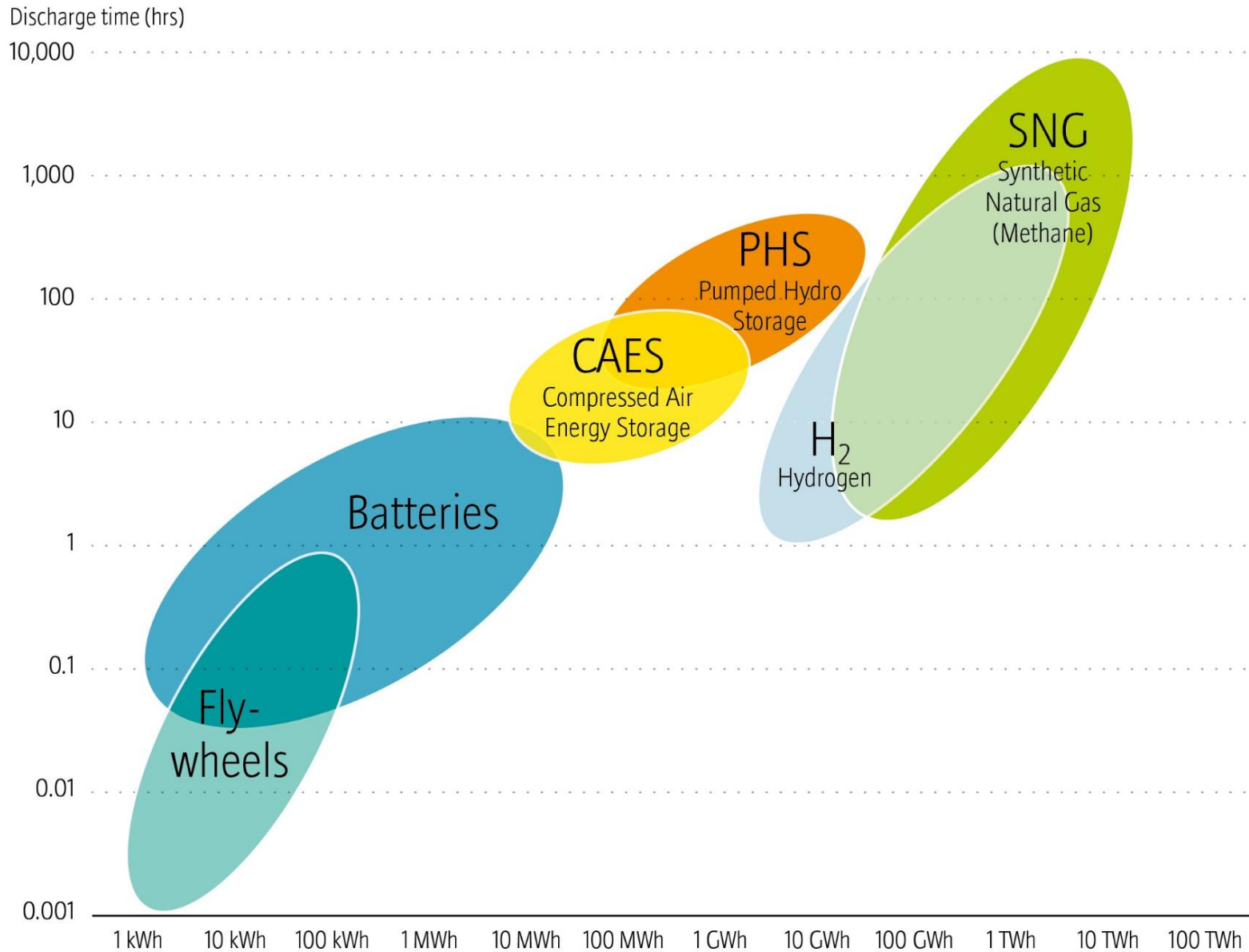


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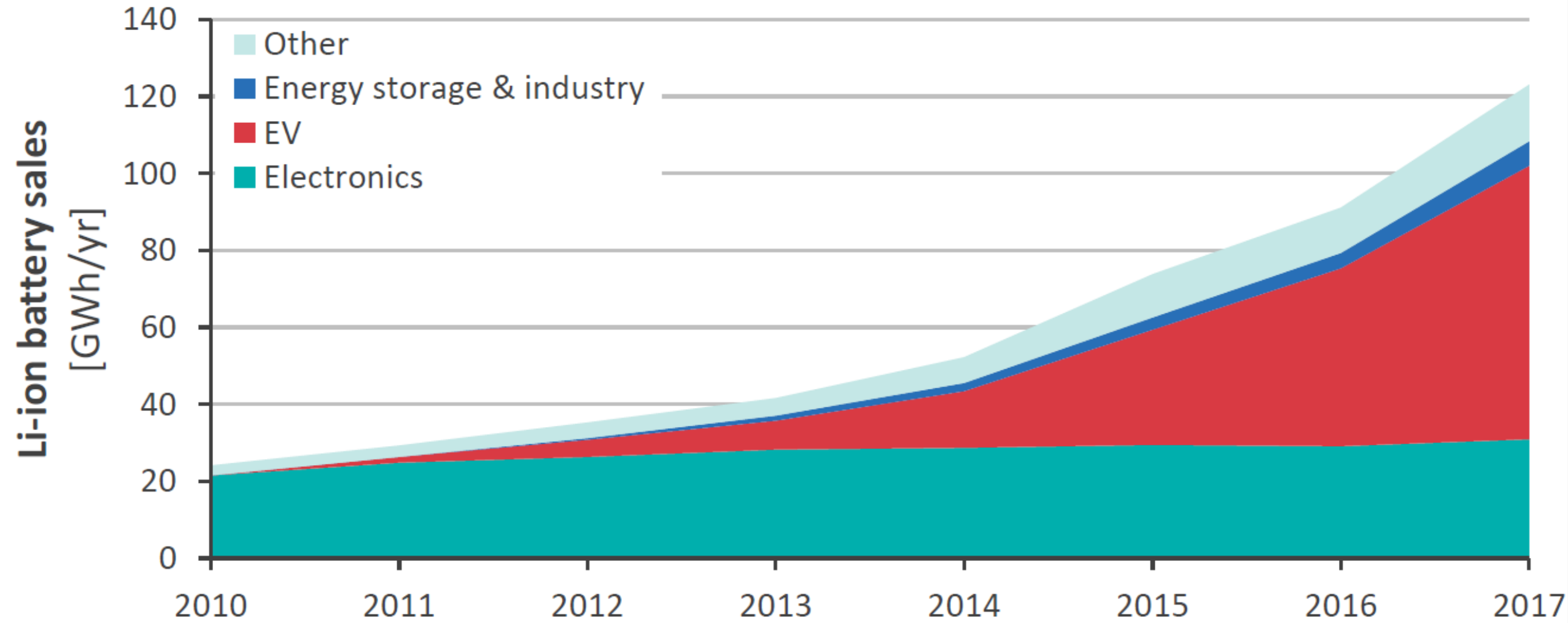
Notes: PLDVs = passenger light duty vehicles; LCVs = light commercial vehicles; BEVs = battery electric vehicles; PHEV = plug-in hybrid electric vehicles.

