

Scenario Modelling of National Battery Material Flows: Availability and Recoverability of Secondary Raw Materials within EU27+4

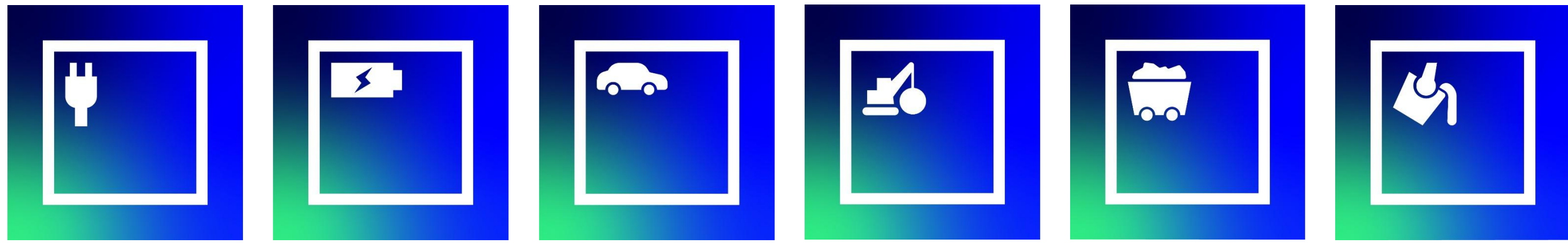


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Introduction

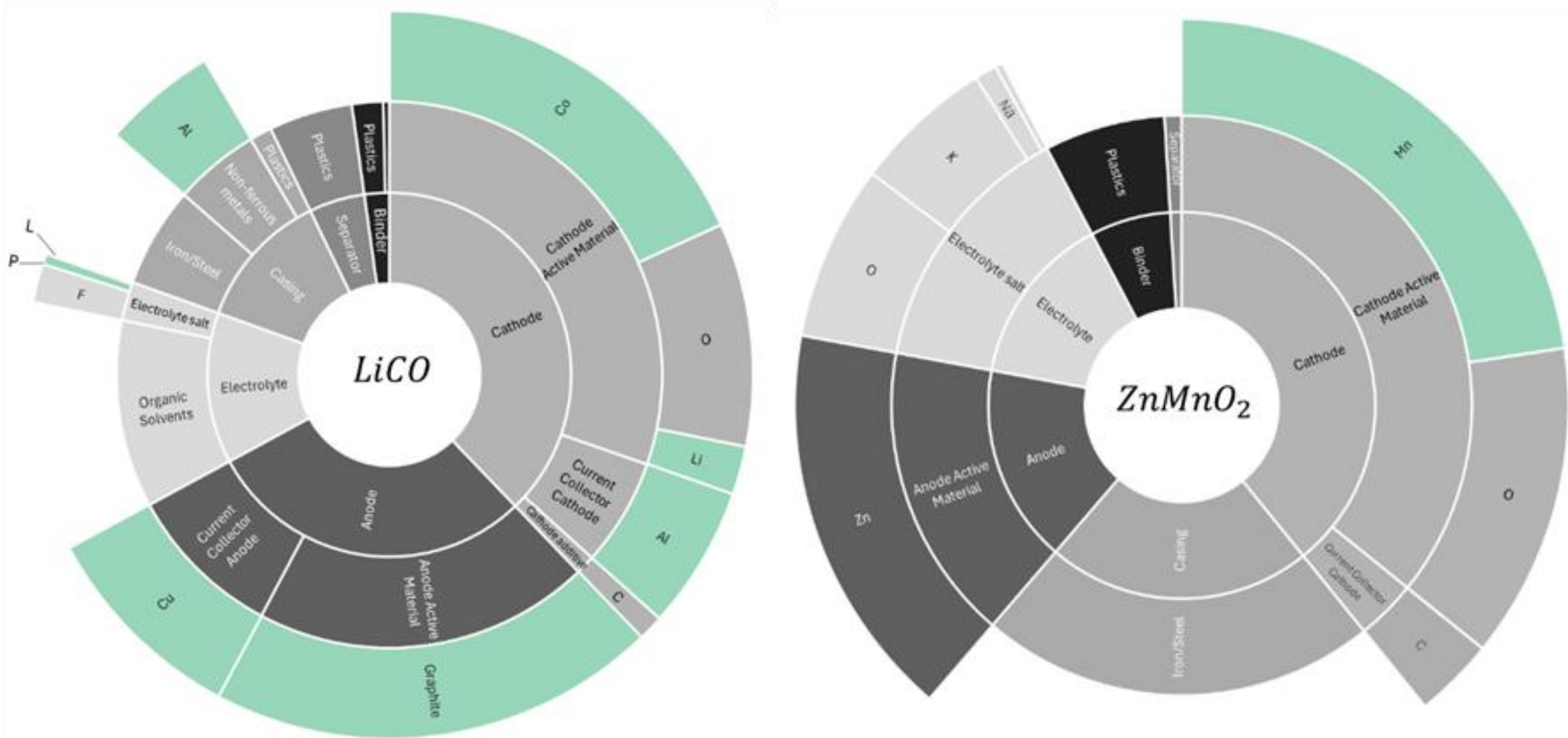
FutuRaM will develop a Secondary Raw Materials knowledge base (Urban Mine Platform) on the availability and recoverability of secondary raw materials within the EU (incl. Norway, Switzerland, UK and Iceland), with a special focus on critical raw materials in six different waste streams:



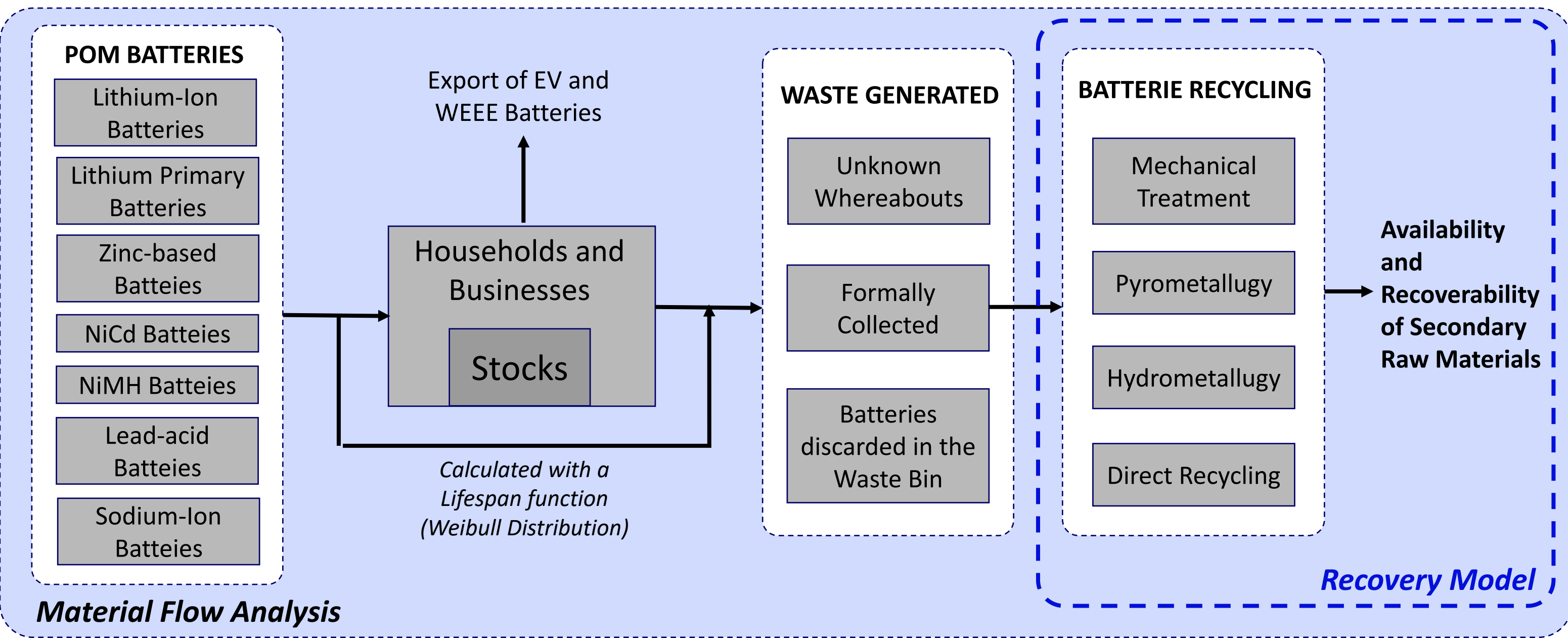
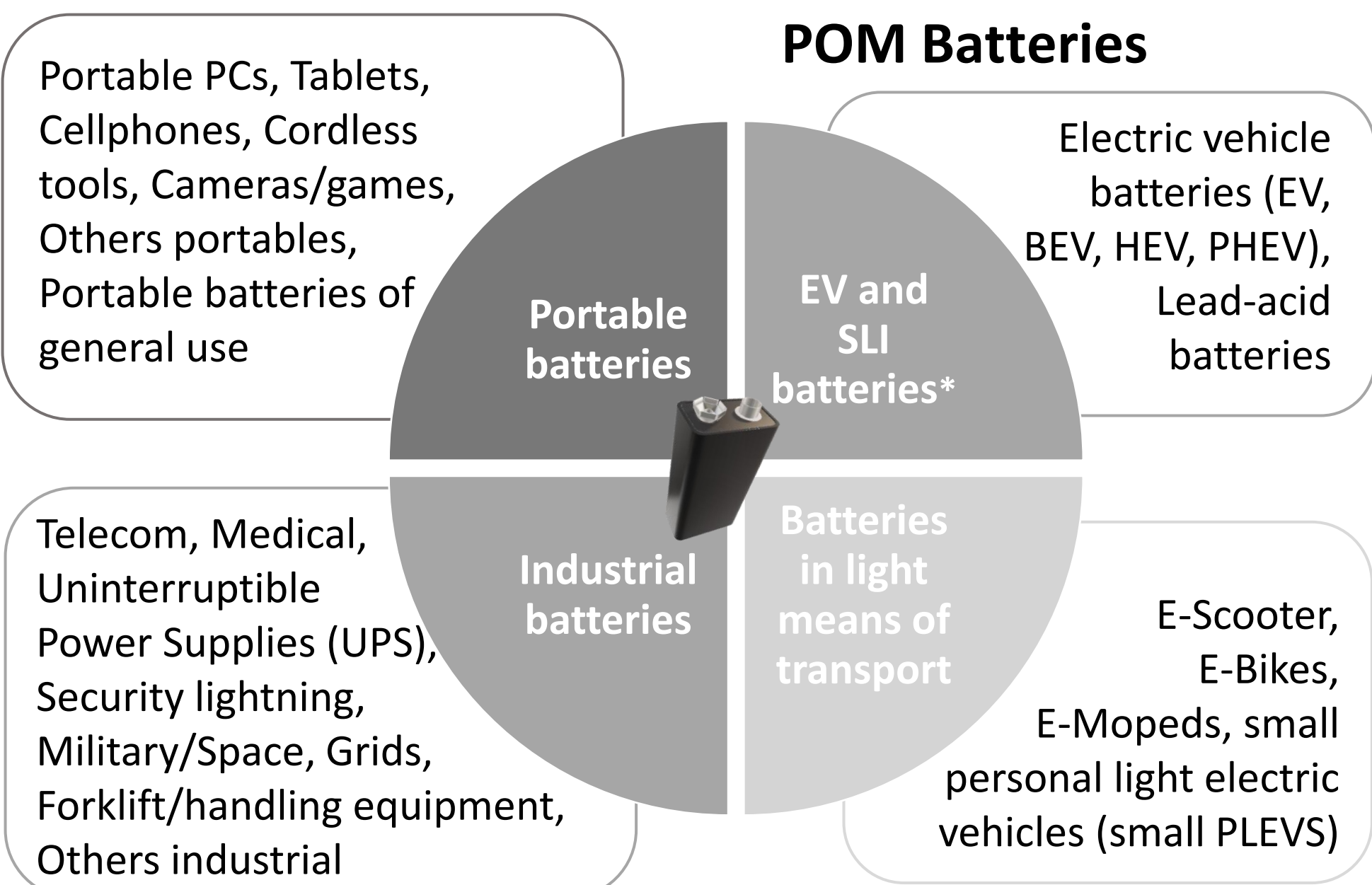
FutuRaM will establish a methodology, reporting structure, and guidance to improve the raw materials knowledge base up to 2050. It will integrate strategic raw material and critical raw material (SCRM) data to model their current stocks and flows, and consider economic, technological, geopolitical, regulatory, social and environmental factors to further develop, demonstrate and align the secondary raw material recovery projects with the United Nations Framework Classification for Resources (UNFC). UNFC is a tool that enables a better understanding of the viability of raw material projects and FutuRaM will apply this tool extensively to secondary raw material recovery projects, testing and improving the methodology so that it can be used with confidence to assess future projects.

