Critical raw material free battery technology for automotive and stationary applications

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LEITAT Technological center

Founded in 1906 Leitat is a private & non-profit technological center. It is recognised by the Catalan Government (TECNIO) and by the Spanish Ministry of Science and Innovation.

Mission

Create and transfer economic, social and sustainable value to companies and entities, through research and technology processes.

Vision

Be an acknowledged technological partner in the management of innovative technologies, stimulating people's creativity and talent.

Values

- Respect
- Achievement
- Enthusiasm

LEITAT in 2018

312 persons
50% Women – 50% Men
24 M€ Income*
> **1.500** customers
> 90% Customers loyalty
77 Ongoing R&D European projects**
154 Ongoing R&D National projects
365 Industrial contracts
2.900 Advanced Technological solutions

* 16% non-competitive public funding

**We participate in European projects with more than 550 partners from 58 countries with a global budget of 361M €

LEITAT BU and location

Business

5 **Units**

- Health & Biomedicine
- **Circular Economy**
- Energy + Engineering
- Advanced Technological Solutions
- Applied Chemistry & Materials

Spain

Terrassa (Headquarters)

Vilanova del camí

Barcelona

Chile

Santiago de Chile

Hospital Vall d'Herbron

Parc Cientific de Barcelona

Hospital la Fe Valencia

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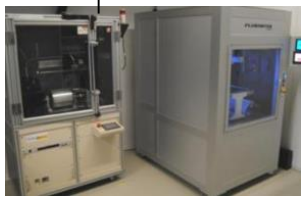
LEITAT infrastructure overview related to Energy Storage

Thermal evaporator

Chemical Lab **TRL4**

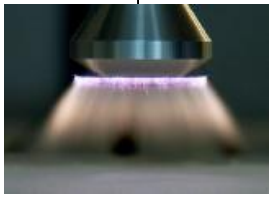
Physical Coating **TRL3**



Electrospinning

Dispersion/Milling

Surface **TRL5**



Plasma

Ink Manufacturing **TRL5**

Twin-screw extruder

Autoclave

Polymer & Process **TRL6**

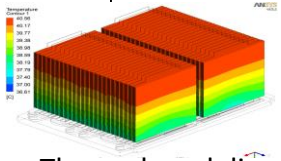
ARBIN &Biologic (80V, 10A)

Energy Lab **TRL3**

Glove Box

3D Multi Jet Fusion

Modeling **TRL3**



Thermal modeling

Additive Manufacturing **TRL6**

Regatron (16kW, 130Vcc, 192Acc)

