The Batteries Regulation

Performance and Safety Requirements

Andreas Pfrang

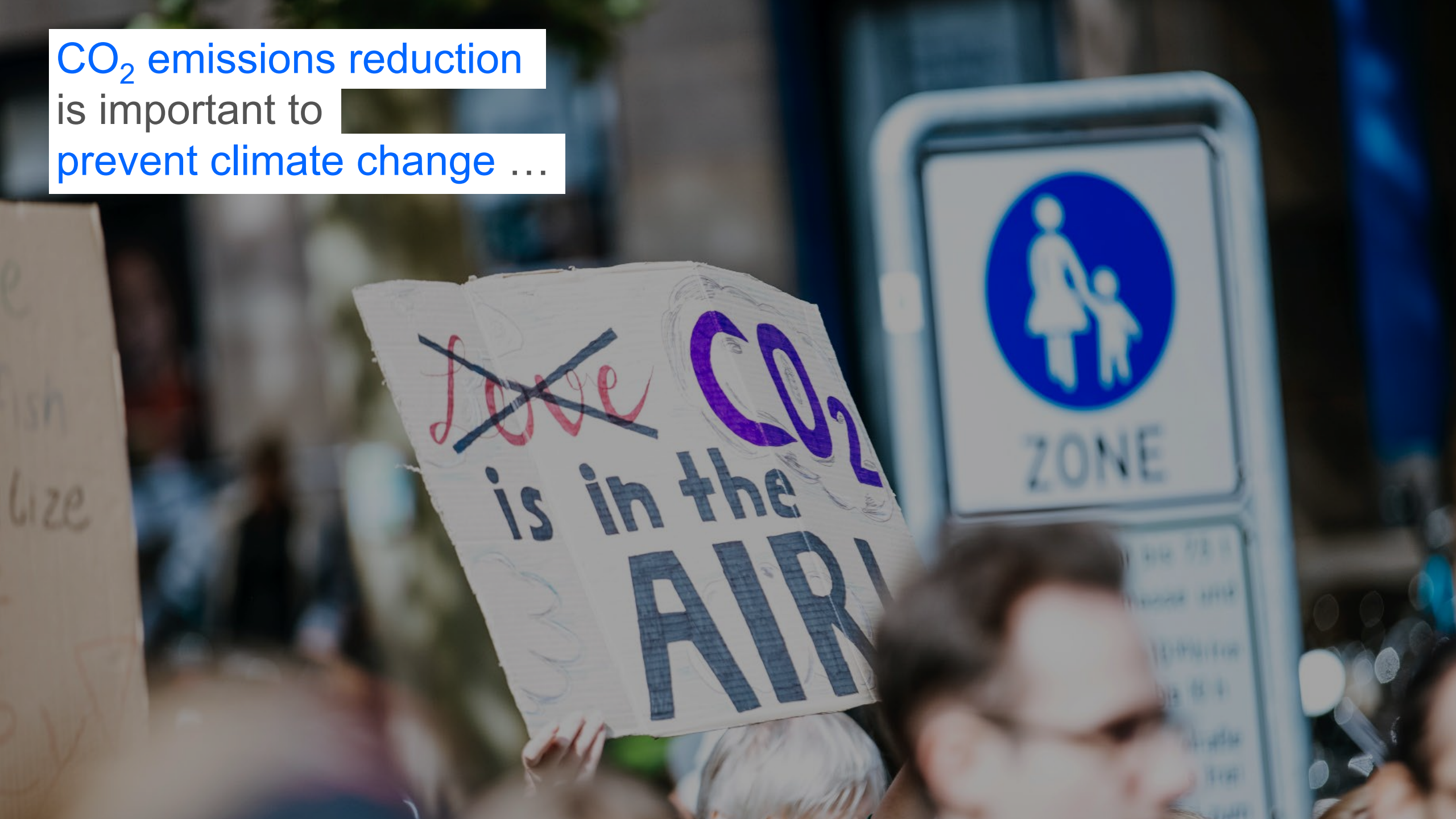
European Commission, Joint Research Centre (JRC), Petten, Netherlands

