Strategy Research Agenda for Battery Research in Europe

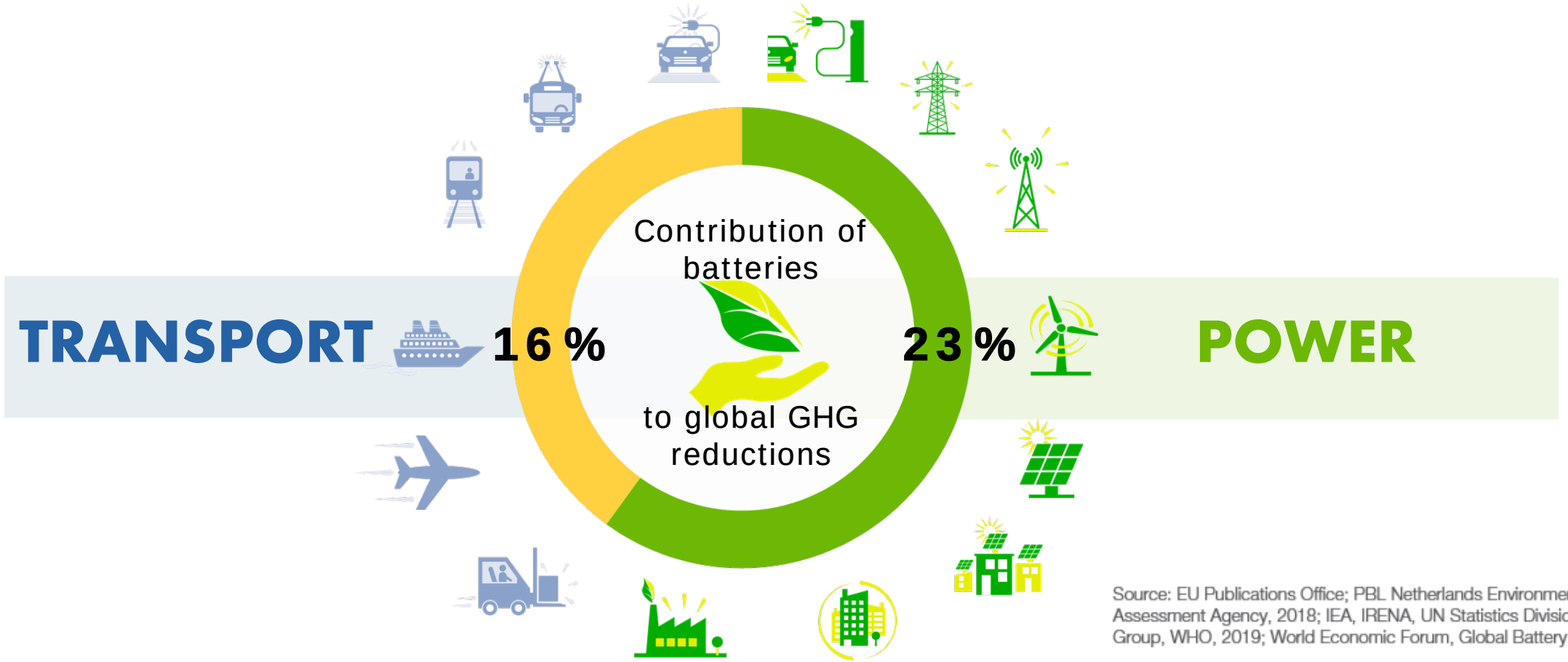
Dr. Edel Sheridan

Senior Business Developer

SINTEF ENERGY

BEACON

« Everything we can electrify will be electrified »



Source: EU Publications Office; PBL Netherlands Environmental Assessment Agency, 2018; IEA, IRENA, UN Statistics Division, World Bank Group, WHO, 2019; World Economic Forum, Global Battery Alliance

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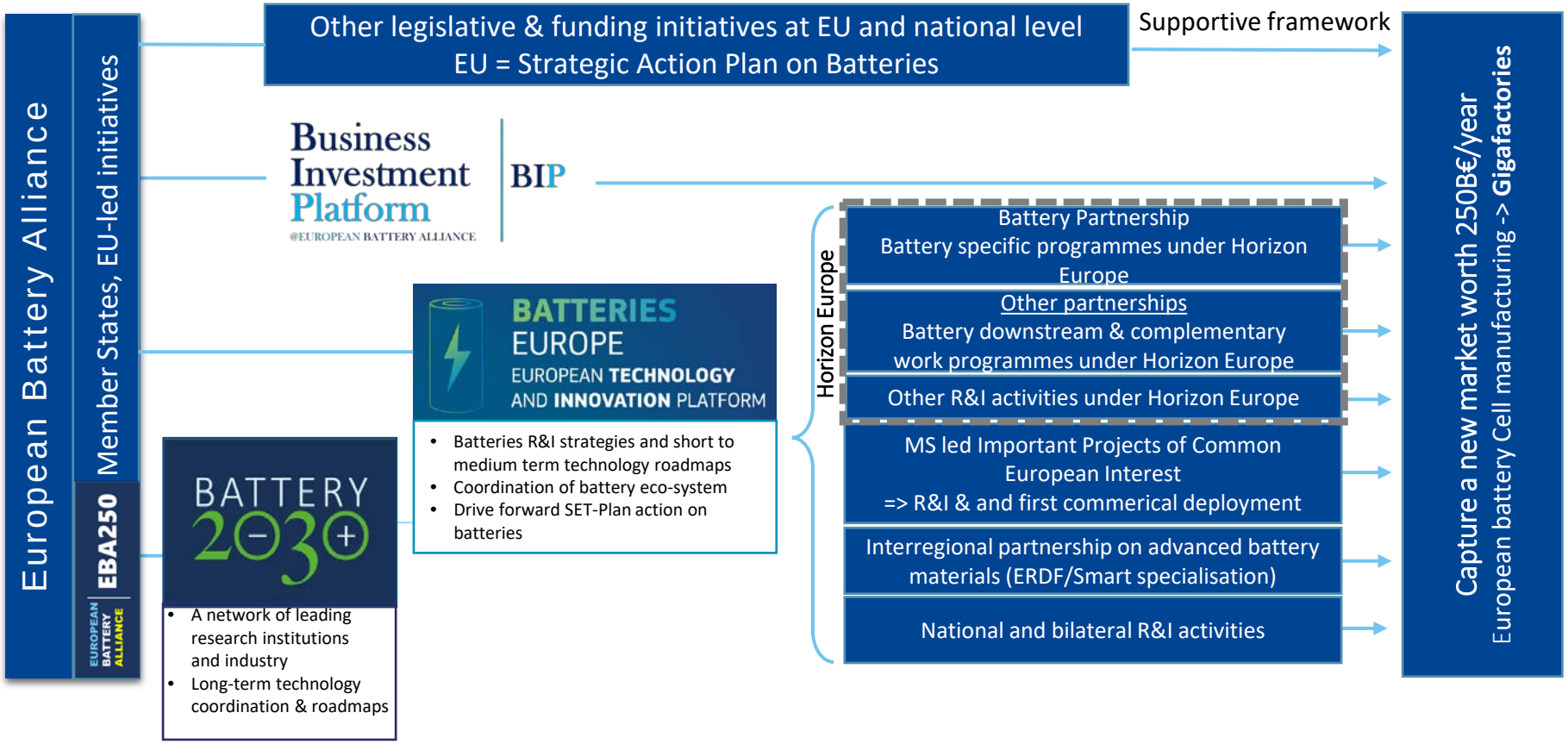
European Battery Networks Landscape