Testing Lab **TRL9**

Climatic Chamber EUCAR HLnº4

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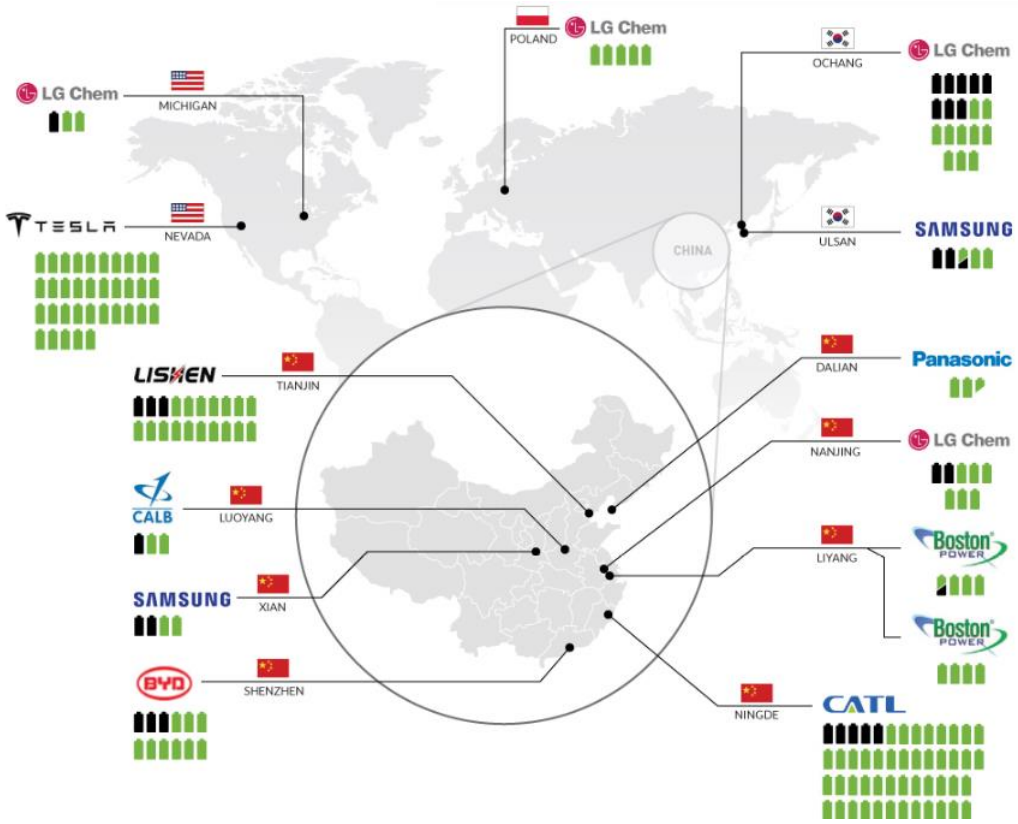
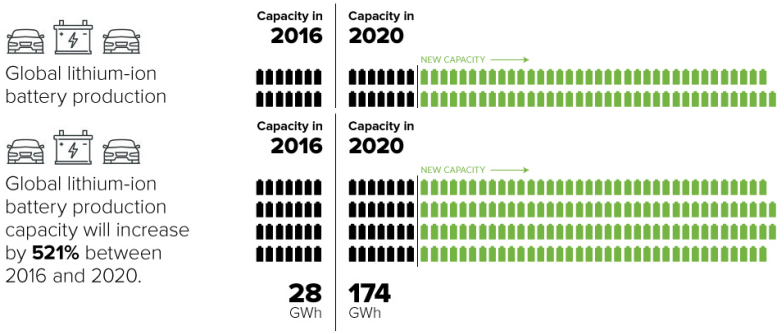
Outline: CRM-free battery technology for automotive and stationary applications

Global Li-ion battery manufacturing



- Asia is leading Li-ion mass production market
- In Europe, lithium-ion cell manufacturer and capacity are lacking in the value chain
- Impacting on industrial sector (OEM, TIER1...)



Source: Visual capitalist (2017)

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LG reportedly threaten to cut VW’s battery cell supply for EVs over gigafactory plans

“We must not make ourselves dependent on a few Asian manufacturers in the long term,” VW CEO Herbert Diess

Source: Volkswagen Group's annual general meeting in Berlin, Germany, May 3, 2018. REUTERS/Axel Schmidt

VW will invest 30 billion euros in electromobility by 2023 and will require battery capacity of 150 GWh per year by 2025.

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European Battery Alliance

https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-energy_en.pdf

Call - Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries
LC-BAT-1-2019: Strongly improved, highly performant and safe all solid state batteries for electric vehicles (RIA)
LC-BAT-2-2019: Strengthening EU materials technologies for non-automotive battery storage (RIA)
LC-BAT-3-2019: Modelling and simulation for Redox Flow Battery development
LC-BAT-4-2019: Advanced Redox Flow Batteries for stationary energy storage
LC-BAT-5-2019: Research and innovation for advanced Li-ion cells (generation 3b)
LC-BAT-6-2019: Li-ion Cell Materials & Transport Modelling
LC-BAT-7-2019: Network of Li-ion cell pilot lines
LC-BAT-8-2020: Next-generation batteries for stationary energy storage
LC-BAT-9-2020: Hybridisation of battery systems for stationary energy storage
LC-BAT-10-2020: Next generation and realisation of battery packs for BEV and PHEV
LC-BAT-11-2020: Reducing the cost of large batteries for waterborne transport
A large-scale research initiative on Future Battery Technologies
LC-BAT-12-2020: Novel methodologies for autonomous discovery of advanced battery chemistries
LC-BAT-13-2020: Sensing functionalities for smart battery cell chemistries
LC-BAT-14-2020: Self-healing functionalities for long lasting battery cell chemistries
LC-BAT-15-2020: Coordinate and support the large scale research initiative on Future Battery Technologies