Green Transport Delta Electrification
Sounding board meeting

Joint Research Centre

Eindhoven, NL
10th October 2023

CO_2 emissions reduction is important to prevent climate change …

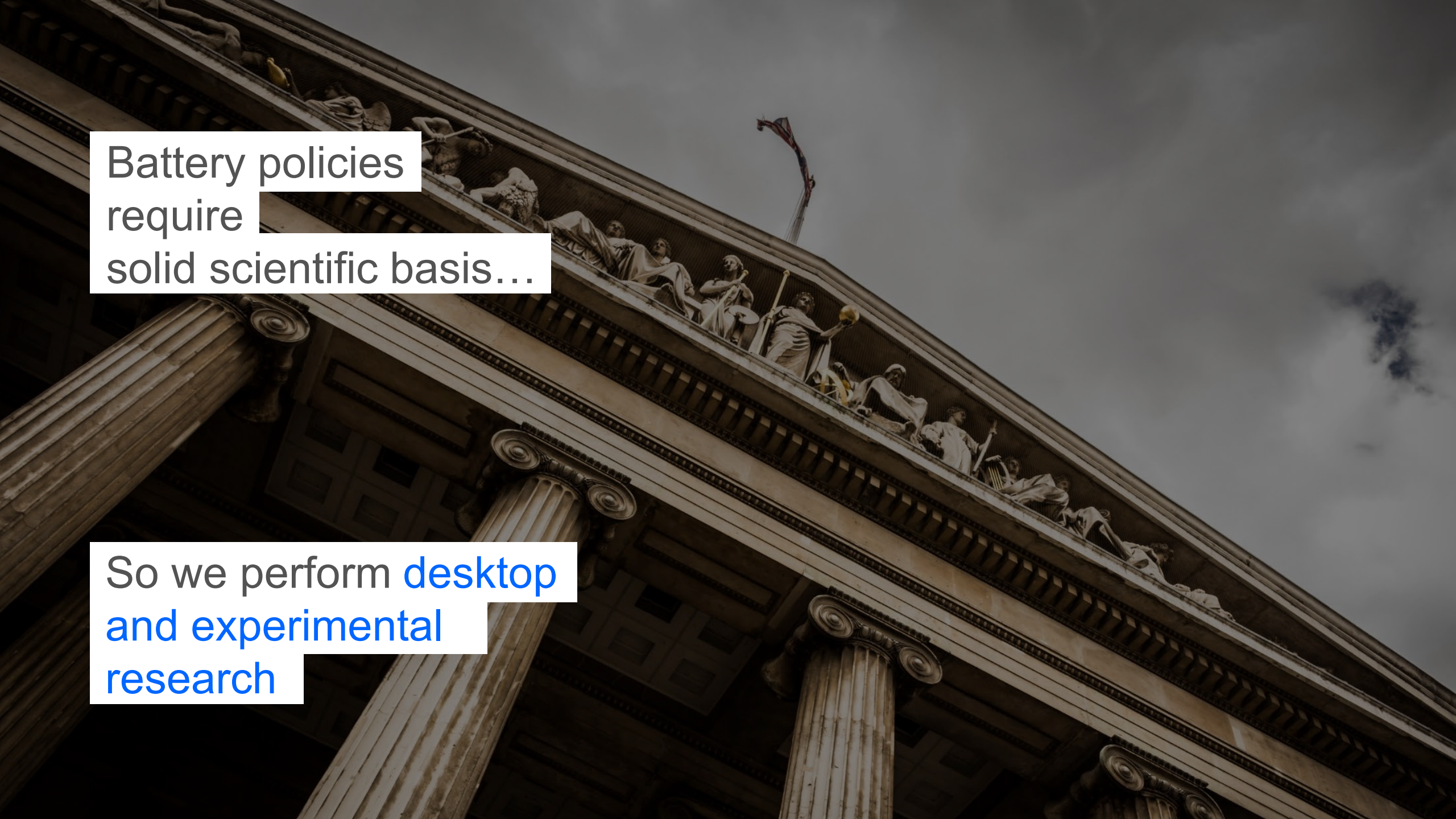


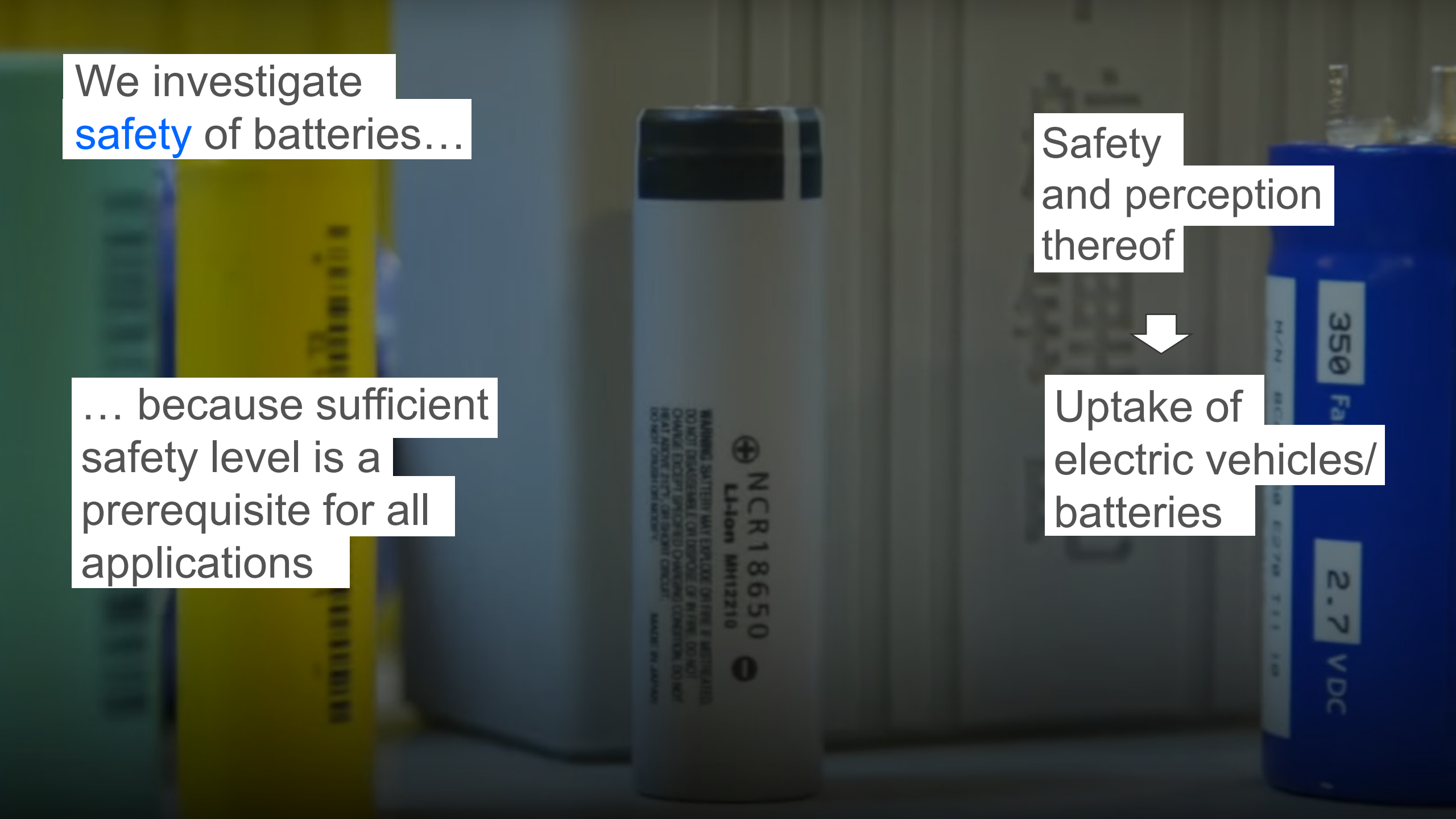
Batteries

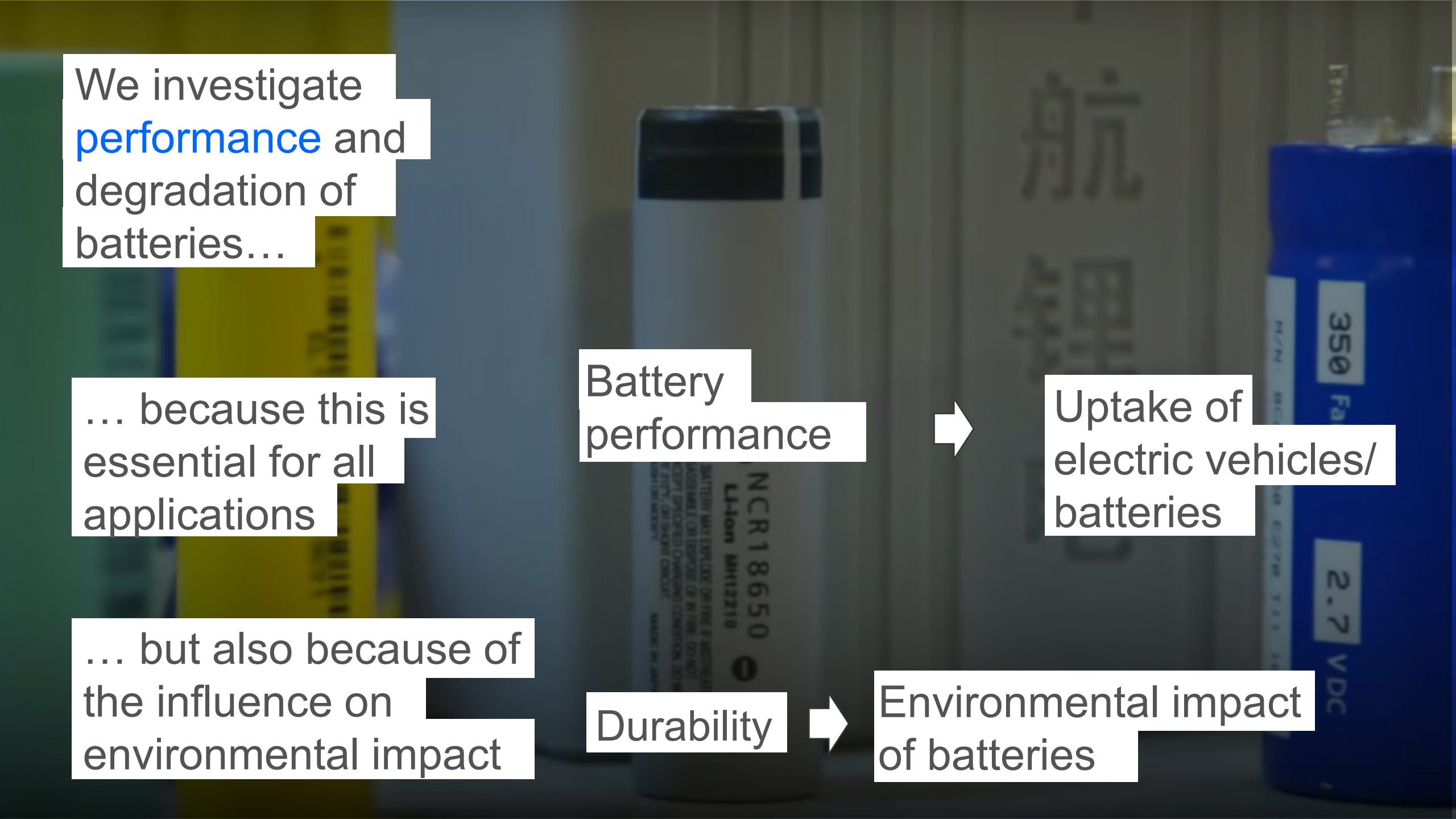
will play a crucial role …


…facilitating
renewables integration
into the power grid …

… facilitating the shift to electric vehicles


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

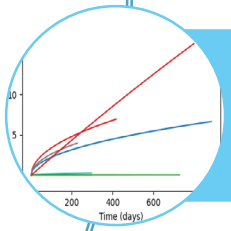

We investigate safety of batteries…
… because sufficient safety level is a prerequisite for all applications
Safety and perception thereof
Uptake of electric vehicles/ batteries
NCR18650
LiIon
3500
2.7 V DC


We investigate performance and degradation 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
Durability
Environmental impact of batteries