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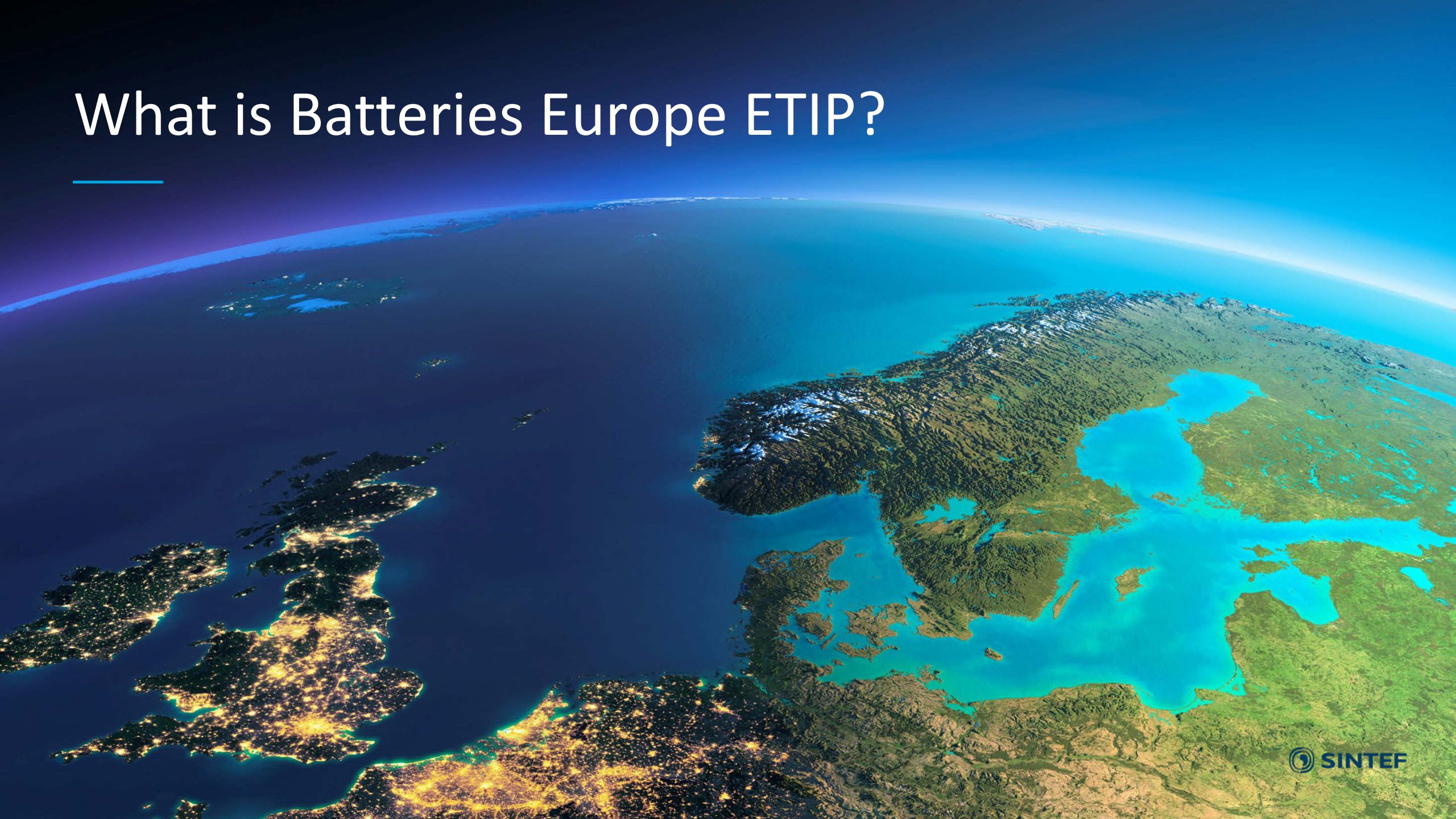
What is Batteries Europe ETIP?



