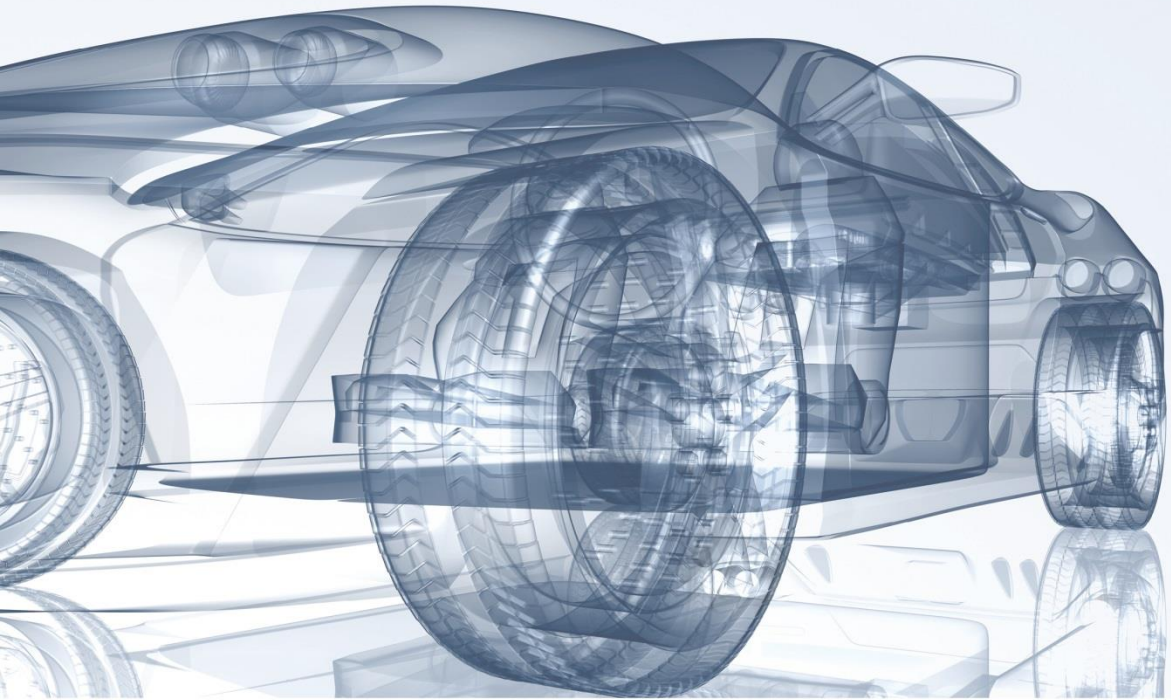
evs 30



The 30th International
Electric Vehicle
Symposium & Exhibition

October 9–11, 2017

Messe Stuttgart, Germany

www.evs30.org

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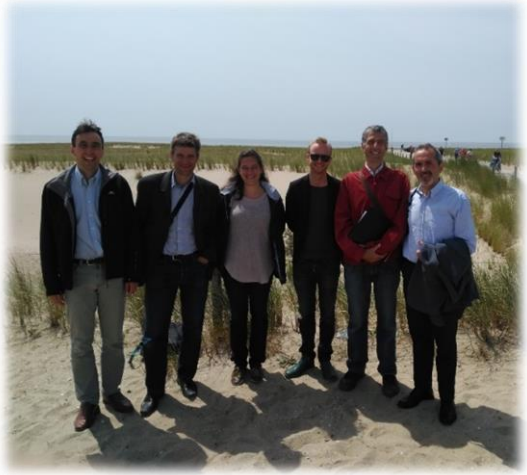
Sustainability Assessment of Second Use Application of Automotive Batteries:
Ageing of Li-Ion Battery Cells in Automotive and Grid-scale Applications



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Vrije Universiteit Brussels, Faculty of Engineering, Brussels, Belgium

Outline

- European Commission's Joint Research Centre
- Battery testing activities at JRC
  - Facilities
- Sustainability Assessment of Second Use Application of Automotive Batteries
  - Experimental results
  - Environmental assessment
- Other battery-related activities
- Conclusions

The Joint Research Centre at a glance

3000 staff

Almost 75% are scientists and researchers.
Headquarters in Brussels and research facilities located in 5 Member States.

