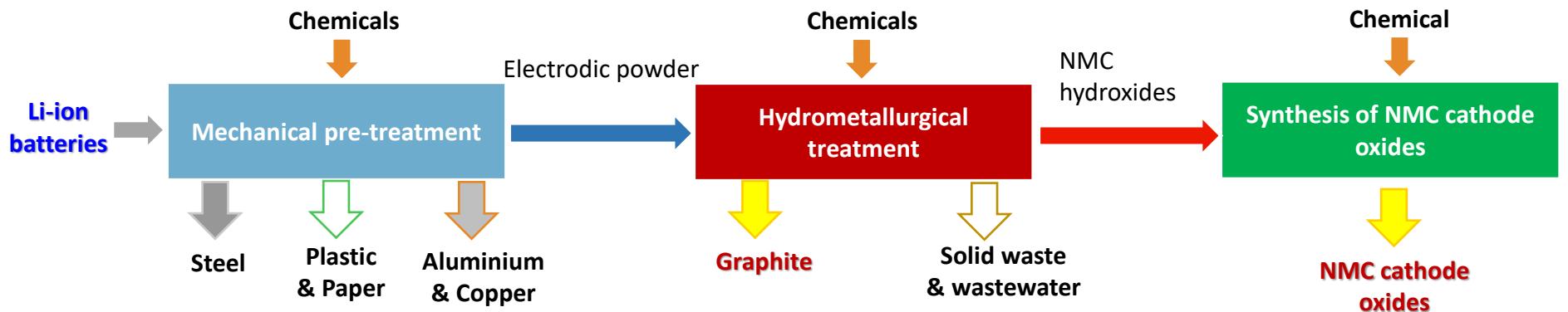




## DELIVERABLES B1.1: Basic and Detailed design of the prototype for lithium-ion battery recycling

### Process description:

The following figure shows a simplified block flow diagram of the process for the innovative recycling process for lithium-ion battery, which permits to recover graphite and directly synthesize a high-quality cathodic material for new NMC batteries:



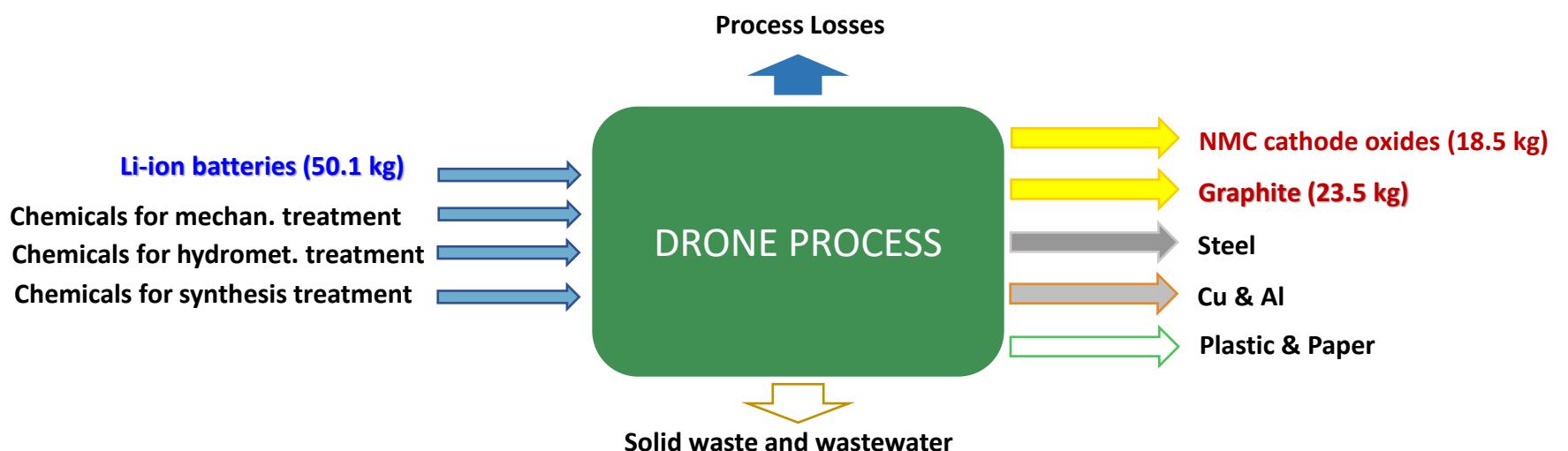
The three main sections of the process are:

- Mechanical pre-treatment;
- Hydrometallurgical treatment;
- Synthesis of NMC cathode oxides.

