A HOLISTIC APPROACH TO BATTERY SAFETY AND SUSTAINABILITY

Online workshop organised by BATTERIES EUROPE

15 June 2021

Welcome and Opening

Claude Chanson

RECHARGE General Manager

Agenda

14.00 - 14.05	Opening of the Workshop
14.05 - 14.20	The new battery regulation- an important milestone in creating a sustainable and safe battery industry in Europe?
14.20 - 14.30	Safety, performance and sustainability of batteries – technical aspects in a policy context
14.30 – 14.40	Battery Safety in a Circular Value Chain
14.40 – 14.50	The Challenges for a Sustainable Battery Ecosystem
14.50 – 15.00	The Industry Perspective on Safety and Sustainability
15.00 – 15.15	Q&A Session
15.15 – 16.00	Panel Session: A Holistic Approach to Battery Safety and Sustainability

Technicalities

Please,

- Turn **off** your camera
- Turn **off** your microphone
- Ask **questions in the chat**
- If you write a question, please **specify to which speaker** your question is addressed

The new battery regulation- an important milestone in creating a sustainable and safe battery industry in Europe

Ilka von Dalwigk

(Policy Manager, EBA 250)

EBA250 – The industrial development programme of the European Battery Alliance

EUROPEAN BATTERY ALLIANCE | EBA250

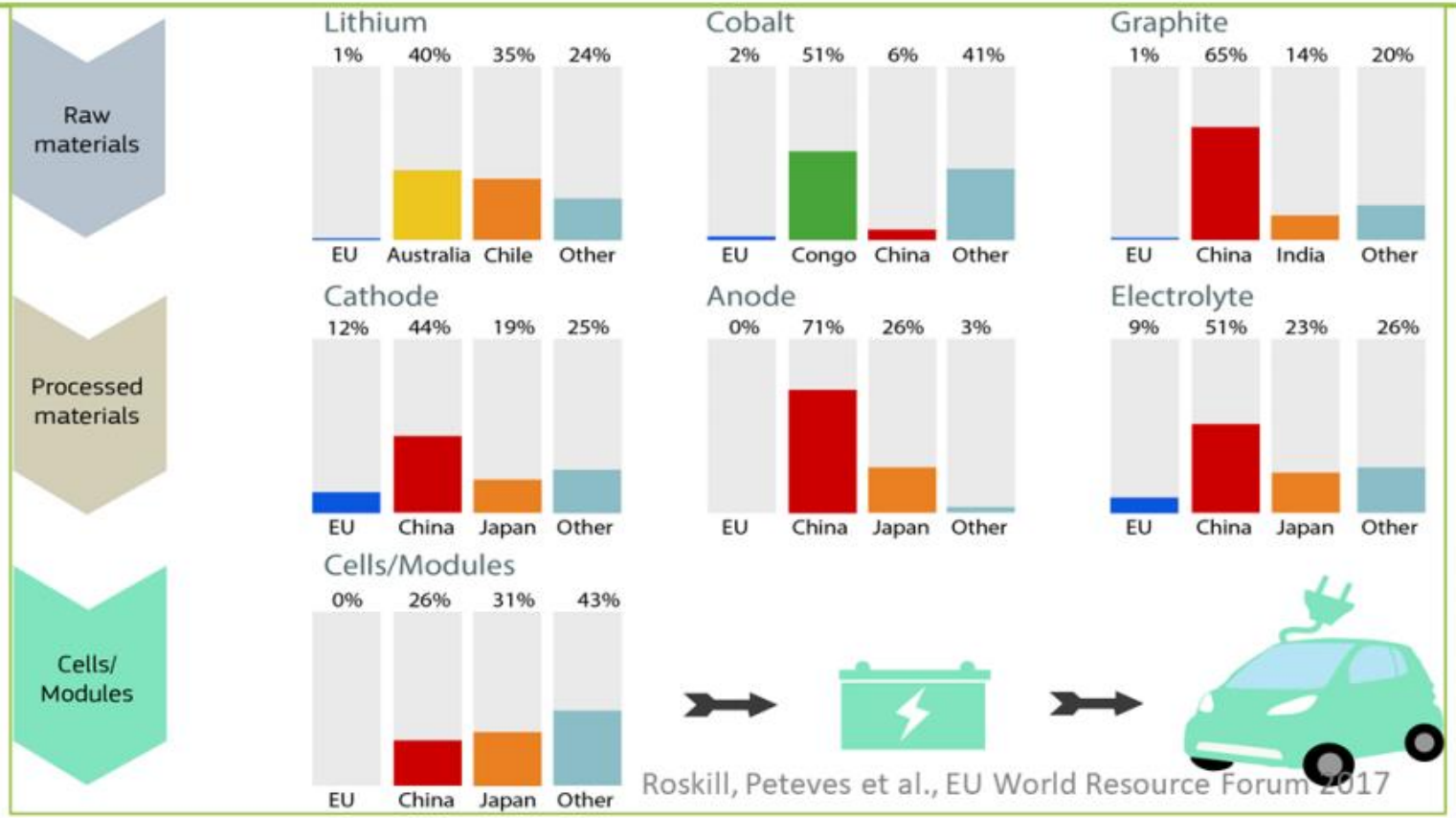
This cooperative ecosystem gathers the European Commission, interested EU countries, investment institutions and key industrial, innovation and academia stakeholders

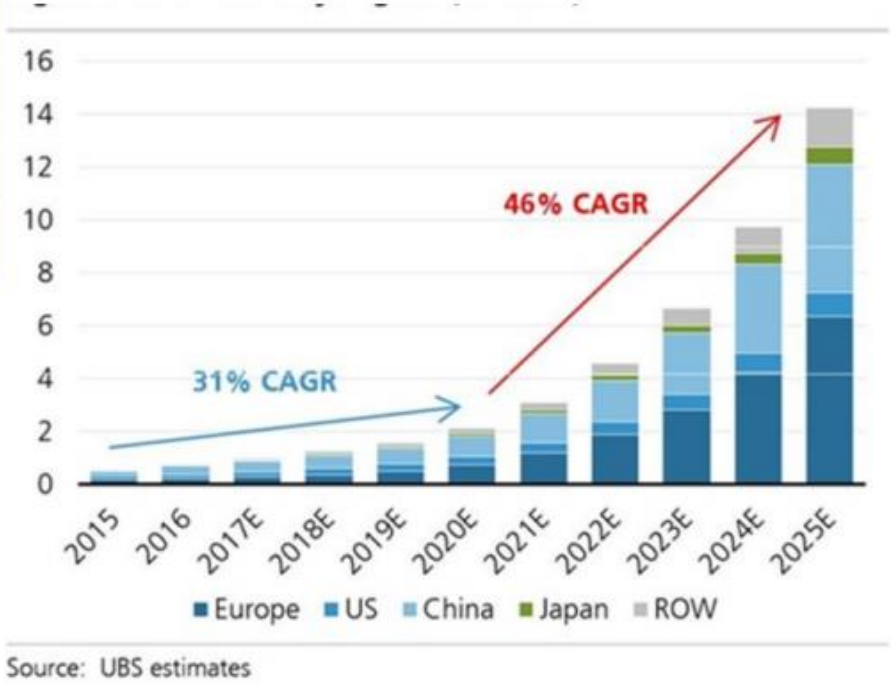
EIT InnoEnergy has been trusted by the European Commission to drive forward and promote EBA250 activities, acting as network manager and project facilitator

700+ members

60+	Research and associations active in large parts of the value chain
10+	European Commission Services
50+	Financial Institutions

Starting point 2017





Source: UBS estimates

EUROPEAN BATTERY ALLIANCE | EBA250

The greatest industrialization project in EU

EIT InnoEnergy Knowledge Innovation Community

EIT InnoEnergy is supported by the EIT, a body of the European Union

Timeline European Battery Alliance

11. Oct. 2017
EU launches
European Battery Alliance

19. Dec 2017
1st High-Level Meeting

11. Oct 2017
EBA Launch

30. Jan 2018
2nd High-Level Meeting

12. Feb 2018
3rd High-Level Meeting

March 2018
Launch EU Battery Strategy

4. Sep 2018
4td High-Level Meeting

29. Jan 2019
5th High-Level Meeting

6th High-Level Meeting
25 Sept. 2019

Implementation

18 recommendations to harvest the 250bn €

49 actionable actions

20 legitimized actions

Building a competitive and sustainable European battery value chain: Starting point 2017

eit InnoEnergy

Funded by the European Union

Create a pan-European and cross sectoral batteries ecoystem to make Europe a fast follower in battery technology and capture a new market worth 250B€/year in 2025

Objective	Recommendations	Actions
Secure access to **sustainably produced battery raw materials** at reasonable costs	1. Secure access to raw materials from resource rich countries outside the EU	1a. Apply diplomacy, strategic investments and stretch trade agreements (e.g. Canada, Republic of Congo) to secure access to raw materials
		1b. Implement same compliance rules to foreign battery products imported to Europe as applied to European products
	2. Facilitate the expansion/creation of European sources of raw materials	2a. Build European alliances between industries from different parts of the value chain and politics to boost mining and intermediate product production in EU
		2b. Map geological and urban sources, and potential scenarios considering conflicting interests – and possible actions to take from a European and National perspectives
		2c. Define and implement a simplified application process for opening of raw mines
	3. Secure access to secondary raw materials through **recycling in a Circular Economy of Batteries**	**3a. Define and implement regulation and demonstration projects for recycling and second life of batteries.**
		3b. Improve regulation and align with strategic objectives: Battery Directive, Energy Union, REACH, Critical Raw Materials, Mobility Package, Permitting, Transport Regulations
Make Europe the global leader in sustainable battery technology	4. Support the growth of **a cell manufacturing industry that comes with the smallest environmental footprint possible**. This will provide a key competitive and commercial edge versus competitors.	**4a. Develop a standardised EU life cycle assessment scheme, with targets of carbon footprint including guidlines for the calculation thereof**
		4b. Define and implement certification/labelling of batteries made in Europe. Use the declaration as a tool in trade agreements / tax treatment with non-EU battery providers
		4c. Reduce carbon footprint of advanced battery materials making and cell manufacturing by securing access to renewable Energy
		4d. Develop a standardised life cycle assessment for all transport technologies
	5. Create and sustain a cross-value chain ecosystem for batteries, incl. mining, processing, materials design, 2nd life, and recycling within the EU, encouraging cross-sectoral initiatives between academia, research, industry, policy, and the financial community.	5a. Invest in R&D and pilot plants to take the technology lead in primary and secondary raw materials processing
		5b. Establish a clearing house for battery recycling
		5c. **Strengthen all currently existing battery collection systems**
Support European Battery manufacturing in order not to miss the hockey stick phenomenona in market demand (250B€/year in 2025)	6. Ensure the availability of high quality and high-performance cells for European industries to maintain the competitiveness of several European industries.	6a. Define cell manufacturing as a strategic industry for the high-tech area Europe.
		6b. Nugged tax incentives can help establish cell manufacturing in Europe
		6c. Generate and secure European IP
	7. From loading financially, e.g. IPCSI (important projects of common European interest) and/or other financial instruments such as tax incentives, the needed investments is a must for not missing the demand uptake.	7a. Investigate and implement de-risking possibilities (e.g.: direct funding and funding bridges) for cell manufacturers
		7b. Define and implement criteria for IPCSI projects for cell manufacturing.
	8. Accelerate time to market to meet market demand and international competitors	8a. Standardize and simplify approval procedures ("Fast track") and permitting (environmental, manufacturing, construction) process
		8b. Investigate and implement investment risk sharing between companies along the value chain, EU and member states to support new cell manufacturing
Create and support new markets for batteries, e.g. through the "Clean Energy" & the "Mobility" packages but also new initiatives, in order to support sustainable solutions for power, transportation and industry sectors in line with EU climate goals	9. Increase the demand for e-mobility solutions including "yellow machines"	9a. Set clear targets for charging infrastructure for homes, urban areas and public roads as well as along freeways. Provide incentives for building charging infrastructure.
		9b. Define and implement a consistent incentivizing framework for the uptake of the EV market (e.g. emission standards for "yellow machines", promotion schemes for ZEV sales, public procurement targets for clean vehicles including public transport, tax and "soft" incentives such as use of public lanes and free parking)
		9c. Implement favourable tax incentives for e-taxi operators e.g. special VAT schemes
	10. The function of batteries and battery systems must be seen pluri-functional, in a context of both power and transportation sectors. For ESS, regulation (or absence of it) enabling of right business models is crucial.	10a. Develop a power market design that enables the integration of ESS (including EV batteries through vehicle to grid) allowing ESS and EV batteries to support the power system management with high penetration of EV charging. Battery based actors/systems shall be able to participate in all parts of the power market and network tariff shall not penalize storage while driving electrification (capacity based + Time-of-use, with no generation charges)
		10b. Establish a transparent data hub for use data for e-vehicles (similar to best practice data for hub metering data of electricity customer)
	11. Incentivize storage as alternative to conventional grid reinforcement.	11a. Integrate battery storage options and V2G in grid planning and resource planning (addressing security of supply)
	12. Enable integration of ESS on all levels of the power system including behind the meter	12a. Develop standardized interoperability interfaces allowing seamless secure integration of battery management systems of ESS and EVs and bi-directional communication with aggregation platforms or Energy markets. Evolution of digitalized innovative energy services shall be enabled.
Grow the European R&I capacity. Develop and strengthen skilled workforce in all parts of the value chain and make Europe attractive for world class experts.	13. Create competitive advantage with constant incremental (e.g. Lithium ion) and disruptive (e.g. solid state) R&I connected to the industrial ecosystem in all the steps of the value chain (advanced materials, new chemistries, advanced manufacturing process, BMS, recycling, business model innovations).	13a. Define how to reach TRL 7 in 2023 on Generation 3b (advanced lithium-ion technologies with liquid electrolyte) for e-mobility
		13b. Define how to faster reach TRL 7 on Generation 4 (all-solid-state lithium-ion technologies, e.g., with polymer or ceramic electrolyte) for e-mobility in 2023 by concentrating R&I efforts on this strategic topic
	14. Conduct advanced research in battery chemistry, battery systems, manufacturing, recycling and increase university output in these areas by involvement of industrial stakeholders.	14a. Create stronger focus and more prescriptive R&I calls, co-defined with industry and sustained over longer periods
		14b. Establish a technology board within the EU Battery Alliance, with the mandate to update the roadmaps and the R&I orientations, and manage the project portfolio (R&I project portfolio management)
	15. Sufficient and key human capital skills are missing in Europe especially on applied process design. Lighthouse projects for cell manufacturing will attract worldwide talent.	15a. Actively identify and utilize synergy effect between large scale cell production and educational system to secure workforce competence transition
		15b. Establish a European open access pilot line network to gain manufacturing experience
		15c. Create a link between the educational network (Master programs in Universities) and the European pilot line network, in order to train the students on battery manufacturing
		15d. Build new degree courses in consultation between universities and industries
		15e. Dedicate national and ESF (European Social fund) funds for training professionals to new technologies systems and applications
	16. Make Europe attractive for world class experts and create competent workforce.	16a. Define instruments to attract global key talents including process engineers and operators
Involve (+ inform, educate & motivate) the EU citizens in the journey.	17. At the end of the supply chain there is always a B2C transaction. Public efforts (education in schools, role modelling, ...) should be spent on citizen awareness of the vehicle value/chain, so there is a societal appropriation from the start. Fighting for keeping the supply chain in Europe will definitely help to bridge the gap citizen-politics.	17a. Involve Industry + Citizens + Policy makers on Use patterns/Re-use & Sustainability
		17b. **Highlight importance of batteries as a means to meet decarbonization goals in power and transport.**
		17c. Safeguard non-discriminatory access for consumers to energy service providers including charging services
Ensure maximum safety for European citizens and create competitive advantage through standardization.	18. Standardize storage related installations including charging infrastructure, safety rules, active load compensation and enable vehicle to grid solutions	18a. Develop and implement performance and safety assessment standards for batteries
		18b. Harmonise charging protocols and billing systems in Europe

The EU The Strategic Action Plan on Batteries

EUROPEAN COMMISSION

Brussels, 9.4.2019
COM(2019) 176 final

ANNEX

ANNEX

to the Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank

Building a Strategic Battery Value Chain in Europe

This Strategic Action Plan combines targeted measures at EU level including in raw materials (primary and secondary), research and innovation, financing/investment, standardisation / regulatory, trade and skills development, in order to **make Europe a global leader in sustainable battery production and use, in the context of the circular economy**.