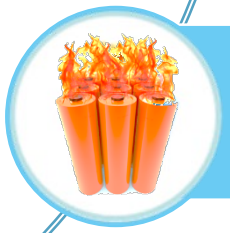
Outline

Joint Research Centre

Batteries Regulation

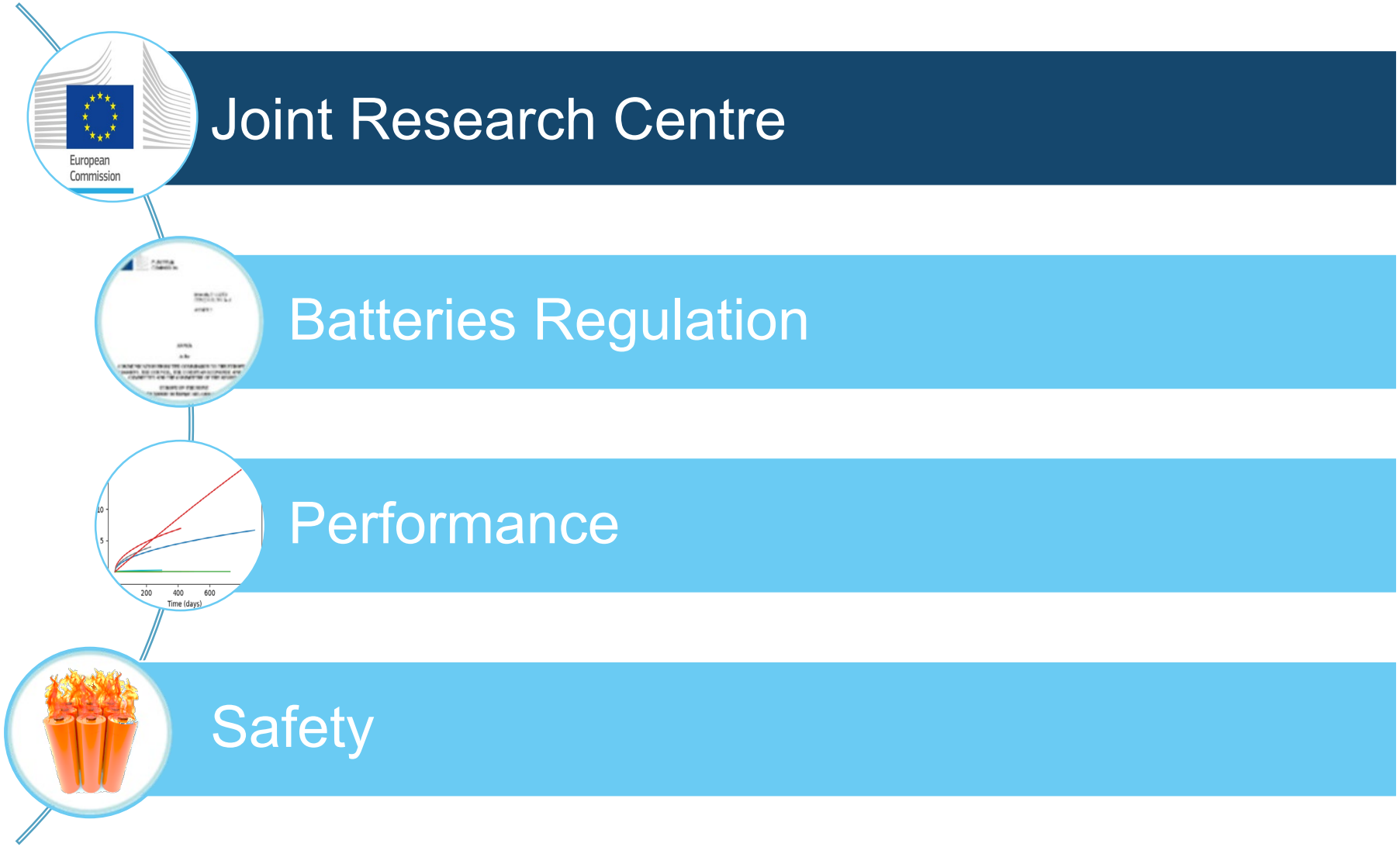


Performance



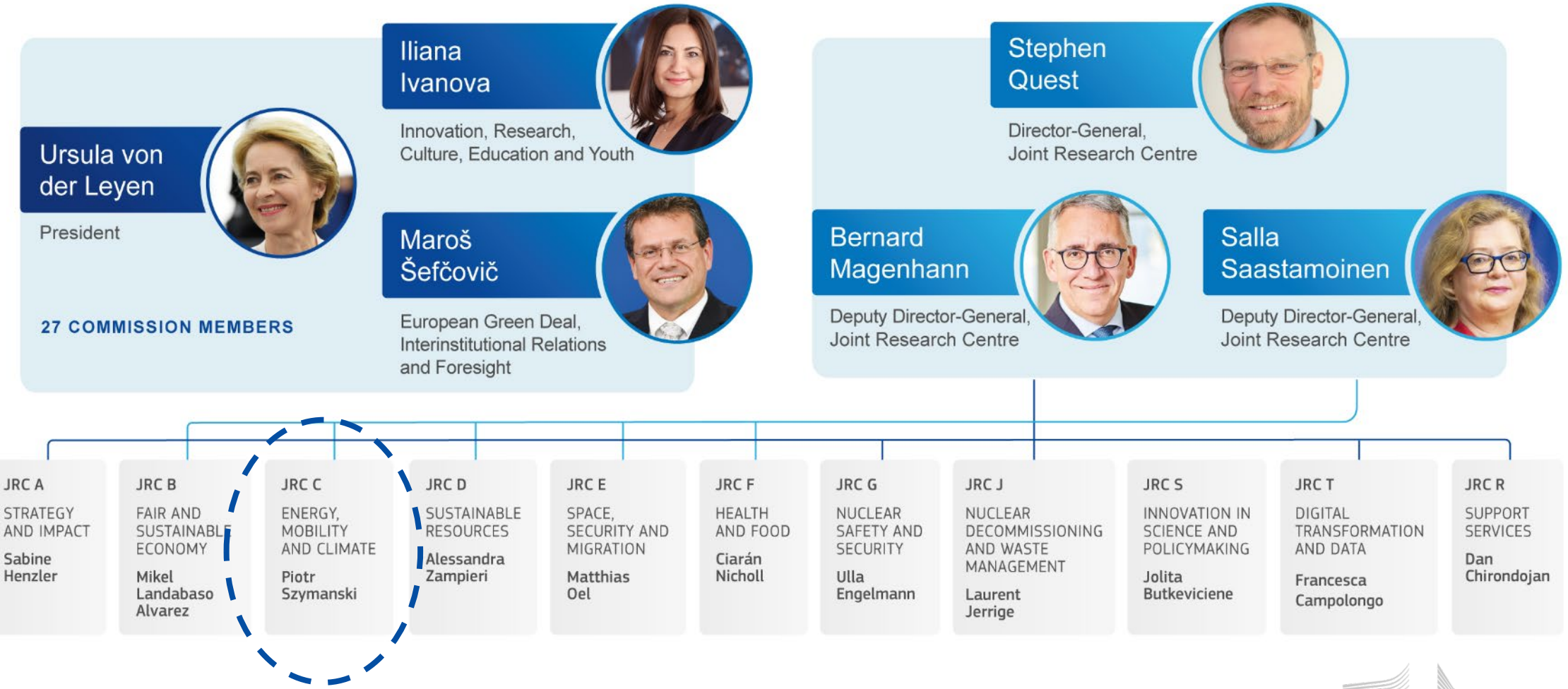
Safety

Outline



European Commission

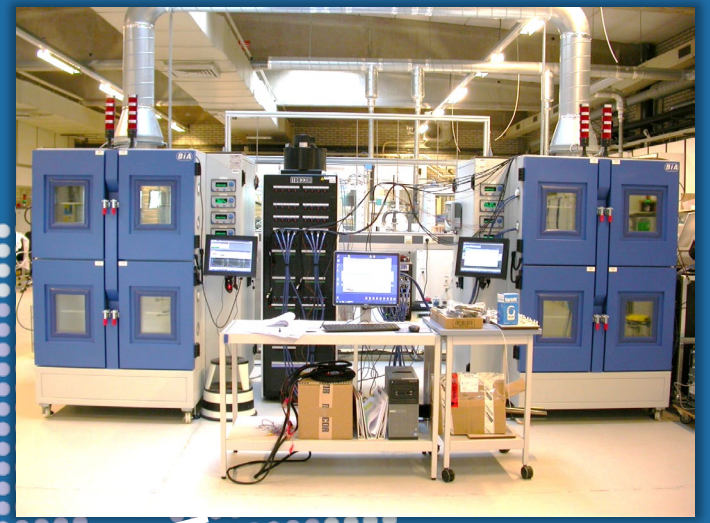
The Joint Research Centre within the Commission



European Commission

Science for policy

Headquarters in **Brussels** and research facilities located in **5 EU Countries**



Our purpose

The Joint Research Centre provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society.

European Commission

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/law/better-regulation/have-your-say_en
- Other publicly available information
- …

Information supporting regulations

- Existing legislation
  - consistent, holistic

Industry input required

- Industry practices / standards
- Scientific literature, (experimental) data and knowledge
- Dedicated modelling
  - Socio-techno-economic
- Dedicated research

JRC role

Pre-normative research

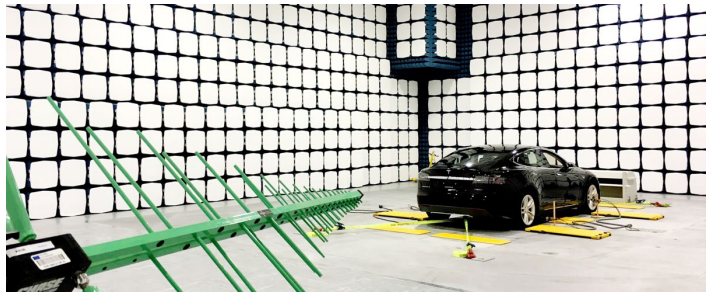
- Lobbying
- Public consultation
  - e.g. https://ec.europa.eu/info/law/better-regulation/have-your-say_en
- Other publicly available information
- …

JRC – 50 large scale research facilities

Battery Testing Laboratory

JRC neutron time-of-flight facility (GELINA)

Vehicle Safety Research (MASSAF)



European Interoperability Centre for Electric Vehicles and Smart Grids

Vehicle Emission Laboratory (VELA)

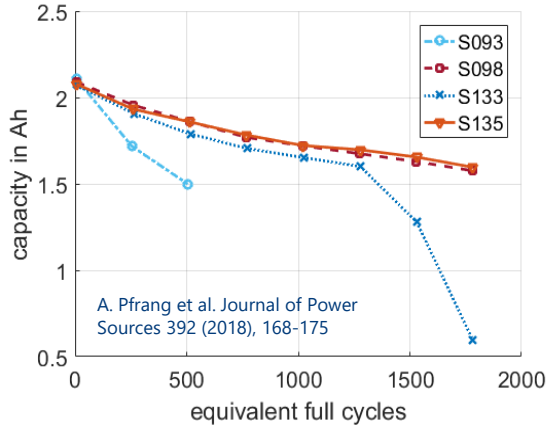
Nanobiotechnology Laboratory

https://visitors-centre.jrc.ec.europa.eu/en/media/virtualtours/take-virtual-tour-battery-testing-facilities-laboratory

JRC Petten – BESTEST

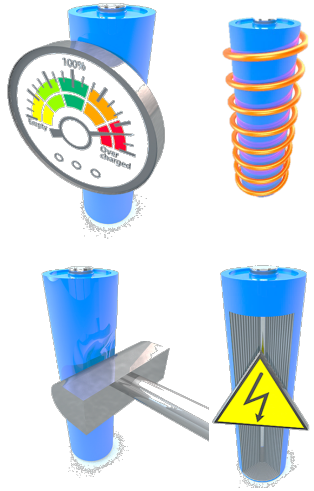
Experimental activities

Performance and durability

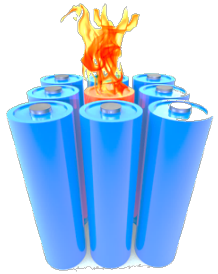


Safety

Failure scenario



Thermal runaway

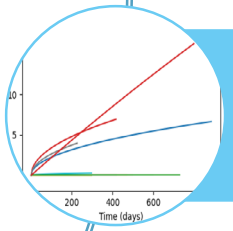


Thermal runaway propagation

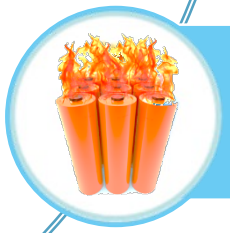
Outline

Joint Research Centre

Batteries Regulation

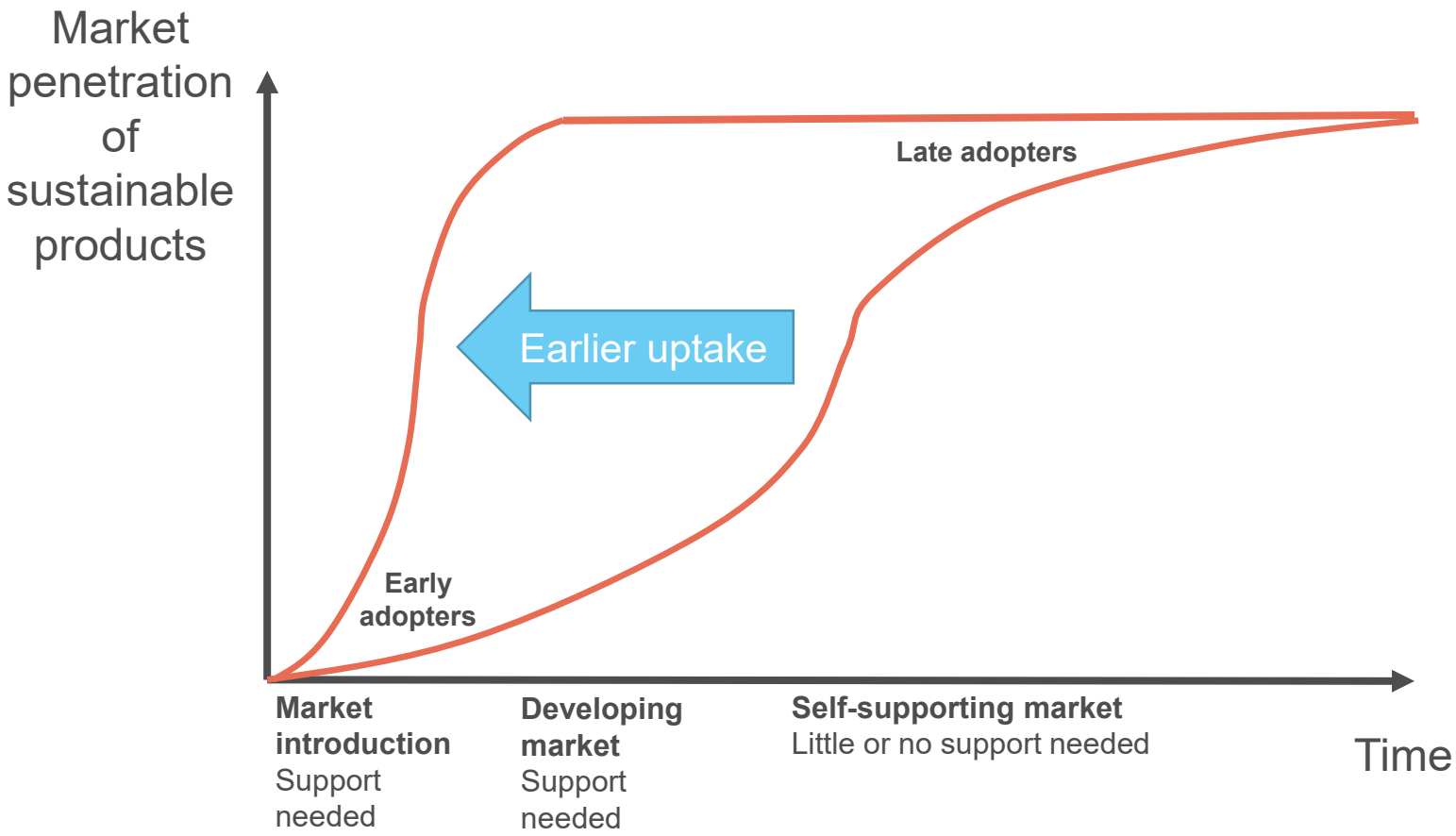


Performance



Safety

Batteries as sustainable product



Objectives of the Batteries Regulation

- Leverage the EU's internal market to foster the production of sustainable high-quality batteries
- Ensure appropriate collection and recycling of waste batteries
- Ensure better functioning markets for secondary raw materials and related industrial processes
- Reduce the environmental and social impact throughout all stages of the battery life cycle
- Reduce the EU's dependence on imports of materials of strategic importance