Petten, Netherlands

Seville, Spain

Ispra, Italy

JRC mission

As the European Commission's science and knowledge service, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

⇒ Independent of national or commercial interests…. for the European citizen

Dedicated battery testing facilities

1. Battery cell/material performance testing
2. Battery pack performance testing 

3. Battery cell safety testing 

Battery cell/material performance testing

- Cyclers (3 with 96 channels)
- 3 potentiostats
- 2 environmental chambers
- 12 temperature chambers
- IR camera thermal imaging
- 3 glove boxes
- STA with FTIR&GC/MS analysis
- 2 Accelerated rate calorimeters

For more info about the laboratory see poster tomorrow: Battery Safety Testing Methods Assessed from a Policy-Making Perspective…

Outline

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SASLAB exploratory research project

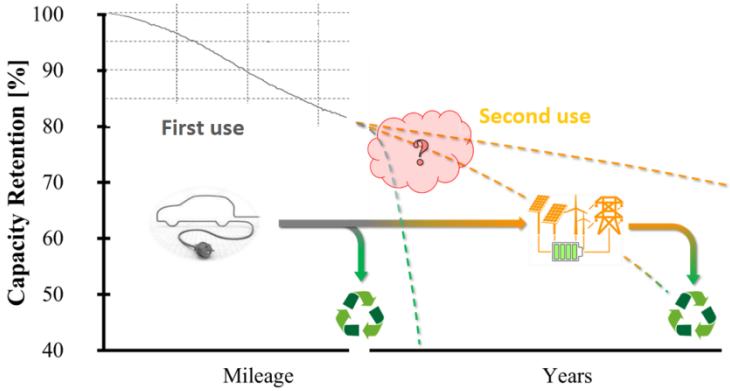
Petten, Netherlands

Sustainability Assessment of Second Use Application of Automotive Batteries

2016-2017, 24 person months

Ispra, Italy

Battery Testing



Environmental Assessment

Outline

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SASLAB battery testing

LMO-NMC /graphite automotive cells (38 Ah), fresh and from EV after 136.000 km

Cell opening
Material breakdown

Input to Environmental Assessment

First use

Second use

Calendar Ageing

WLTC

CC-CV / CC

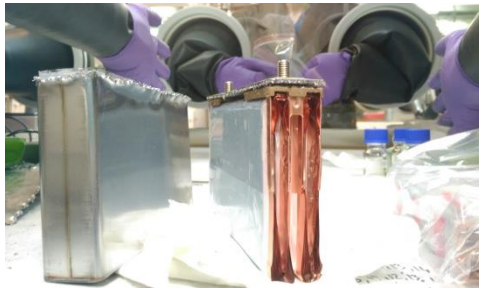
PV firming
PV smoothing
primary frequency regulation
peak shaving

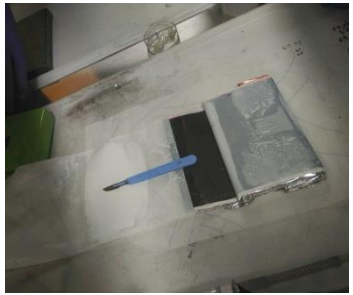
Application-dependent lifetime
Efficiency
Remaining capacity

Material breakdown as input for LCA

Components of a fresh LMO-NMC/graphite cell after opening

Cell #394 (total weight before opening: 1396.2 g)	% in weight	Accuracy / g
Steel: external case, connectors	21.47%	+/- 2
Al: current collectors, electrode foils	3.74%	+/- 2
Cu: current collectors, electrode foils	10.03%	+/- 6
Polymer: wrapping, tapes, separator	5.99%	+/- 2
Anode active material: graphite	10.17%	+/- 12
Binder	2.68%	+/- 6
Cathode active material: LMO-NMC	27.47%	+/- 20
Carbon black in the cathode	3.38%	+/- 32
Electrolyte	13.75%	+/- 20
Uncounted materials lost in cutting/drilling/handling (steel, polymer, Cu, Al, active materials)	1.32%	+/- 5