1. SECURING THE SUPPLY OF RAW MATERIALS

2. SUPPORTING PROJECTS COVERING DIFFERENT SEGMENTS OF THE BATTERY VALUE CHAIN, INCLUDING CELL MANUFACTURING

3. TARGETING RESEARCH AND INNOVATION TO SUPPORT A COMPETITIVE BATTERIES VALUE CHAIN

4. DEVELOPING AND STRENGTHENING A SKILLED WORKFORCE IN ALL PARTS OF THE VALUE CHAIN

Development of a **New Regulatory Framework for Batteries** based on Action 4a: 4b. Define and implement certification/labelling of batteries made in Europe amongst others

Measures along battery value chain

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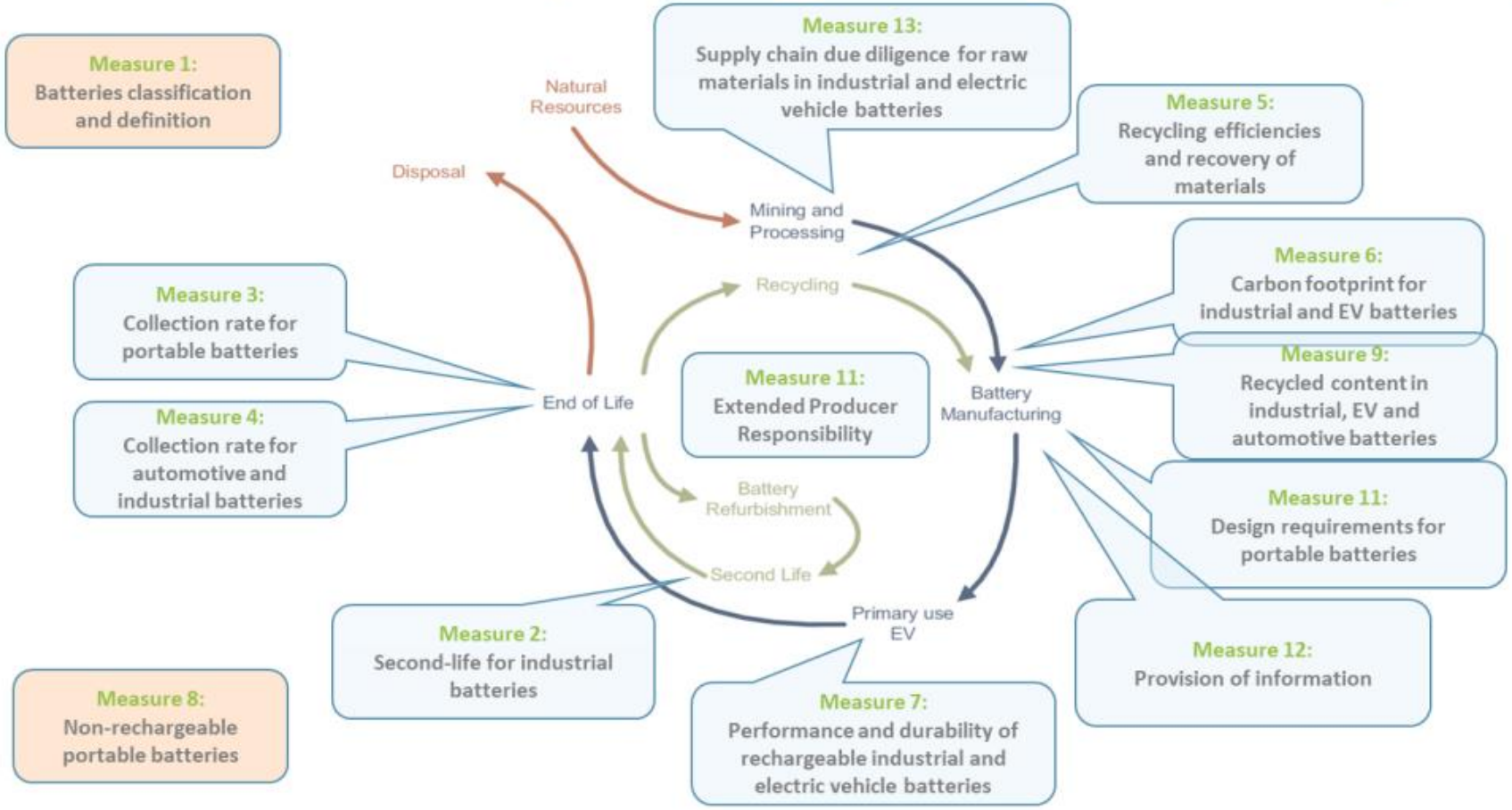
- Strengthening the functioning of the internal market by ensuring a level playing field through a common set of rules
- Promoting a circular economy and creation of more resilient supply chains through recycling
- Reducing environmental and social impacts throughout all stages of the battery life cycle



EBA harvest since October 2017:
Industrial projects all across the value chain in 22 countries

Raw materials | Active Materials | Battery Manufacturing | Application & Integration | Recycling & 2nd life

AUSTRIA
- Raw materials: EUROPEAN LITHIUM (lithium)
- Application & Integration: MAGNA STEYR (E-mobility), CYBERGRID (ESS)

BELGIUM
- Active Materials: UMICORE, LEYDEN-JAR
- Recycling: UMIICORE

CROATIA
- Application& Integration: RIMAC (e-mobility)

CZECH REPUBLIC
- Raw materials: CINOVEC (lithium), EURO MANGANESE (managense)
- Battery Production: MES

DENMARK
- Application& Integration: DTU (ESS) , LITHIUM Balance (BMS)

ESTONIA
- Battery Manufacturing: SKELETON (supercaps)

FINLAND
- Raw Materials: KELIBER (lithium)
- Active materials: BASF
- Recycling: Fortum/BASF/NORNICKEL

FRANCE
- Battery Production: ACC, VERKOR
- Recycling: SNAM/HONDA

GERMANY
- Raw Materials: VULCAN (lithium)
- Active Materials: BASF
- Battery manufacturing: ACC, NORTHVOLT/VW, TESLA, CATL, VARTA, BMW, CELLFORCE, AKSAOL, MICROVAST, FARASIS
- Recycling: VW, PROMOBIUS

HUNGARY
- Battery Production: SAMSUNG, SKI Innovation

IRELAND
- Raw materials: INTERNATIONAL LITHIUM (lithium)

ITALY
- Battery Production: FAAM/LITHOPS
- Application &Integration: ENEL (ESS)

NETHERLANDS
- Active Materials: LEYDEN-JAR

POLAND
- Active materials: UMICORE
- Battery manufacturing: LG CHEM

PORTUGAL
- Raw materials: SAVANNAH (lithium)

ROMANIA
- Application & Integration: ROMBAT

SLOVAKIA
- Battery Production: INOBAT, SK Innovation

SPAIN
- Raw Materials: Infinity, LITHIUM IBERIA (lithium)

SWEDEN
- Raw Materials: TALGA, VOXNA (graphite)
- Active Materials/Battery manufacturing/Recycling: NORTHVOLT
- Applications: EPIROC (industrial), SEEL (IPCEI)

NORWAY
- Active Materials: SKALAND and ELKEM (grap... anodes)
- Battery manufacturing: MORROW and FREYR

SERBIA
- Raw materials: RIO TINTO, NEOMETALS (lithium)

UK
- Raw Materials: Cornish Lithium
- Battery Manufacturing: ENVISION, BRITISHVOLT

Industrial projects all across Europe, creating jobs and growth

What happened to the predicted tipping point?

EU car makers' electrification ambitions

Daimler announced that it will electrify its entire fleet before 2035, Q1 2021

Volkswagen announced a dramatic acceleration of their electrification plans from from 35% of sales pure EV:s to 70% pure EV:s by 2030, Q1 2021- announced own cell production (6x40 GWh!) in Europe

BMW is aiming to build "a quarter of a million more electric cars than originally planned" between 2021 and 2023 and aiming to more than double the share of electrified vehicles in its sales from around eight per cent this year to around 20 per cent in 2023,

Stellantis wants to substantially increase sales of electrified cars in Europe from 14 per cent this year, (around 400,000 vehicles), to up to 70 per cent in 2030.

Volvo announced that all its new car sales will be pure-electric from 2030.

Audi has stopped the development of new combustion engines

And the result is:

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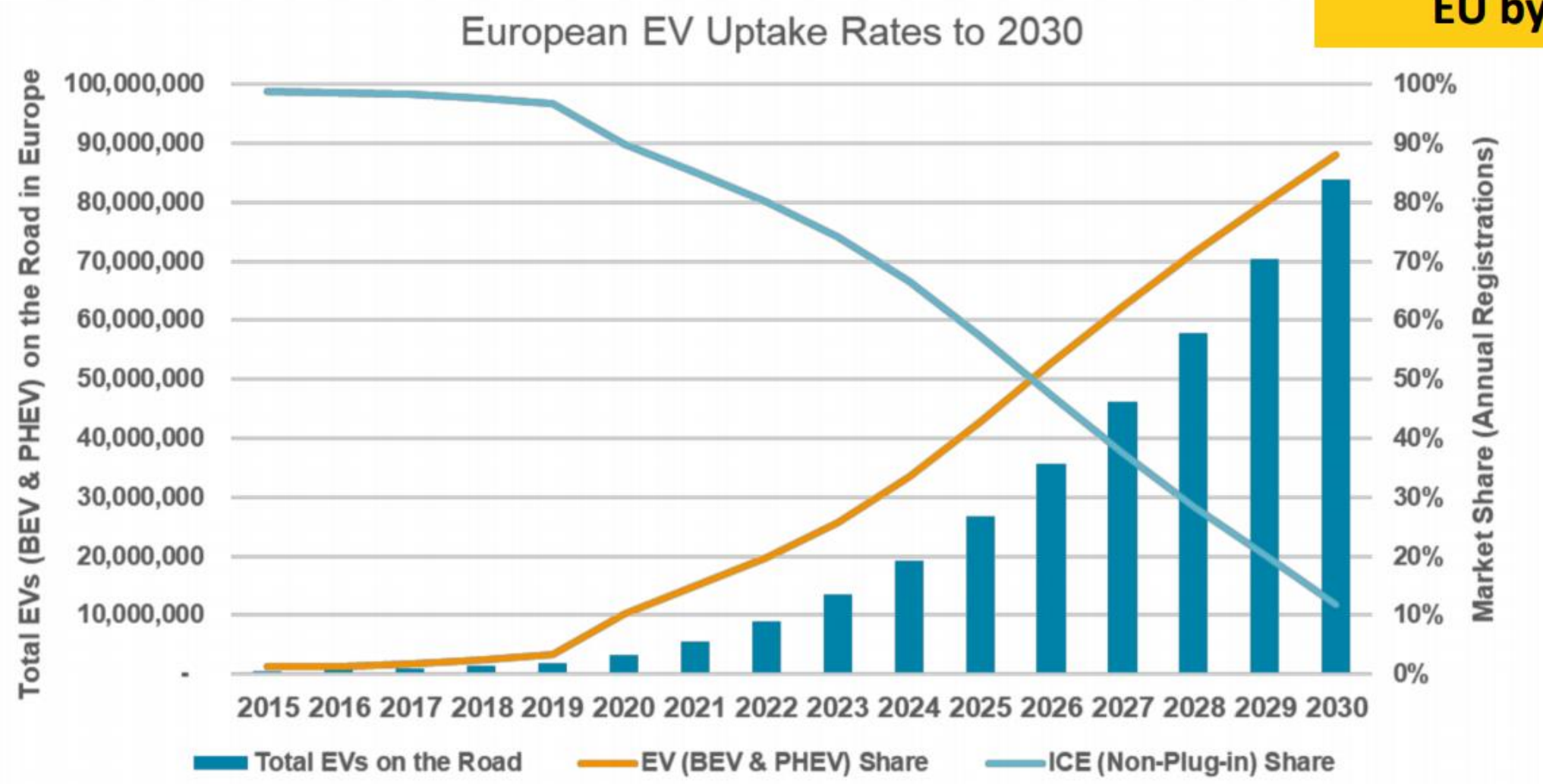
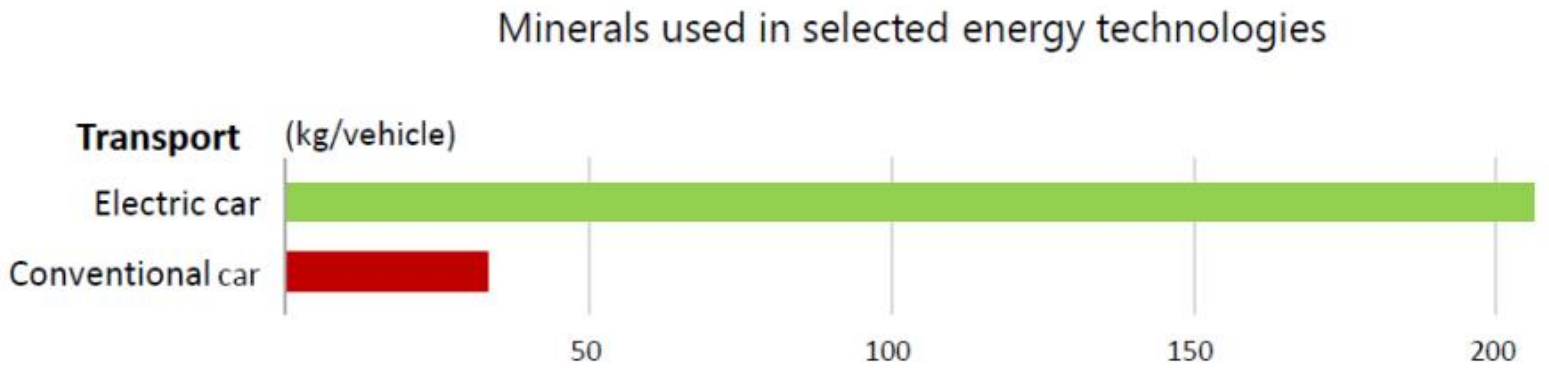
Close to 90 % EV's in EU by 2030



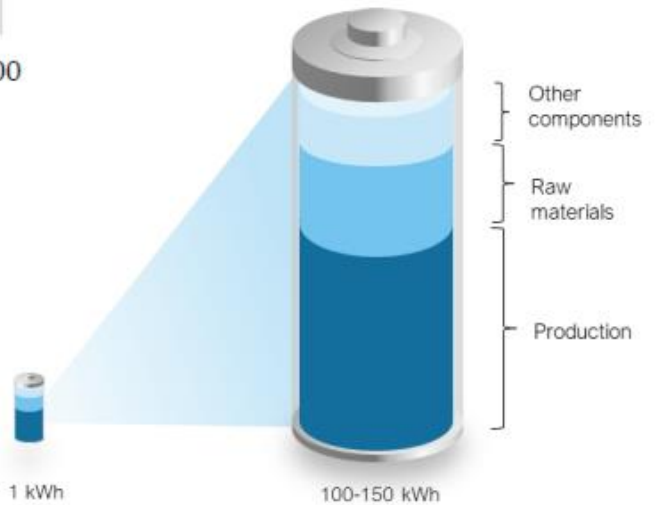
Source: Delta-EE & ACEA ¦ Europe: EU + EFTA + UK ¦ EVs: BEVs, PHEVs & eLCVs ¦ Actual data: 2015-2020. Forecast data from 2021.