SET-Plan ACTION n°7

"Become competitive in the global battery sector to drive e-mobility forward".

https://setis.ec.europa.eu/sites/default/files/set_plan_batteries_implementation_plan.pdf

1. Advanced lithium-ion batteries for e-mobility
2. Influence of fast/hyper charging of Li ion batteries on materials and battery degradation
3. Advancement of batteries for stationary energy storage
4. Post Li ion for e- mobility
5. Recycling of batteries (Li-ion and Post Li-ion)
6. Lithium recovery from European geothermal brines
7. Foster development of materials processing techniques
8. Foster development of cell and battery manufacturing equipment
9. Hybridisation of battery systems for stationary energy storage
10. Second use and smart integration into the Grid

Cell generation	Cell chemistry	
Generation 5	• Li/O_2 (lithium-air)	> 2025 ?
Generation 4	• All-solid-state with lithium anode • Conversion materials (primarily lithium-sulphur)	
Generation 3b	• Cathode: HE-NCM, HVS (high-voltage spinel) • Anode: silicon/carbon	~ 2025
Generation 3a	• Cathode: NCM622 to NCM811 • Anode: carbon (graphite) + silicon component (5-10%)	~ 2020
Generation 2b	• Cathode: NCM523 to NCM622 • Anode: carbon	current
Generation 2a	• Cathode: NCM111 • Anode: 100% carbon	
Generation 1	• Cathode: LFP, NCA • Anode: 100% carbon	

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Critical Raw Material

Cobalt prices Apr. 2016 - Apr. 2019

http://www.infomine.com/investment/metal-prices/cobalt/5-year/

Li / Li-ion

Expensive materials, such as **nickel** and **cobalt**

- **Batteries still cost ca. US$150**/kWh, **limit** set by the US Department of Energy: **US$100**
- **Cobalt speculation** (Bloomberg, "Cobalt's Klondike in Congo"). Rebound is starting. Price currently ca. **US$ 33k/Tonne.**
- **Geopolitical issues**
- **Cobalt shortages by early 2030**. **Nickel crisis** is expected by **mid-2030**.

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Power or Energy and associated Challenges