# BATTERIES WILL ALSO CONTRIBUTE TO THE DECARBONIZATION OF THE POWER SECTOR



REN21, 2017

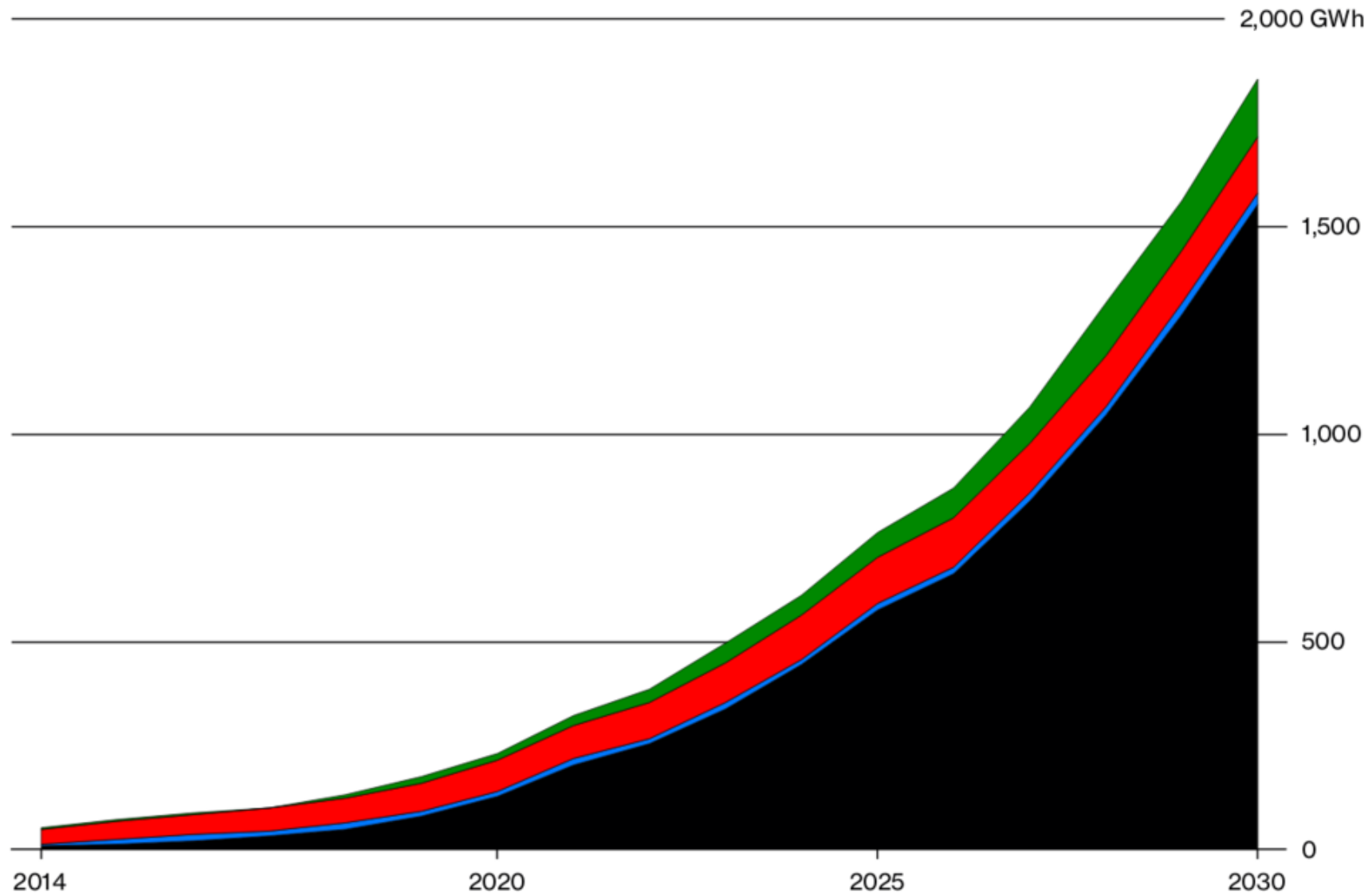
# LITHIUM-ION BATTERY MARKET IS BOOMING



# Battery