Europe needs sustainable batteries

Metals and and minerals will be the fuel of the future - We can not drive a clean car with a dirty battery

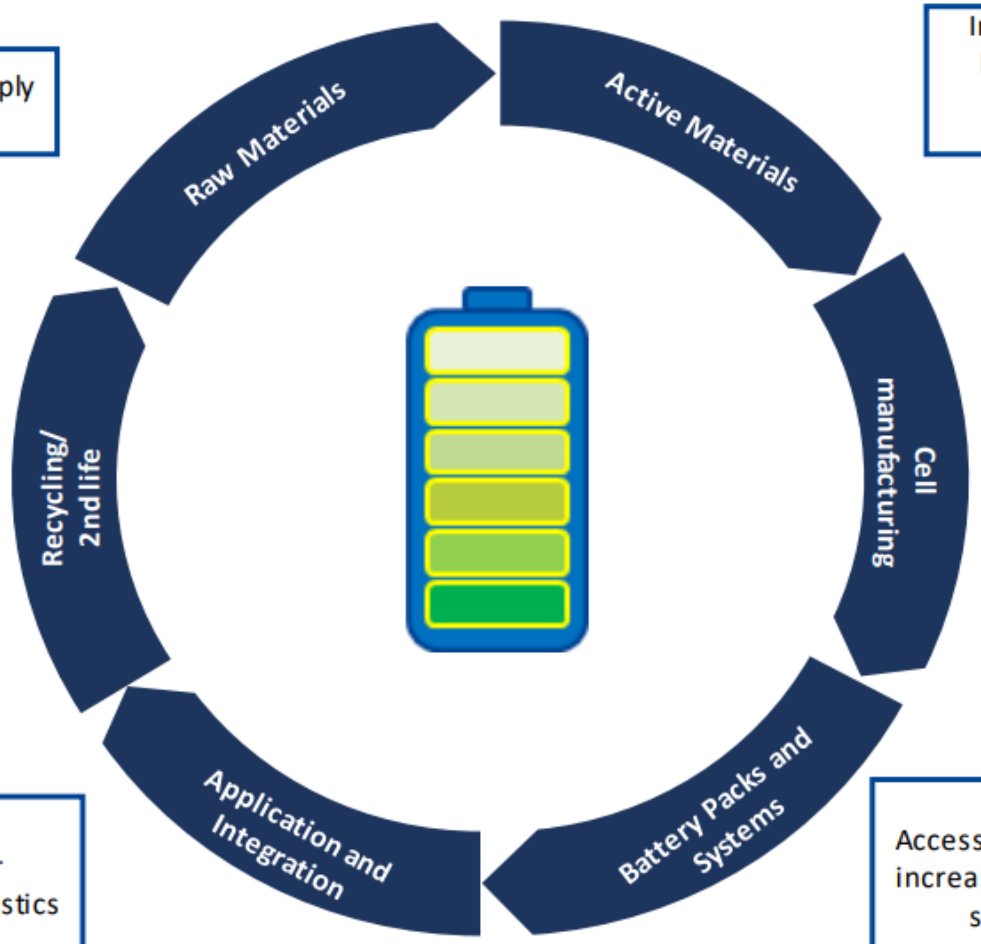


Low-carbon, circular and sustainable battery manufacturing begins at sourcing and continues through recycling



Reference battery, Ellingsen et.al. (2014)

Need for a coherent and supportive regulatory framework for sustainable batteries from Europe – in line with principles of circular economy and EU decarbonisations objectives



Sustainable and ethical supply chains

Incentives for sustainable battery production with lowest CO2 footprint possible

Ambitious goals for recycling with specific targets to recover battery materials

Transparent methods for calculation of CO2 footprint

Easier transport for recycling, reversed logistics

Access to battery data on different levelsto increase business opportunities and ensure safety when handling batteries.

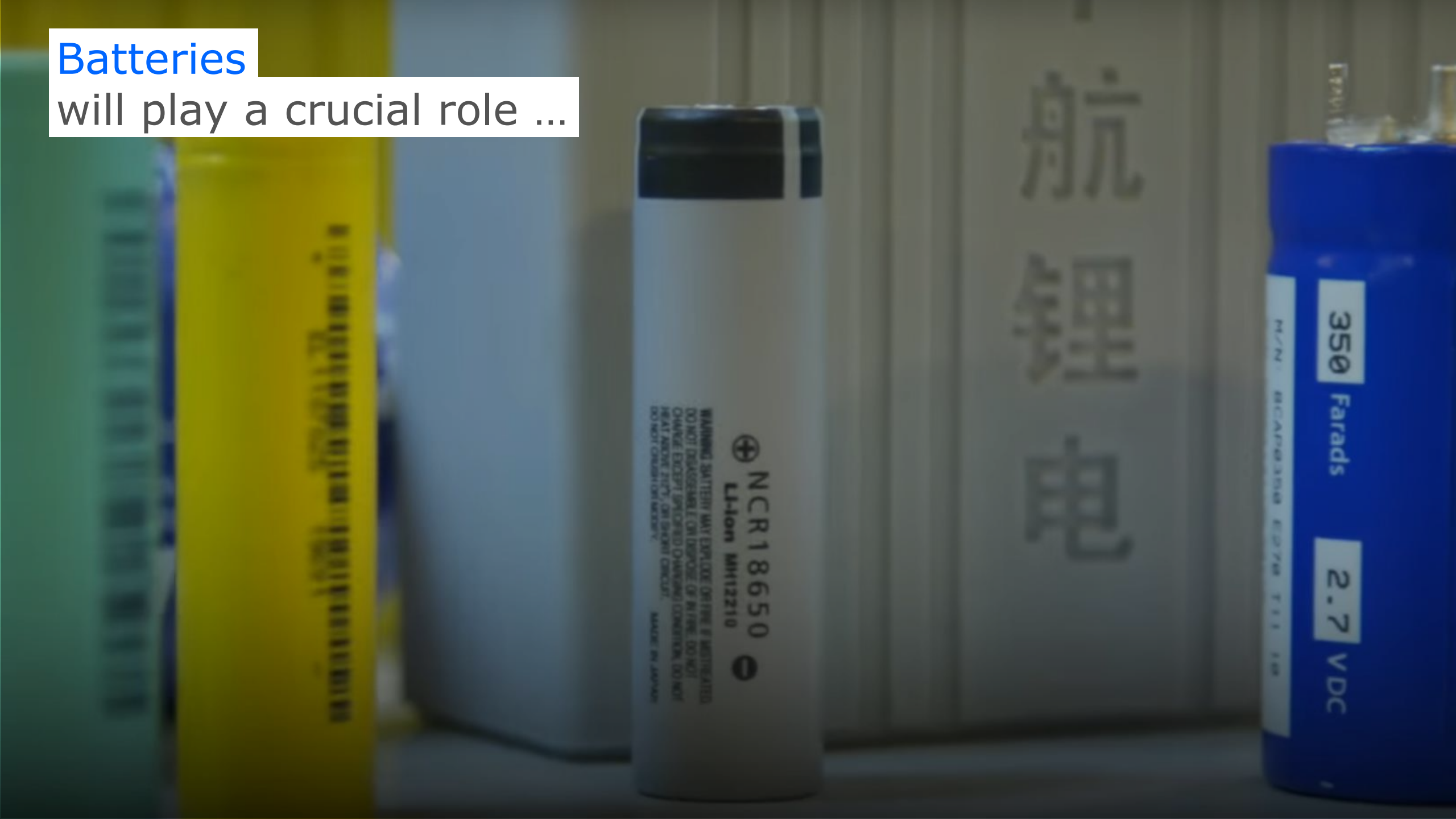
- **At the birth of the European Battery Alliance in 2017**
  - Almost no discussion on “green” batteries
  - No coherent regulatory framework covering batteries along the value chain
  - Sustainability and Recycling identified as important from the start of the EBA

- **Current status on a supportive and coherent regulatory framework**
  - Batteries recognised as a key technology for the green transition
  - Regulatory framework is needed to support and incentive the creation of a sustainable European battery value chain in a circular economic framework
  - The legal basis creates a high level of predictability
  - Sustainability important for the entire battery value chain – we cannot replace one “dirty technology” with another without loosing the trust of consumers
  - Access to sustainable raw materials will be a prerequisite to fule the green transition
  - Regulatory framework needs to be supportive and inclusive – also for future developments

Safety, performance and sustainability of batteries – technical aspects in a policy context

Andreas Pfrang (European Commission - JRC)


CO_2 emissions reduction
is important to
prevent climate change …
love
CO_2
is in the
AIR
ZONE

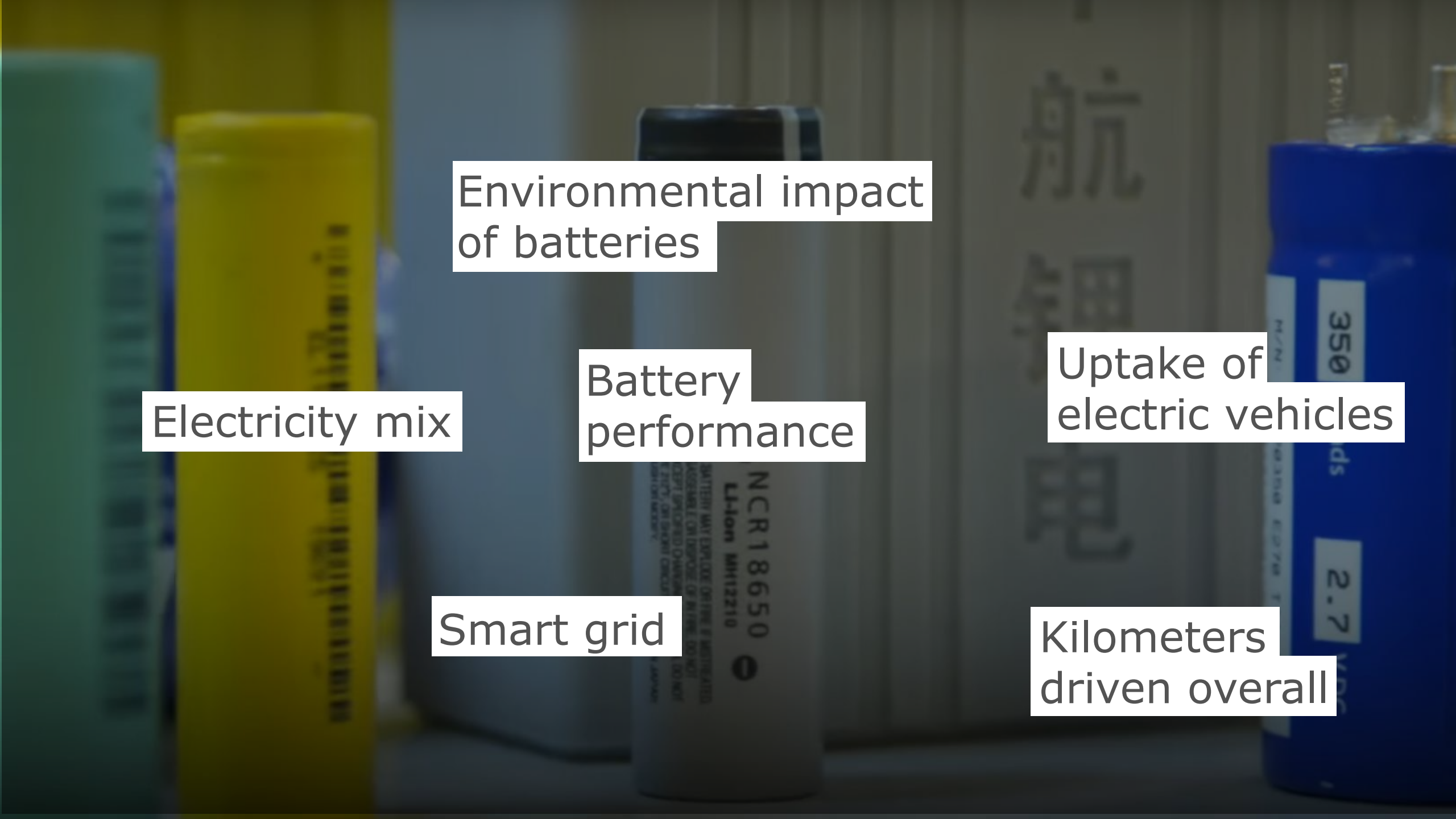


Batteries

will play a crucial role …

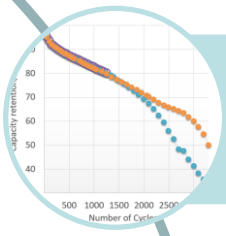

…facilitating
renewables integration
into the power grid …

… facilitating the
shift to electric vehicles


Environmental impact of batteries
Electricity mix
Battery performance
Uptake of electric vehicles
Smart grid
Kilometers driven overall
NCR18650
LiIon
350
2.7


Battery policies require solid scientific basis…
So we perform desktop and experimental research