Use case 1
nanocellulose- based printed electronics

Capacitive

Supercap

e.g. Stationary

€/kWh/Cycles

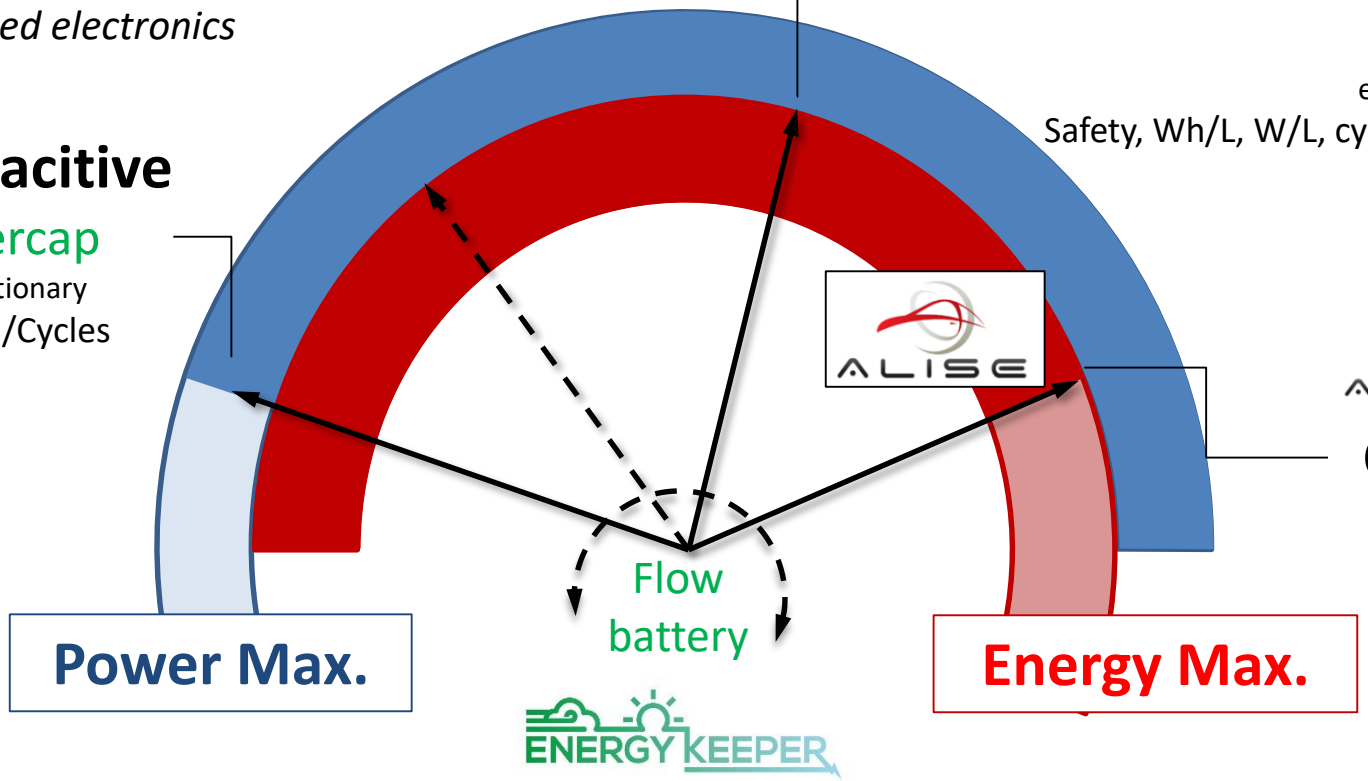
Intercalation

Li-ion

e.g. E-mobility

Safety, Wh/L, W/L, cycles, €/kWh

Use case 2
Aluminium ion for stationary (Power)



