CIRCULAR IMPACTS

Prospects for electric vehicle batteries in a circular economy

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Why electric vehicle batteries?

- **Critical Raw Materials (CRMs)** – high economic importance, subject to supply risk.
- **Scale of the challenge** – influx of EVs with no strategy for managing end-of-life batteries.
- **Important from a policy perspective** – EU Action plan for the Circular Economy, EU Battery Alliance, Battery Directive.

EV batteries and the circular economy

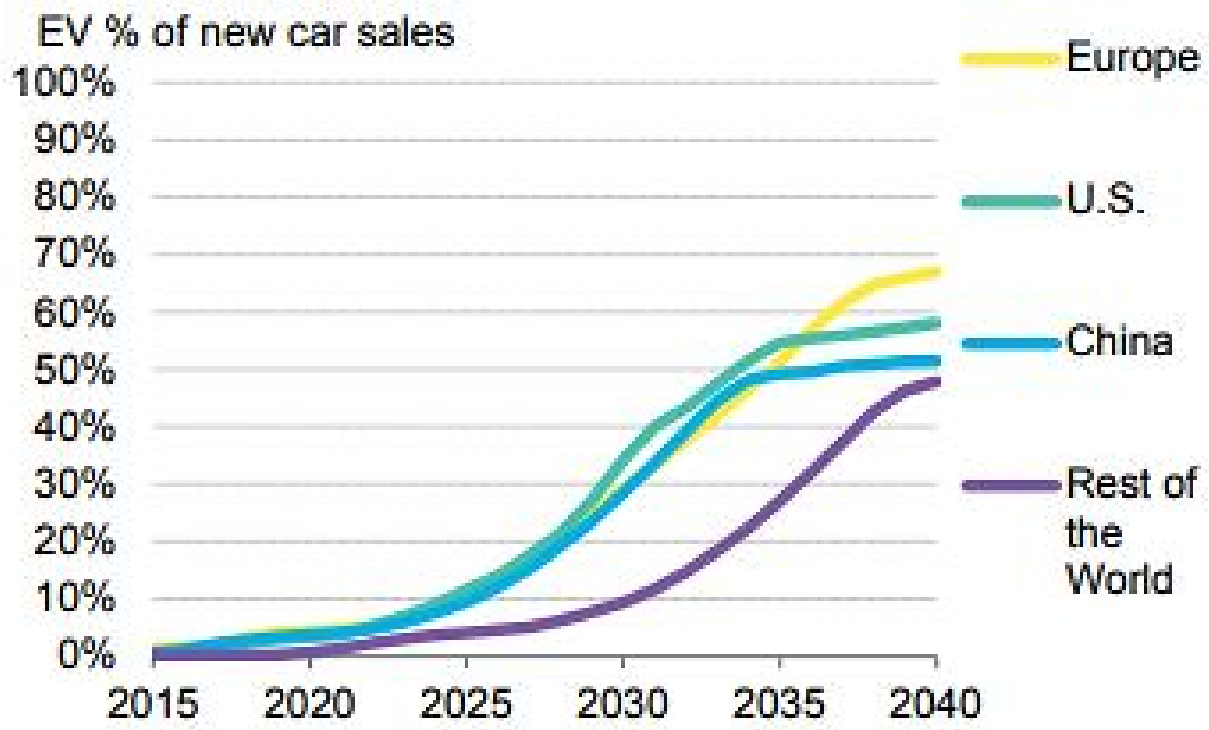
- Battery-powered EVs are among the **key technologies for decarbonising road transport**.
- **Lithium-ion batteries** are the most common type of batteries used in these vehicles.
- A key question is: ***What will happen to this large number of batteries when they reach their end of life?***
- Europe is currently **lacking a strong battery cell manufacturing base**.

Introduction to the case study

- This study aims to provide evidence about the impacts of managing the large number of lithium-ion batteries for EVs.
- There is a focus on the potential benefits for the EU economy.
- The analysis is based on the comparison of two different hypothetical scenarios.
- Information collected through a literature review and interviews with experts.