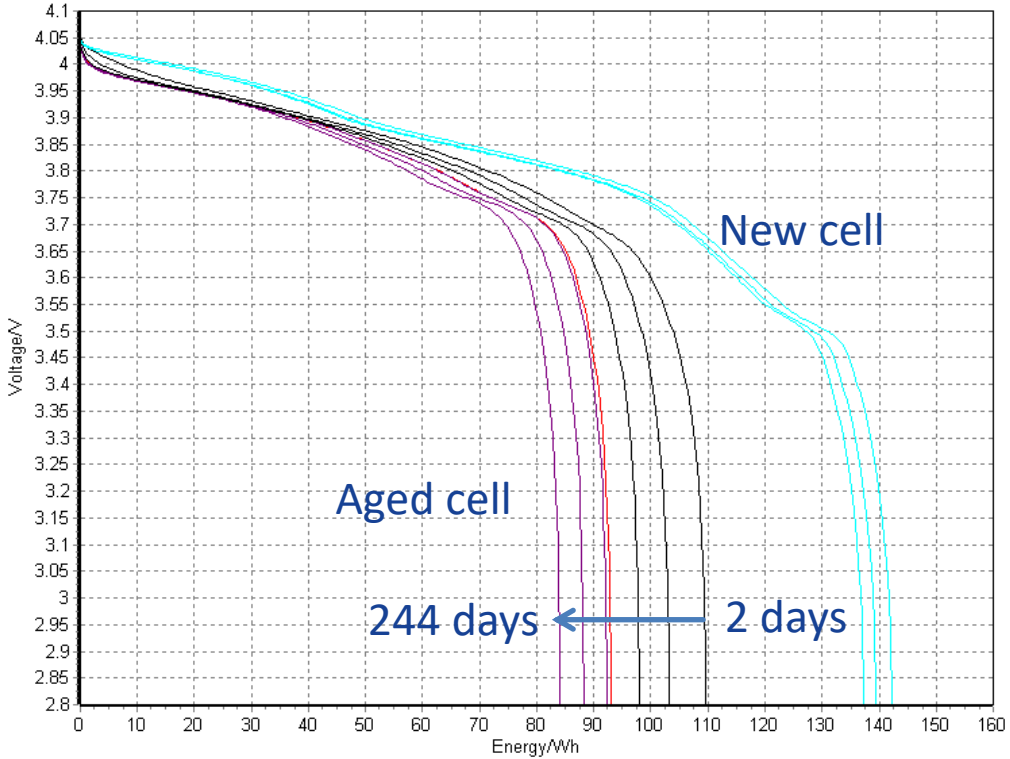


Experimental campaign

(A) Calendar ageing			(B) Automotive use cycle ageing		
Temperature [°C]	SoC	Cell (fresh or aged in EV)	Temperature [°C]	Cycling profile Charge / Discharge	Cell (fresh or aged in EV)
45	100	Aged	45	CC-CV / CC	Fresh
	50	Fresh		CC-CV / CC	
	50	Aged		WLTC	
	50	Aged			
	50	Fresh			ged
	100			WLTC	Aged
25		Aged	25	CC-CV / CC	Fresh
	100	Fresh		WLTC	Fresh
	50	Fresh		WLTC	Fresh
	100	Aged		CC-CV / CC	Aged
				CC-CV / CC	Aged
				WLTC	Aged