Outline



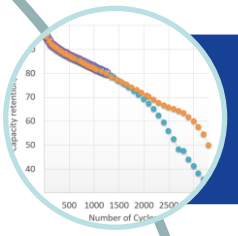
Performance and Durability

Safety

Sustainability

Informed policy making

Outline



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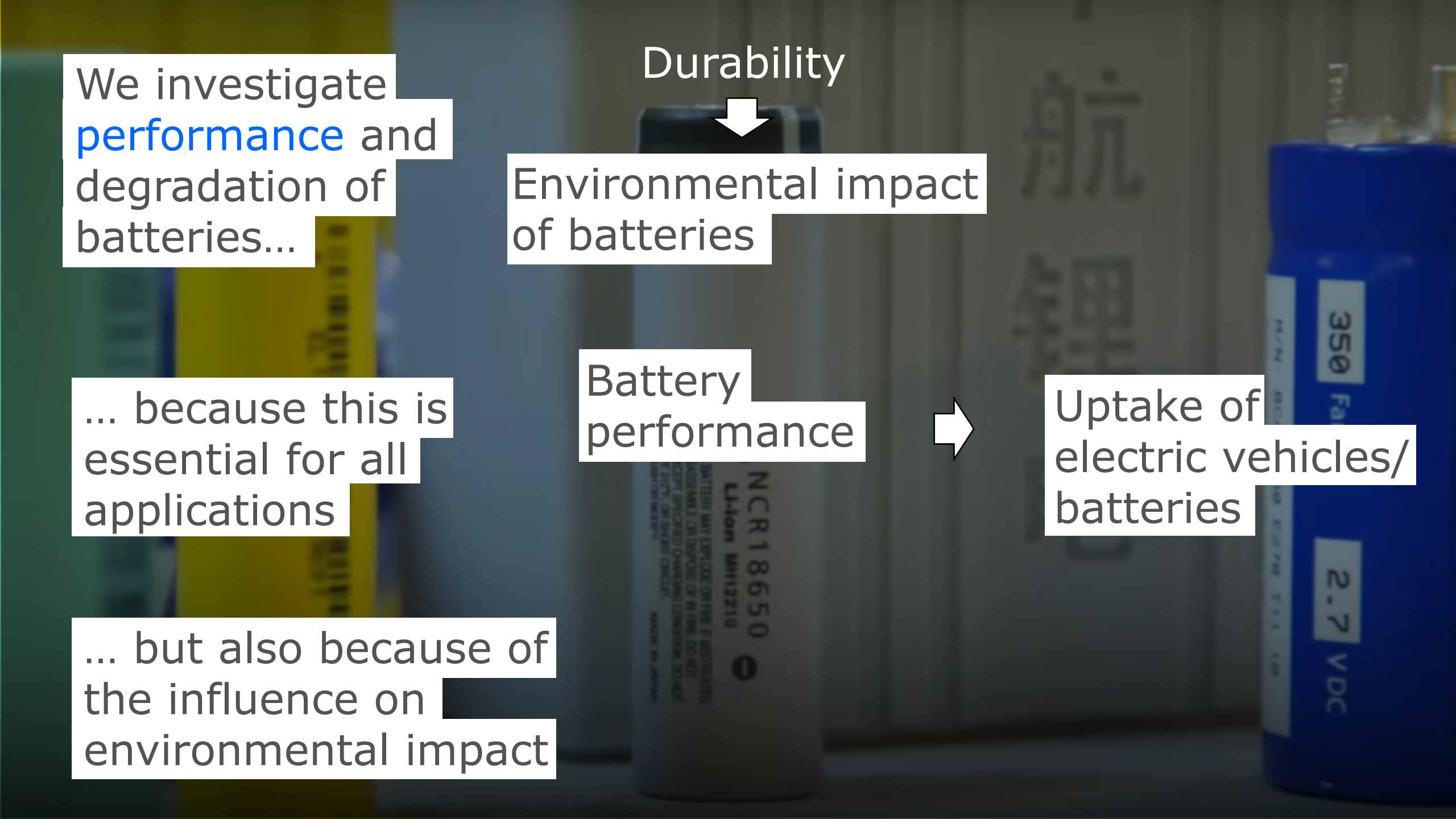

We investigate performance and degradation of batteries…
Durability
Environmental impact of batteries
… because this is essential for all applications
Battery performance
Uptake of electric vehicles/ batteries
… but also because of the influence on environmental impact

Performance and durability

Initial performance

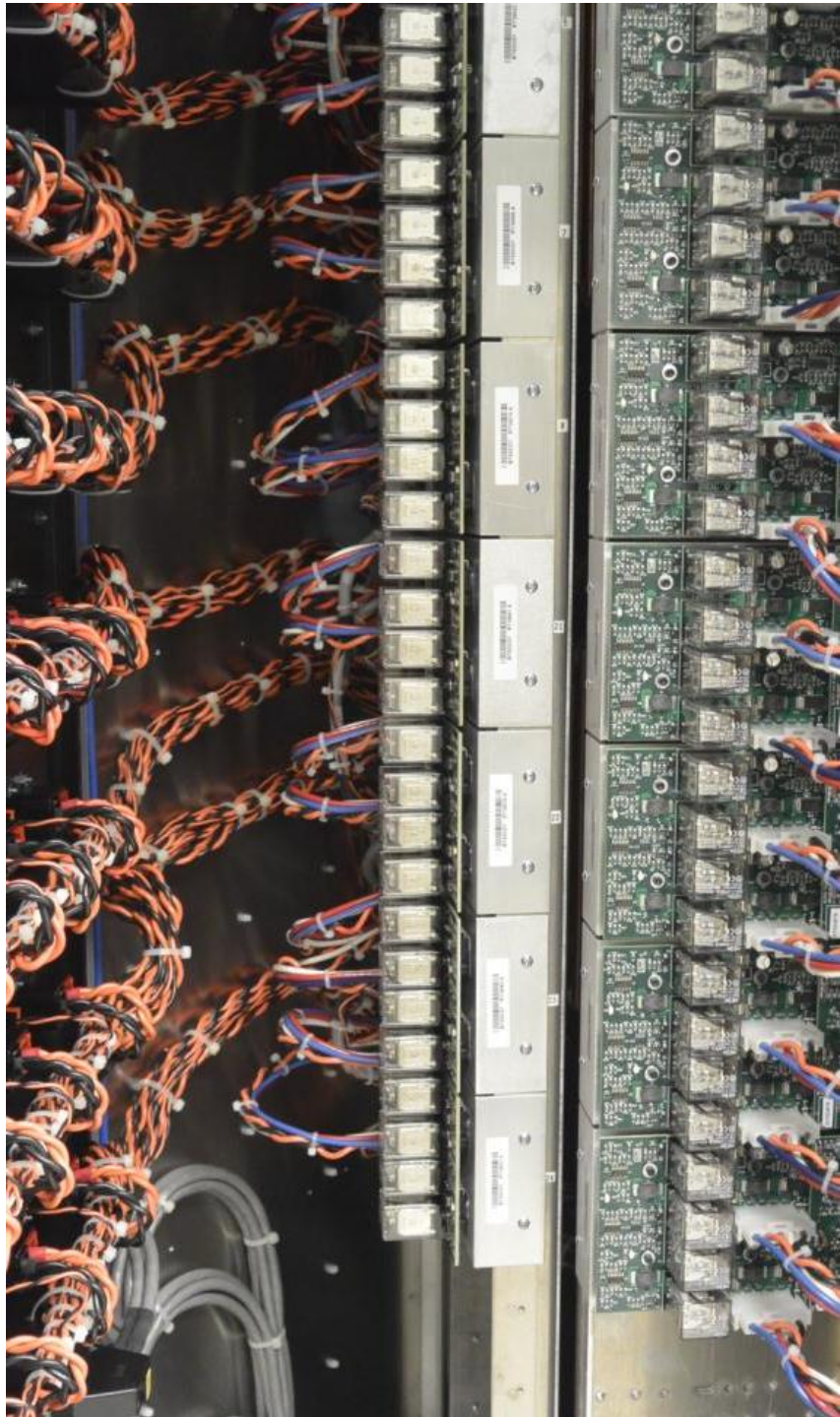
- Round trip efficiency (RTE)

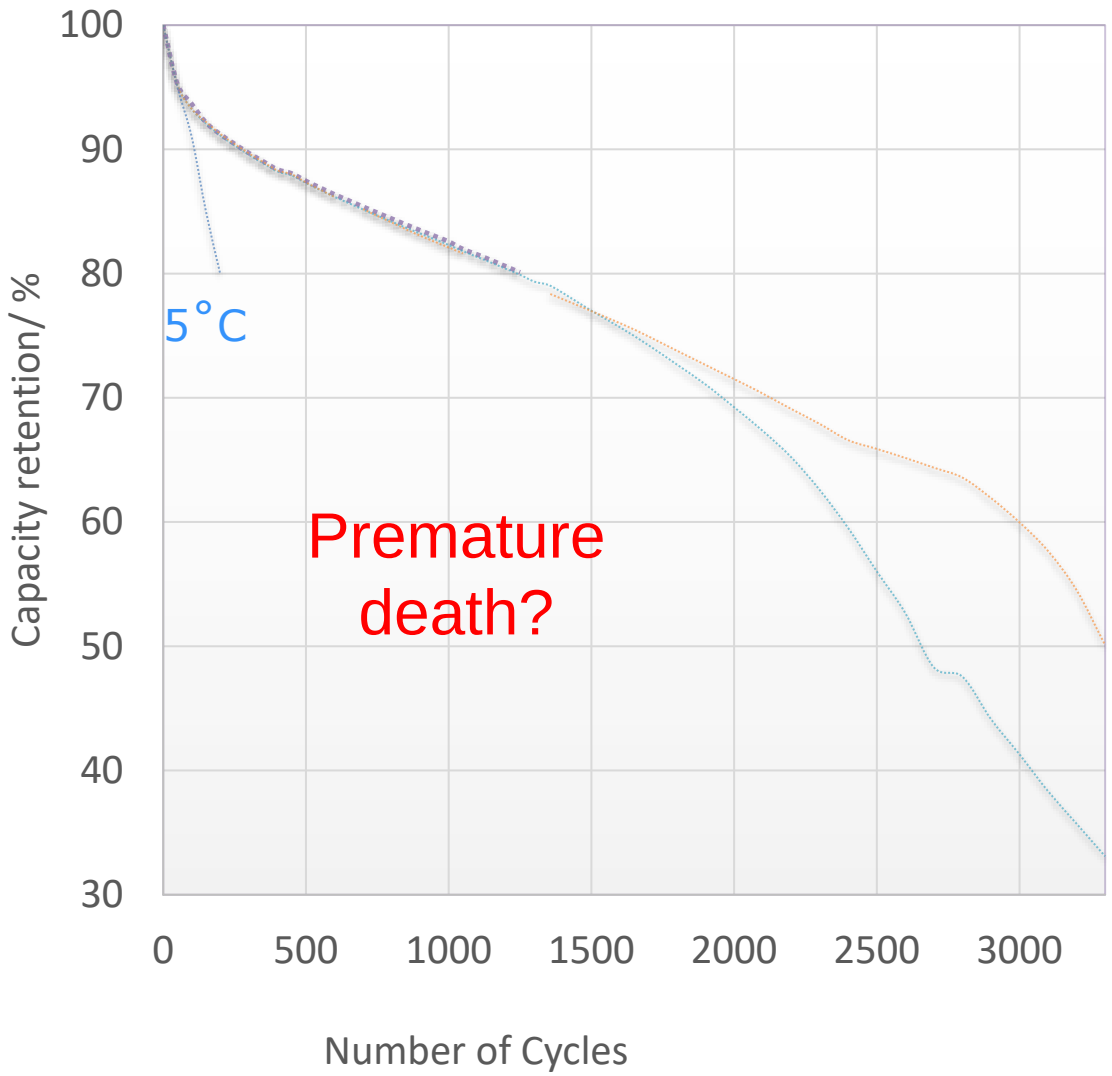
Durability

- Capacity, power and RTE fade

Test procedures should reflect real operation

- Long test duration
- Test acceleration challenging





Degradation

Depends strongly on operation conditions

Example

- LG 18650HG2 3.0 Ah cell
- Cycled at different temperature

This project 17IND10 LiBforSecUse has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme

Lithium Batteries for Second Use

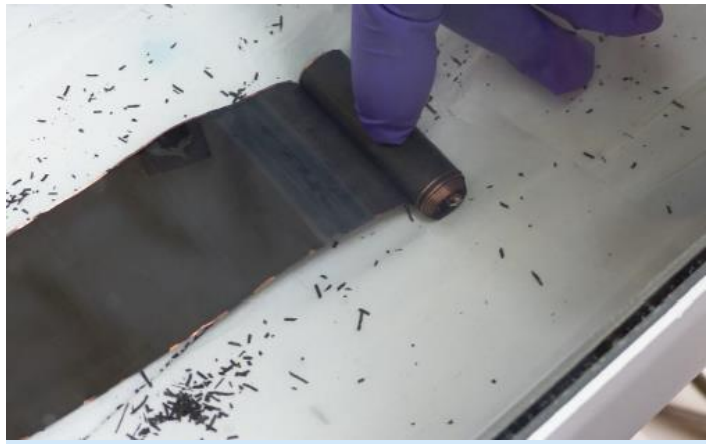
European Commission

State of health depends on history

80 % SoH (capacity retention)

30 % SoH

1250 cycles at 45 ºC



200 cycles at 5 ºC

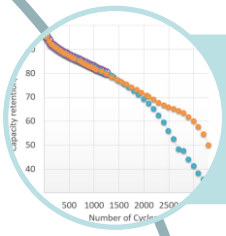
3500 cycles at 45 ºC

This project 17IND10 LiBforSecUse has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme