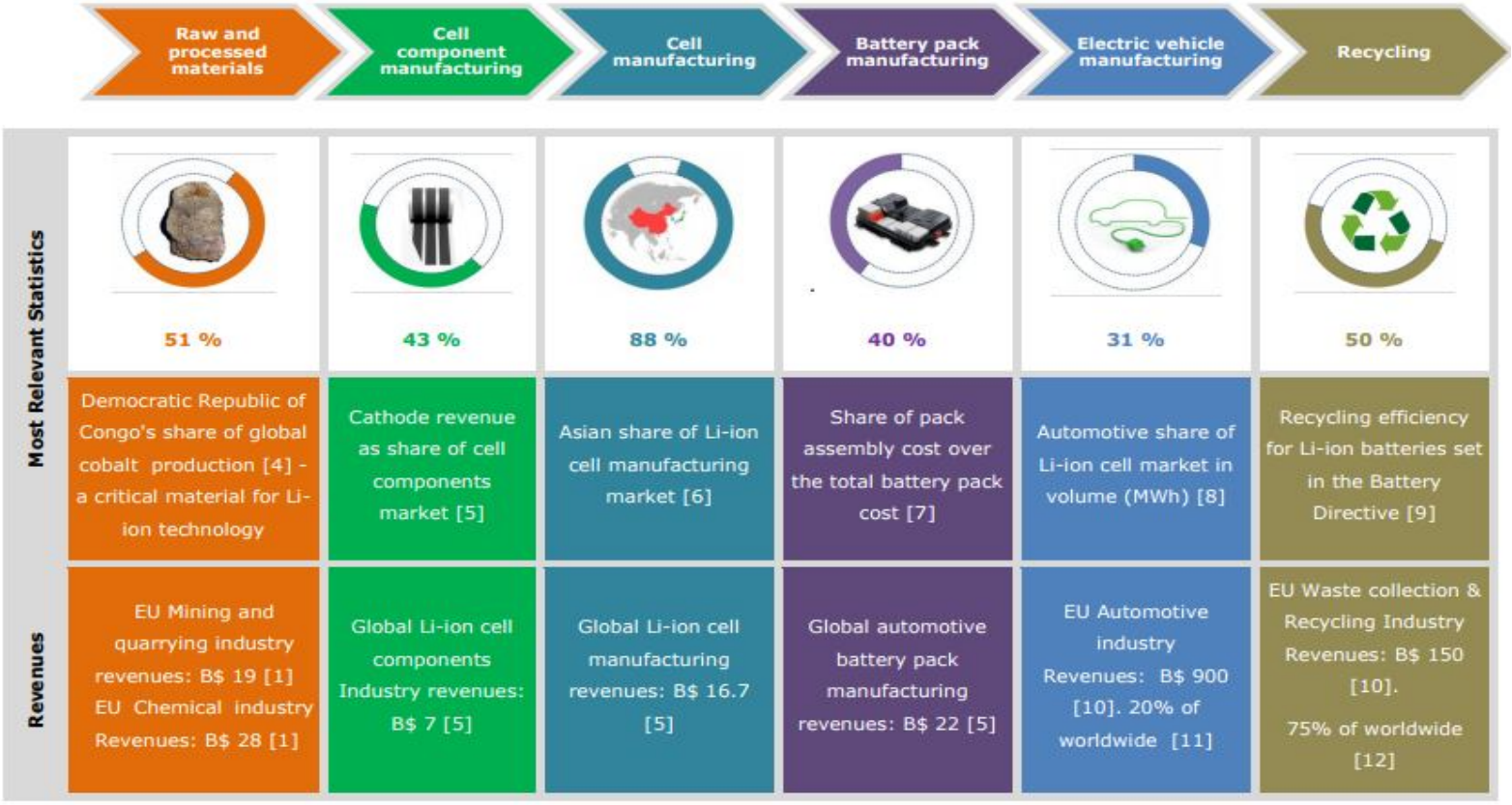
Trend: Long-term predicted diffusion of EVs

Long-term predicted diffusion of EVs by region



Source: Bloomberg New Energy Finance

Automotive lithium-ion battery value chain



Source: JRC, 2017

Scenario development

Methodology and assumptions

- A **quantitative analysis** was performed.
- Investigated using **two ex-ante scenarios**.
- **Assumptions** were made on:
  - The quantity of EV batteries at their end-of-life in 2030, 2035 & 2040:
    - 1,163 million (2030), 2,596 million (2035) and 5,380 million (2040).
  - Volume and price of raw materials in end-of-life batteries.
  - Jobs required for the collection, dismantling and recycling of EV batteries
  - Second-life rates
  - CO2 emissions in the recycling process compared with the extraction of raw materials

Scenario development

Building the scenarios

- **Collection/take back rates**: the share of end-of-life EV batteries that are collected for recycling in the EU. (SET-Plan Action No.7, 2016) – European Commission