Battery Composition

In order to investigate the stocks and flows of batteries at element level, it is necessary to have a consolidated battery composition of all battery types as well as the individual cathode chemistries. Therefore, an extensive literature search was carried out on the composition data of batteries screening 156 sources in total. The following examples present the composition data for a lithium-ion battery (LIB) with lithium-cobalt-oxide (LCO) battery chemistry and a zinc-based battery with zinc-manganese-dioxide battery chemistry.

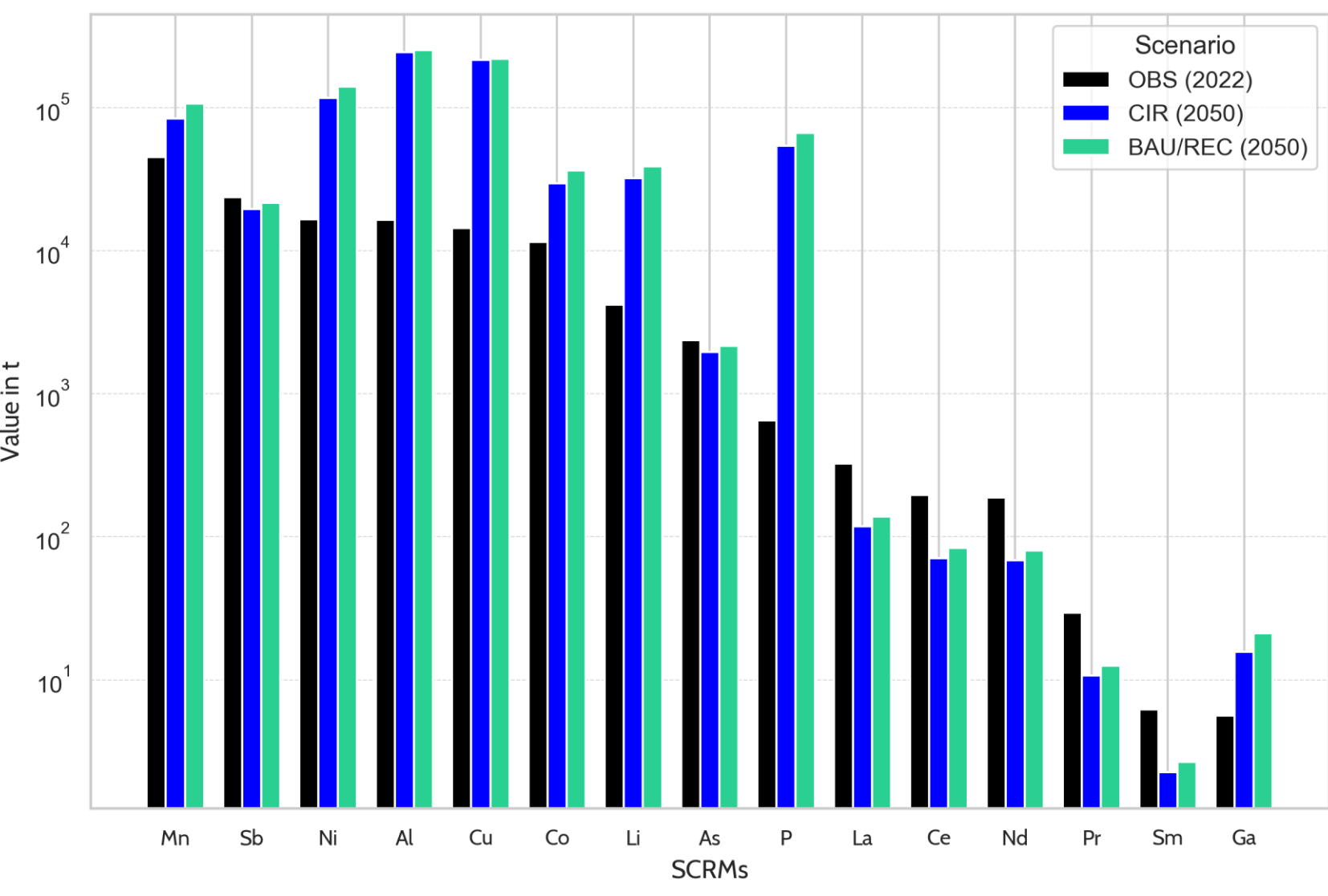


Approach of the Battery Waste Stream



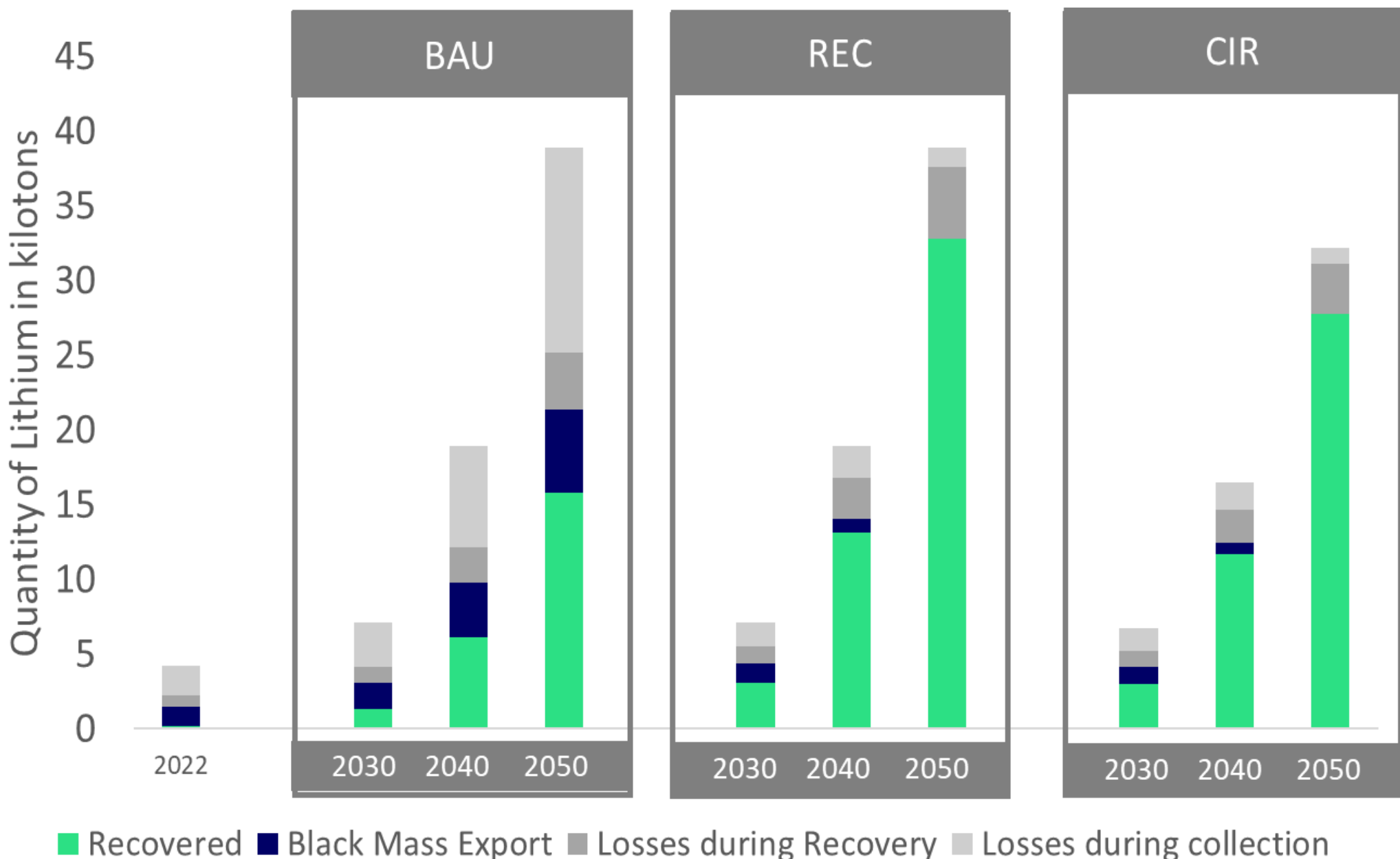
The **Recovery Model** is designed to estimate the secondary raw materials available after the recycling and recovery process. Within the Recovery Model, batteries undergo various recycling pathways, each tailored to optimize the recovery of specific materials. These pathways are characterized by distinct transfer coefficients, which determine the efficiency and yield of material extraction during the recycling process.