A European Technology and Innovation Platform for Batteries

An R&I focused network for all battery stakeholders

The "one stop shop for Batteries R&I"

Batteries Europe is not a funding program however if you want to…

Network with the battery community

Understand the state of play in the battery eco-system

Contribute your view to Roadmaps, the Strategic Research Agenda, Task Force white papers..

Influence the R&I agenda for batteries on both European and National level

www.batterieseurope.eu

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Batteries Europe
Working Groups's and Task Forces's

BATTERIES EUROPE
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

New and emerging Battery technologies

Raw Materials and Recycling

Advanced Materials

Cell Design and Manufacturing

Mobility Applications & Integration

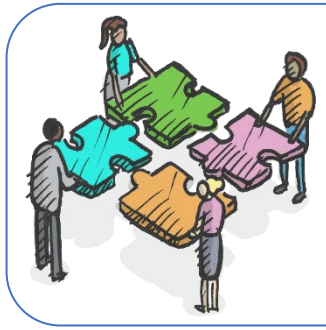
Stationary Applications & Integration

Sustainability

Safety

Digitalization

Skills and Education



+550 experts

Industry, Research, Policy

Across entire value chain

Low to high TRL

Upstream to downstream

Road, rail, sea, air, homes, grids, power stations

Leadership of Working Groups : Chairs and Co-Chairs

BATTERIES EUROPE
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

Thematic Working Groups	WG1 New & Emerging Battery Technologies	WG2 Raw Materials and Recycling	WG3 Advanced Materials	WG 4 Manufacturing and Cell Design	WG5 Application and Integration- Mobile	WG6 Application and Integration- Stationary
Chair	*Kristina Edström* **Uppsala University**	Ilkka Kojo **Outotec**	Fabrice Stassin **Umicore**	Oscar M. Crespo **CIDETEC**	Simon Perraud **CEA**	Luigi Lanuzza **ENEL**
Sherpa	*Ivana Hasa,* KIT	*Mari Lundström,* **Aalto university**	Marcel Meeus, **EMIRI**	Arno Kwade, **TU Braunschweig**	*Lucie Beaumel* **EGVIA**	*Rachele Nocera*, **ENEA**
Co Chair	Stefano Passerini **Helmholtz Institute**	Olli Salmi **EIT Raw Materials**	*Silvia Bodoardo* **University di Torino EERA ES**	Carlo Novarese, **FAAM/Lithops**	Franz Geyer **BMW**	Javier Olarte **CIC Energigune**
Co-Chair	Philippe Stevens **EDF**	Alain Vassart **EBRA**	Daniel Gloesener, **Solvay**	Michael Krausa **KLIB**	Josef Affenzeller **AVL**	Jesus Varela Sanz **Iberdrola**

Research | Industry

Strategic Research Agenda: Batteries Europe

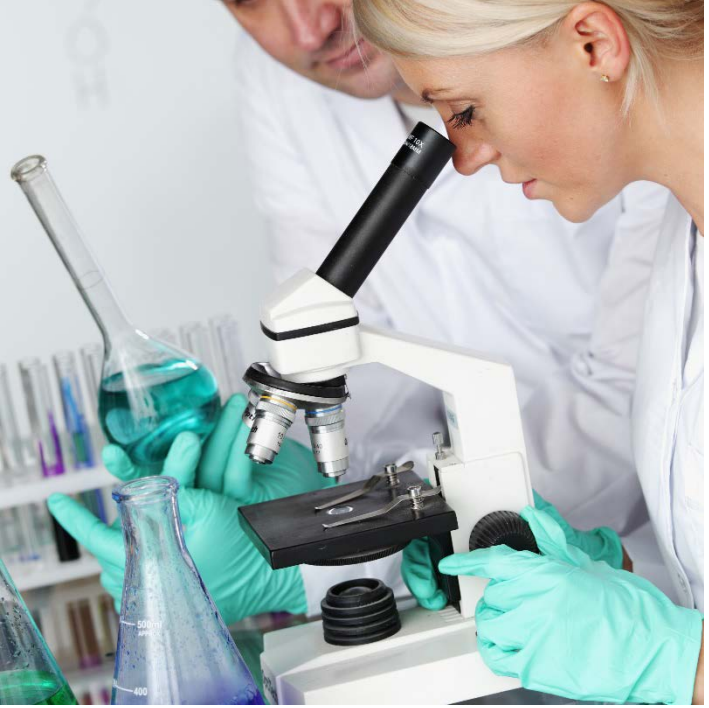
Strategic Research Agenda (SRA)

R&I needs across entire battery value chain
- Holistic and scientific approach
- Long term and short term needs
- Includes Current and target KPI's

Mission:
- Audience EC, MS, Industry and Research
- Guideline to develop coherence and completeness of R&I activities in EU

Key Recommendations

- Urgent prioritisation of Battery Research to support the European Battery Industry
- Ensure Continuity and Amplitude of Battery Research and Innovation
- Holistic approach to supporting R&I across the Battery Value Chain
- Provision and Coordination of Battery Research Infrastructures
- Develop, support and Implement Reporting Methodologies
- European Development of International Battery Standards
- Enhance Regulatory and Policy Framework to drive sustainability and competitive advantage
- Mutual engagement of battery industry and end users to prepare for new technological advances