European Commission

Regulation (EU) 2023/1542

- Commission proposal from December 2020
- Entered into force 17 August 2023
- Replaces the battery directive 2006/66/EC
- Individual measures to be introduced over the next years, often by secondary legislation

28.7.2023 EN Official Journal of the European Union L 191/1

I

(Legislative acts)

REGULATIONS

REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 12 July 2023
concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 114 thereof and Article 192(1) thereof in relation to Articles 54 to 76 of this Regulation,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee (1),

After consulting the Committee of the Regions,

Acting in accordance with the ordinary legislative procedure (2),

Whereas:

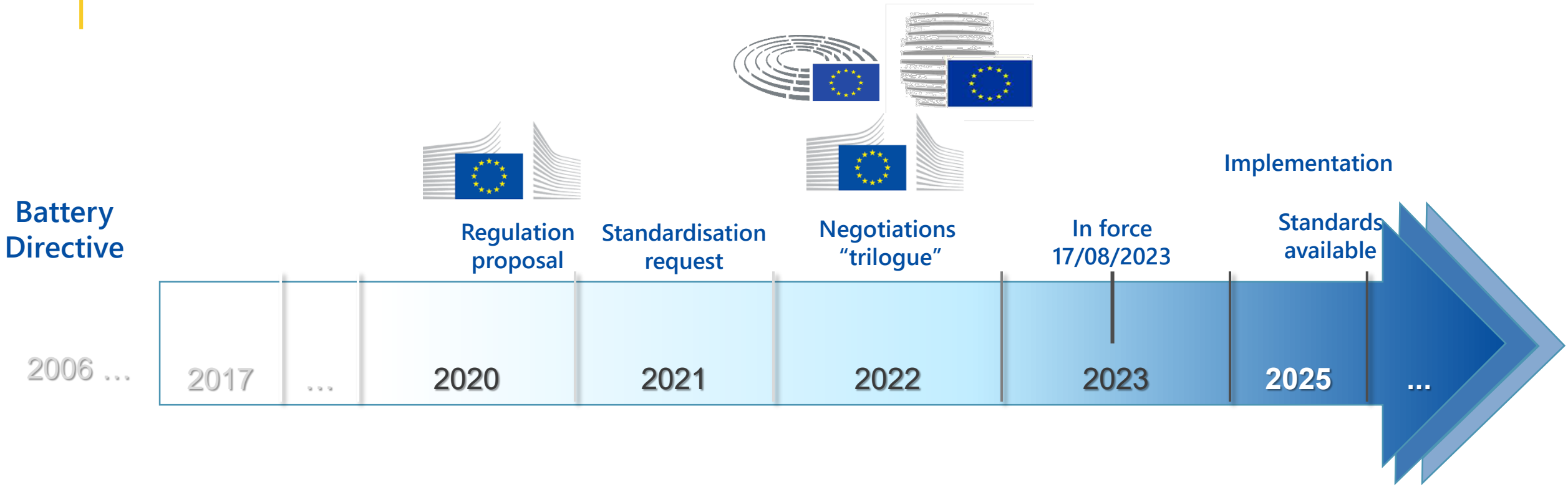
(1) The Communication of the Commission of 11 December 2019 on 'The European Green Deal' (the 'European Green Deal') is Europe's growth strategy that aims to transform the Union into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net greenhouse gas emissions in 2050 and where economic growth is decoupled from resource use. A shift from the use of fossil fuels in vehicles to electromobility is one of the prerequisites for reaching the climate neutrality goal in 2050. In order for the Union's product policies to contribute to lowering carbon emissions on a global level, it needs to be ensured that products marketed and sold in the Union are sourced and manufactured in a sustainable manner.

(2) Batteries are thus an important source of energy and one of the key enablers for sustainable development, green mobility, clean energy and climate neutrality. It is expected that the demand for batteries will grow rapidly in the coming years, notably for electric road transport vehicles and light means of transport using batteries for traction, making the market for batteries an increasingly strategic one at the global level. Significant scientific and technical progress in the field of battery technology will continue. In view of the strategic importance of batteries, to provide legal certainty to all operators involved and to avoid discrimination, barriers to trade and distortions on the market for batteries, it is necessary to set out rules on the sustainability, performance, safety, collection, recycling and second life of batteries as well as on information about batteries for end-users and economic operators. It is necessary to create a harmonised regulatory framework for dealing with the entire life cycle of batteries that are placed on the market in the Union.

(1) OJ C 220, 9.6.2021, p. 128.
(2) Position of the European Parliament of 14 June 2023 (not yet published in the Official Journal) and decision of the Council of 28 June 2023.

http://data.europa.eu/eli/reg/2023/1542/oj

The timeline of the Batteries Regulation



Discussions before regulation proposal

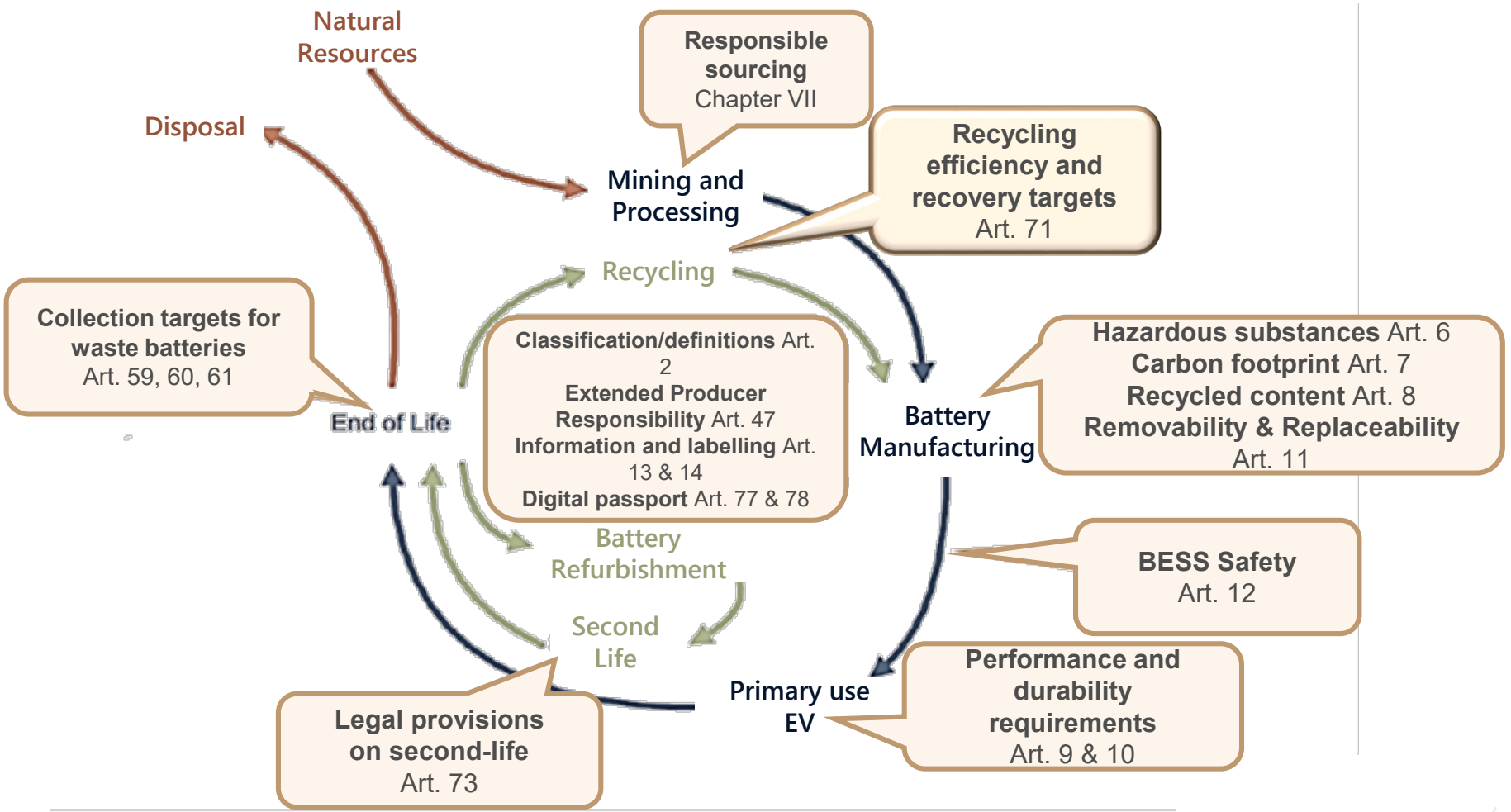
Joint Research Centre JRC

Technical support
from regulation proposal and beyond regulation implementation

http://data.europa.eu/eli/reg/2023/1542/oj

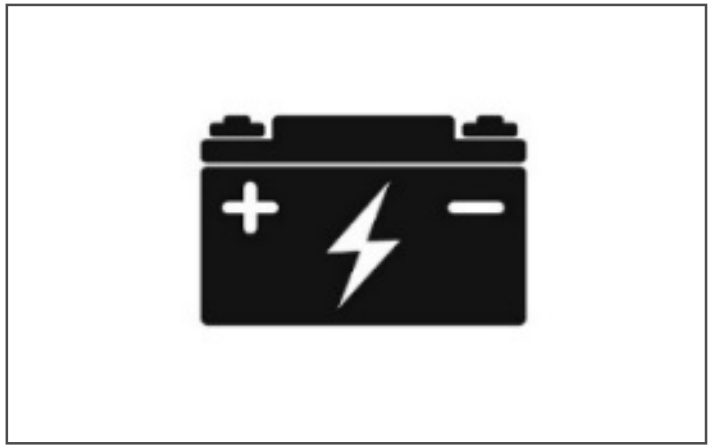
European Commission

Batteries Regulation



European Commission

Scope



SLI batteries

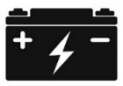
Light means of transport batteries

Portable batteries

Electric vehicle batteries

Industrial batteries

Battery categories: 5 plus 2 sub-categories



- **SLI battery** means any battery designed to supply electric power for starter, lighting, or ignition, and that may also be used for auxiliary or backup purposes in vehicles, other means of transport or machinery.

- **Light Means of Transport (LMT)** battery means any battery that is sealed and weighs below or equal to 25 kg, designed to provide electric power for the traction to wheeled vehicles that can be powered by the electric motor alone or by a combination of motor and human power, including type-approved vehicle of category L in the meaning of Regulation (EU) No 168/2013, and that is not an electric vehicle battery.