Lithium Batteries for Second Use

European Commission

Outline

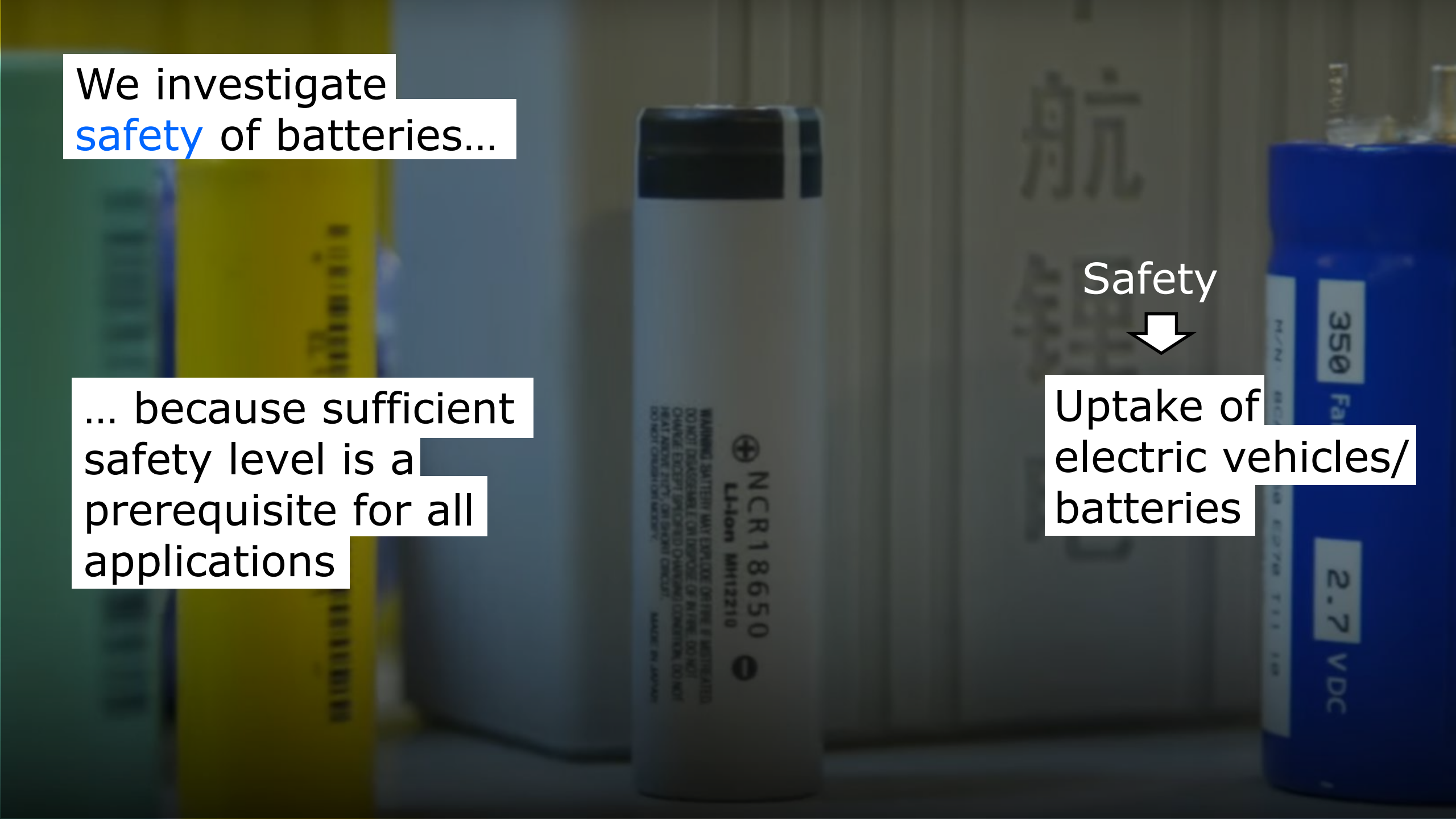


Performance and Durability

Safety

Sustainability

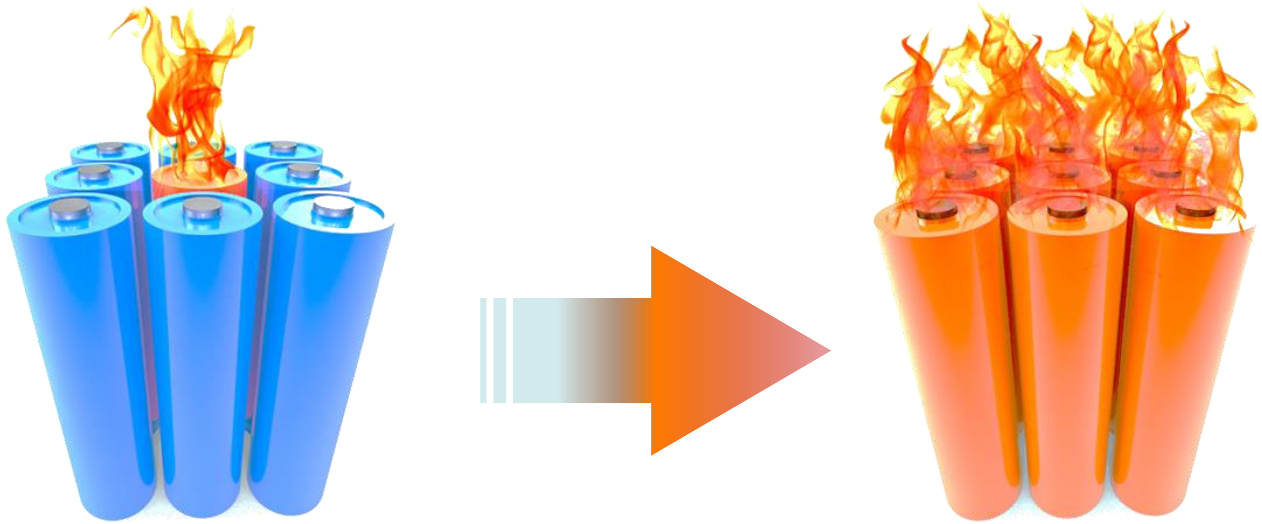
Informed policy making


We investigate safety of batteries…
… because sufficient safety level is a prerequisite for all applications
Safety
Uptake of electric vehicles/ batteries
NCR18650
LiIon
350
2.7 V DC

Safety

- Safety for **primary use of batteries for EVs** already covered by EVS-GTR (enacted into EU law as type-approval internal market legislation); phase 2 on-going

- Safety of **batteries for stationary application?**



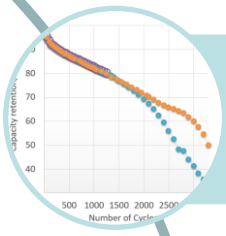
Safety

- Safety for **primary use of batteries for EVs** already covered by EVS-GTR (enacted into EU law as type-approval internal market legislation); phase 2 on-going

- Safety of **batteries for stationary application?**

- Safety of **second-use batteries?**
  - Different level of modification of second use batteries
  - Different SoH/history of second use cells and batteries
  - Lower number of batteries per product?

Outline



Performance and Durability

Safety

Sustainability

Informed policy making

European Commission

Recycling efficiency / recycled content

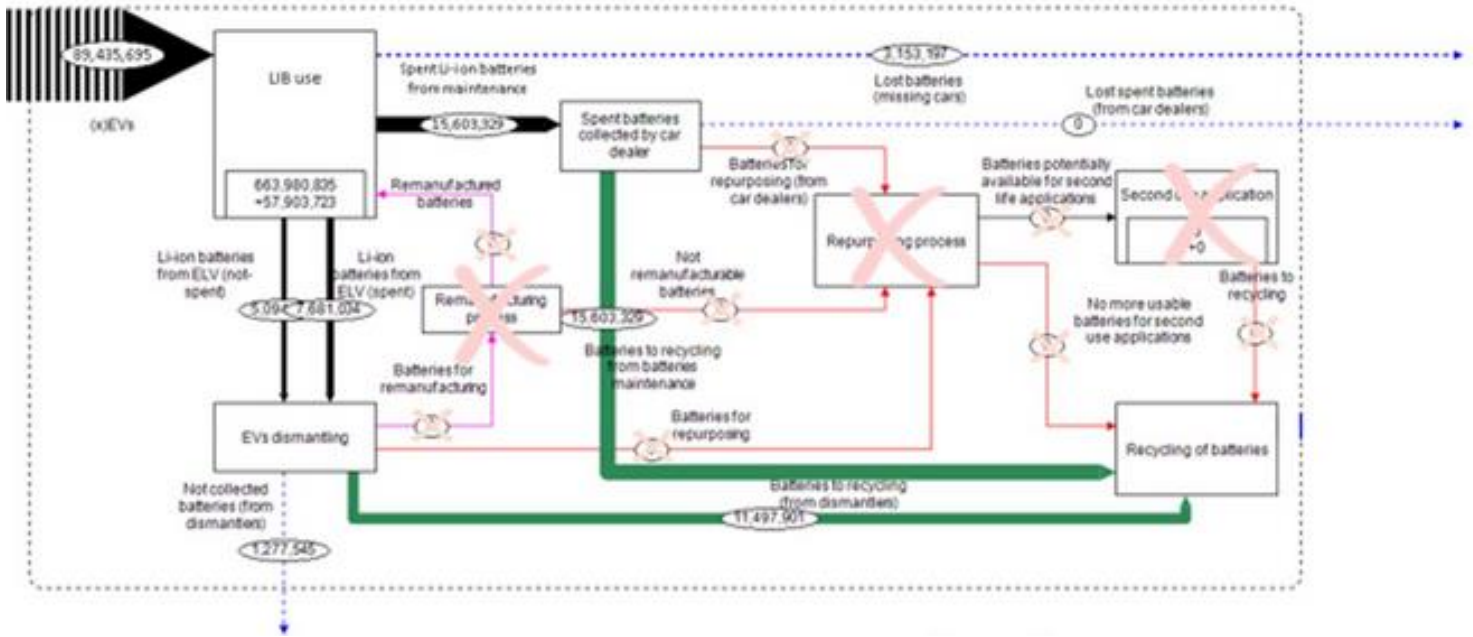
Novel provisions on

- **recycling efficiency**, incl. levels of recovered materials (Co, Cu, Ni, Pb, Li)
- **recycled content** of Co, Ni, Pb and Li in new batteries

Methodologies and reporting to be adapted/developed

Recycling efficiency / recycled content

Time lag between put on the market and availability for recycling to be considered



- Maximize the incorporation of recycled materials
  - not only maximize recycling efficiencies
  - but also maximize collection rates

S. Bobba, F. Mathieux, G. A. Blengini, How will second-use of batteries affect stocks and flows in the EU? A model for traction Li-ion batteries, Resources, Conservation and Recycling 145 (2019), 279

European Commission

Life cycle carbon footprint criteria

- Common provisions needed for **comparability** across battery models, as well as for **verifiability**

- Existing Product Environmental Footprint Category Rules (PEFCR) on batteries

  good basis, further adjustments needed (e.g. system boundaries, secondary datasets) -> technical discussions with stakeholders starting

- How will carbon footprint criteria **drive innovations** ?
  (multiple steps in the life cycle; many technical parameters)

- Future technologies-proof rules ?

We investigate removability and replaceability of portable batteries…

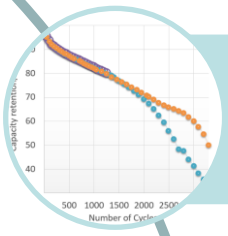
…Replaceable batteries enable prolonged lifetime of the appliances they are part of

…Removable batteries ensure proper collection and treatment for recycling

Battery Labelling enables informed purchasing decisions by consumers

Green Public Procurement Criteria enable informed procurement decisions by public authorities

Outline



Performance and Durability

Safety

Sustainability

Informed policy making

Information supporting regulations

- Existing legislation
  - Consistent, holistic
- Industry practices /standards
- Scientific literature, (experimental) data and knowledge
- Dedicated modelling
  - Socio-techno-economic
- Dedicated research
- Lobbying
- Public consultation

  e.g. https://ec.europa.eu/info/consultations_en
- Other publicly available information

...

Informed policy making

Information supporting regulations

Industry input required

- Existing legislation
  - Consistent, holistic
- Industry practices /standards
- Scientific literature, (experimental) data and knowledge
- Dedicated modelling
  - Socio-techno-economic
- Dedicated research
- Lobbying
- Public consultation
  e.g. https://ec.europa.eu/info/consultations_en
- Other publicly available information

...

JRC role

Pre-normative research

Relevant standards / regulations

New test procedures / standards

Performance Durability

ISO 12405-4:2018
IEC 62660-1:2018
IEC 62620:2014
IEC 61427-1:2013
IEC 61427-2:2015
GTR EVE (ongoing)
Commission Regulation (EU) No 1103/2010
…

Safety

UN R 100.02 (03 in preparation, GTR No. 20)
ISO 6469-1:2009
IEC 62660-2:2018
IEC 62660-3:2016
SAE J2929:2013
SAE J2464:2009
IEC 62619:2017
IEC/TS 62933-5-1:2017
…

Reusability Reparability Recyclability

…

Recycling

…

Carbon footprint

…

Bielewski, M., Blagoeva, D., Cordella, M., Di Persio, F., Gaudillat, P., Hildebrand, S., Mancini, L., Mathieux, F., Moretto, P., Paffumi, E., Paraskevas, D., Ruiz, V., Sanfélix, J., Villanueva, A., Zampori, L., EUR 30597 EN, Publications Office of the European Union, Luxembourg, 2021.

We are European Commission's Joint Research Centre Ispra, Sevilla and Petten teams working together

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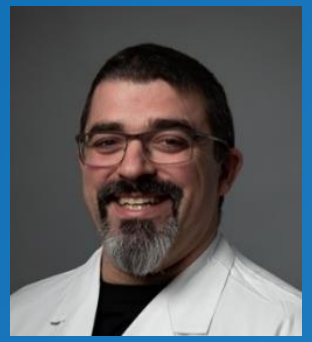
Ricardo Da Costa Barata


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Paul Hodson


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Fulvio Ardente

...

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A. Pfrang, A. Kriston, V. Ruiz, N. Lebedeva, F. di Persio, Safety of rechargeable energy storage systems with a focus on Li-ion technology, in: L. Martinez-Rodrigez & N. Omar (eds.), Emerging nanotechnology in rechargeable energy storage systems, ISBN 978-0-323-42977-1, Elsevier, 2017.

Project website https://ec.europa.eu/jrc/en/research-facility/battery-energy-storage-testing-safe-electric-transport
Movie about battery testing at JRC https://www.youtube.com/watch?v=6u2Gjiudcas

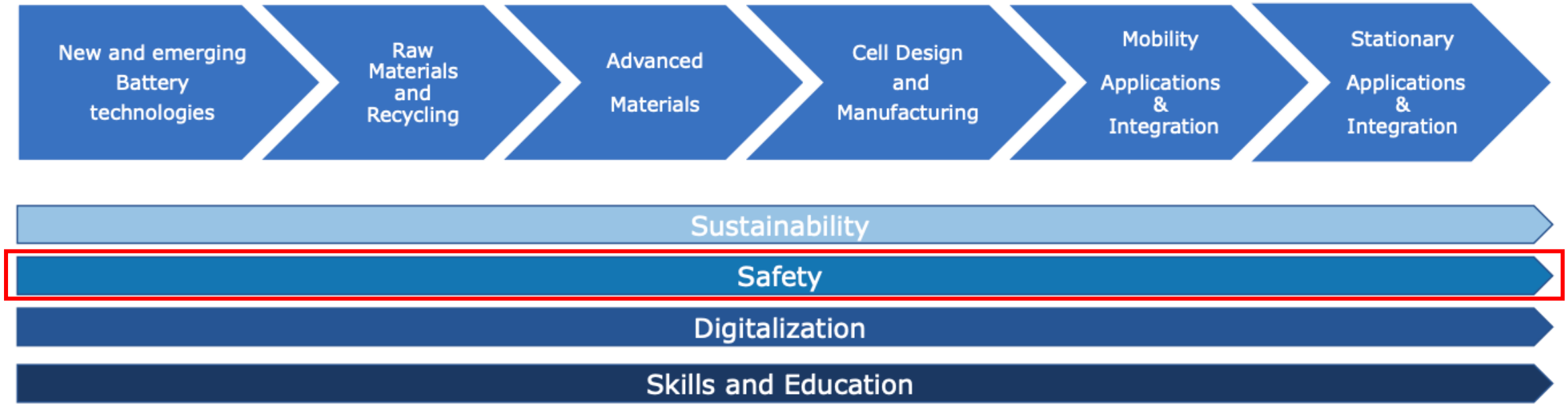
Thank you

European Commission

Battery Safety in a Circular Value Chain

Maitane Berecibar &
Arnaud Bordes
(Co-Chairs of Batteries Europe Safety Task Force)

Battery Safety in a Circular Value Chain



Objective: Identify the coming challenges of the cross-cutting topic 'Safety' along the whole battery value chain

BATTERIES EUROPE
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

Participants of the Task Force:

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Guillaume Cherouvrier (Safran)

** Chairs of the Task Force:
Arnaud Bordes (INERIS)
Maitane Berecibar (VUB)

Agenda

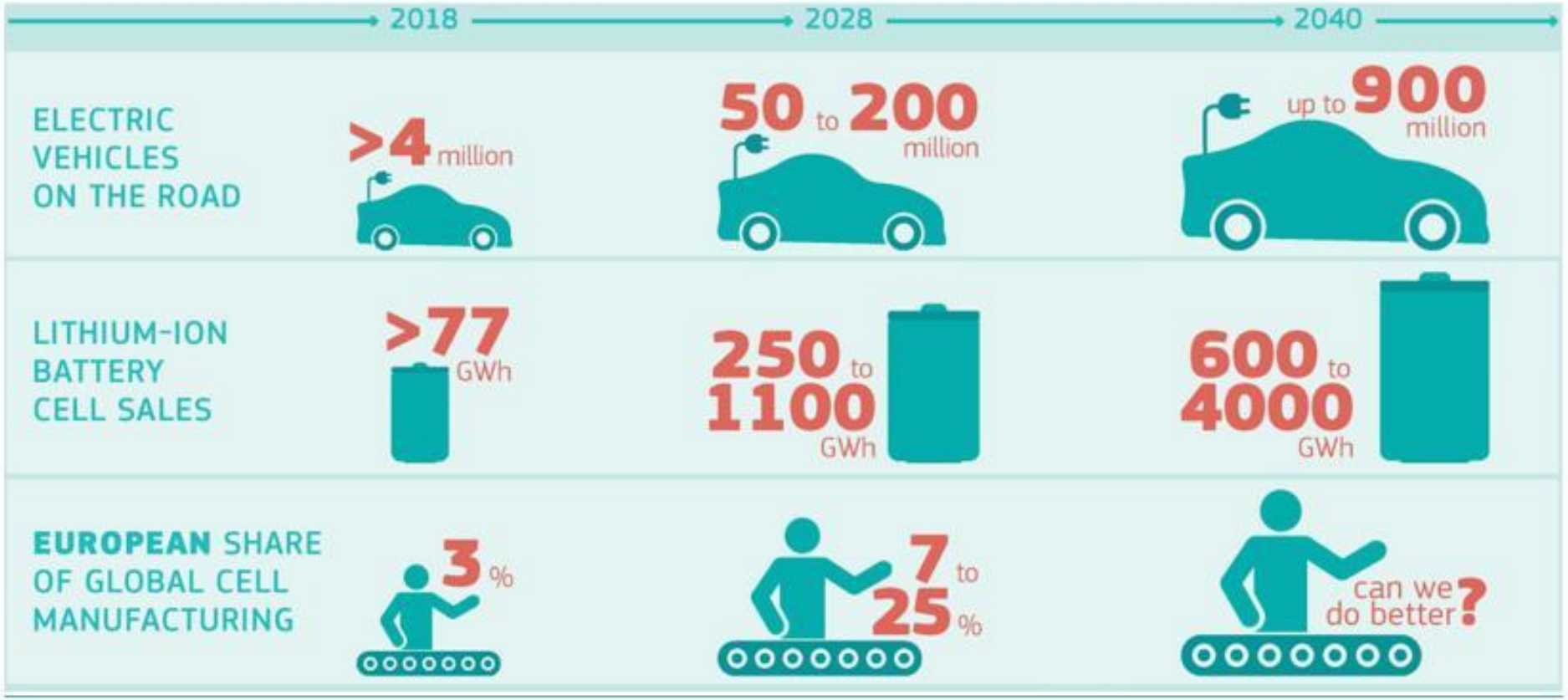
1- Why Safety

2- Safety at each level of the value chain

- 2.1 Material Level
- 2.2 Cell Level
- 2.3 Pack and system Level
- 2.4 Safety Testing