Cross-cutting topics

Education

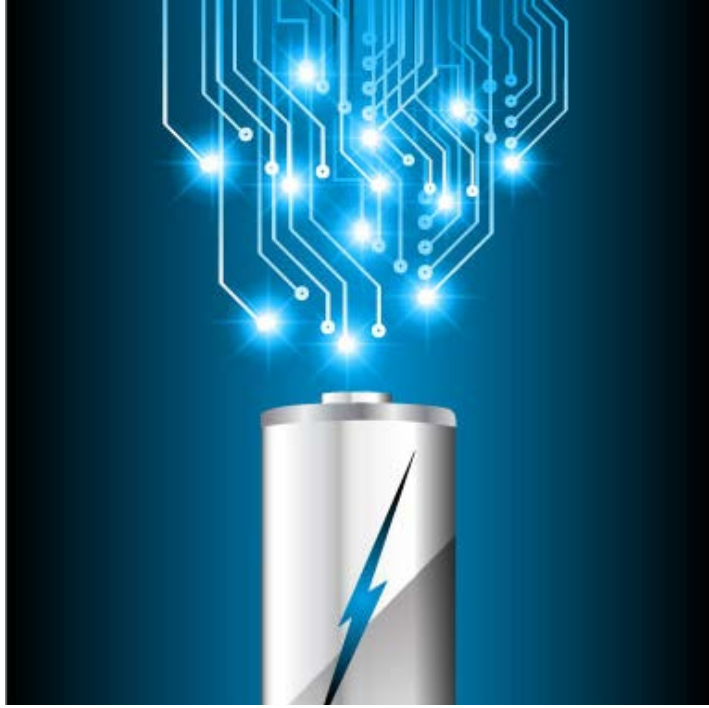
Academic, Professional, Vocational and Public/User segments

32GWh battery production facility 2900 – 5800 people directly employed.

Digitalization

Digitalization as a booster

Accelerate developments
Digital twins
Battery passport
Virtual production plants



Sustainability

Sustainability as a differentiator

Environmental sustainability

Economic sustainability

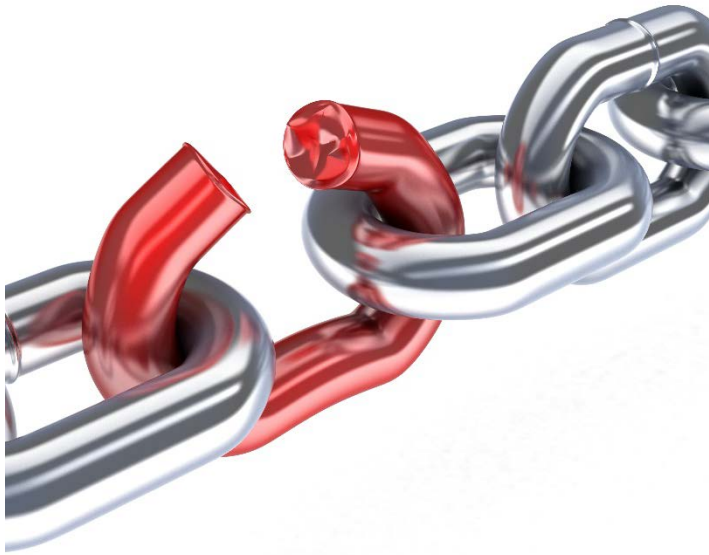
Social sustainability

Safety

New advances in battery technology

Automatization of the processes and robotics

Creation and adaptation of existing standards



Raw Materials for Batteries

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Raw Materials

- **Sourcing, sustainability and traceability of raw materials**
- Development and evaluation of tracing and labelling technologies, digital ledger technologies
- **Sustainable extraction and refining of battery grade raw materials**
- Developing processing solutions for Li, Ni, Co, Mn and graphite to be used to both domestic and imported raw materials
- **Raw Material LCA and material Flow Analysis**
- Greater environmental sustainability via new holistic and applicable quantitative tools of circular batteries. Reliable holistic LCA tools, reduced carbon footprint, new approaches to recycling and reuse and greater understanding of societal sustainability and coherent measurement of the SLCA

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WG 2 of Batteries Europe

EIT Raw Materials

BAT CIRCLE project

2Zero Partnership

Advanced Materials

Battery Generation	Electrodes active materials	Cell Chemistry / Type	Forecast market deployment
Gen 1	• Cathode: LFP, NCA • Anode: 100% carbon	Li-ion Cell	current
Gen 2a	• Cathode: NMC111 • Anode: 100% carbon	Li-ion Cell	current
Gen 2b	• Cathode: NMC523 to NMC 622 • Anode: 100% carbon	Li-ion Cell	current
Gen 3a	• Cathode: NMC622 to NMC 811 • Anode: carbon (graphite) + silicon content (5-10%)	Optimised Li-ion	2020
Gen 3b	• Cathode: HE-NMC, HVS (high-voltage spinel) • Anode: silicon/carbon	Optimised Li-ion	2025
Gen 4a	• Cathode NMC • Anode Si/C • Solid electrolyte	Solid state Li-ion	2025
Gen 4b	• Cathode NMC • Anode: lithium metal • Solid electrolyte	Solid state Li metal	>2025
Gen 4c	• Cathode: HE-NMC, HVS (high-voltage spinel) • Anode: lithium metal • Solid electrolyte	Advanced solid state	2030
Gen 5	• $Li|O_2$ – lithium air / metal air • Conversion materials (primarily Li|S) • new ion-based systems (Na, Mg or Al)	New cell gen: metal-air/ conversion chemistries / new ion-based insertion chemistries	>2030

Advanced Materials

- **Generation 3 Li-ion batteries for mobility applications**
- enabling higher energy / power density thanks to higher capacity and/or operating at higher voltage
- **Generation 4 Li-ion batteries for mobility applications**
- solid state electrolytes, cathode materials and anode materials enabling higher thermal and electrochemical stability while targeting higher energy / power densities, fast charging, cyclability and improved safety
- **Li-ion batteries for stationary storage applications**
- used in utility scale applications (> 100 MW, P/E < 1/3) and
- in commercial high-power applications (< 100 MW, P/E > 4).
- **Advanced materials to enable ultra-fast charging**
- power transfer capability exceeding 350 kW

"about 70% of the cost of a battery cell being the cost of the cathode, anode, separator and electrolyte materials"