Blastoff

Demand for energy storage is forecast to rise as prices fall

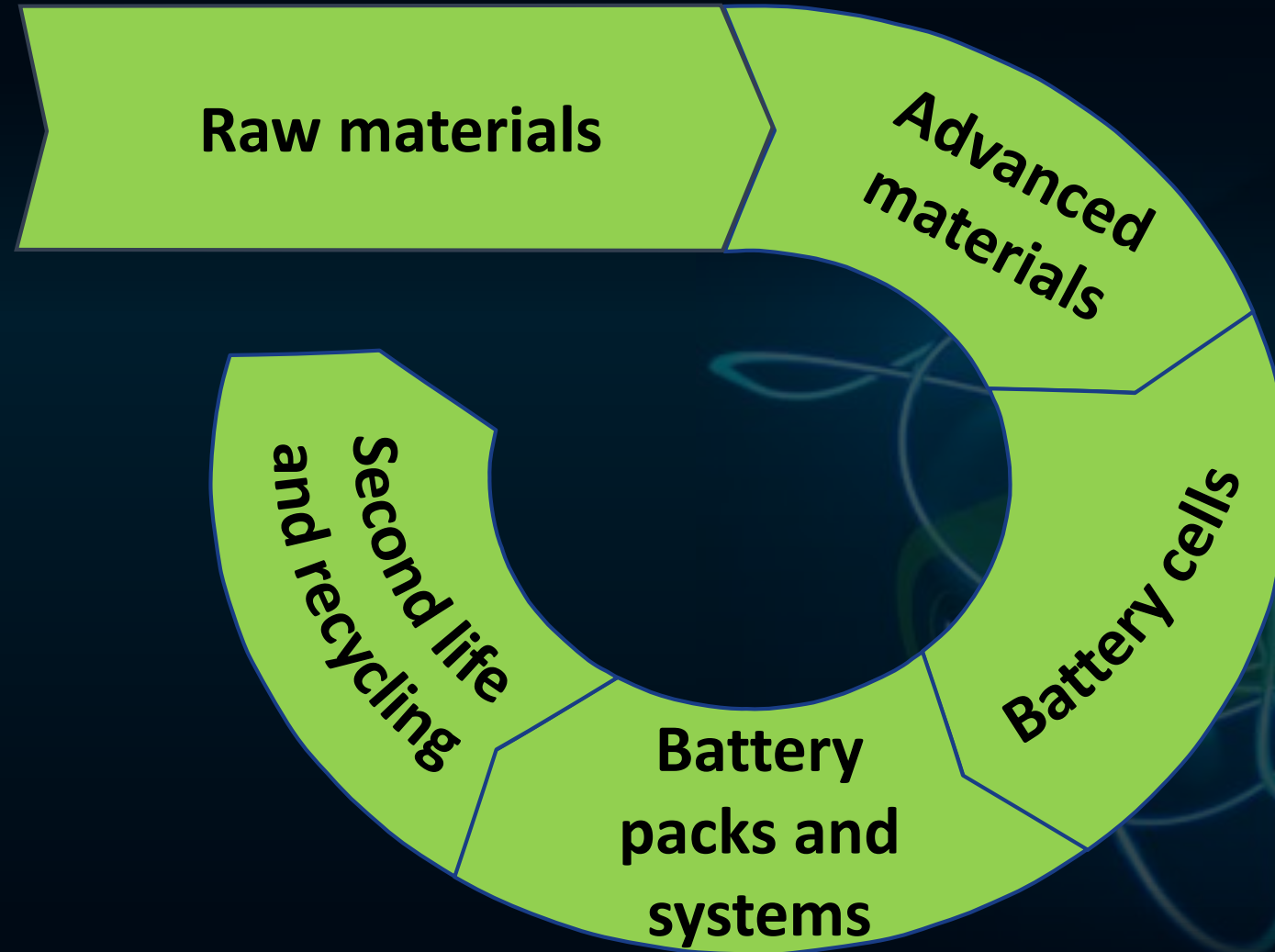
■ Passenger EVs ■ E-buses ■ Consumer electronics ■ Stationary storage



