



Recycling of low value components using high purity pre-treatment, direct recycling and green hydrometallurgical approaches for recycling of Lithium Ion and Sodium Ion batteries.

D1.1 Definition use case

WP1 – Pre-processing, separation and delamination

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1. Introduction

Description of Deliverable 1.1

Determination of parameters that need to be achieved for project to be considered successful. This is specifically in relation to the quality and characteristics of input material in recycling process to make the recycling process close-looped. The final outputs will be identified to be benchmarked against initial definition. This deliverable will be a result of Task 1.1.

2. Discussion of Goals and Success Criteria

2.1 Goals of the project

The project proposal defines the project goals as follows:

- 1) "REVITALISE will develop pre-treatment technologies that do not require the use of hammer mills to give cost-effective approaches for the initial shredding, separation, and delamination to achieve the purity values shown in Table 1." This definition is focussed on the outputs of work package 1. Hence this work package should produce at least one output fraction that corresponds to each of the lines in Table 1 through the various technologies developed and tested.

Table 1. Pre-treatment material purity.

Stream	Purity
Cathode	≥97%
Graphite	≥97%
Al	≥95%
Cu	≥90%
Plastics	≥95%

- 2) Successful separation of cathodic and anodic black mass streams in high quality. This goal also relates mainly to work package 1 but may also be achieved in combination with work package 3 (hydrometallurgy).
- 3) Enabling up to 40% of the active materials to be used in direct recycling, while the remaining 60% can be recycled using hydrometallurgy, reducing GHG emissions and direct costs of obtaining these materials.
- 4) Lastly, it shall be possible to reach recycling rates (recovery rates) that are significantly beyond the state of the art, and also exceed the goals defined in the EU battery directive for 2030 (Table 2). This is mainly a goal for work package 3 (input to output recycling rate).

Table 2. Material Outputs

Materials	2030 Target	REVITALISE
Cobalt	95%	95%
Nickel	95%	95%
Manganese	--	95%
Lithium	70%	75%
Graphite	--	85%
Copper	95%	95%
Aluminium	--	95%
Phosphates	--	75%
Fluorides	--	75%

None of these goals are currently achieved by commercially established LIB recycling processes, even for currently existing battery waste streams. At the moment there is no comprehensive overview over average or maximum possible recovery rates and recycling qualities for established processes publicly available.

Hence, they are going to be challenging for the new materials under consideration in this project (high nickel NMC, LFP, Na-ion) and with various the innovative technologies employed in the project that are still under development.

2.2 Success criteria for the project

However, since a range of different technologies for each recycling stage are going to be used within the project, we are confident – and consider the project to be successful – if 3 out of the 4 above goals are reached at least to 90%.

Beyond the above-described, narrowly defined recycling goals, an overall goal of the project is to explore in how far the mentioned new technologies are suitable to improve recycling efficiency. Hence the project is deemed successful if we can produce an assessment for each technology as to which recycling qualities and recycling rates it can produce for different battery materials at TRL 4 level.

Beyond that we would consider the project to be very successful if we can produce an estimate for each technology, in which direction these recycling qualities and recycling rates may develop at higher TRL levels.

3. Conclusions

Defining success criteria is not a one-time activity but shall rather develop as the project progresses.

- First, a collection of baselines of state-of-the-art recycling parameters shall be defined.
- Secondly, each technology shall be compared against those parameters, possibly differentiating various input materials.