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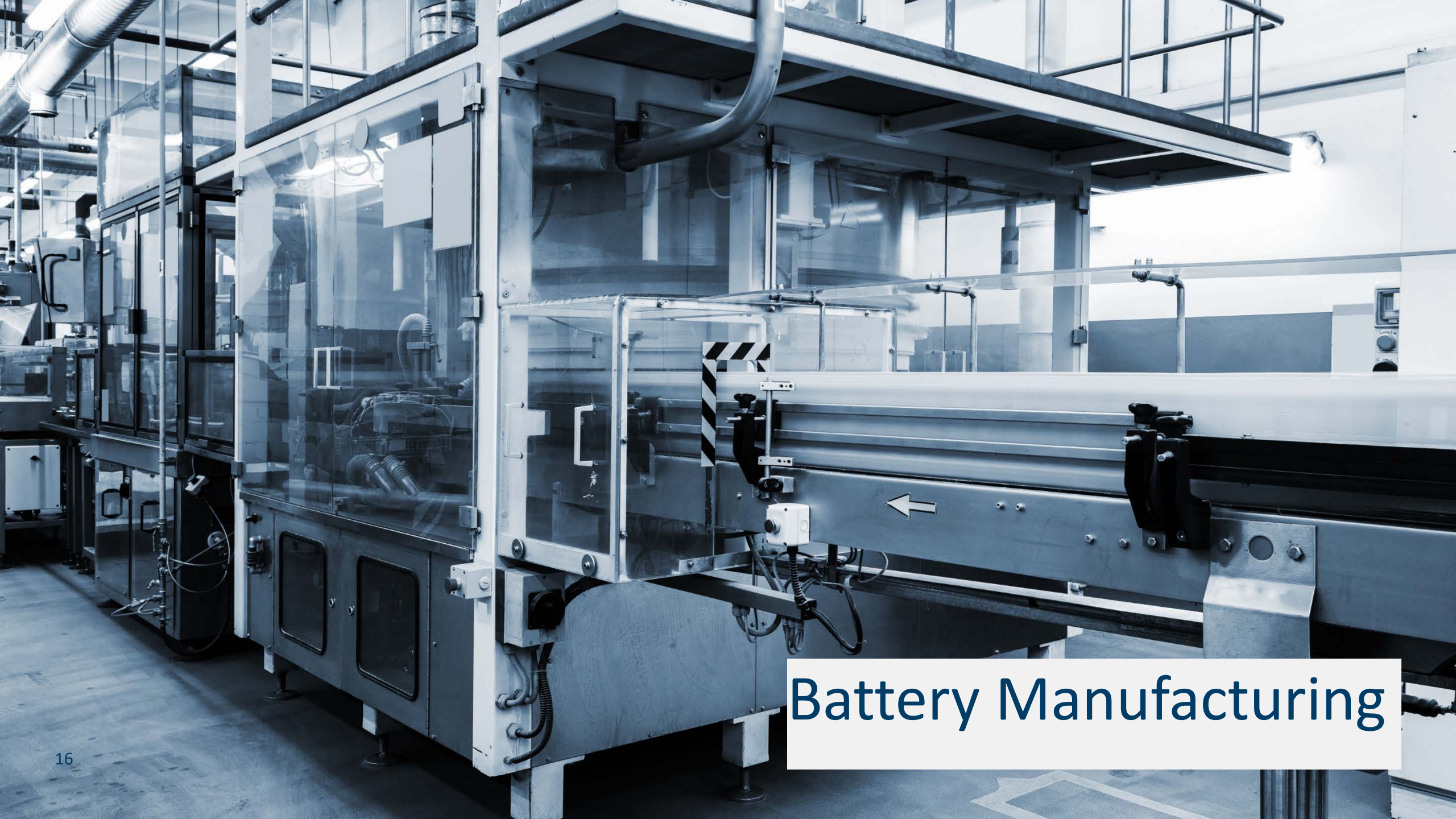
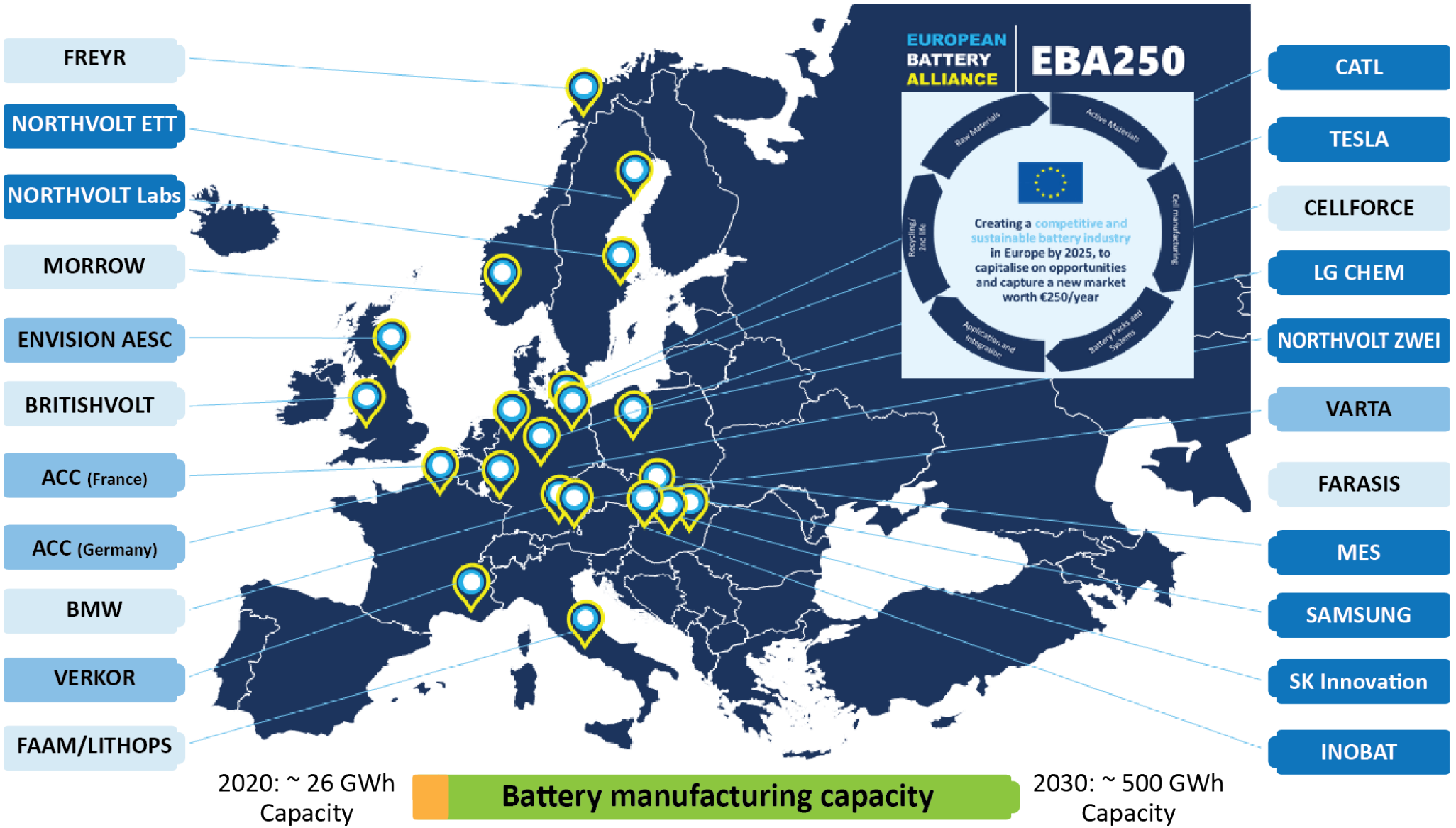
WG 3 of Batteries Europe