Data: BloombergNEF; graphic by Bloomberg Businessweek



# LITHIUM-ION BATTERY VALUE CHAIN

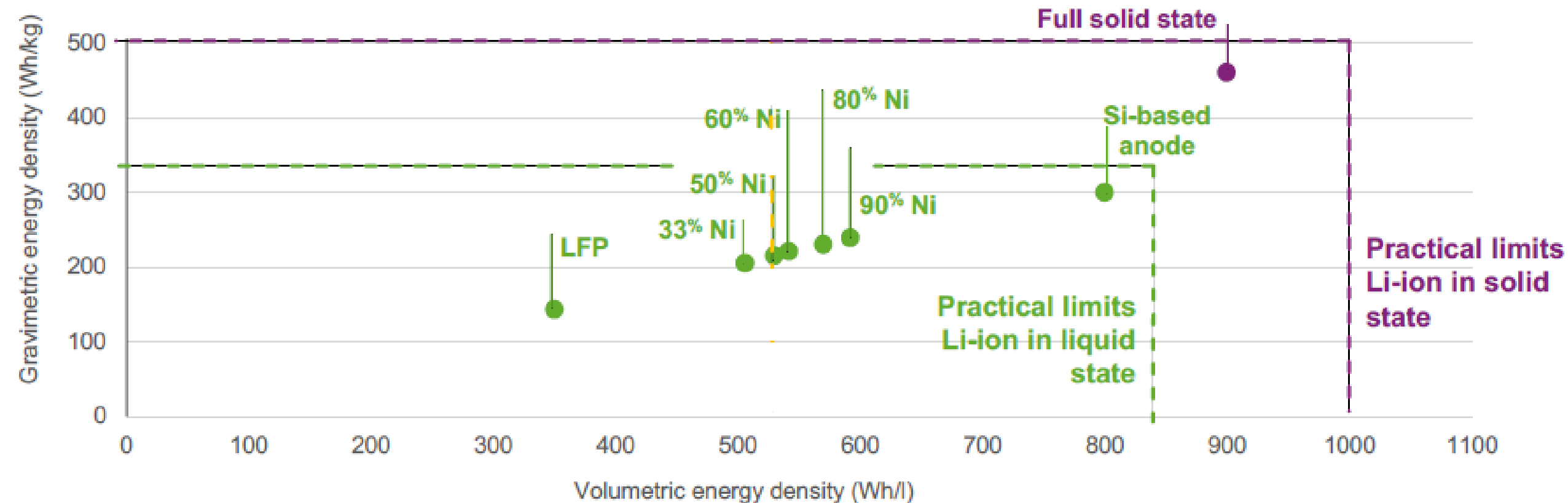


## LITHIUM-ION BATTERY INDUSTRY IN EUROPE

- The European lithium-ion battery industry is strong in the upstream part (battery materials) and downstream part (electric vehicles, recycling) of the value chain
- The core part of the value chain (battery cells) is witnessing significant changes:
  - Installation of large manufacturing capacities in Europe by some Asian players
  - Several industrial projects led by European players, with the support of Member States and the European Commission
- In this context, the European research community has a crucial role to play to support the European industry along the full value chain



# LITHIUM-ION BATTERY SHORT-TO-MEDIUM TERM R&I



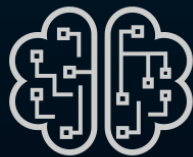
Source: Umicore

## BATTERY 2030+ VISION FOR LONG-TERM R&I

- 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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# BATTERY 2030+ RESEARCH AREAS

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## BATTERY 2030+ RESEARCH AREAS:

- Accelerated battery material discovery & interface engineering
- Integration of smart sensing & self-healing functionalities
- Cell design & manufacturability (cross-cutting)
- Recyclability (cross-cutting)

FUTURE BATTERY CHEMISTRIES

POST-LITHIUM BATTERY CHEMISTRIES  
Sodium-ion, multivalent metal-ion, metal-air, etc.