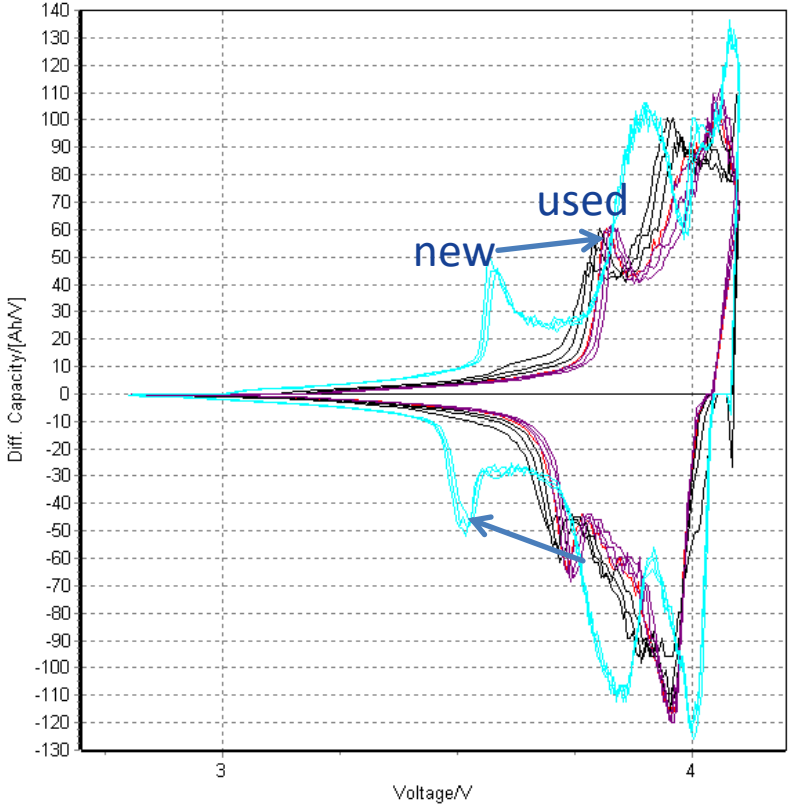
Tests ongoing

Calendar ageing



Temperature 45 ºC
100% SoC

Calendar ageing



Temperature 45 ºC
100% SoC