EMIRI Roadmap



Battery Manufacturing


FREYR
NORTHVOLT ETT
NORTHVOLT Labs
MORROW
ENVISION AESC
BRITISHVOLT
ACC (France)
ACC (Germany)
BMW
VERKOR
FAAM/LITHOPS
EUROPEAN BATTERY ALLIANCE
EBA250
Raw Materials
Active Materials
Cell manufacturing
Battery Packs and Systems
Application and integration
Recycling/ 2nd life
Creating a competitive and sustainable battery industry in Europe by 2025, to capitalise on opportunities and capture a new market worth €250/year
CATL
TESLA
CELLFORCE
LG CHEM
NORTHVOLT ZWEI
VARTA
FARASIS
MES
SAMSUNG
SK Innovation
INOBAT
2020: ~ 26 GWh Capacity
Battery manufacturing capacity
2030: ~ 500 GWh Capacity
Under construction/ in operation
Planned, partially financed
Announced, financial status unclear

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Battery Manufacturing

- **Research in innovative cell components and designs and its manufacturing processes**

- Increase energy density and intrinsic safety by 40%. Reduction of carbon intensity of 25% CO2/kWh - lower inactive materials use. Reduce the production costs by at least 20% vs. current cell production.

- **Cell design digitalization**

- Structure-property relationship, degradation models and large-scale data driven testing are required to reduce development times and costs and to improve the final cell designs

- advanced multiscale models, electrochemical performance as well as ageing mechanisms, combined with large-scale data harvesting