3- Conclusions

1- Why Safety



JRC, Li-ion batteries for mobility and stationary storage applications, 2018

1- Why Safety

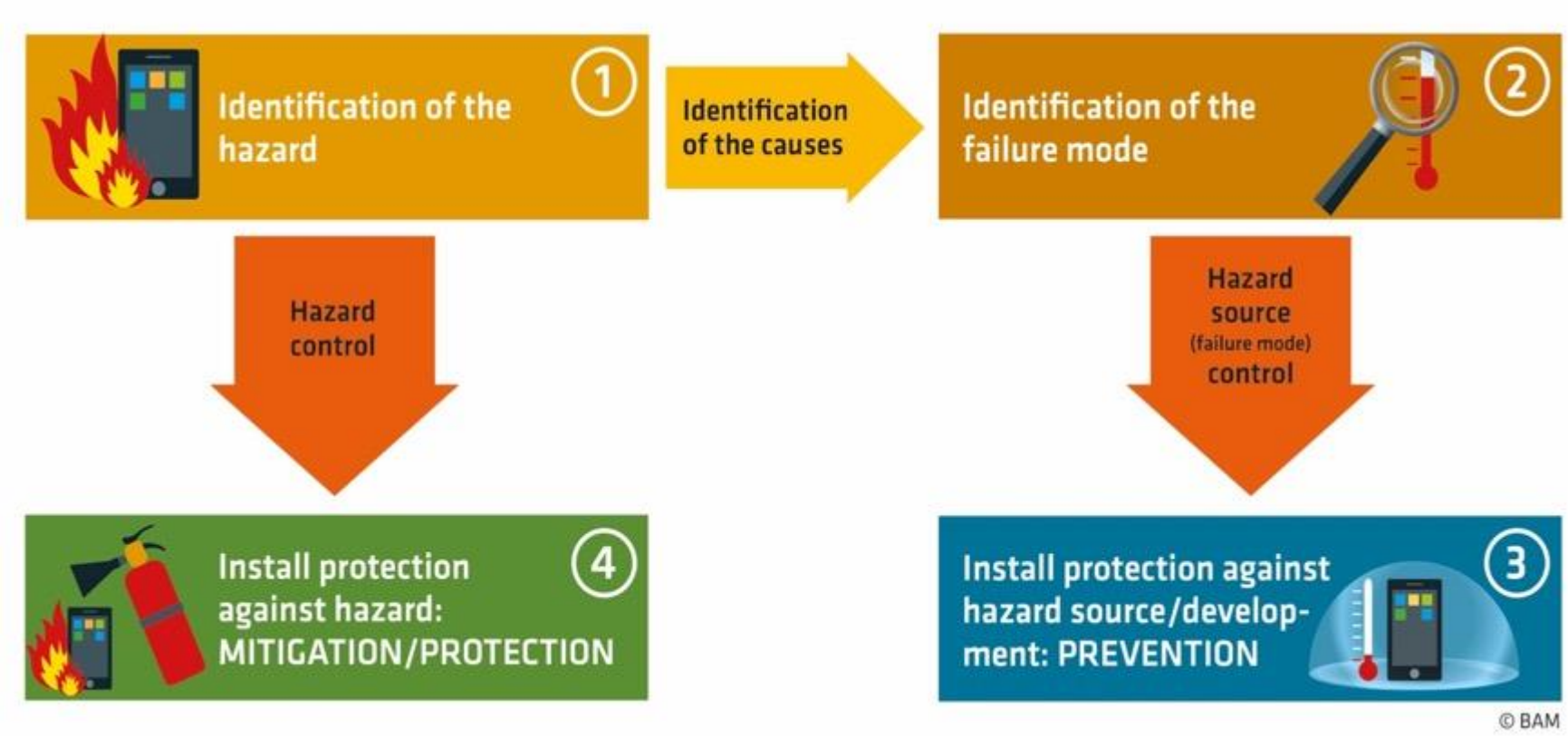
Tesla (June 2019, California)

Samcheok PV power plant (Dec 2018, Korea)

Safety standards or regulations produced by private or public bodies (ISO, IEC, CEN-CENELEC, UNECE) provide the required standards to proceed safely with battery solutions.

1- Why Safety

Functional Safety Analysis (IEC 61508)



2- Safety at each level of the value chain

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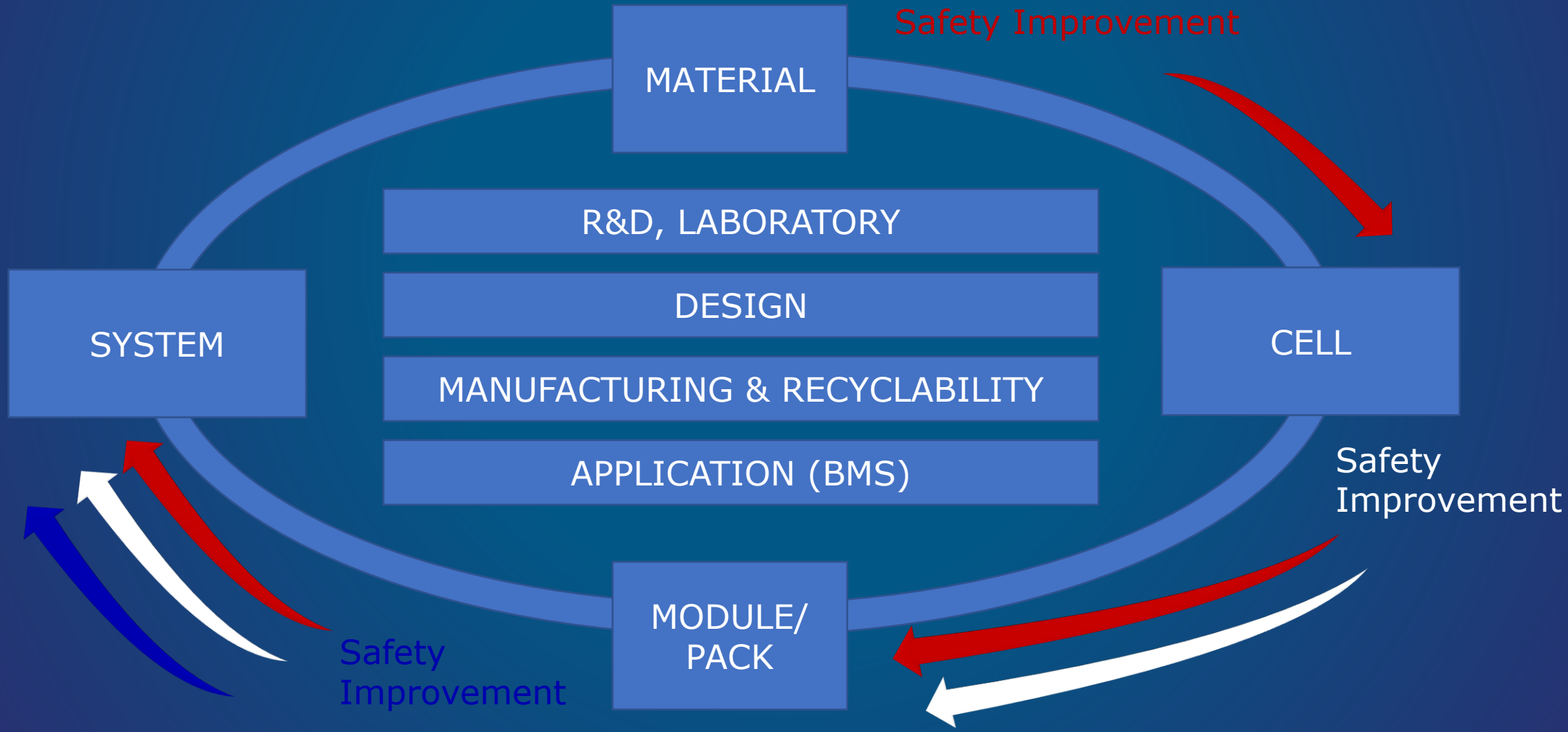
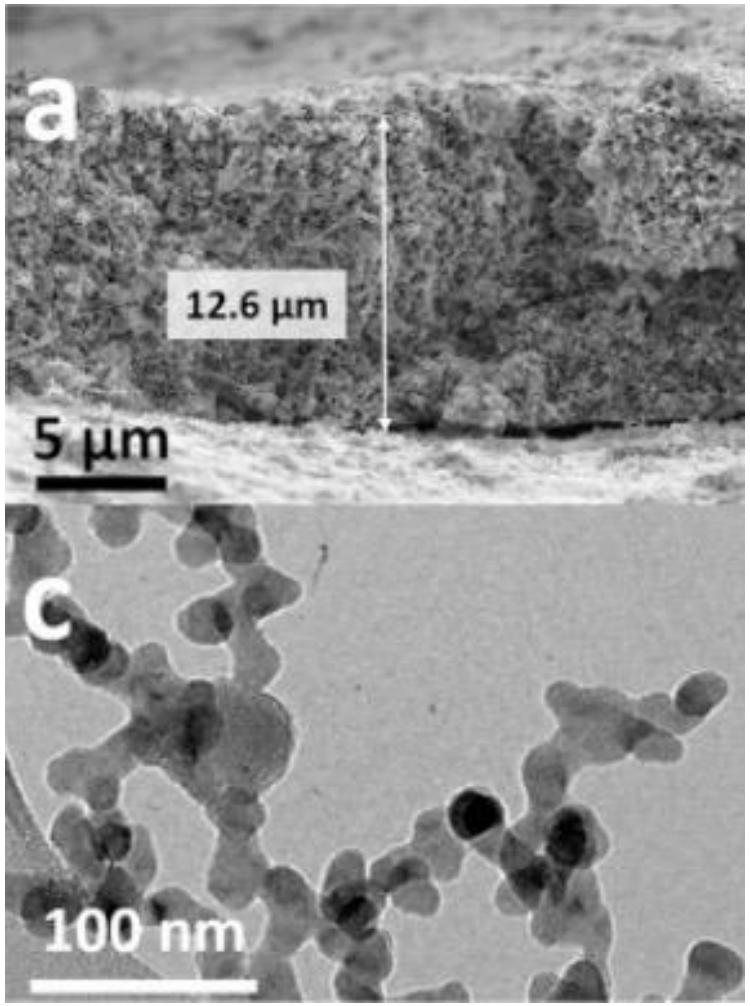


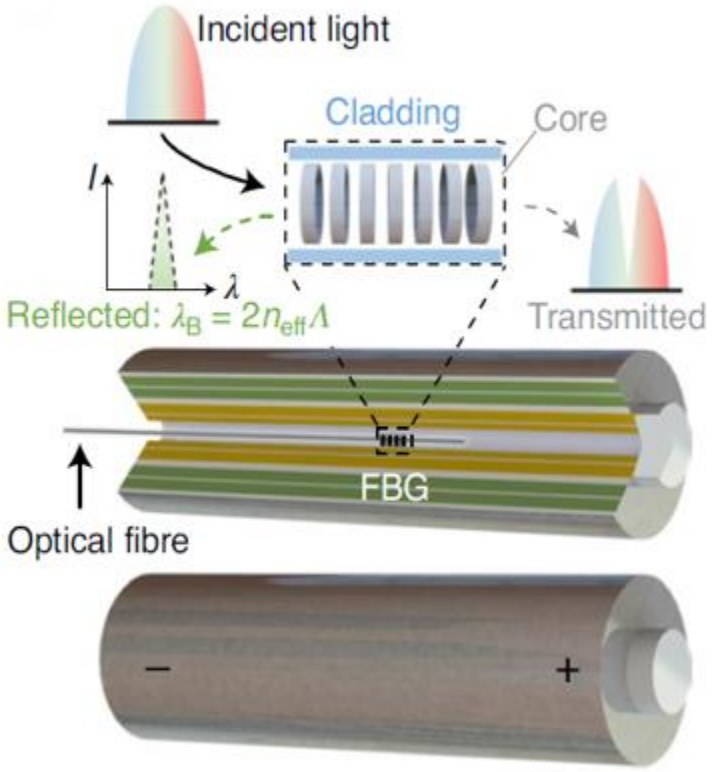
2.1 Material Level



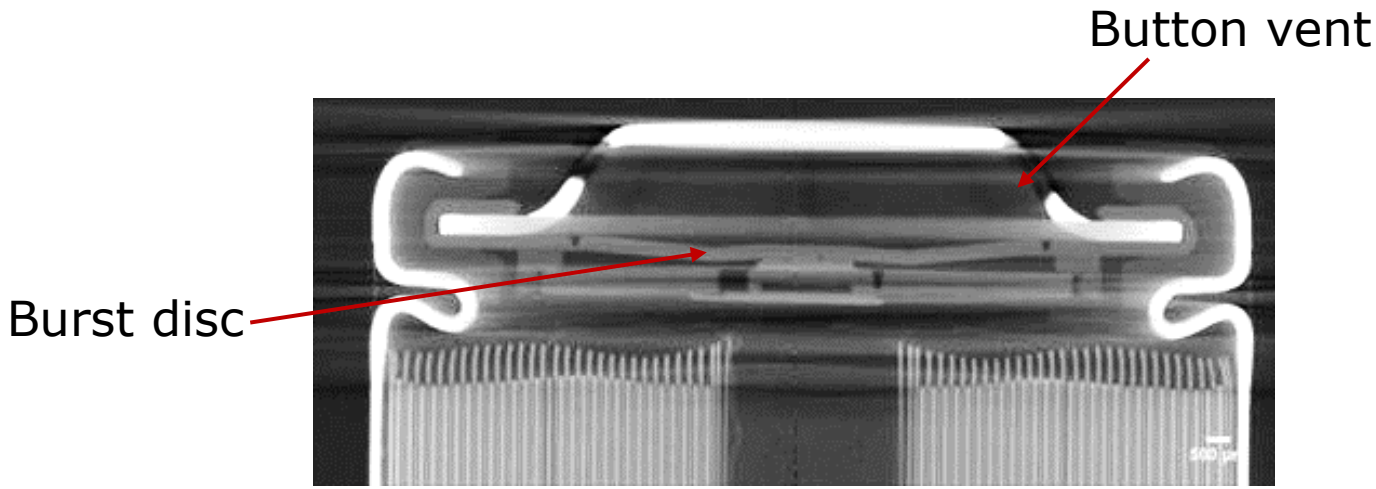
- Development of more stable material (electrolyte, electrodes)
- Research activities such as self-healing at material level may help to improve safety
- Separators with better thermal/mechanical stability or shut down