- **Portable battery** means any battery that is sealed, weighs less than 5 kg, is not designed specifically for industrial uses, and is not an SLI nor a LMT battery.
  - **Portable battery of general use** means a rechargeable or non-rechargeable portable battery specifically designed to be interoperable and with the following common formats: 4.5 V (3R12), button cell, D, C, AA, AAA, AAAA, A23, 9 V (PP3);

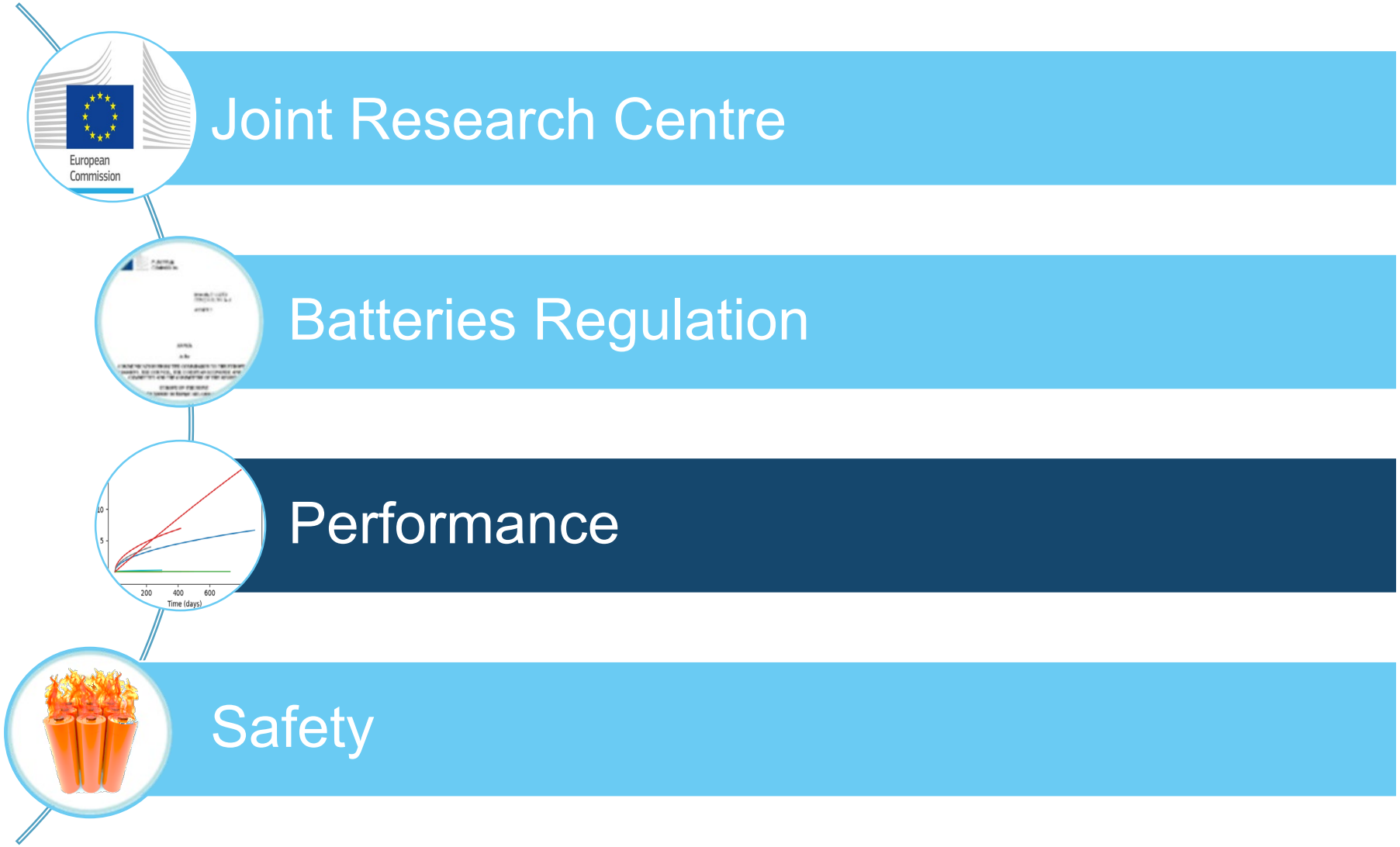
- **Electric Vehicle (EV)** battery means any battery specifically designed to provide electric power for the traction of hybrid or electric vehicles of L category as provided for in Regulation (EU) No 168/2013, and with a weight above 25 kg, or designed to provide electric power for the traction to hybrid or electric vehicles of M, N or O categories (as in Regulation (EU) 2018/858).

- **Industrial battery** means any battery designed specifically for industrial uses, or intended for industrial uses after being subject to preparing for repurpose or repurposing, or any other battery with a weight above 5 kg that is not a LMT battery, an electric vehicle battery or a SLI battery. includes flow batteries

  - **Stationary battery energy storage system (SBESS)** means a rechargeable industrial battery **with internal storage** specifically designed to store and deliver electric energy from and into the grid or store and deliver electric energy to end-users.

- Any battery does not fit in any of the four first definitions is, as a residual category, an industrial battery. In case a battery conforms to more than one battery category, where different requirements are applicable, the most restrictive requirements shall apply.

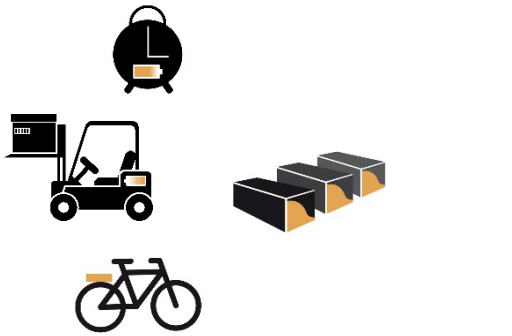
Outline



European Commission

Performance & Durability Requirements

- Categories of Batteries:
  - Portable batteries of general use
  - Rechargeable industrial batteries > 2 kWh
  - Light Means of Transport Batteries
  - (EV batteries are mostly covered by UNECE GTR-EVE)

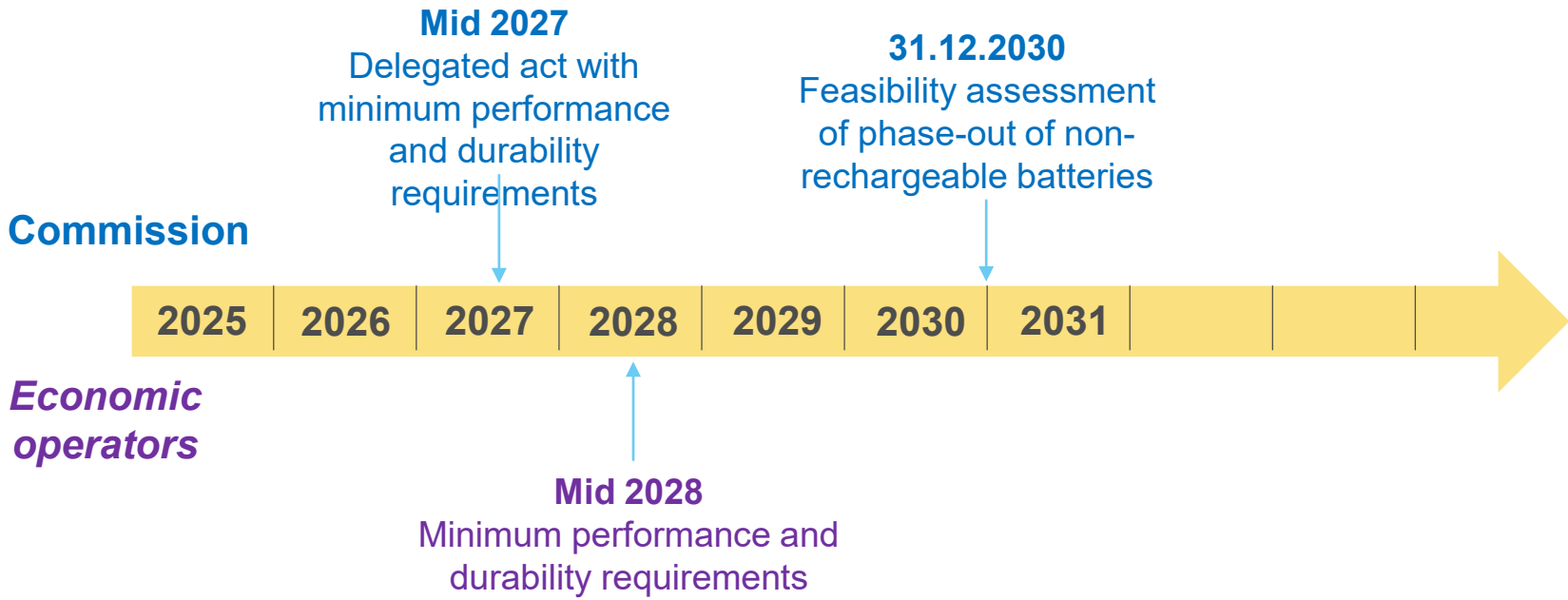


- Measurement **procedures** in harmonized standards (CEN/CENELEC)
- Minimum **requirements** set by Delegated Acts
  - Stakeholder consultation

PORTABLE BATTERIES

Provisions on performance and durability
Portable batteries of general use

- Applicable to all portable batteries of general use, **except button cells**
- Performance and durability parameters in Annex III
  - Specific to rechargeable and non-rechargeable portable batteries of general use
  - Methods for determining parameters to be described in harmonized standards
  - Minimum requirements for these parameters to be set by Delegated Acts



European Commission

Annex III Part A non-rechargeable batteries

Primary batteries

Electrochemical performance and durability parameters for portable batteries of general use

1. Minimum average duration, minimum average time met by a sample of batteries on discharge when used in specific applications.
2. Delayed discharge performance, the relative decrease of the minimum average duration, with the initially measured capacity as the reference point, after a defined period of time and specific conditions (temperature, and relative humidity)

