European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

**From iron and manganese oxides wastes to valuable metal alloys using novel carbon sources materials**

Acronym:
HOPE-4-0

Abstract / executive summary:

The European process industry needs to boost the reuse and recycling rates of process by-products. World leading metal producers (ERAMET for manganese based alloys, ArcelorMittal for steel) and recyclers (Comet Traitements) have managed to reduce waste and increase yield by continuously improving their processes. However, there are still large amounts of waste that for different reasons are still landfilled (~100,000 t/y for the manganese industry and > 1,000,000 t/y for the steel). Over the last decades a myriad of different waste processing technologies have emerged, covering many different processing steps like separation, agglomeration, and high temperature treatments. Finding solutions for retrieving valuable secondary raw materials or producing saleable products is a matter of choosing and combining the most suitable technologies, optimising operational parameters, and testing equipment in a sufficient scale. Furthermore, these technologies require high CAPEX and need high amounts of waste to be profitable. Therefore, to minimize the cost there is a need to combine waste from several sectors.

The main objective of the project is to reduce the need for landfill deposits by turning waste streams from the metal industry into valuable products. How? Through investigation of the most optimised process routes from waste to product for common and large impact waste streams originating from:

- Carbothermic production of Silicon & Ferro-manganese alloys;
- Metal and carbon containing waste streams from steel and metal recycling activities.

Links to the Strategic Implementation Plan:

- I. Technology Pillar
  - I.B Priority Area: Technologies for primary and secondary raw materials’ production
    - Action area n° I.4: Processing and refining of raw materials
      - 1) Innovative and flexible processing
      - 2) Metallurgical systems
    - Action area n° I.5: Recycling of raw materials from products
      - 1) End-of-life products recycling

Coverage of the Action Areas referred to above:
The main activities of the project are to increase resource efficiency in mineral and metallurgical processes but also to recycle and optimize material chain for End-of-Life products.

**Objectives of the commitment:**

The main objective of the project is to reduce the need for landfill deposits by turning waste streams from the metal industry into valuable products through investigation of the most optimised process routes from waste to product for common and large impact waste streams originating from carbothermic production of Silicon & Ferro-manganese alloys, or from metal and carbon containing waste streams from steel and metal recycling activities. This will be done by the creation of a new process value chain consisting of pre-treatment and treatment stages where the use of carbon retrieved from EOL vehicles (& carbon from old deposits) as a reducing agent combined with iron and manganese production waste, is the key. The demonstration will be done in a value chain at semi-industrial scale able to achieve ~ 15 tons of FeMn alloys. The project aims at a metal recovery rate of 60%.

**Description of the activities:**

The proposed solution is based on the use of both innovative compaction methods (new technique without binder) and commercially available high temperature pre-treatment technologies (Rotary Hearth Furnace, Multiple Hearth Furnace, Rotary kiln) needed to remove impurities (alkalis, heavy metals...). These different technologies will be compared in terms of OPEX/CAPEX vs. targeted output composition. As these technologies require high CAPEX and need high amounts of waste to be profitable, an innovative approach consists to combine waste from several sectors (manganese, steel, recycling). Once the impurities removed, the semi-product obtained will be tested in the production of new FeMn alloy but also as new material that could be directly recycled in the steel industry.

A specific advantage in this project is the partner’s availability of lab-, pilot- and industrial - scale equipment for performing the process step tests. Low cost and quick laboratory tests may be performed to scan different operational parameters of the technology, allowing larger more resource demanding (pilot / industrial scale) tests to be more focused and achieve a higher probability of success.

The project output will be a demonstration validation of the most optimised process route, to retrieve valuable elements out of process by-products that are today landfilled. A detailed technical and economical evaluation will be carried out to validate the viability of the optimised process route. If successful, the implementation of this new recycling route could be considered in a period of time lower than three years after the end of the project. Furthermore, the acquired knowledge during this project could be further extended to other sectors (production of ferrochrome, zinc production...).

**Description of the expected impacts:**

Large quantities of metal bearing dust are generated by the metallurgical industry. Worldwide, it is estimated that at least 50 million tons of metallic dust and sludges are produced annually and only a fraction of this amount is currently recycled. Public authorities, customers and the public are making ever greater demands on the metallurgical industry to reduce emissions, and this is increasing the need to develop new, more cost-effective ways of dealing with the dust problem. The problem is exacerbated by the obsolescence of some of the existing alternatives. One example is landfills, which are no longer suitable and will soon be prohibited in some countries (Norway, Belgium, France, and Germany). Existing technologies for handling and recycling dust are also expensive. Transportation and treatment often cost hundreds of euros per tonne. In most cases, there is also a lack of
technology for recycling sludge generated in metallurgical production. Product flow often goes from treatment to recycling or landfill. An important trend is the increasing pressure being applied by authorities and key customers, which is leading to a change in practice from landfill dumping to treatment and from treatment to recycling, i.e. towards dust prevention. Alternatively, if complete recycling cannot be achieved, the goal is to obtain a product that can be classified as inert material with negligible environmental impact. The classification of waste as it is applied in many landfill places is threefold: (i) Inert material; (ii) Waste; (iii) Hazardous waste. If waste such as dust or sludge can be turned from “hazardous waste” into “waste” or from “waste” into “inert material”, it is highly favourable from a cost perspective, and from an environmental perspective.

**Expected innovation outcomes:**
- New processes
- New technologies

**Comments:**

The final goal of this project is to succeed in finding a process which generates zero waste.

**Name of the coordinating organisation:**
ERAMET Research

**Country:**
France

**Entity profile:**
Private sector - large company

**Role within the commitment:**
ERAMET will be the lead partner of this project as they are in the core of the new recycling value chain proposed in this project. Furthermore, industrial validation of this concept will be tested in one of ERAMET’s industrial furnace.

**Other partners:**

**Name of partner:**
CRM

**Country:**
Belgium

**Entity profile:**
Governmental/public body

**Role within the commitment:**
CRM Group will provide its know-how in by-products pre-processing (briquetting, pelletizing...), in order to minimize the cost and maximize the productivity of the high temperature pre-treatment processes. CRM owns three high temperature pilot scale technologies (RHF, MHF & rotary kiln), in order to assess to most suitable pre-treatment technology of the considered by-products mix.

**Name of partner:**
Arcelor Mittal

**Country:**
Luxembourg

**Entity profile:**
Private sector - large company

**Role within the commitment:**
Arcelor Mittal will collect and characterize different partners by-products (chemical analyses, moisture content, transportation of enough material to the different test facilities)

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**Name of partner:**
ERAMET Norway

**Country:**
Norway

**Entity profile:**
Private sector - large company

**Role within the commitment:**
ERAMET Norway will collect and characterize by-products especially coming from Norwegian industries.

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**Name of partner:**
Eurotab

**Country:**
France

**Entity profile:**
Private sector - SME

**Role within the commitment:**
EUROTAB will bring its expertise in cold agglomeration without binder. It owns different sizes and types of press, to explore the technology feasibility in this industry as well as produce large quantities of products for semi-industrial furnace tests.

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**Name of partner:**
COMET Traitements

**Country:**
Belgium

**Entity profile:**
Private sector - SME

**Role within the commitment:**
COMET TRAITEMENTS has already set up a pilot demonstration unit at its site in Obourg to showcase how organic shredder residues that would previously have ended up in landfill are now being used to generate energy. This process will be used in the project.

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**Existing EU contribution:**
Yes

**Source:**
Other

**Period to implement the commitment:**
Tuesday, 1 March, 2016 to Sunday, 1 March, 2020