Source *et al.* JPS, 2016

2.2 Cell Level



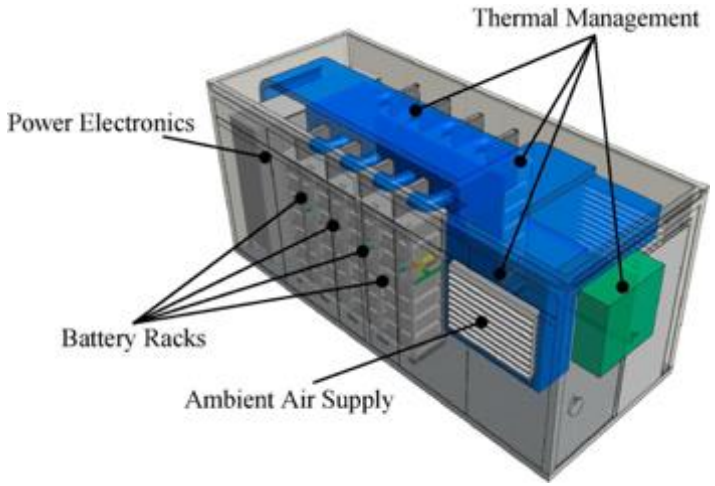
- Improved passive safety devices (CID, PTC…)
- New smart sensors inside the cells
- Strict quality control during manufacturing/automatization



Jiaqiang Huang *et al*. Nature 2020

Adapted form Thi Thu Dieu Nguyen *et al*. World Electric Vehicle journal 2019

2.3- Pack and system Level



- Develop advanced SoX and BMS for: improved safety performance and failure prognosis models,
- More efficient cooling systems and BTMS.
- Increasing the standards in sectors like stationary storage, reuse (evaluation tools, SoS)
- More resistant housing of EES
- Effective warning and extinguishing systems
- Updated emergency procedures in case of fire and/or explosion

P. Sun *et al.* Fire Technology, 2020 M. Schimpe et al. Applied Energy, 2017

2.4- Safety Testing

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Material

Cell

Module

Pack

System

Simulation
Modelling
Digitalization

Avoid testing to become the bottle neck of Europeans batteries

Pictures from INERIS batteries tests facilities

3- Conclusions

- Current batteries have a **good level of safety**
- Creation and **adaptation of existing standards**
- The **improvement of safety** should be considered in a **whole sustainable battery-circular-chain perspective**:
  - from material -cell -module -application (1st and 2nd life) and recyclability levels.
  - if safety is treated at material level it will enhance safety at higher levels

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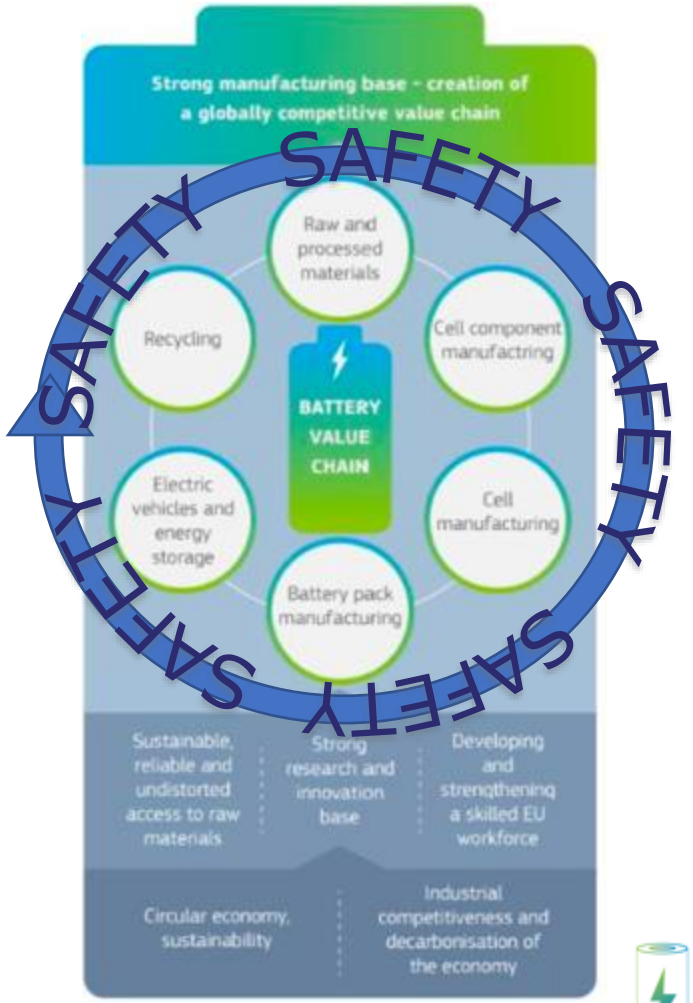
AND **INNOVATION** PLATFORM

3- Conclusions

- The European Batteries of the future including safety (research, testing and regulatory framework).

  - **Novel technologies**, smart **functionalities**
  - **Automatization, robotics** together with **digitalization**
  - **Education** and training needs on safety
  - **Sustainability**: focus on recycling and second-life

    - ✓ Improve **selection and diagnosis tools** (SoS, SoH) of end of 1st life cells
    - ✓ **Material selection and battery design** thought for the whole life cycle of the battery (re-use, second-use, remanufacture, recycling)
    - ✓ The **creation of a database** containing safety relevant data on EES should be developed in order to support safe recyclability.



Contact us

Our position paper will be published soon!

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Head Battery Innovation Center – VUB

The Challenges for a Sustainable Battery Ecosystem

Fanny Barde &

Marcel Weil

(Chair and Member of Batteries Europe Sustainability Task Force)

Agenda

BATTERIES EUROPE
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1. What is sustainability?

- Definition of sustainability
- Three key dimensions
- Cross-cutting considerations

2. Sustainability hotspots

- What are the key aspects of sustainability we should focus on?
- Combined safety & sustainability aspects

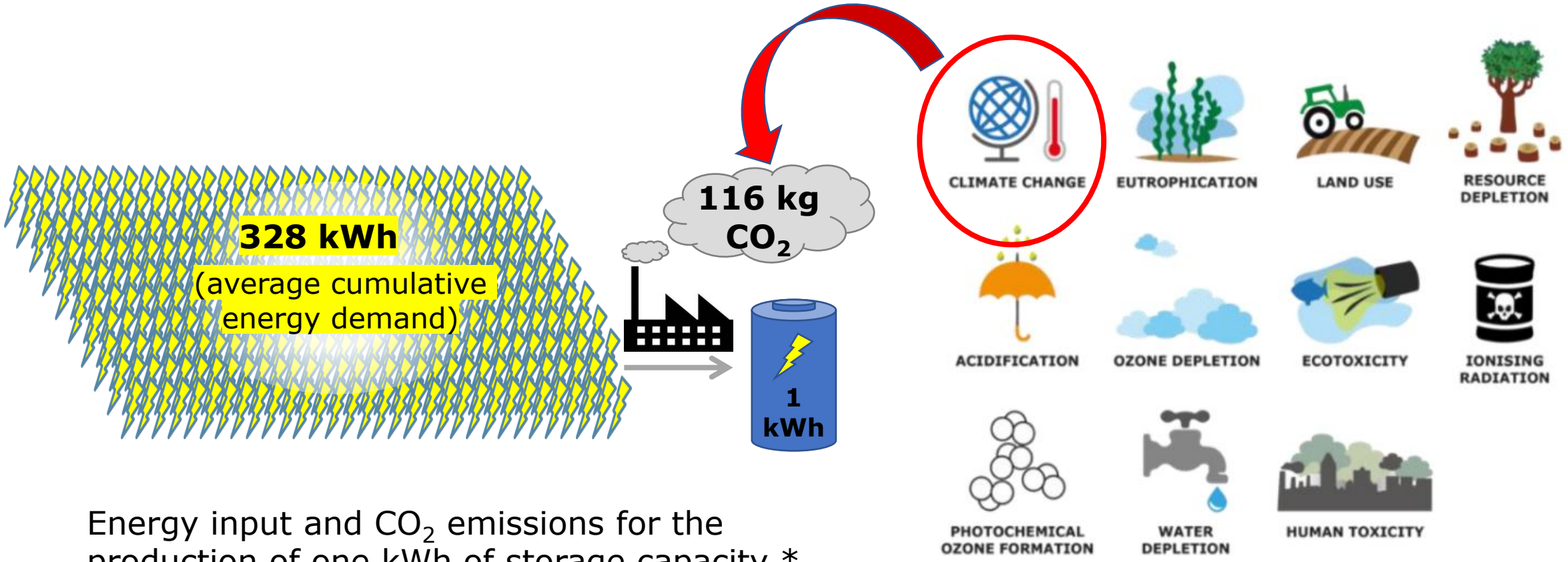
3. Recycling

4. Sustainability label

5. Conclusions

What is sustainability?

What is sustainability? Considered environmental impact indicators



Energy input and CO_2 emissions for the production of one kWh of storage capacity *

Peters JF, Baumann MJ, Braun J, Weil M. The environmental impact of Li-Ion batteries and the role of key parameters – A review. Renew Sustain Energy Rev, 67, 491–506 (2017)

https://eplca.jrc.ec.europa.eu/lcProjects.html

Approch towards the Position Paper exercise

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ECONOMIC

SOCIAL

ENVIRONMENTAL

Three key dimensions of sustainability

Cross-cutting considerations

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Raw materials	- Supply: **geophysical** and **geopolitical** considerations. - **Lack** of raw materials.	- **Workers' rights** & others **social aspects** in the value chain. - **Jobs**, **reskilling** and **training**.	- **Hazardous** materials. - **Resource use** across value chain. - **GHGs** (CO_2, NOx, SOx, and others) released during **mining**, **refining**, and **preparation** of precursors and active materials.
Cell design materials	- **Geopolitical** considerations. - **Lack** of raw materials. - Improving **technical performance** to decrease costs.	- **Workers' rights** & other **social aspects** in the value chain. - **Jobs**, **reskilling** and **training**.	- **Hazardous** materials. - **Resource use** across value chain.

Cross-cutting considerations

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		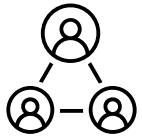	
 **Manufacturing**	- **Sustainability of imports** from outside the EU. - **Geopolitical** considerations. - Improving **technical performance** to decrease costs.	- **Workers' rights** & other **social aspects** in the value chain. - **Jobs**, **reskilling** and **training**.	- **Resource use:** chemicals, energy, water and resources in manufacturing. - Type of **infrastructures** needed (solvent recovery / recycling, dry / clean room, machinery.)
 **Applications**	- **New business models** enhancing sustainability and competitiveness.	- **Workers' rights** & other **social aspects** in the value chain. - **Jobs**, **reskilling** and **training**.	- **Resource use** across value chain. - **Energy transition** and **electrification**.

Cross-cutting considerations

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		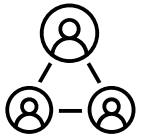	
 **Recycling**	- **Economic feasibility**, **economic degradation** and **business models**.	- **Workers' rights** & other **social aspects** in the value chain. - **Jobs**, **reskilling** and **training**.	- **Resource use** across value chain. - Environmental **benefits & negative impacts**.
○ ○ ○ **Other**	- **Regulatory aspects** related to R&D projects.	- **Social Life Cycle Assessment** (LCA).	- **Life Cycle Assessment (LCA)** & **carbon footprint** (or GHG-equivalent footprint).

What are the most important aspects for further consideration?

Key sustainability **hotspots** along the battery value chain

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Raw material → Cell design materials → Manufacturing → Applications (1st & 2nd) → Recycling → Other

New **sustainable business models** (incl. regulatory aspects)

Lack of (raw) materials

Improve tech. perf. & decrease TCO

Geopolitical considerations / **Sustainability of imports** / Circular economy

Sustainable business models

Workers rights and social aspects along the value chain

Safety of workers along the value chain

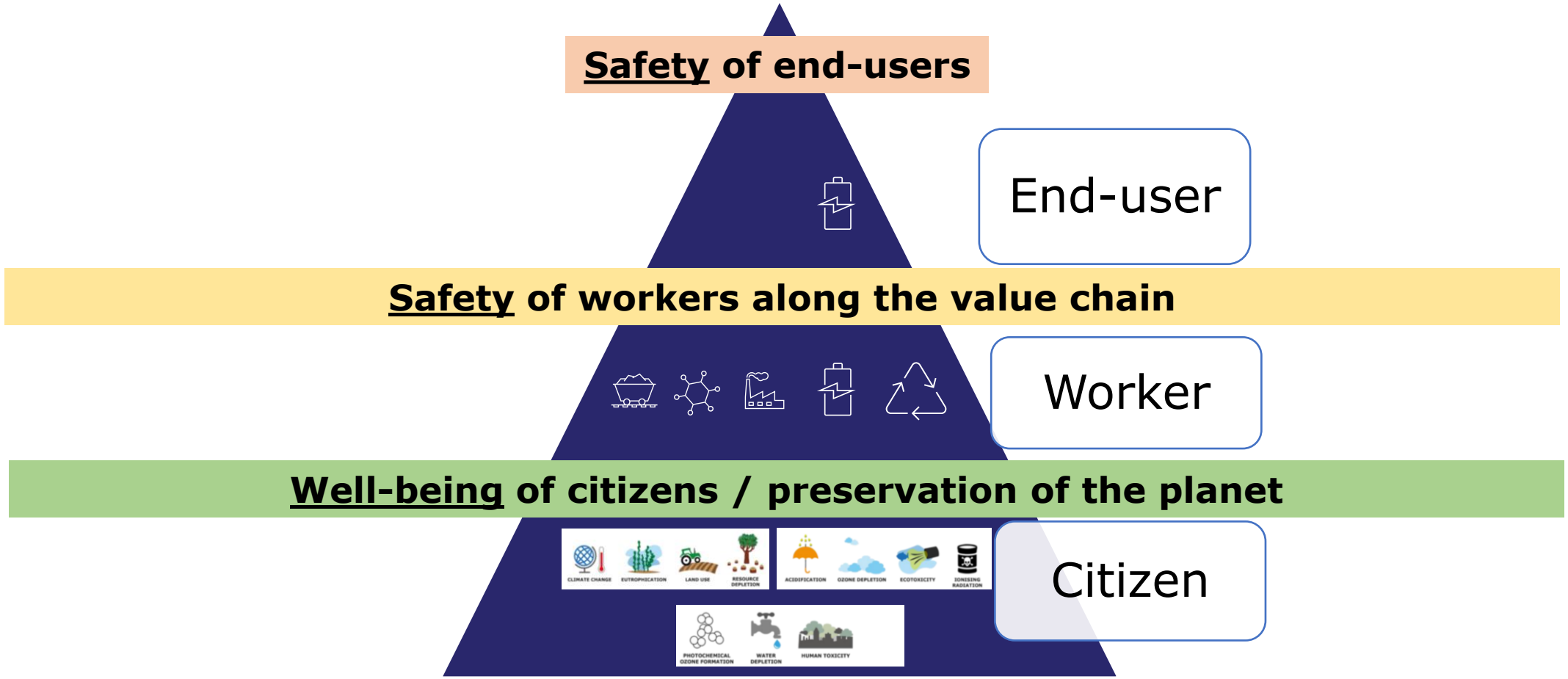
Social-LCA (incl. safety)