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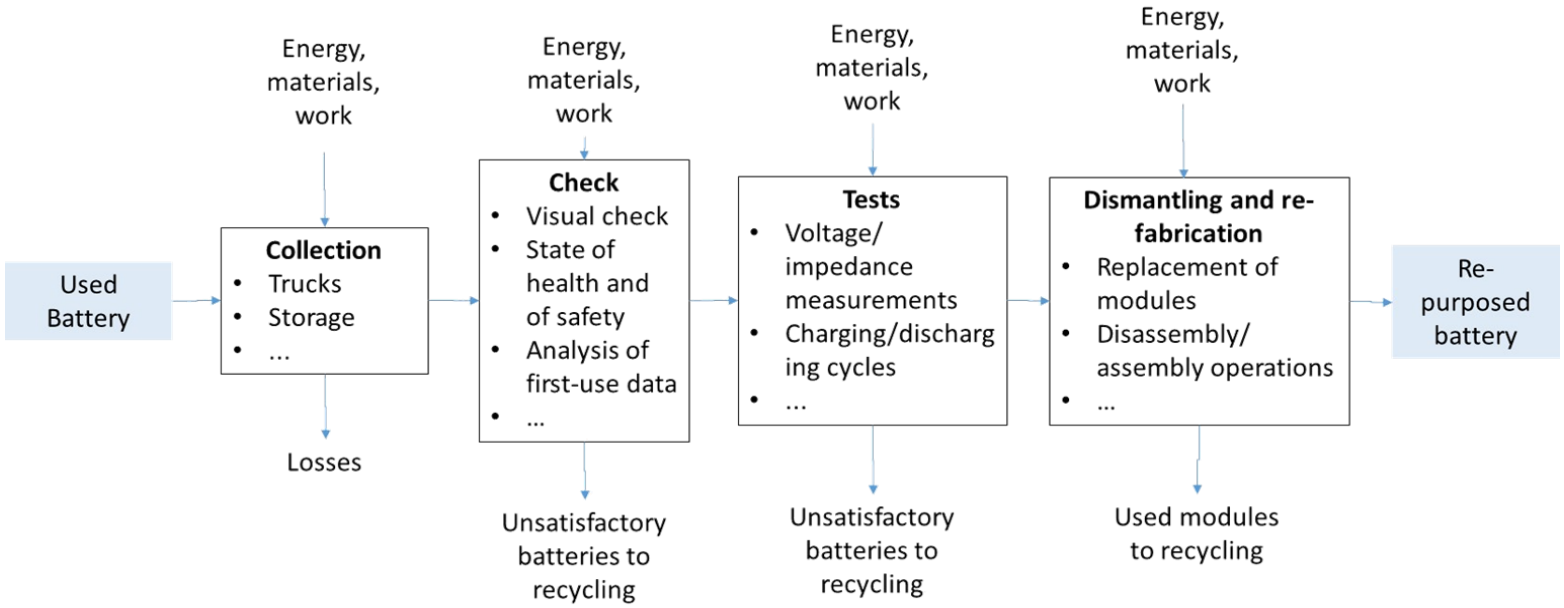
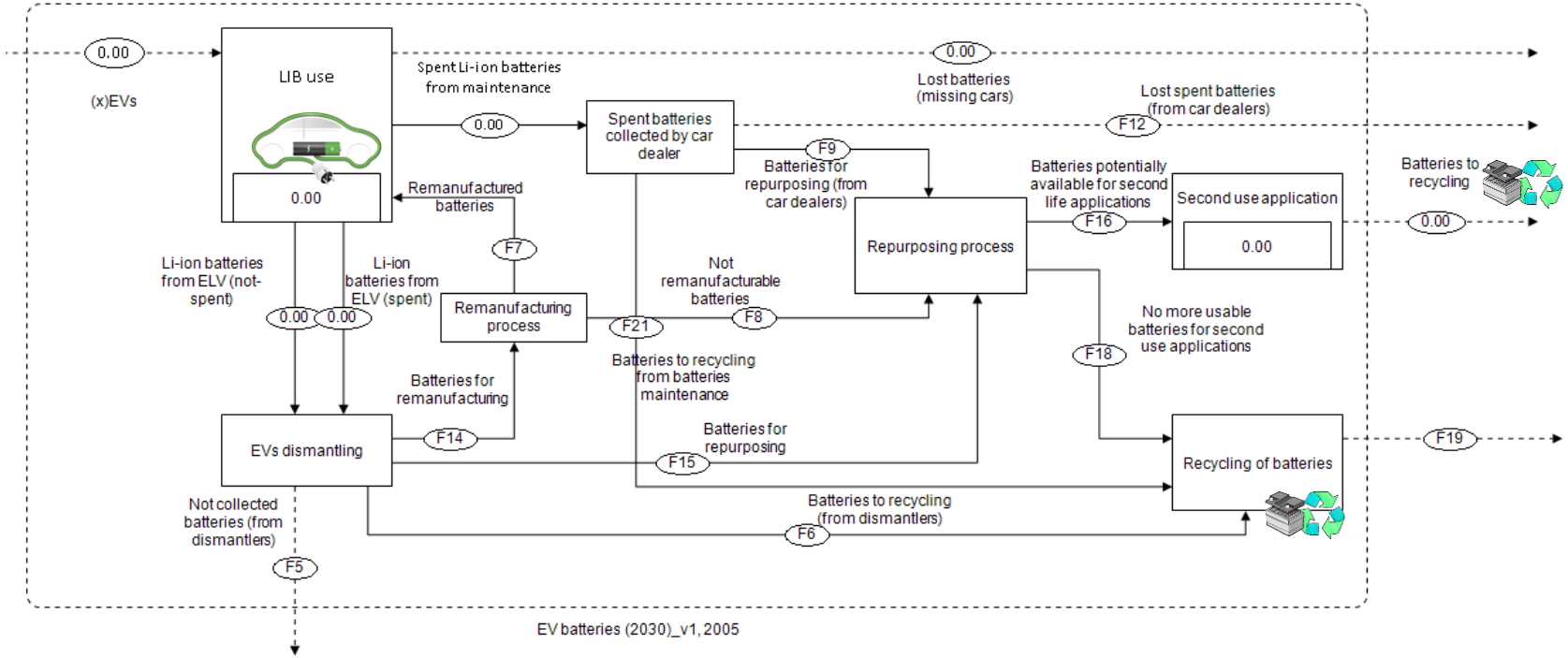
Battery value chain