- **Recycling efficiency rates**: the percentage of materials recovered from collected spent EV batteries. (Lebadeva et al., 2016) - JRC

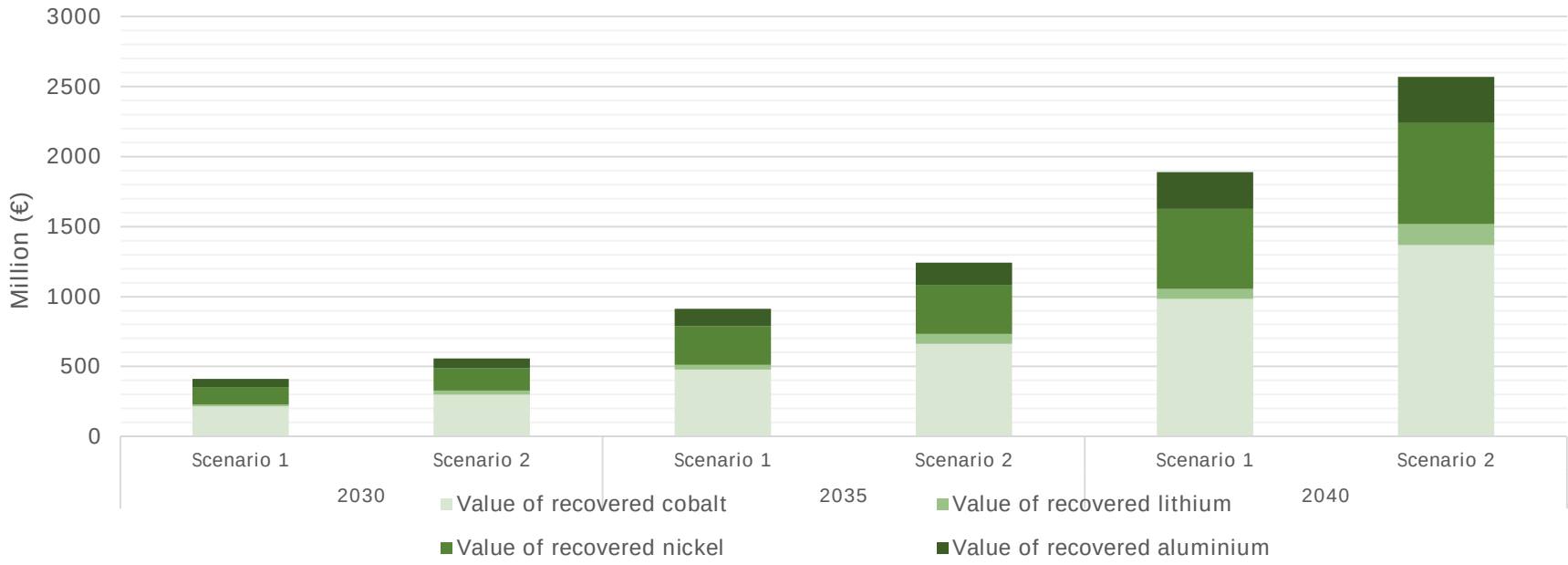
Scenario variables	Scenario 1	Scenario 2
Collection/take back rate for recycling within the EU	65%	85%
Cobalt recycling efficiency rate	94%	99%
Nickel recycling efficiency rate	95%	97%
Aluminium recycling efficiency rate	98%	98%
Lithium recycling efficiency rate	57%	94%

Impacts

Trade: amount and value of materials recovered

- In general, Scenario 2 recovers the **almost 40% more** value of raw materials than Scenario 1
- In the year 2040, Scenario 2 can generate in total **€2.6 billion euros** for the four materials included.