LITHIUM BATTERY CHEMISTRIES  
Gen 5 (lithium-air, lithium-sulfur)  
Gen 4 (all-solid-state lithium-ion or lithium-metal)  
Gen 3 (advanced lithium-ion)

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# ACCELERATED BATTERY MATERIAL DISCOVERY & INTERFACE ENGINEERING

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



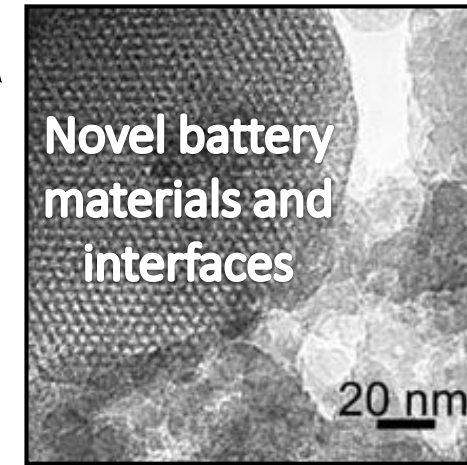
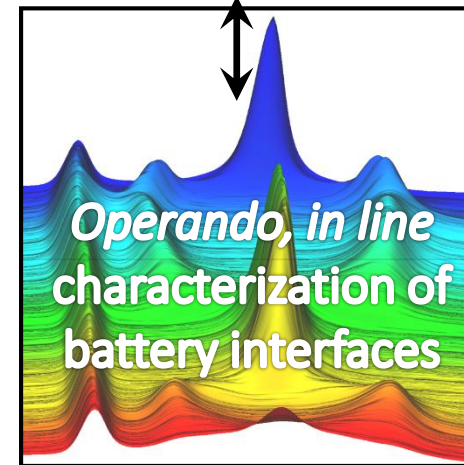
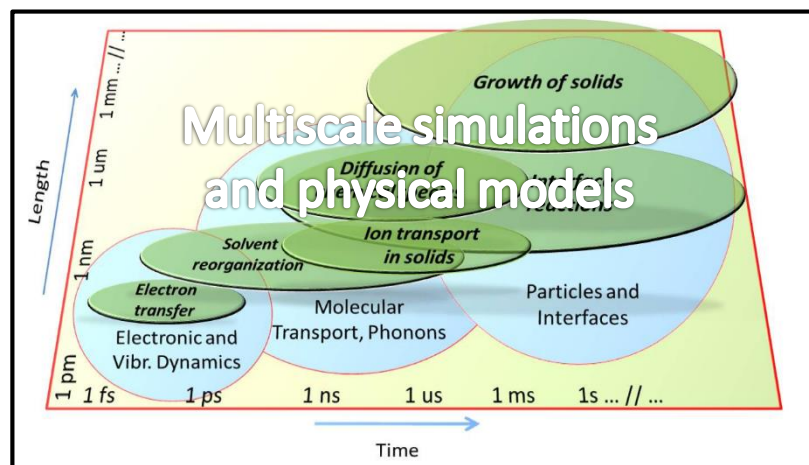
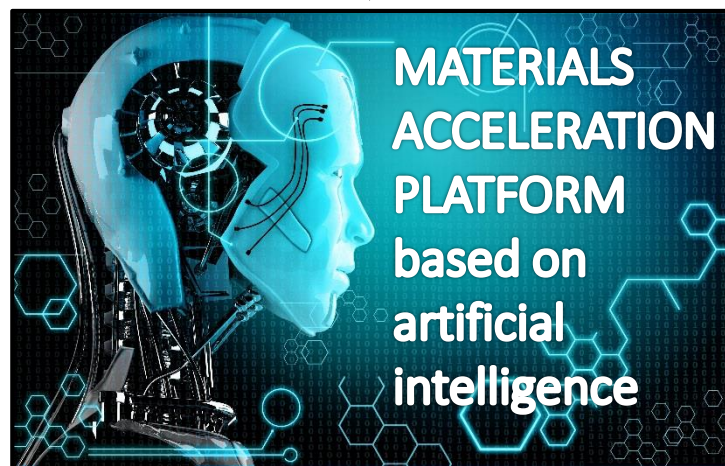
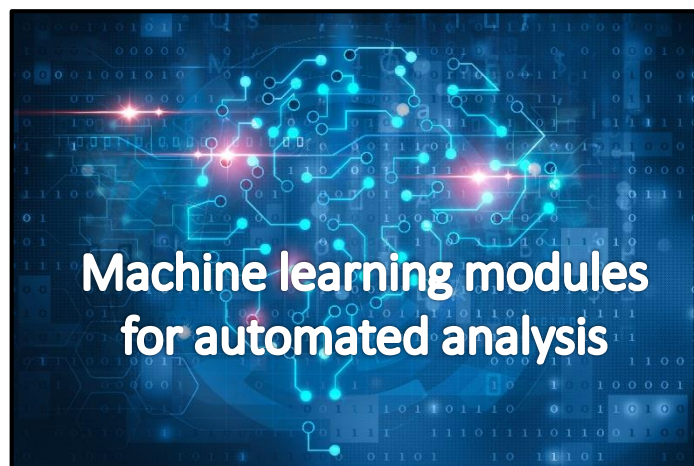
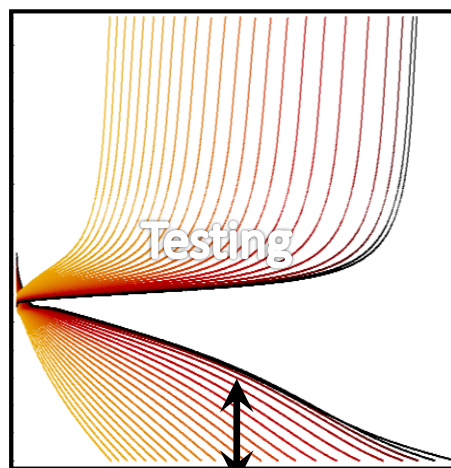
10× acceleration of the development cycle