Conversion

Li-S

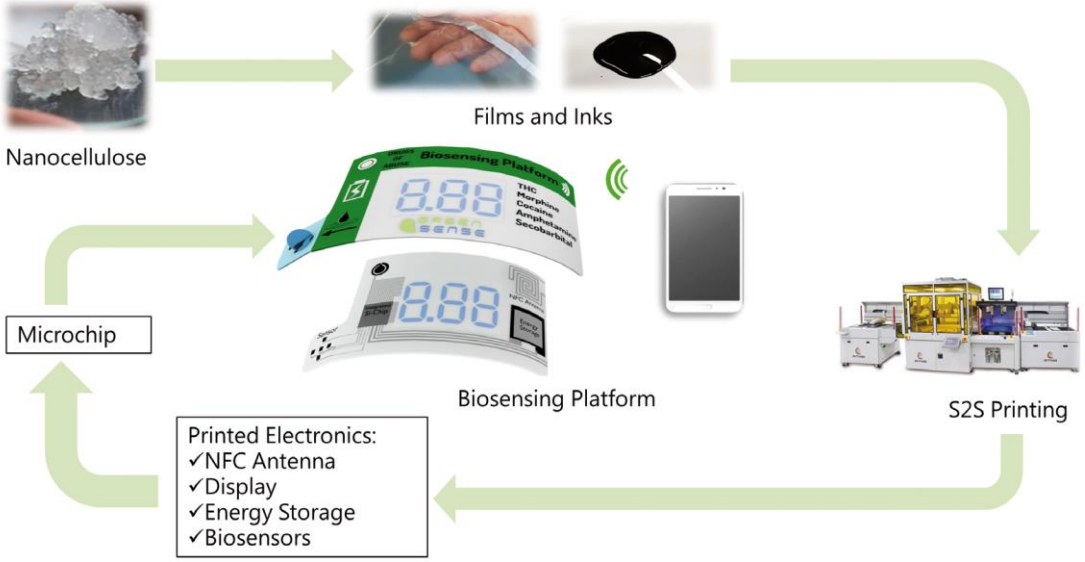
Wh/kg

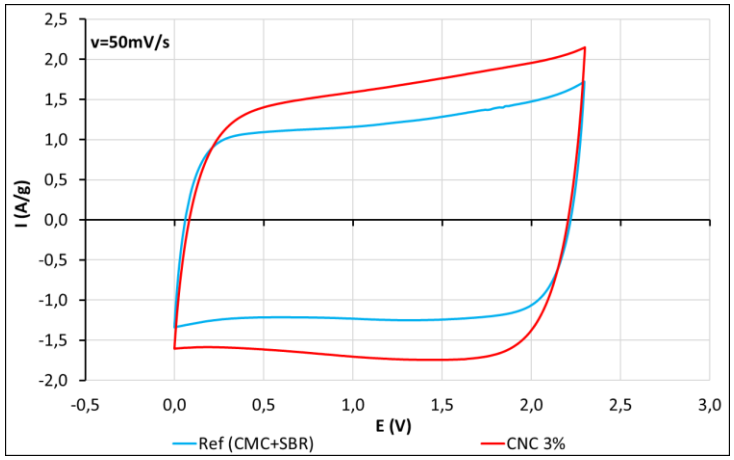
Use case 3
Lithium Sulfur for e-mobility (Energy)

Nanocelulose to replace polymers

https://www.greensense-project.eu/

Replacement of CMC+SBR by CNC for aqueous ink formulation with higher capacity and energy (+40%) for the same power.

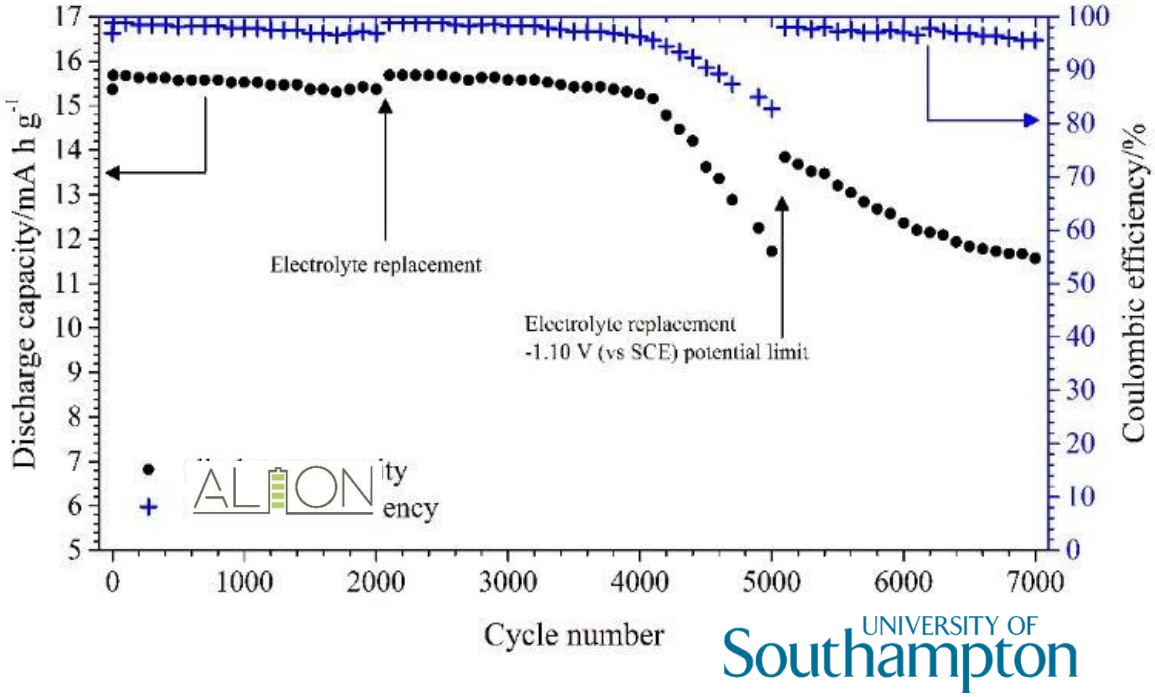




Cyclic voltametry of reference electrode (CMC+SBR as a binder) and electrode with CNC at 50mV/s with 1M Et_4NBF_4-ACN electrolyte.