1. Minimum average duration
2. Minimum average duration after storage e.g. one year

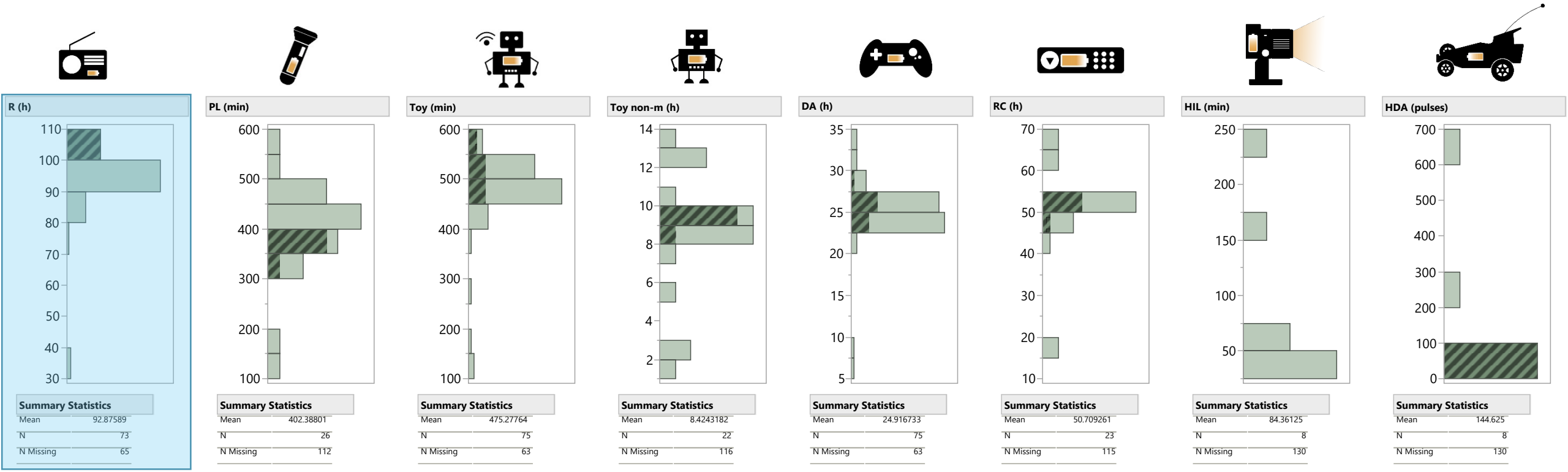
Annex III Part B rechargeable batteries

1. Rated capacity, capacity value of a battery determined under specified conditions and declared by the manufacturer.

2. Charge (capacity) retention, capacity that a battery can deliver after storage, at a specific temperature, for a specific time without subsequent recharge as a percentage of the rated capacity.
3. Charge (capacity) recovery, capacity that a battery can deliver with subsequent recharge after storage, at a specific temperature, for a specific time, as percentage of rated capacity.
4. Endurance in cycles, the number of charge and discharge cycles a battery can perform under specific conditions before the capacity drops below a specified fraction of the rated capacity.

1. Capacity Ah
2. Capacity after storage (self-discharge)
3. Capacity recovery after storage
4. Cycles

AA Batteries (all Chemistries)



- Performance of a battery can very significantly between different applications
- Reduce number of application tests (→ CENELEC SR 35)

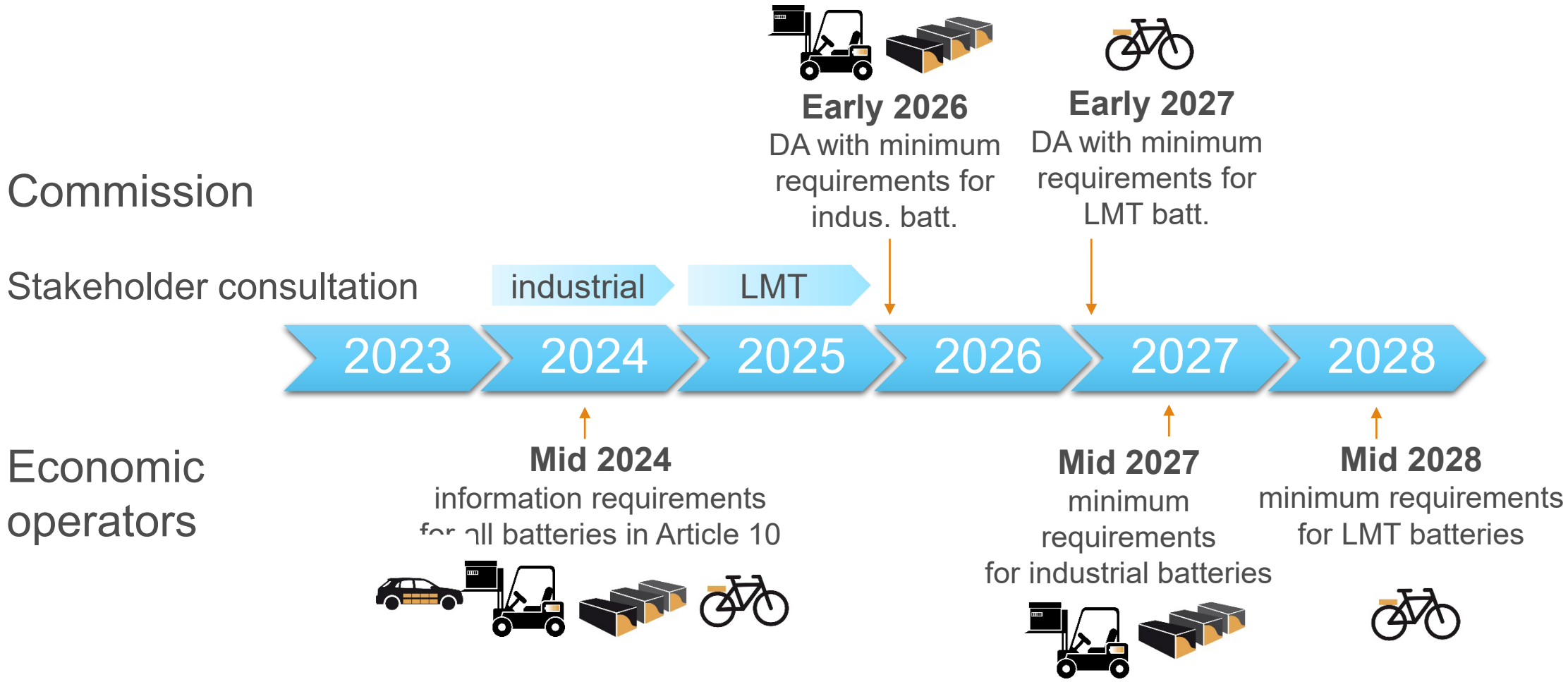
European Commission

Provisions on performance and durability EV, LMT and industrial batteries

- Applicable to:
  - LMT and rechargeable industrial **(>2 kWh**) batteries
    - industrial with exclusively external storage - **information only**
  - EV **information only** (not to clash with proposed Euro 7/UNECE GTR 22 in-vehicle requirements)

- Batteries that have undergone **preparation for re-use**, **preparation for repurposing**, or **remanufacturing** are exempt, if originally put in service before obligations became applicable
- Performance and durability parameters are specified in Annex IV, minimum requirements applicable

Provisions on performance and durability Industrial, EV, LMT batteries



Article 10, Annex IV

Electrochemical performance and durability requirements

For LMT batteries, industrial batteries with a capacity greater than 2 kWh and electric vehicle batteries:

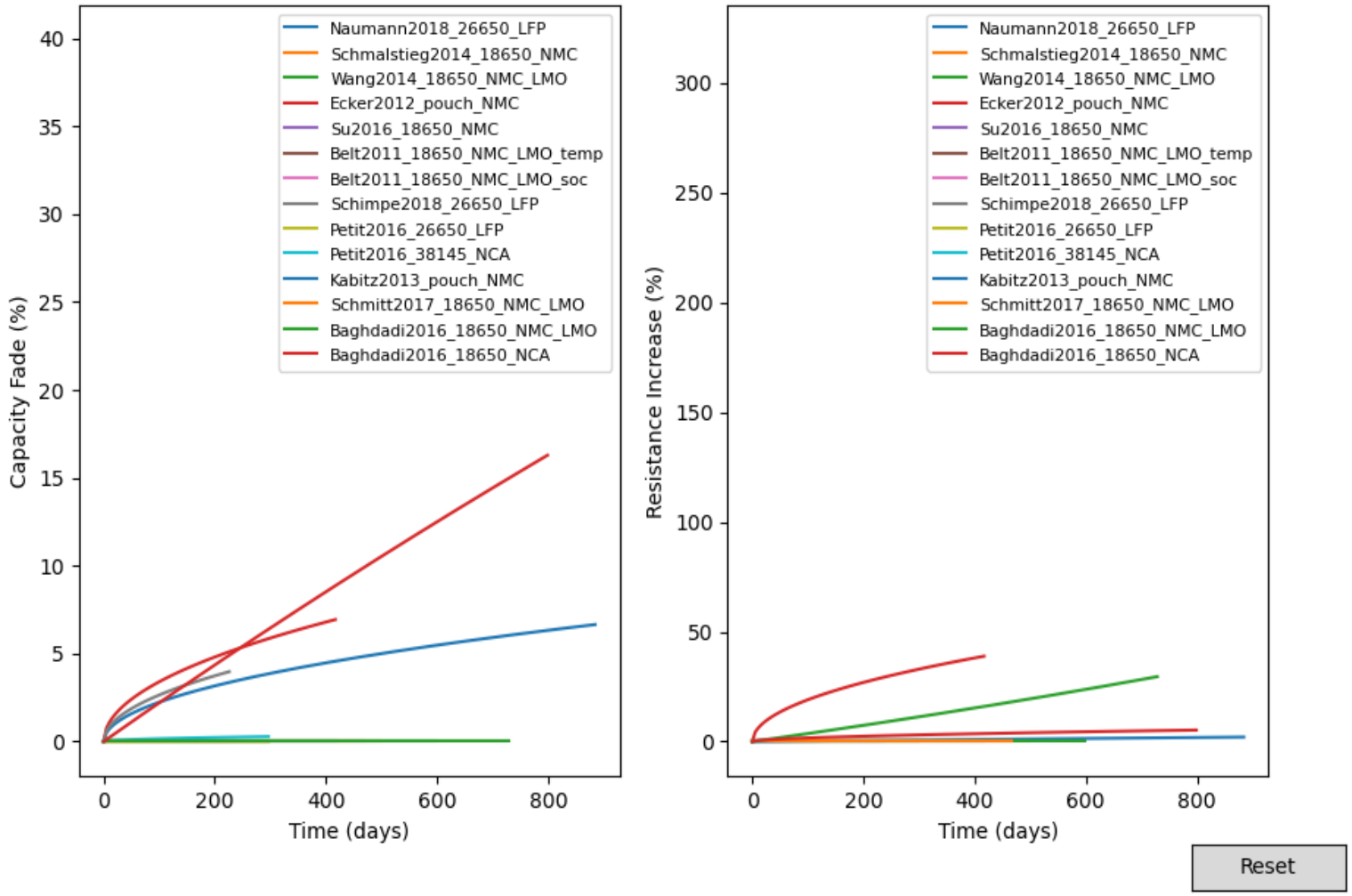
1. Rated capacity and capacity fade (in %)
2. Power (in W) and power fade (in %)
3. Internal resistance (in Ω) and internal resistance increase (in %)
4. Energy round trip efficiency and its fade (in %)
5. The expected life-time of the battery under the reference conditions for which it has been designed, in terms of cycles, except for non-cycle applications, and calendar years.