Results



The left graphic shows an overview of the SCRMs generated as waste within 3 scenarios for EU27+4. The quantities of rare earth metals are expected to decrease over time because of the substitution of NiMH batteries with LIBs. The quantities of phoursphourous is expected to increase during the shift of NMC to LFP cathode chemistry.

The right graphic shows an example of lithium quantities recovered, lost during recycling or collection and black mass exports within 3 scenarios for EU27+4. The most losses and exports occur within the BAU scenario, while REC and CIR show higher revocery.



Scenarios

- BAU**: Management of end-of-life batteries remains largely unchanged. The lack of technological innovation and regulatory incentives leads to a continued low recovery rate of valuable materials from battery waste.
- REC**: End-of-life batteries become a crucial source of secondary raw materials, primarily due to the increased adoption of electric vehicles and renewable energy storage systems. Technological innovation drives the recovery and recycling process, ensuring valuable materials are extracted from waste batteries for reuse.
- CIR**: Battery waste treatment undergoes a massive transformation. The shift towards electric vehicles and renewable energy storage significantly increases the quantity of end-of-life batteries. However, thanks to new regulations, technological advancements, and business models, the majority of battery components are recycled or reused.

Urban Mine Platform

The whole datasets of the battery waste stream is made publicly available on the Urban Mine Platform (www.urbanmineplatform.eu). On this platform can be found national data of EU27+4 countries on POM, stocks, waste generation, waste collection, complimentary flows and recycled battery flows. Furthermore, data is available on recovered SCRMs within different recycling routes for different battery types. The data is shown in bar charts and sankey diagrams and can be downloaded.