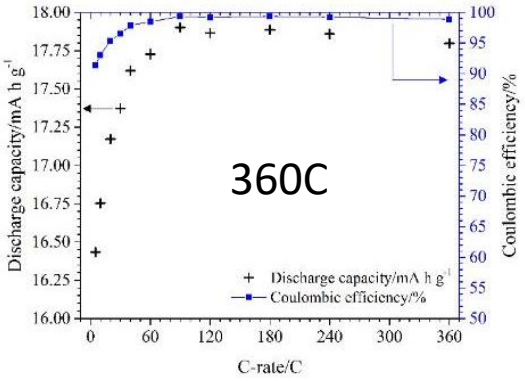
Al-ion for eletrical grid stabilization

http://alionproject.eu/



Lab cell: TiO2 in aqueous Al-based electrolyte

- 15 Wh/kg of cell
- 43,000 W/kg of cell
- 7.000 cycles



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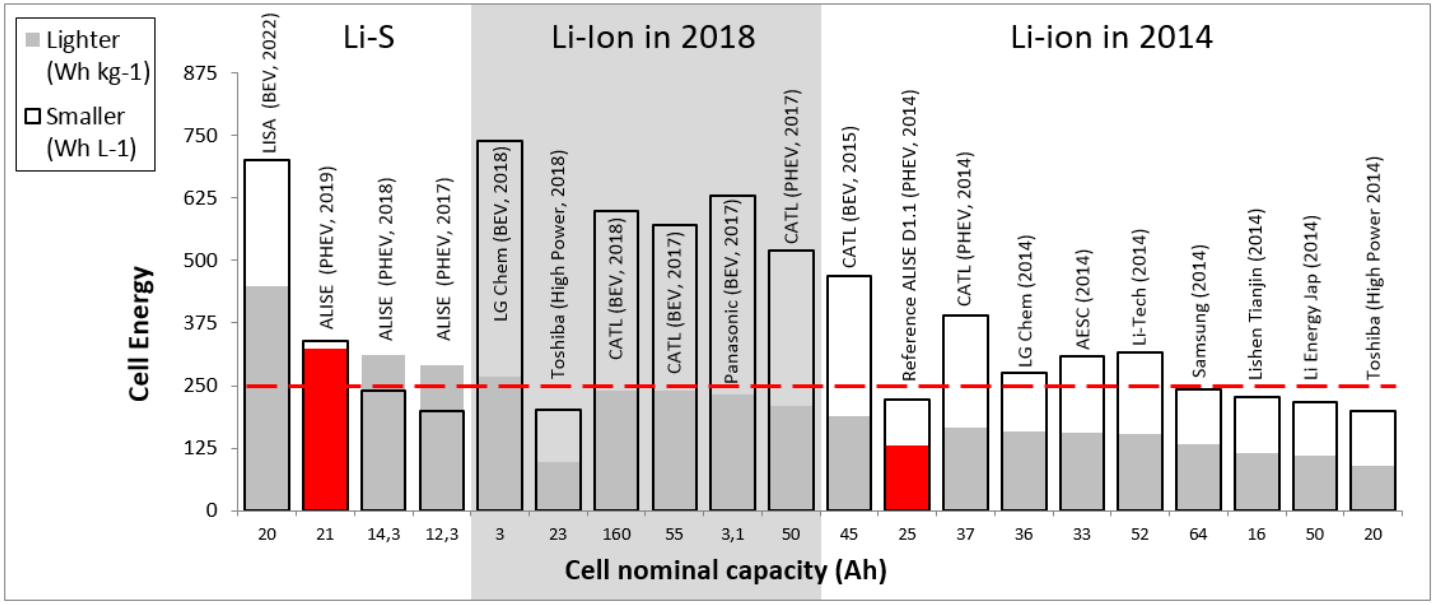
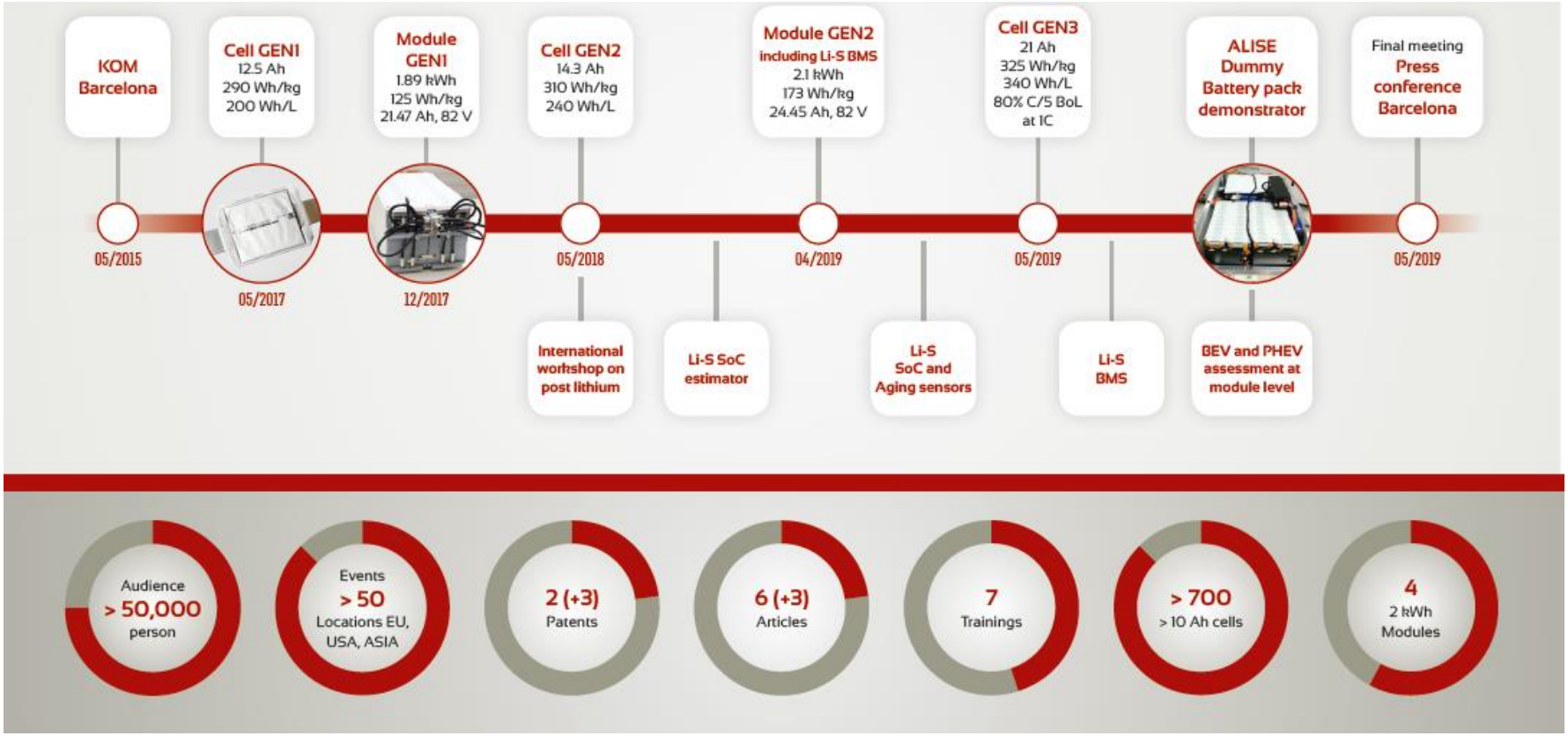
Lithium Sulphur versus Lithium ion battery cell state-of-the-art