Electrochemical performance and durability requirements

Elements to explain the measurements

1. Applied discharge rate and charge rate
2. Ratio between nominal battery power (W) and battery energy (Wh)
3. Depth of discharge in the cycle-life test
4. Power capability at 80% and 20% state of charge
5. Any calculations performed with the measured parameters, if applicable

Calendar aging



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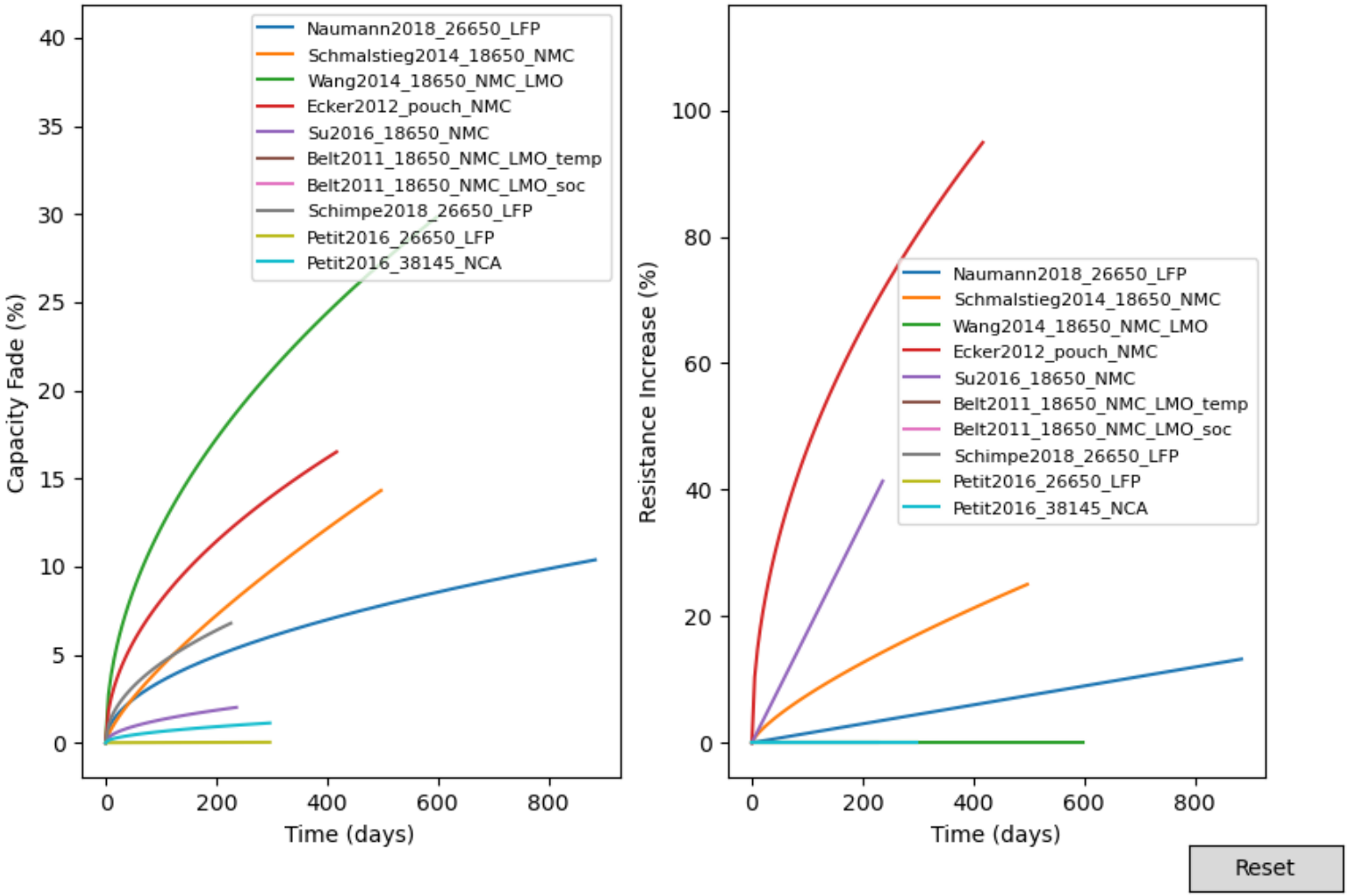
Calendar aging



Access to BMS data and estimation of State of Health

- The regulation tries to reconcile the interests of different market players facilitating new business models on distributed energy storage and battery second-life.

- From **mid-2024**, **read-only access to the data in the Battery Management System** (BMS) of EV, LMT and industrial (stationary BESS) batteries, shall be provided to legal or natural persons with a legitimate interest, for the following purposes:

a) **making the battery available to independent aggregators or market participants** through energy storage;

b) **evaluating the residual value or remaining lifetime** of the battery and **capability for further use**, based on the estimation of the state of health;

c) **facilitating the preparing for re-use, preparing for repurpose, repurposing or remanufacturing** of the battery.

Parameters for **state of health**:

- **For electric vehicle batteries:**

  state of certified energy (SOCE)

- **For stationary battery energy storage systems and LMT batteries:**

  1. the remaining capacity;
  2. where possible, the remaining power capability
  3. where possible, the remaining round trip efficiency
  4. the evolution of self-discharging rates
  5. where possible, the ohmic resistance

Parameters for **expected lifetime**

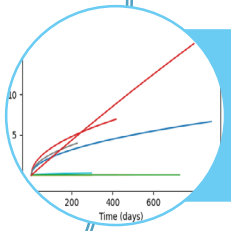
For stationary battery energy storage systems and LMT batteries:

1. the **date** of manufacture of the battery and**,** where appropriate, the date of putting into service;
1. the energy throughput;
2. the capacity throughput**;**
3. the **tracking of harmful events, such as the number of deep discharge events, time spent in extreme temperatures, time spent charging in extreme temperatures;**
4. the **number of full equivalent charge-discharge cycles.**

Outline

Joint Research Centre

Batteries Regulation



Performance

Safety

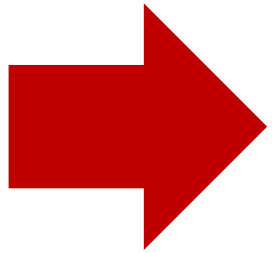
SAFETY

JRC activities on battery safety

Safety for **first use of batteries for EVs** covered by EVS-GTR 20 (enacted into EU law as type-approval internal market legislation)

Safety for **first use of batteries for stationary application**

Safety for **batteries for second-use**



Batteries Regulation

SAFETY

https://unece.org/fileadmin/DAM/trans/main/wp29/wp29wgs/wp29gen/wp29registry/ECE-TRANS-180a20e.pdf

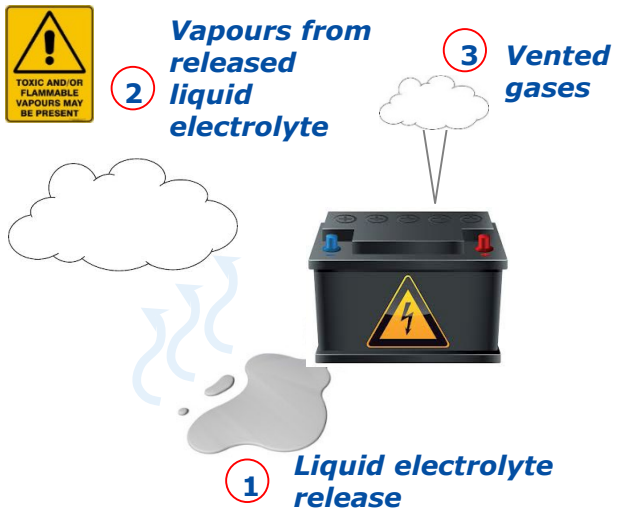
Experimental activities on battery safety

Thermal runaway & propagation

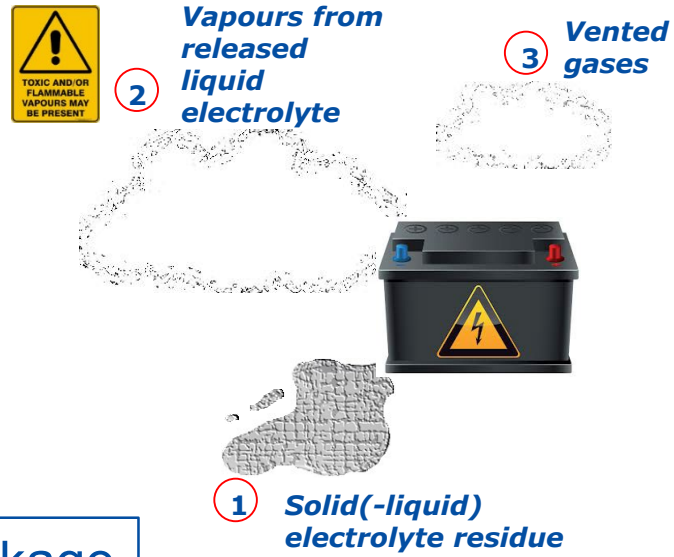
Failure scenario

Thermal runaway

Thermal propagation



time

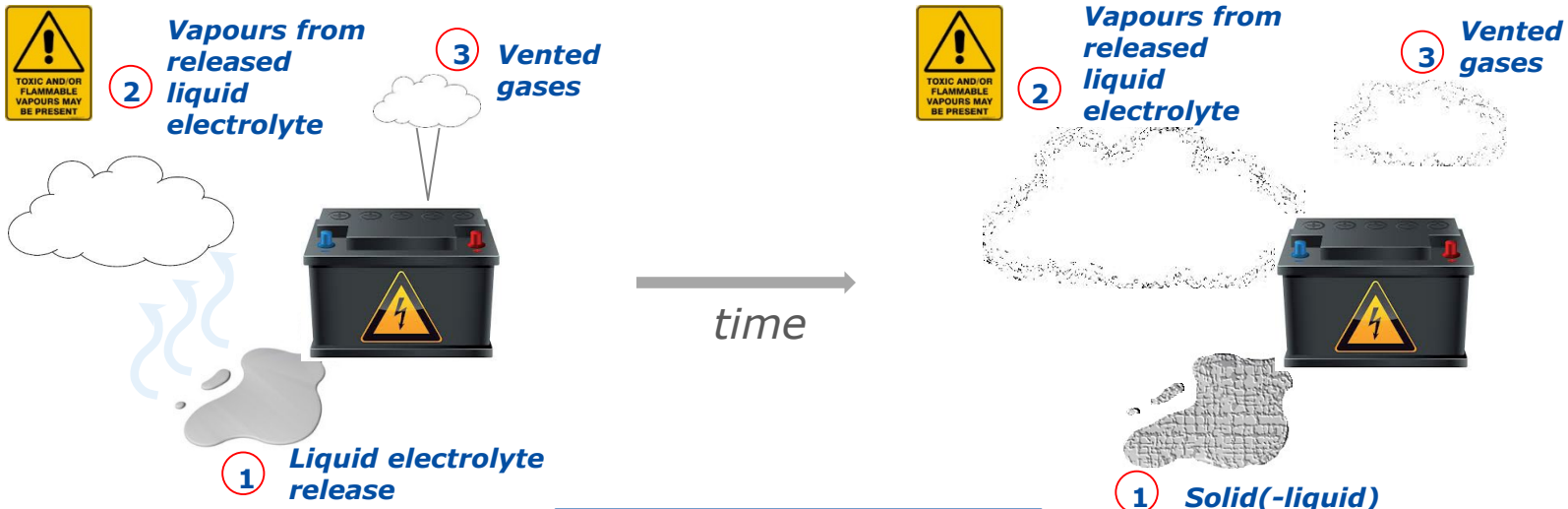


Electrolyte leakage

European Commission

Experimental activities on battery safety

S. Hildebrand et al, Comparative overview of methods for the detection of airborne electrolyte components released from lithium-ion batteries, Energy Technology, accepted 08/10/2023