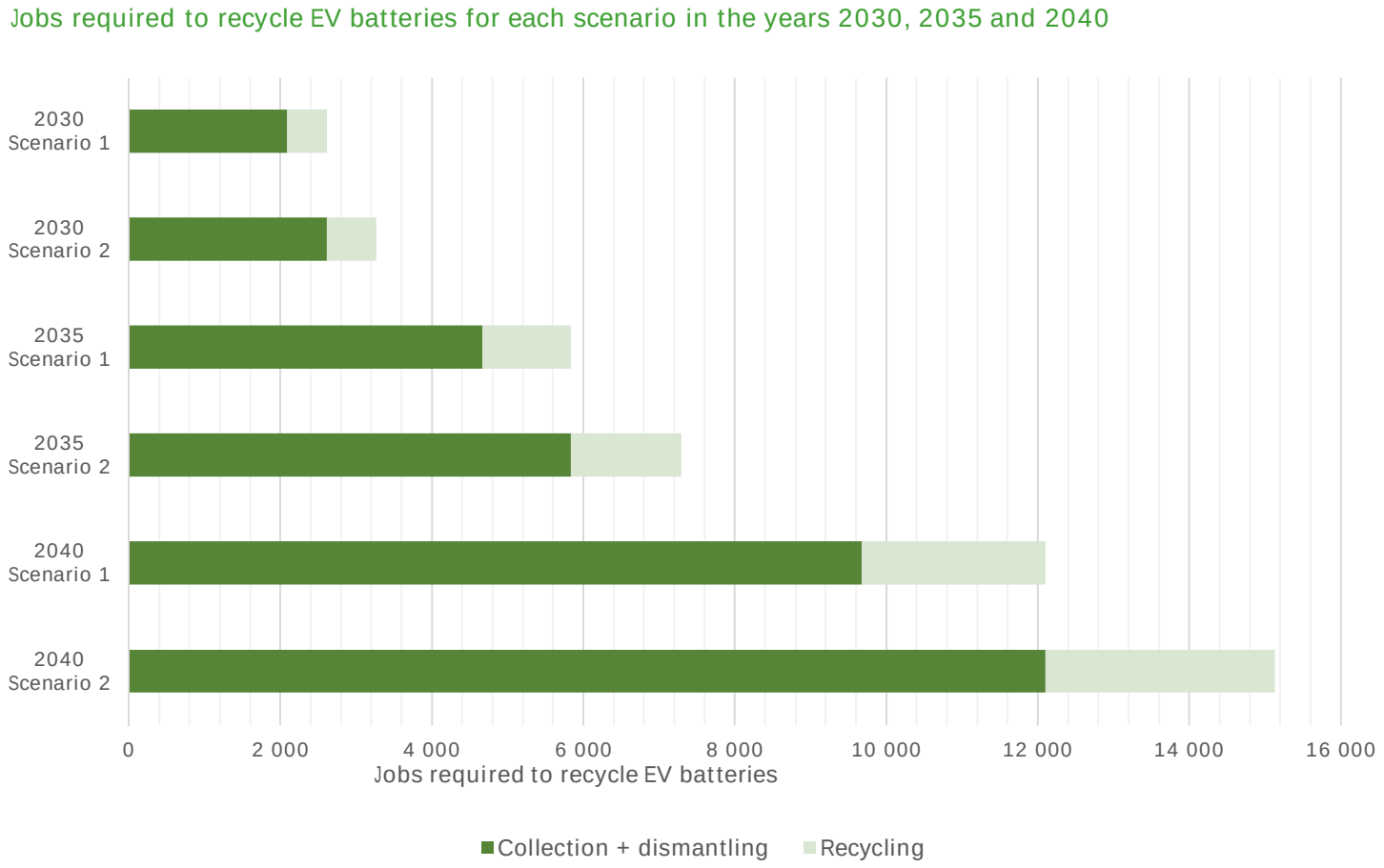
The value of materials recovered in each scenario for the years 2030, 2035 and 2040



Source: Authors' own calculation.