- 2 kinds of Li-ion, High Power **OR** High Energy (e.g. Toshiba and LG Chem charge respectively in 6 and 40 minutes)
- Lithium Sulphur achievements in 2019 is 440 and 360 Wh kg-1 respectively at C/10 (10 hours discharge) and at C/5 (5 hours)
- ALISE demonstrators reached 325 Wh kg-1 (x2.5 our reference), 340 Wh L-1 at C/5 (5 hours), 21 Ah, 80% of the C/5 BoL at 1C



ALISE results



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LISA Project dedicated to lithium metal protection

Obj. 450 Wh kg-1, 700 Wh L-1, 700 W kg-1, 1.000 cycles at 80% BoL

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Take away: CRM-free battery technology for automotive and stationary applications

- Application is driving technology
- Technology is driving material
- Material, technologies, advantages and barriers are already well identified

  https://setis.ec.europa.eu/sites/default/files/set_plan_batteries_implementation_plan.pdf
- New opportunities from a real EU (public/private) motivation to be competitive

  https://ec.europa.eu/inea/en/news-events/newsroom/horizon-2020-nearly-500-million-requested-next-generation-batteries
- Manufacturing concept must be considered (existing production, and TRL value chain)

- New opportunities such as sensor, self-healing and circular economy

Thanks for your attention

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