Energy & power densities approaching the theoretical limits

Outstanding lifetime & reliability

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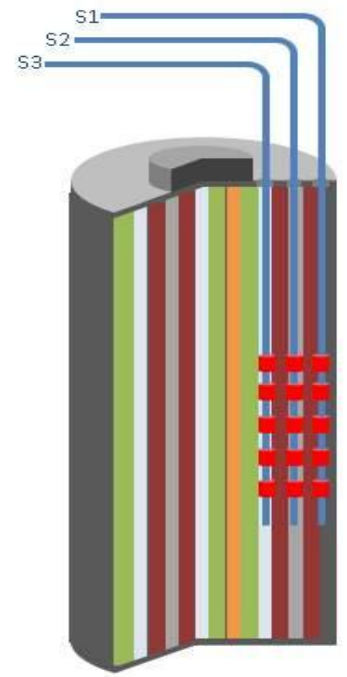
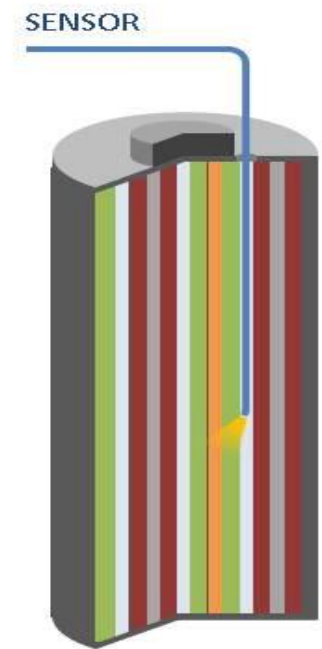
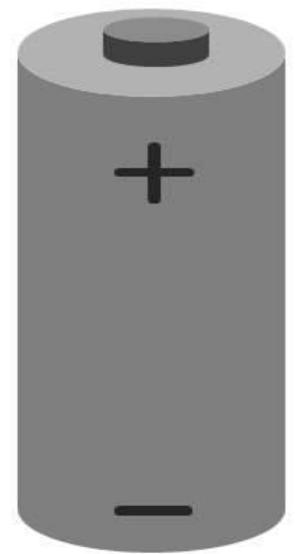
# SMART SENSING & SELF-HEALING FUNCTIONALITIES

E, i, R

What else?

- T
- $\epsilon$
- $\sigma$
- [X]
- SEI
- PERCOLATION

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



Outstanding lifetime and reliability

Enhanced safety

Environmental sustainability (second life)

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# SELF-HEALING

Looking ahead: new research challenges

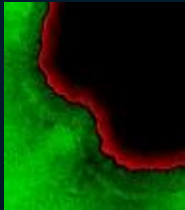
Sensors also serve to identify defective components and local spots in the cell that need to be repaired



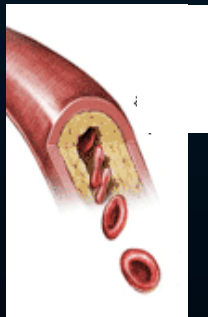
Develop self-healing processes



Electrode recovered by an SEI

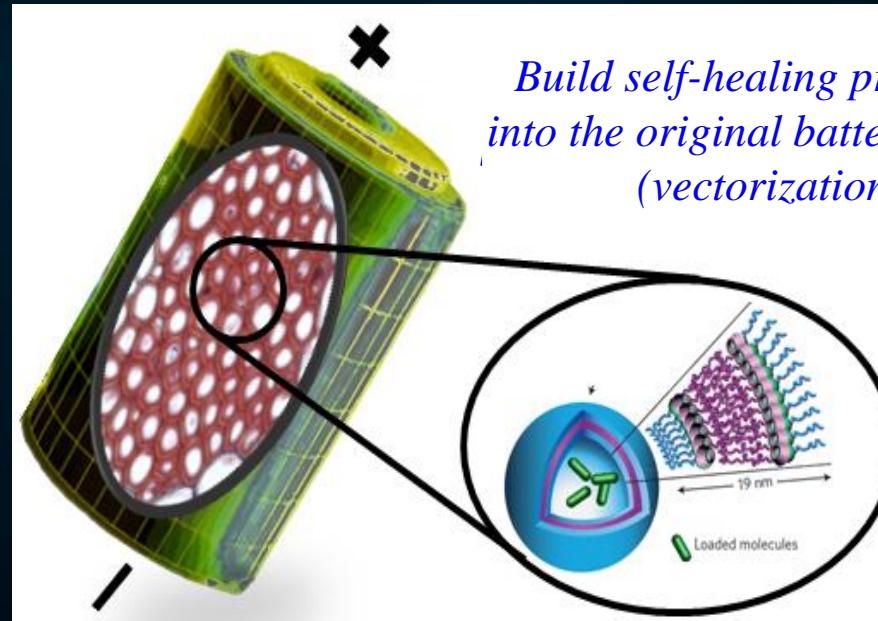


(Prevents the crossing of  $\text{Li}^+$ )