Based on consultation with stakeholders (surveys)

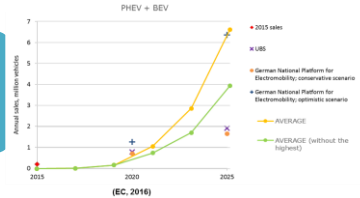


Battery flow analysis



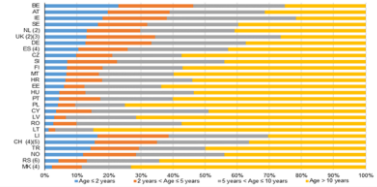
Quantification of battery flows in the system (waste batteries, recycled batteries, available batteries for repurposing…)

EV penetration rate and EV sales

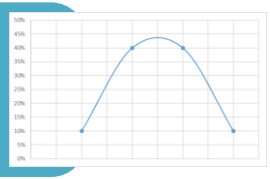


Collection rate of EV batteries

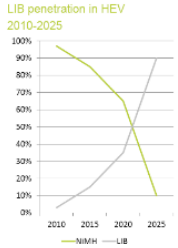
Average vehicles lifetime



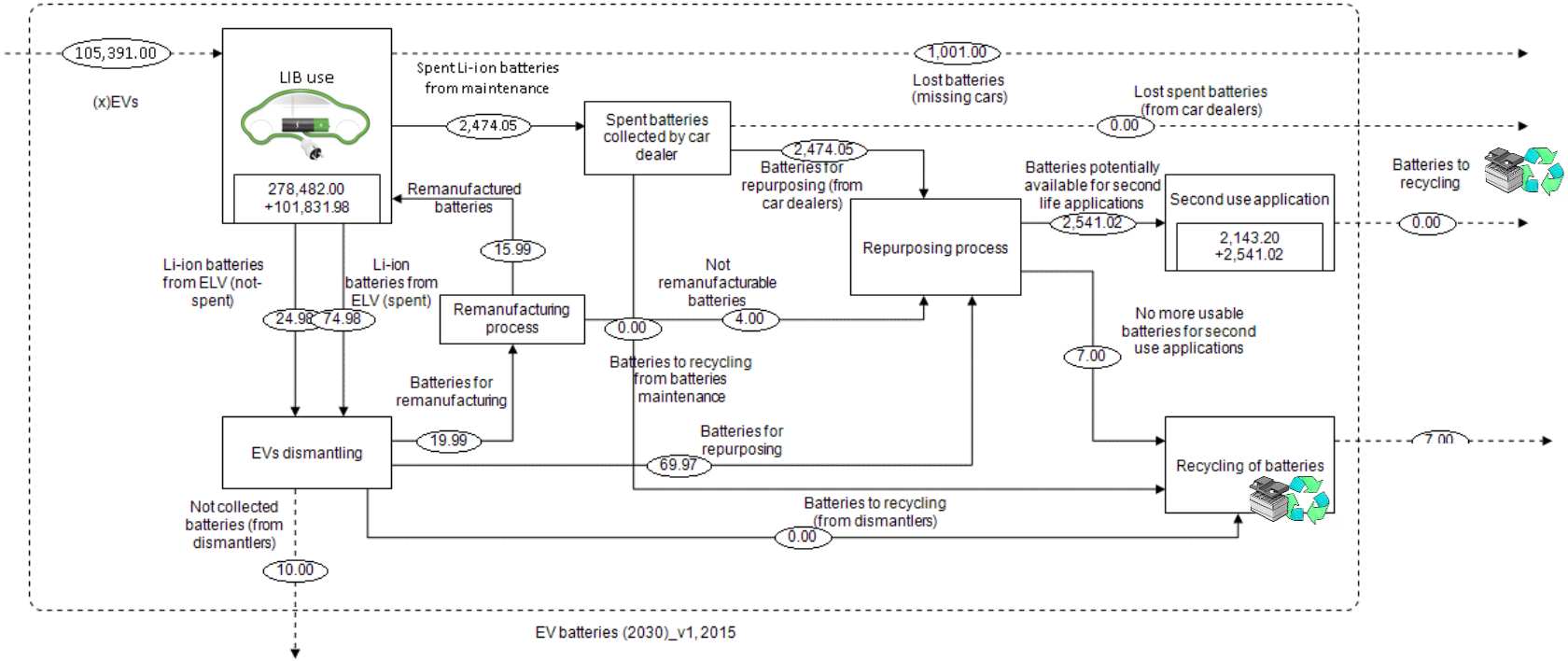