Carbon footprint / GHG emissions

Resources (water, hazmat, energy...) used along the value chain

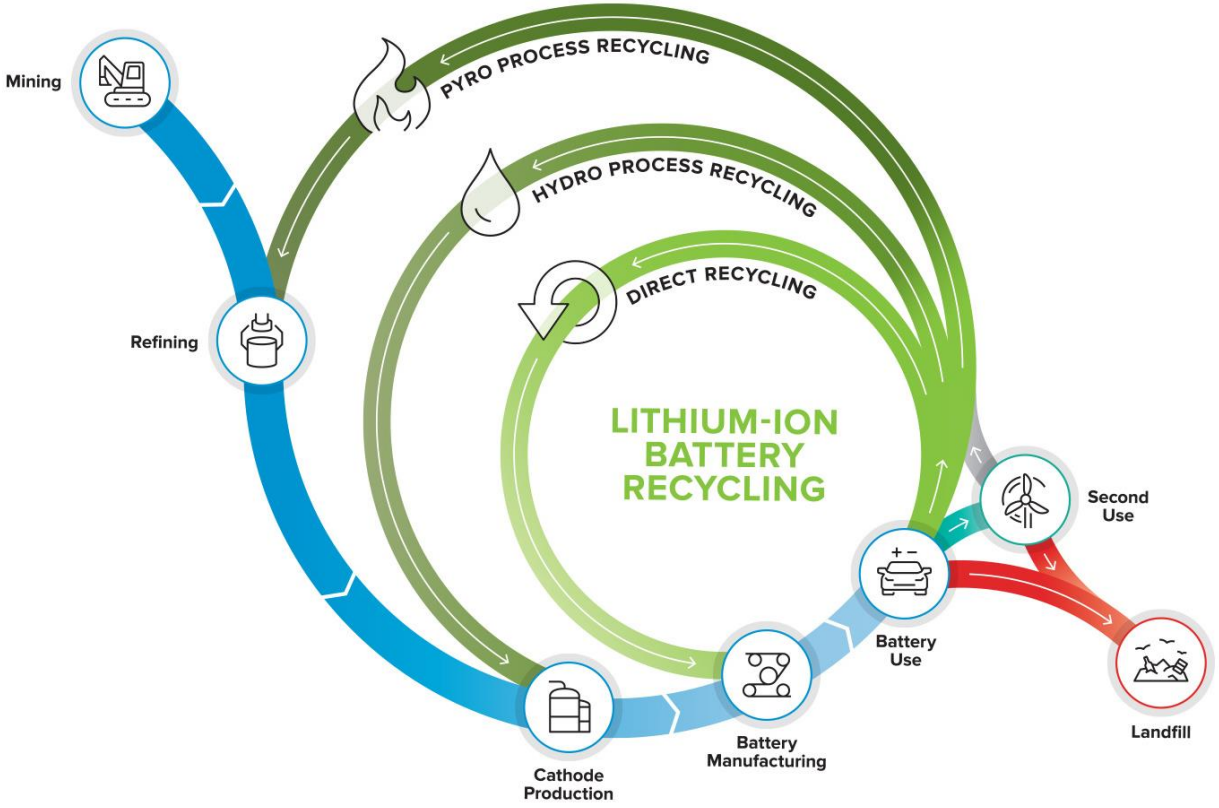
Full LCA

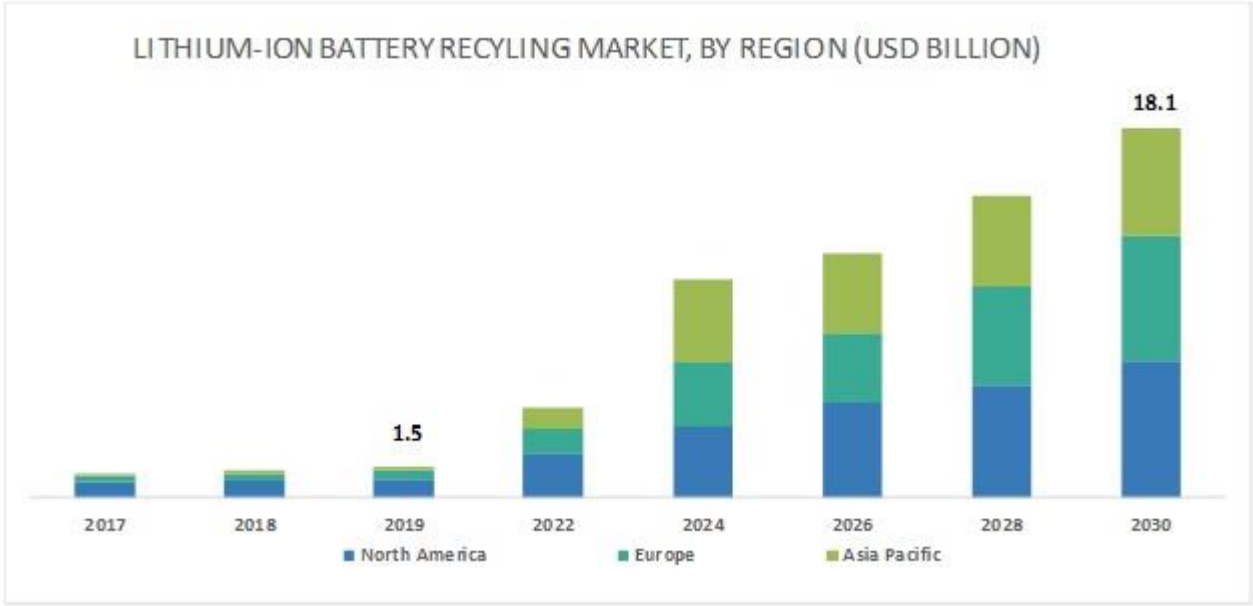
Combined safety and sustainability aspects



Focus on: Recycling

Growing importance of recycling





Pictures: Argonne National Laboratory; montana-ledger; www.marketsandmarkets.com

Focus on: The sustainability label

New business models enhancing sustainability and competitiveness

Four possible mechanisms would allow established industry to carry out competitive investments with high sustainability standards:

- Development of competitive sustainable technologies.
- **Development of a recognised and broader eco-label than exists today for sustainable battery and battery related products, trustworthy due to traceability at environmental and socio-economical levels;** this could lead to a higher level of responsibility and willingness to pay (customer demand).
- Implementing the new battery regulation.
- Focused funding policies at both EU and member state levels and/or taxes to reach Green batteries standards.

Sustainability label

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In order to take all the dimensions of what sustainability is about, one option we recommend is to design and implement, together with main stakeholders along the battery value chain, a **new sustainability label for battery and battery-related products.**

The current EU eco-label promotes Europe's transition to a circular economy, but focuses mostly on environmental aspects (less waste, CO_2, energy, raw materials; longer lifetime; easy to repair / recycle).

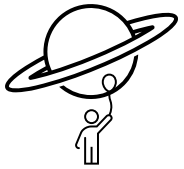
We propose to emphasise and add criteria on socio-economical aspects to reflect the broader definition of sustainability.
We need to **define ethical, social and environmental indicators**.

As a result, the information can be used for marketing enabling choices of customers based on quantified and validated environmental and societal performances. A rise in customer interest and willingness to pay for higher quality products is expected: this trend has already taken place in food and textile industries.

Eco-label

= Environment aspects

Logo to be found!



Sustainability label

= Environment
+ ethical
+ social aspects

- Responsible sourcing
- Traceability along the value chain and for 1st & 2nd life applications (...)
- Social LCA criteria...

Conclusions

- ✓ **Sustainability requirements are a cross-cutting topic** that impacts all the different steps of the battery value-chain, **and which has to be considered through the social, economic and, of course, environmental perspective.**
- ✓ In order for the battery value chain to fulfil the sustainability requirements needed to set up a strong battery industry in Europe, specific challenges still need to be overcome. **R&I is still needed to achieve a future battery system which has a significantly better performance and better environmental footprint than today.**
- ✓ Moreover, **competitiveness and sustainability**, two aspects that can be hard to articulate, **need to be thought of in relation with each other, especially in EU regulations and dissemination action** that can address this potential conflict.
- ✓ **Dissemination actions towards end-customer via the introduction of a new 'sustainability label' going much further in scope than the current 'eco-label'** might help overwin the dilemma sustainability versus competitiveness.
- ✓ **Sustainability** appears as a key factor that industry must take into account in order to ensure the green energy transition, and which **needs to be integrated from an early stage in order for the industry to succeed**.

Contributors

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The Industry Perspective on Safety and Sustainability

Etienne Briere
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(EDF R&D)

EVs & BESS are becoming an important commercial reality

- **EDF Storage plan, aiming to install 10 GW by 2035 + Strong growth of EDF Renewables**

- **Almost 600,000 electric vehicles and plug-in hybrids are now on the roads in France. In May 2021 market share of 14.2 % among new registrations !**

LE PLAN stockage électrique

LE PLAN MOBILITÉ ÉLECTRIQUE

From cells to system : safety and sustainability address all the levels

Cells

Modules

Packs VE

5-100 kWh

EV

Cabinets ESS
few kW-kWh

Résidential, C&I, off grid

Containers
MW-MWh

Grid services

Need to address sustainability and safety at all levels: cells/modules/packs

- ✓ <u>Cell level</u> : intrinsic safety, internal protections by specific devices and advanced materials. Reduce footprint of manufacturing and materials.
- ✓ <u>Module level</u> : Propagation barriers in case of cell event. Structure dedicated to facilitated recycling & second use from EV packs
- ✓ <u>System level :</u> Monitoring safety at system level taking account aging. Robust calculation of the carbon footprint of the system over its entire life cycle.

The safety & sustainability for batteries assets are essential 1/3

Poor battery safety management can kill the business !

Safety management is essential for long-term BESS projects (20-30y). Mitigation measures are costly for projects, including environmental issues in case of accidents.

Projects are global and their competitiveness must be ensured.

Managing safety is complex with lithium-ion batteries. It will require research, engineering & innovation actions at different scales.

Study the influence of the use case profile and ageing of batteries on safety (State of Safety index - SOS)

Develop more destructive testing + specific monitoring for Safety diagnosis/prognosis + control and maintenance actions in real time.

Regulation must consider the specificity of the different technologies and use cases

New standards for battery safety :

- **Accelerate standards adoption and certifications to assess the risk of fire propagation in ESS.**
- **Favorise emerging new designs are emerging**

The safety & sustainability for batteries assets are essential 2/3

- For a sustainable battery system, life cycle analysis (LCA) is essential for batteries manufacturing, but it also depends on their use during their lifetime and the carbon content of the energy mix where the battery system is used.

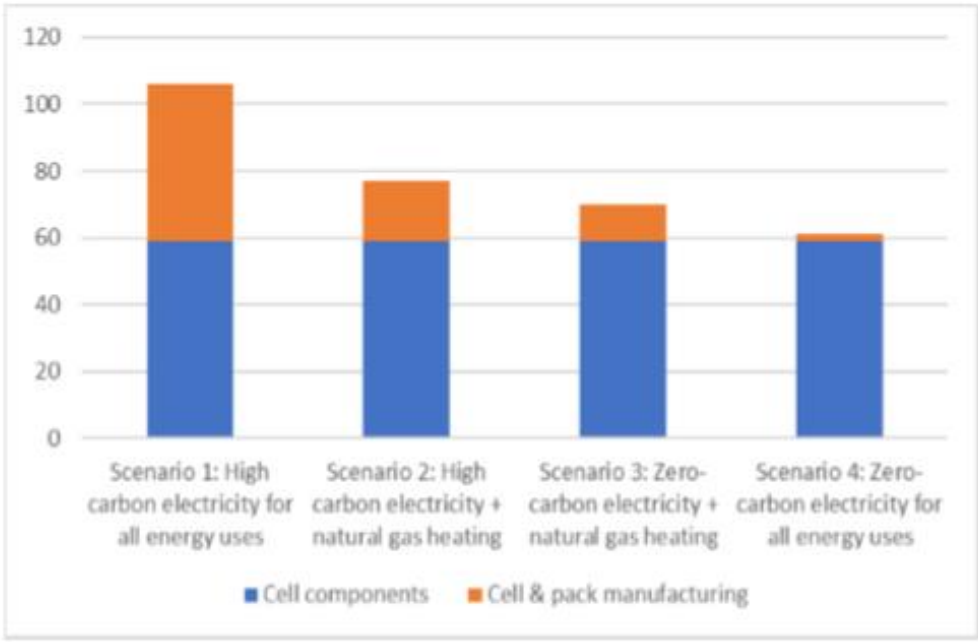
- Recycling is expensive nowadays and there is also a link to safety. This should not also penalise the competitiveness of the European industry.

Develop robust global LCA methods

Better consideration of technological specificities and uses and sharing of battery information

IFRI

Carbon footprint calculation based on different energy supply scenarios for cell and pack manufacturing (in $kgCO_{2e}$/kWh)



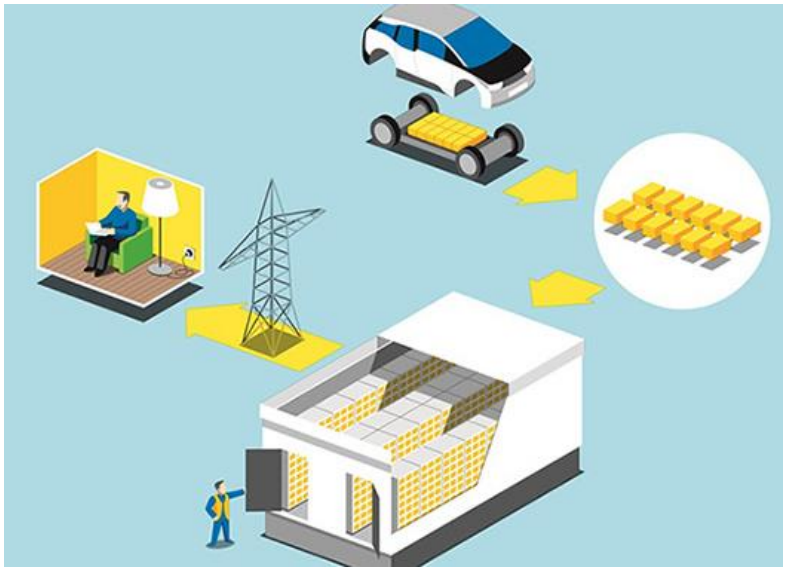
Note: the high-carbon electricity is estimated at 1 $kgCO_{2e}$/kWh.

Source: Ifri, based on data from the Dai et al. study of a NCM111 battery pack, 2019.

The safety & sustainability for batteries assets are essential 3/3

- Second life batteries from EVs is in competition with direct recycling and V2G.

- The cost of logistics is very important because of the regulations on the transport of used LIB batteries



Guidelines in battery regulation project is weak for second life batteries

The profitability of the second life business model must be demonstrated

EDF is open to collaborate on these R&I subjects !

THANK YOU

Improve EDF Group-performance
in all of its current ventures and enable customers to benefit.

Prepare the energy scenarios of the future
by working on disruptive technologies.

Carry out
research for external commissioning bodies
within the framework of partnerships or orders.

Q&A SESSION

PANEL DISCUSSION

A Holistic Approach to Battery Safety and Sustainability

CLOSING REMARKS

Claude Chanson
RECHARGE General Manager

Coming up next:

Skills and Education for the Emerging Battery Economy: European Challenges and Solutions

The third workshop organised by Batteries Europe will take place on **Tuesday 29 June (10:00-12:00)**

Save the Date! Registrations will open later this week!

This Workshop has been organised by:

BATTERIES EUROPE