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WG 4 of Batteries Europe

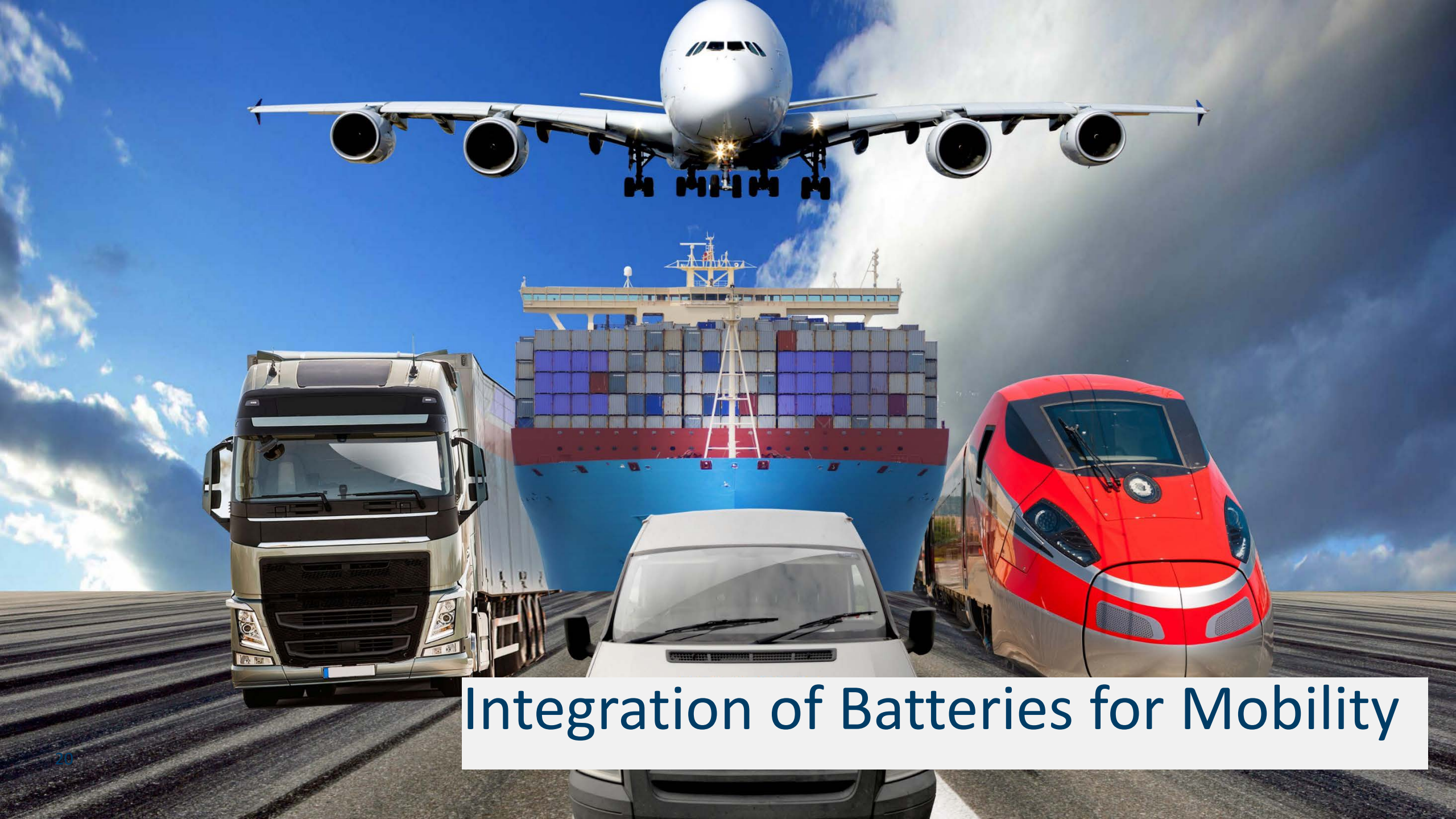
LiPlanet network

Battery Manufacturing

- **Innovation in manufacturing machinery and processes**
- improvement of process capability, reduction of material waste, energy efficiency and product consistency for SoA and new chemistries

- **Digitalization for process integration and plant operations**

Digitalization on two levels: (i) at the production line level, supported by machine learning and artificial intelligence, and (ii) at the plant level within its local energy and materials flow ecosystems integration supply ecosystem, i.e. sector coupling.



Integration of Batteries for Mobility

Integration of Batteries for Mobility

- **Battery systems**
- cells and battery system design and related manufacturing processes, considering mechanical, electrical and thermal aspects

- **Battery management**
- knowledge & data-based battery management, - algorithms, software, hardware, including sensor integration, standardization & interoperability - systems inside/outside the vehicle & vehicle-to-grid

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WG 5 of Batteries Europe

2Zro partnership

Waterborne partnership

Clean Aviation partnership

Integration of Batteries for Mobility

- **Digital twins for battery system design and manufacturing**
- **Digital twins for battery management**
- **Methods and tools for assessment of battery performance and safety**
- new approaches, including the combination of physical and virtual testing, for a faster and more accurate assessment of battery lifetime, reliability and safety

Batteries for Stationary Storage

Batteries for Stationary storage

- **Innovative technologies and components to decrease the cost of batteries for stationary applications, improve calendar and cycle life and ensure optimal performance**

- **Technologies, methodologies and tools to enhance safety in stationary electrical energy storage systems**

- **Open access and interoperable advanced Battery Management Systems**

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WG 6 of Batteries Europe

ETIP SNET

Recycling and Circular Economy

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Recycling and Circular Economy

- **Collection, reverse logistics, sorting and dismantling**

safe and effective handling of the growing battery streams before they finally will enter the recycling process

- **Metallurgical recycling processes, industrial integration and secondary material based precursors**

recover the valuable (or hazardous) raw materials with lowest possible environmental footprint and costs ensuring that the recycled materials fulfil the sustainability targets

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WG 2 of Batteries Europe

EIT Raw Materials

New and Emerging Battery technologies

New and Emerging Battery technologies

1. Develop battery chemistries that mitigate risks related to critical minerals in the long term.
2. Develop synthesis and production routes that use less energy, lower temperatures, less toxic solvents and minimize risks for workers and environment.
3. Improve battery resistance to fires and thermal runaway. A major breakthrough is needed towards the minimization or replacement of the present flammable electrolytes.
4. Reduce chemicals that can potentially produce toxic materials with the target to remove them in the long term, i.e., beyond 2030.
5. Develop hybrid systems enabling the use of materials and/or devices for multiple intersectoral energy storage.

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WG 1 of Batteries Europe

Battery 2030+ Roadmap

Emerging Battery technologies TRL ≥ 2

- **Li metal-based batteries beyond Generation 4, employing innovative high voltage (> 4.8 V)/ capacity (> 500 mAh/g) cathodes and solid state electrolytes** to achieve very high energy densities and full recyclability**; (TRL 2-4)**
- **Zinc-based secondary batteries (intercalation and zinc-air)** for greener and safer energy storage**; (TRL 2-6)**
- **Na-ion batteries with low-cost electrolytes** for Li-free energy storage; **(TRL 2-3)**
- **Greener Redox Flow Batteries** combining low cost (CRM-free) active materials & improved energy densities**; (TRL 3-6)**

New Battery concepts TRL < 2

- Basic research (TRL 1-2) is needed to establish the feasibility of other innovative chemistries using metals with high availability:

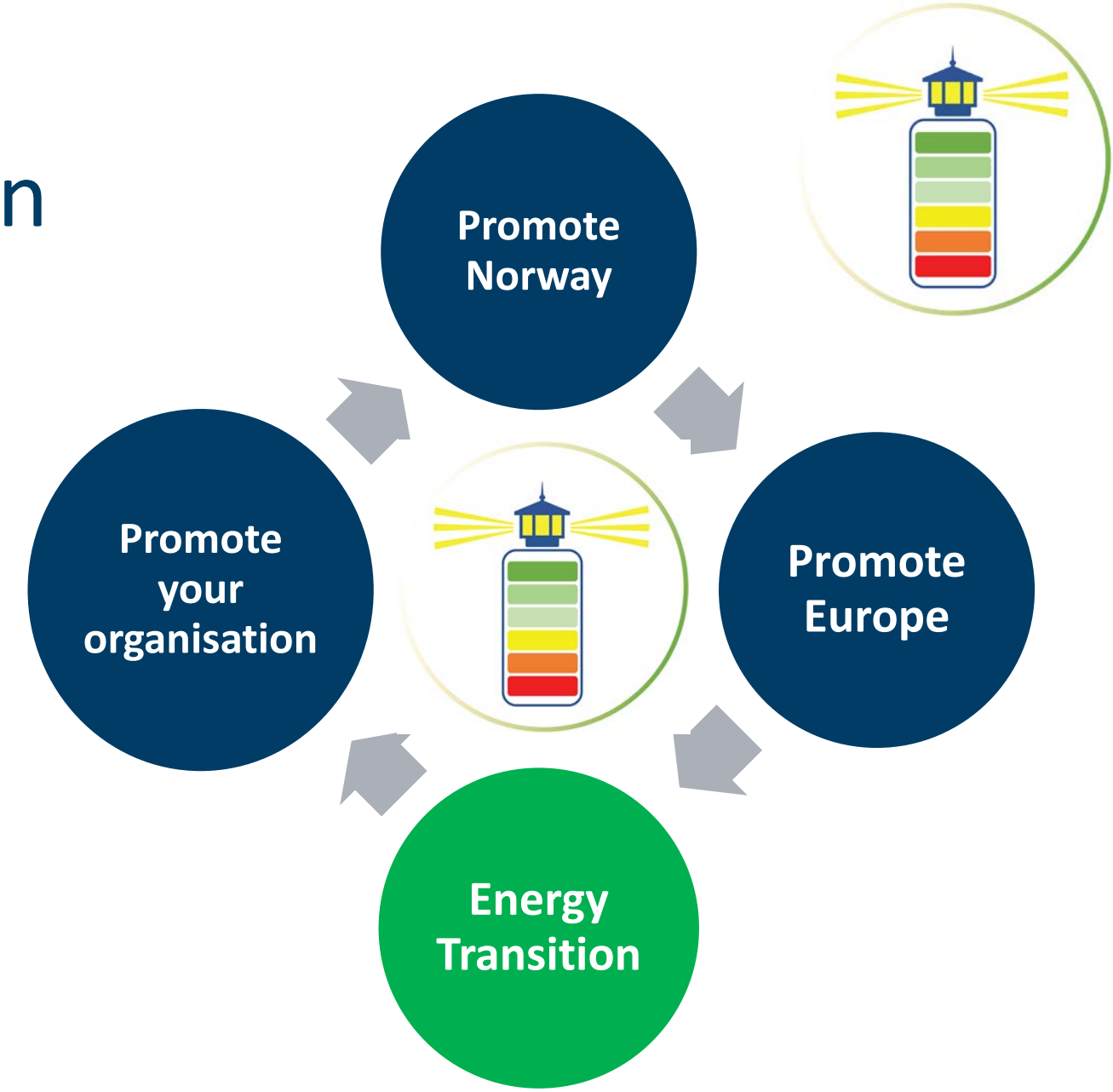
- **Organic batteries including redox-flow (TRL 1-3)**
- **Metal batteries from sodium metal to multivalent ion-carriers other than zinc, including elemental cathode materials (TRL 1)**
- **Anion shuttle-based batteries (TRL 1)**
- **High power primary regenerative batteries based on reactive metals such as Na, Ca, Al, Zn, …, for seasonal/annual electrochemical energy storage (TRL 1-2)**

EU Projects participation

Battery Partnership is being established and has already working with EC has drafted next work program on batteries

Must of the input has come from Batteries Europe ETIP & Battery 2030+

Calls for 2021 - 2022 will be formally published in Dec/Jan……



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Upcoming Batteries Europe Webinar Series

BATTERIES EUROPE
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

Webinar 3

People Power for the Battery Value Chain – from Education and Research to Implementation

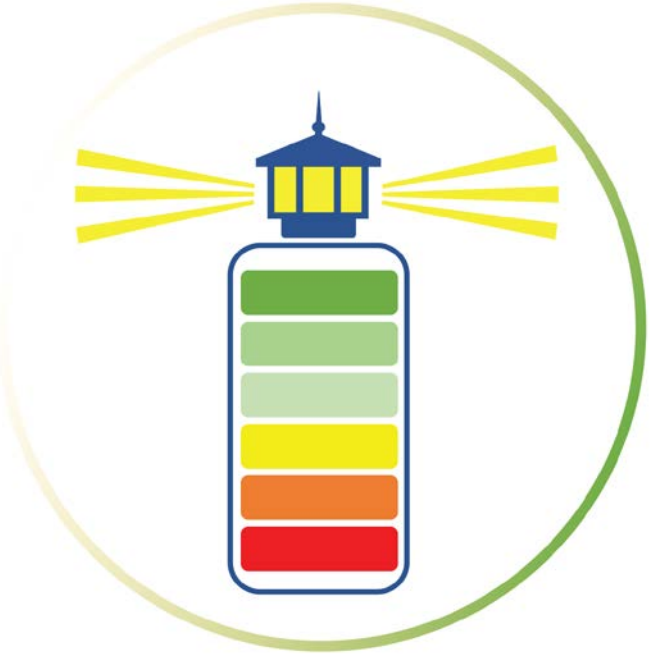
Thursday 29th October 10:00 – 12:00

- **Keynote – Rosa Palacin ICMAB & BE GB member**
- **Education needs – Axel Thielmann Education TF**
- **Strategic Research Agenda – Edel Sheridan**
- **Battery 2030+ & BIGMAP– Kristina Edström WG1 & Tejs Vegge DTU**
- **LiPLANET Roadmap – Li ion cell production in Europe – Arno Kwade WG4 & LiPLANET**

E mail info@batterieseurope.eu

https://ec.europa.eu/eusurvey/runner/a153e50a-d48c-a352-1fbb-bbb923855255

THANK YOU FOR YOUR ATTENTION



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