Average batteries lifetime



Li-ion batteries evolution



Battery flow analysis



Battery flow analysis

CURRENT scenario: no repurposing/remanufacturing of EVs batteries

DYNAMIC scenario: EVs batteries repurposing constantly increase from 0% to 50% from 2005 up to 2030

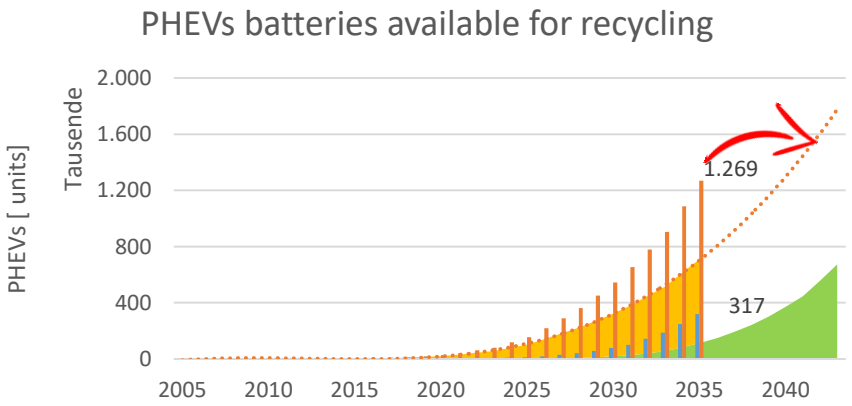
BEST scenario: 80% of the collected batteries are repurposed, 20% remanufactured

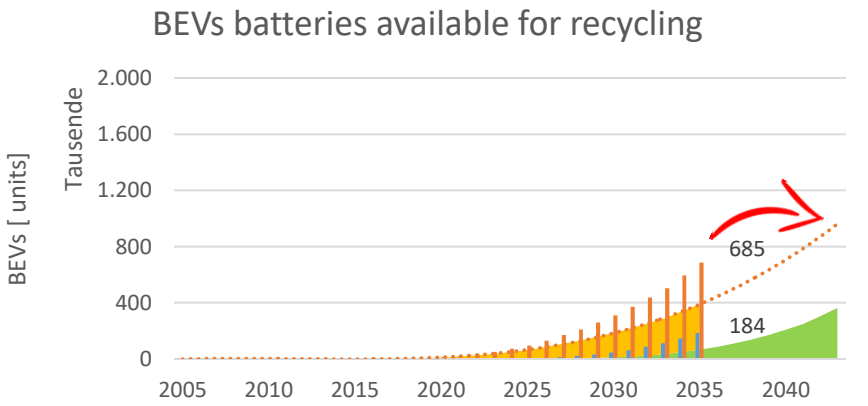
CURRENT scenario: batteries available for recycling after first use