Impacts

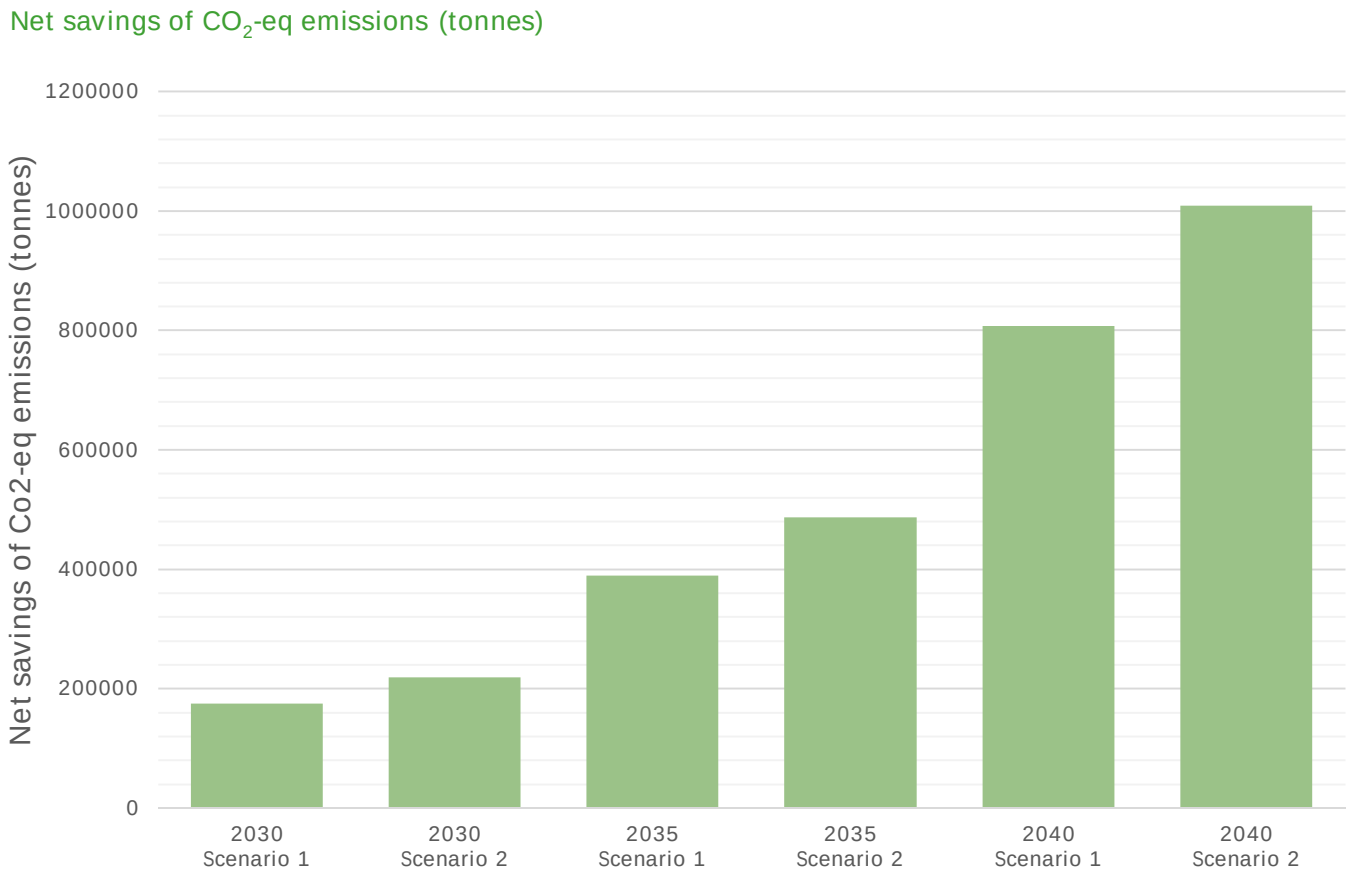
Employment



Source: Authors' own calculation.

Impacts

Environmental impacts



Source: Authors' own calculation and Romare & Dahllöf (2017).

Policies

- **The Battery Directive**: Although lithium-ion batteries are not specifically mentioned, the directive sets collection rates and recycling efficiency rates for EV batteries.

- **Extended Producer Responsibility schemes**: the Battery Directive 2006/66/EC introduces EPR as a policy approach for end-of-life batteries. Under Article 16, it states that member states shall ensure that producers, or third parties acting on their behalf, finance any net costs arising from the collection, treatment and recycling of all waste industrial and automotive batteries.

- **Rules for second-life**: these rules are not yet developed. It is a relatively new concept for EV battery manufacturers since not many have reached their end-of-first-life yet. In March 2018 the European Commission announced that it is tackling barriers to innovation by focusing on batteries for electric vehicles in its second 'Innovation Deal'.

- **Ecodesign**: encourages manufacturers to design products that minimise their impact on the environment throughout their entire life-cycle so that they are more environmentally friendly. This is a directive where the European Commission could set requirements on the durability, reparability and recyclability of EV batteries.

Conclusions

- Case study shows that achieving high rates of recycling of EV batteries in Europe can **mitigate dependence on imported materials** and help **retain the value of recovered materials** in the EU economy.
- There is also **potential for jobs** in the recycling sector as well as for **CO2 emissions savings.**
- Moving beyond 2030 the **estimated impacts become much more significant** as many more batteries will reach their end of life.
- Scale of benefits depends on the **level of ambition**: Scenario 2 provides more significant benefits compared to Scenario 1.
- Achieving these benefits will largely depend on whether the **EU recycling industry** will develop a capacity to manage these batteries, or whether they will be largely exported.
- **More research and evidence is needed** on the cost of recycling the different components of EV batteries and on the level of investments needed.