Clogged arteria by cholesterol

(Prevents blood circulation)



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

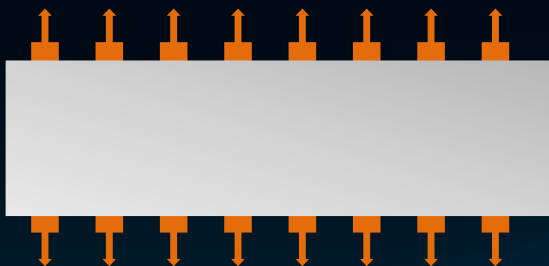
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# SELF-HEALING AND SENSING

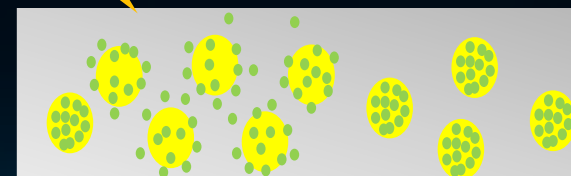
Multilayers



Surface functionalization

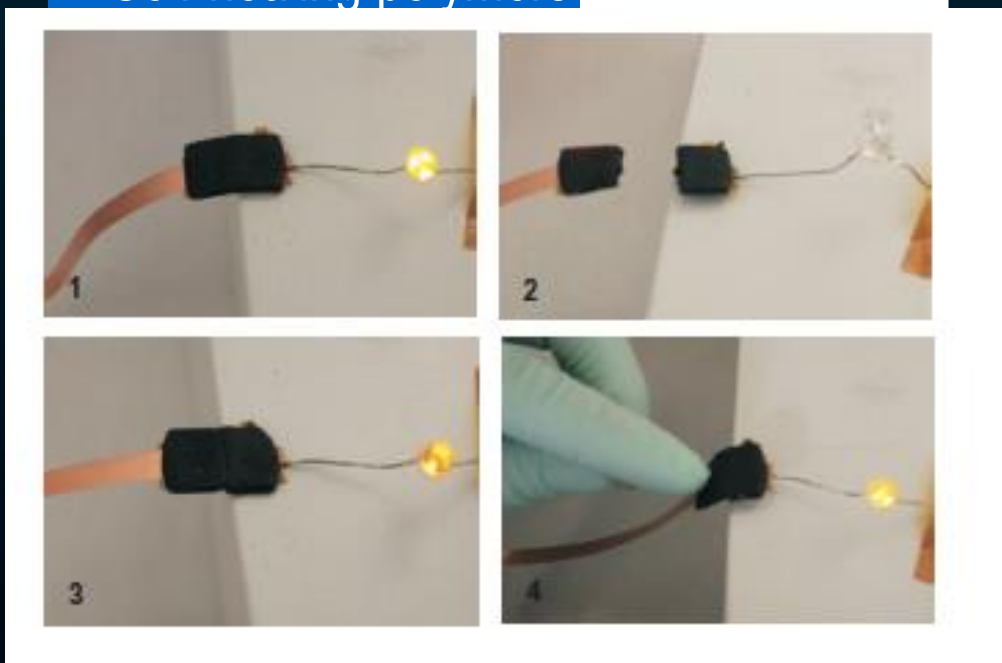


External or internal stimulus

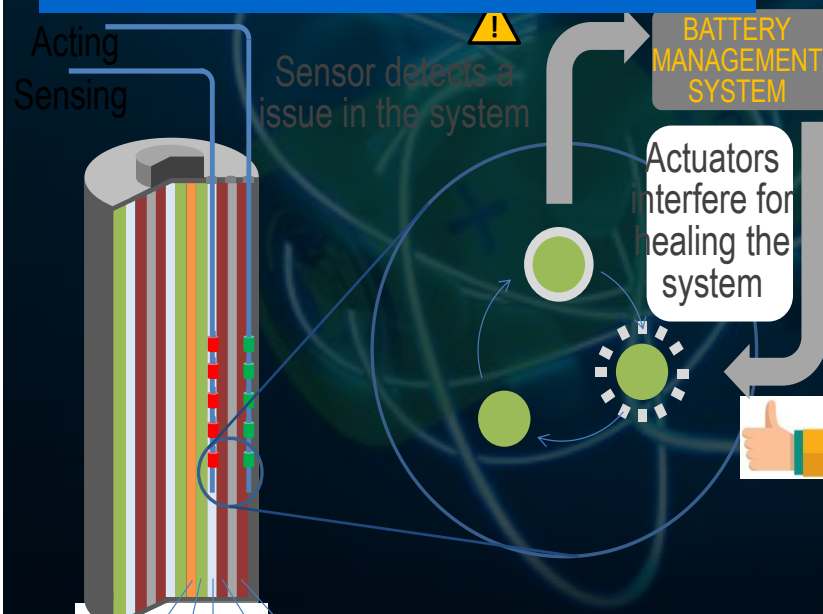


Encapsulated self-healing molecules

Self-healing polymers

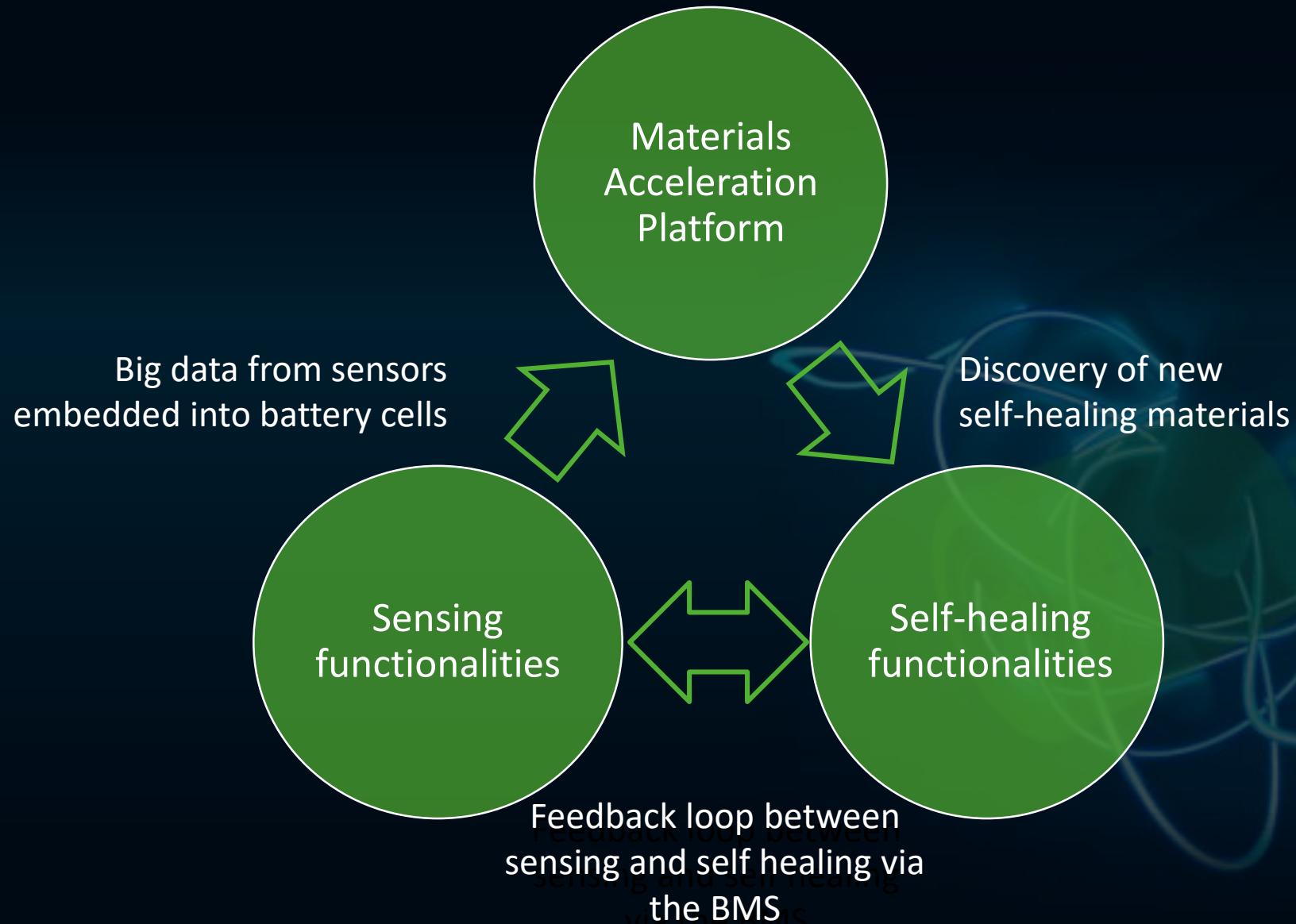


Integrated sensing/self-healing



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# TOWARDS AN INTEGRATED APPROACH FOR THE BATTERIES OF THE FUTURE



## ENDORSE BATTERY 2030+

- **Receive regular news about BATTERY 2030+**
- **Be involved in the roadmap elaboration process (written consultation and stakeholder workshop)**
- **Support a large-scale and long-term European research initiative on future battery technologies**

<http://battery2030project.eu>

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