DYNAMIC scenario: batteries available for recycling after first use

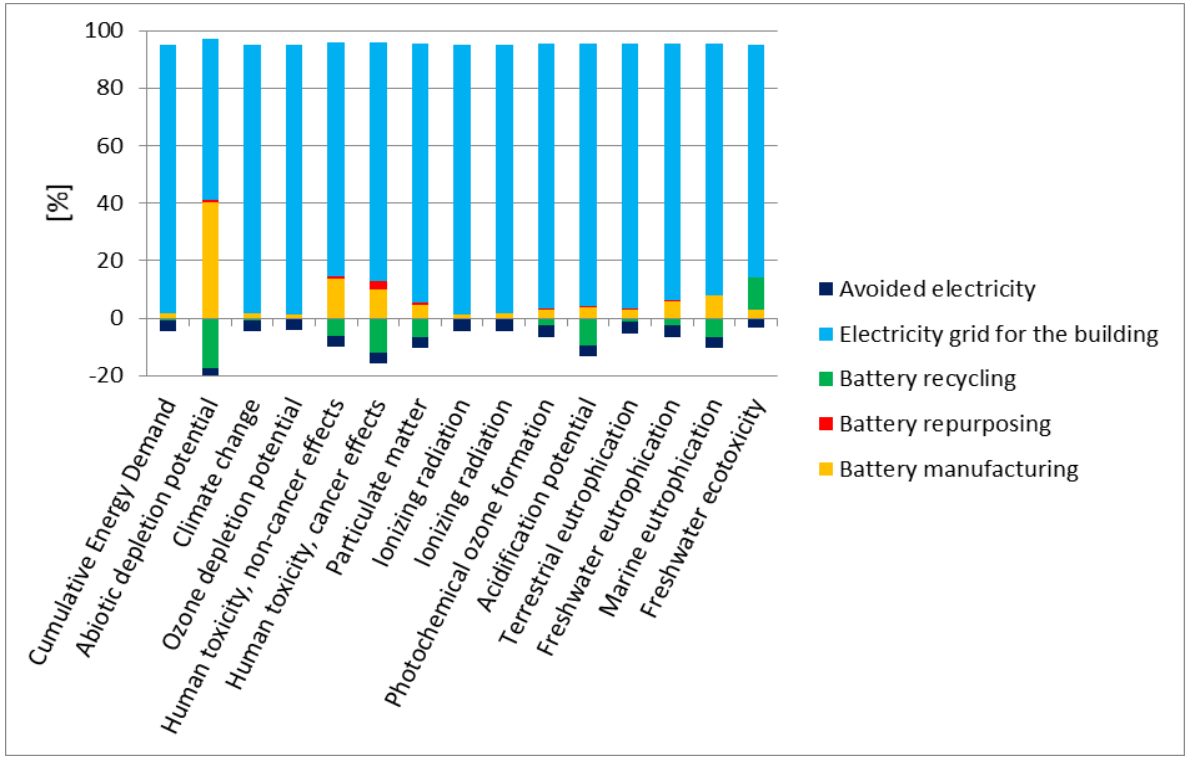
DYNAMIC scenario: batteries available for recycling after second use

BEST scenario: batteries available for recycling after first use





Life Cycle Impact Assessment



Example: peak shaving configuration

Contribution of the processes along the whole life-cycle (battery's manufacturing, use phase and EoL)

Selected other battery-related activities

Global Technical Regulation (GTR) on Electric Vehicle Safety

https://wiki.unece.org/pages/viewpage.action?pageId=3178628

SET plan Key action 7 'Become competitive in the global battery sector to drive e-mobility forward'

https://setis.ec.europa.eu/implementing-integrated-set-plan/batteries-e-mobility-and-stationary-storage-ongoing-work

PSIS workshop 'Driving Towards Decarbonisation of Transport: Safety, Performance, Second life and Recycling of Automotive Batteries for e-Vehicles'

https://ec.europa.eu/jrc/en/event/workshop/putting-science-standards-driving-towards-decarbonization-transport

Conclusions

- JRC battery testing activity
  - Facilities available (and being extended)
  - support informed policy-making

- Second use of automotive batteries: development of methodology
  - Dedicated experimental data (on-going)

  as input for
  - Environmental assessment (on-going)

Selected references

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Movie about battery testing at JRC https://www.youtube.com/watch?v=6u2Gjiudcas

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