In the first section the batteries are sent to dedicated mechanical pre-treatment that allows to separate 4 distinct fractions: steel, plastic/paper, copper/aluminum, electrodic powder. The electrodic powder is treated in the second section of the process, where it undergoes a washing treatment to remove the electrolyte present in the fraction, a leaching treatment, followed by a purification and a precipitation treatment, which result in the separation of purified graphite and mixed NMC hydroxides. In the third section of the process the hydroxides are dried, grinded with added lithium carbonate and fed to the furnace, resulting in the production of NMC cathode oxides.

### Material balance:

This diagram shows the overall balance of the DRONE process:





## **DELIVERABLES B1.1: Basic and Detailed design of the prototype for lithium-ion battery recycling**

### **Production capacity:**

- ❖ The pilot plant has been designed to work in batch
- ❖ Mechanical section plant capacity: 200 ton/y of batteries
- ❖ Hydrometallurgical-synthesis section plant capacity: 30 kg of electrode powder per batch
- ❖ Graphite total production: 470 kg
- ❖ NMC oxides total production: 660 kg
- ❖ Batteries necessary to support the demonstration campaign: 3000 kg

### **Basic & Detailed design of equipment and instrumentation:**

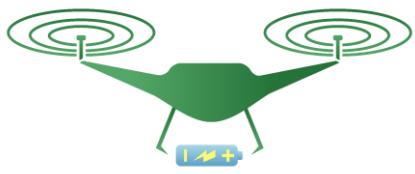
After defining the operations to be performed and the production capacity of the prototype, it was possible to define and design the most suitable equipment and instrumentation to carry out the operations necessary to obtain the product of interest.

The mechanical pre-treatment will consist of a system for grinding safely the batteries, a vibrating sieve for the fine/coarse fraction separation, a magnetic separator belt, for separating magnetic metals from the non-magnetic fraction, and a dedicated unit to separate non-magnetic metals (Cu, Al) from non-metals (paper and plastic).

The hydrometallurgical treatment is composed of a washing system, of leaching reactor for the treatment of the electrode powder and the impure graphite, a reactor for the purification treatment, a reactor for the precipitation of the target hydroxides. Various solid-liquid filtration systems are placed in between the different reactors to separate liquid phases from solid phases.

The synthesis of NMC cathode oxides section, is composed of a dryer, where the residual liquid content of the solid cake of mixed hydroxides is removed, a grinder, which reduces and homogenizes the size of the solid particles of the hydroxide and lithium carbonate to the suitable particle size distribution, and a furnace, where the NMC cathode oxide is produced.

In addition, there are three distinct abatement systems: the first consisting of a bag filter, a scrubber and activated carbon for the mechanical section, the second consisting of two scrubbers for the hydrometallurgical section and finally the third consisting of a filtration system for the synthesis section.



## **DELIVERABLES B1.1: Basic and Detailed design of the prototype for lithium-ion battery recycling**

### **Plant layout:**

Following the detailed design of the equipment, it was possible to carry out a layout of the prototype. The hydrometallurgical section with its abatement systems, assembled from the revamped HydroWEEE project, will be housed inside a standard 12m container, while the synthesis section with its abatement system will be housed inside a new standard 6m container. Both containers will be positioned on the technological platform of the Eco Recycling company. The mechanical section with its abatement systems is already located at the SEVAL industrial plant.

### **Basic & Detailed process design book:**

As an output of this activity, the detailed process design book was produced. This book contains the following sections:

- General process document: which contains a detailed description of the process and a document which describes the basis of design.
- Process Flow Diagrams and Heat & Material balance: where the process diagrams and the material and energy balance are reported.
- Piping and instrumentation Diagram: which shows the detailed piping and instrumentation diagrams.
- Process summaries: In which are reported the consumption of utilities and chemicals, the list of electrical loads, the list of fluids present in the process, the data on the effluents, the list of piping lines, the control philosophy and process instrumentation specifications.
- Process Data Sheet of major equipment: which contains the datasheets of all the equipment that make up the prototype.

Thanks to the information contained in this book, it will be possible to proceed with the purchase of the equipment and the construction of the prototype