Electrolyte leakage

European Commission

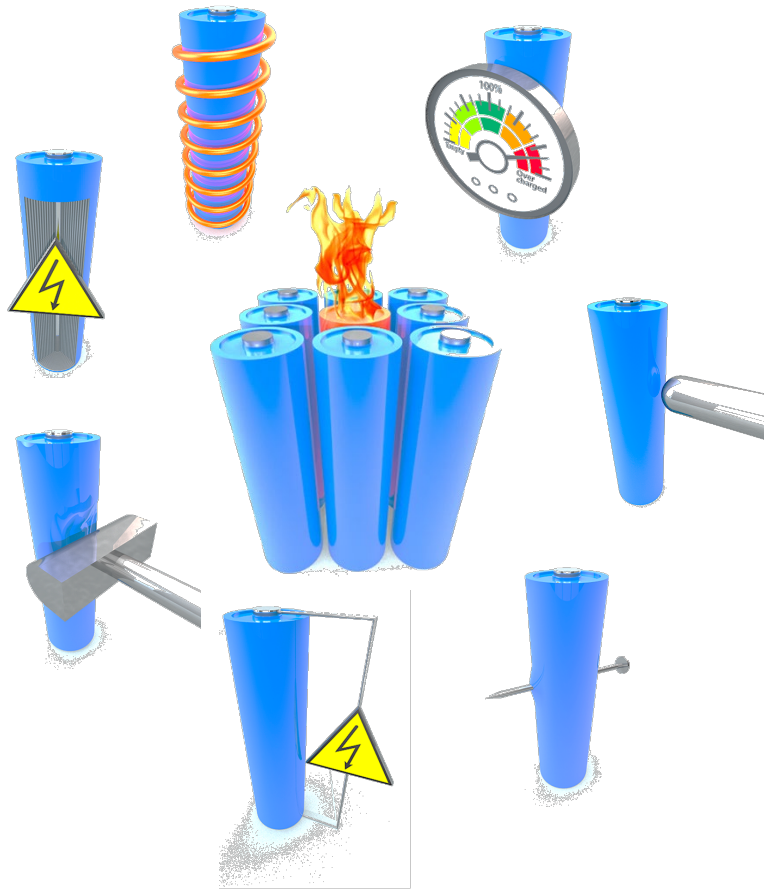
Safety requirements for stationary battery energy storage system

- Batteries in scope: Industrial batteries with internal storage

  (not in scope: with external storage/redox flow)
- Chemistry agnostic
- 12 months after entry in force (mid 2024): provide technical documentation
  - to demonstrate safety in normal operation/use
  - to demonstrate successful test for safety parameters in Annex V
  - Including assessment of possible safety hazards not addressed in Annex V and evidence that such hazards have been mitigated & tested, including mitigation instructions
- Delegated acts to amend safety parameters according technical scientific progress possible (no fixed timing)

Safety requirements for Stationary battery energy storage system

- Safety specifications (Annex V):
  - thermal shock and cycling
  - external short circuit protection
  - overcharge protection
  - over-discharge protection
  - over-temperature protection
  - thermal propagation protection
  - mechanical damage by external forces
  - internal short circuit
  - thermal abuse
  - fire test
  - emission of gases



Standardisation Request to CEN/CENELEC

https://ec.europa.eu/growth/tools-databases/enorm/mandate/579_en

Type	standardisation
Mandate number	579
Consultation date	2021-09-24
New approach ?	No

Title

M/579 COMMISSION IMPLEMENTING DECISION C(2021)8614 of 7.12.2021on a standardisation request to the European standardisation organisations as regards performance, safety and sustainability requirements for batteries

Object

Development of European standards and European standardisation deliverables as regards performance, safety and sustainability requirements for batteries

Text

See attached document

Annex

None

Attachment

Eso

CEN
CENELEC

Policy areas

Consumer protection
Environment

Subjects

None

European Commission

Harmonized standards

- CEN/CENELEC develop harmonized standards to support the regulation
- Standardization request M/579 (under revision)
- Adoption of standards by 7 December 2025 (tbc)
  - CEN/TC 301/WG 18: EV batteries
  - CLC/TC 21X/SR 35: primary batteries (→ IEC/TC 35/MT 14)
  - CLC/TC 21X/WG 5: LMT batteries
  - CLC/TC 21X/WG 6: Stationary storage applications
  - CLC/TC 21X/WG 7: EV cells
  - CLC/TC 21X/WG 8: Portable secondary batteries
  - CLC/TC 21X/ad hoc group: cross-cutting topics

Digital Battery Passport

- Applicable to: EV, LMT and industrial **(>2 kWh)** batteries,
- From 2027
- **Decentralized architecture** relying on protocols developed through standardization; joint with the **digital product passport architecture** proposed in the **Ecodesign regulation**
- Standardisation Request for digital product passports in preparation

Articles 77, 78, Annex VIII

Digital Battery Passport

- **The Commission will further detail access rights** to certain information of the passport (by middle of 2026, implementing acts)

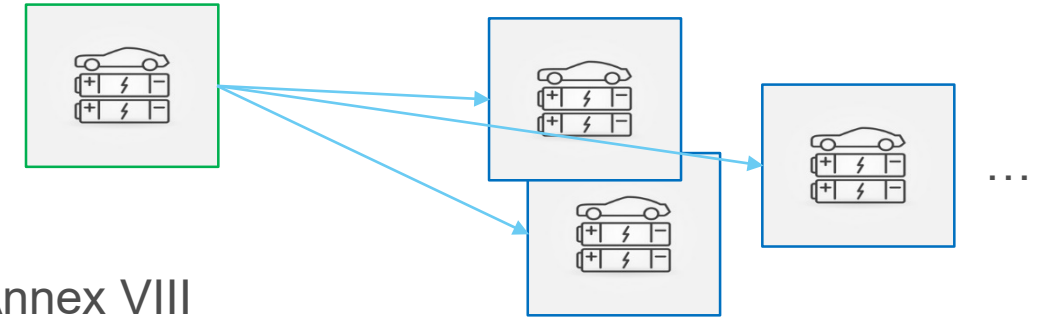
Information specific to each battery model

Information in Annex XIII Part A point 1

+

Information specific to each physical battery

(a) information about the values for performance and durability parameters referred to in Article 10(1), when the battery is placed on the market and when it is subject to changes in its status;
(b) information on the status of the battery, defined 'original', 'repurposed', 'reused', 'remanufactured' or 'waste';
(c) information and data as a result of its use, including the number of charging and discharging cycles and negative events, such as accidents, as well as periodically recorded information on the operating environmental conditions, including temperature, and on the state of charge;
(d) information on the state of health of the battery pursuant to Article 14



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Articles 77, 78, Annex VIII

Summary and Outlook

- New Batteries Regulation brings challenges and opportunities
  - Minimum sustainability level to be ensured
  - Safety of stationary systems to be ensured
- Intensive standardisation work requires industry contribution
- JRC will support transition to sustainable batteries

Selected references

M. Bielewski, D. Blagoeva, M. Cordella, F. Di Persio, P. Gaudillat, S. Hildebrand, L. Mancini, F. Mathieux, P. Moretto, E. Paffumi, D. Paraskevas, V. Ruiz, J. Sanfélix, A. Villanueva, L. Zampori, Analysis of sustainability criteria for lithium-ion batteries including related standards and regulations, EUR 30597 EN, Publications Office of the European Union, Luxembourg, 2021

S. Gonella, M. Bruchhausen, V. Ruiz Ruiz, Available Data and Initial Analysis on Performance and Durability for Portable Batteries of General Use - Preliminary Scenarios for Minimum Requirements, EUR 31231 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-57199-5

V. Ruiz, F. Di Persio, Standards for the performance and durability assessment of electric vehicle batteries, JRC Technical Report, no. EUR 29371 EN. Publications Office of the European Union, Luxembourg, 2018

F. Di Persio, J. Huisman, S. Bobba, P. Alves Dias, G. A. Blengini, D. Blagoeva, Information gap analysis for decision maker to move EU towards a Circular Economy for the lithium-ion battery value chain, no. EUR 30315 EN. Publications Office of the European Union, Luxembourg, 2020

OPEN ACCESS

M.A. Cusenza, S. Bobba, F. Ardente, M. Cellura, F. Di Persio, Energy and environmental assessment of a traction lithium-ion battery pack for plug-in hybrid electric vehicles, Journal of Cleaner Production 215 (2019), 634-649

OPEN ACCESS

V. Ruiz, A. Pfrang, A. Kriston, N. Omar, P. Van den Bossche, L. Boon-Brett, Review of abuse standards and regulations for Li-ion batteries in Electric and Hybrid vehicles, Renewable & Sustainable Energy Reviews 81 (2018), 1427–1452.

OPEN ACCESS

N. Meddings, M. Heinrich, F. Overney, J.-S. Leed, V. Ruiz, E. Napolitano, S. Seitz, G. Hinds, R. Raccichini, M. Gaberšček, J. Park, Application of electrochemical impedance spectroscopy to commercial Li-ion cells: A review, Journal of Power Sources 480 (2020), 228742

OPEN ACCESS

A. Kriston, A. Podias, I. Adanouj, A. Pfrang, Analysis of the Effect of Thermal Runaway Initiation Conditions on the Severity of Thermal Runaway — Numerical Simulation and Machine Learning Study, Journal of The Electrochemical Society 167 (2020), 090555

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

Clean Energy Technology Observatory

Analysis of battery technology development

- Focus on EU
- 2023 report publication imminent
- Contact: Marek Bielewski

https://setis.ec.europa.eu/batteries-energy-storage-european-union_en

Open access to JRC Research Infrastructures

Based on the **European Charter for Access to Research Infrastructures of DG RTD**

Principles and guidelines when defining access policies for Research Infrastructures

ACCESS MODE

- Relevance-driven
- Market-driven

OPEN MODE

- EU Member States
- Countries associated to the EU Research Programme Horizon 2020

We are the Joint Research Centre

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Thank you!

https://visitors-centre.jrc.ec.europa.eu/en/media/virtualtours/take-virtual-tour-battery-testing-facilities-laboratory

https://www.youtube.com/watch?v=6u2Gjiudcas

Discussion

1. What do you see as the main challenge in implementing this EU legislation on battery passport?

2. Is there a part of the legislation where there is unclarity, and if so what?

3. Is there (a lot of) information requested to become public while it is under NDA at the moment?