European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

Development of an innovative and sustainable lithium extraction process from medium lithium grade brines

Acronym:
LiDEP (Lithium Direct Extraction Process)

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.3: Innovative extraction of raw materials
    - 3) Alternative mining
    - Action area n° I.4: Processing and refining of raw materials
      - 1) Innovative and flexible processing
      - 2) Metallurgical systems

Objectives of the commitment:
The objective of the project is to develop and to demonstrate an innovative, sustainable and enhanced lithium extraction and metallurgical valorization process from medium grade lithium brines, the content of which ranges from 100 to 500 mg/L. The innovative process is viewed as an alternative process compared to the conventional production processes based on solar evaporation. The innovative process will be based on a selective solid-liquid extraction technology. A successful project would significantly increase lithium reserves worldwide and allow for industrialization of high quality lithium compounds for industrial applications such as the growing lithium ion battery market. A successful project will also allow to diversy the Li supply currently dominated by four players.

Description of the activities:
Lithium resources are of two main types: (i) brines pumped from aquifers of dried salt lakes (also called “salar”). These lithium rich lakes are mostly found in high plateaus in the Andean regions in South America. Around two thirds of current global lithium compound production is extracted from salar brines. (ii) Lithium can also be extracted from minerals such as pegmatite, from which a third of the lithium compounds world production is extracted.

Medium grade lithium resources are not developed so far because of the lack of a sustainable and
economical process: lithium recovery resulting from conventional evaporation process is low and associated capital expenditure is high.

The proposed project objective is to develop a completely new process aiming at higher Li recovery, less environmental footprint and lesser investment cost. The project will be focused primarily on brines from South American salt lake aquifers and secondarily on geothermal brines located in Europe in particular (Italy, France, Germany) which are known to contain large amounts of lithium resources.

In order to develop a more sustainable and economical extraction process of lithium, the consortium has organized the project in 5 working packages:

- map geothermal resources located in Europe that contain lithium and to which the process could be applied,
- develop a new active solid compound able to selectively extract lithium directly from medium grade brines,
- up-scale the active compound production process and produce a pre-industrial material from a continuous high flow rate process demonstration unit,
- up-scale the lithium direct extraction process and demonstrate its technical feasibility and economic viability,
- pre-qualify high quality lithium carbonate produced at pilot scale for the battery production market.

The five parts of the project will be handled by five different partners in close collaboration with one another.

Description of the expected impacts:

Firstly, a successful project will secure a sustainable long term supply of lithium in Europe and allow for a strong development of the downstream applications such as the high growth potential battery market and the ceramic industry. An European integrated approach will contribute to strengthen the whole European industry by providing the market with competitive and high quality products in line with Europe’s front line player needs.

Secondly, the proposed alternative process aims at significantly reduce the environmental footprint of lithium production industrial units. “The extraction of lithium through evaporation of brines in salt flats can have significant impacts on the often delicate balance of limited fresh and/or ground water supplies” according to Report on the Intersessional Senior Expert Group Meeting on Sustainable Development of Lithium Resources in Latin America: Emerging Issues and Opportunities, 10-11 November 2010, Santiago. The conventional process evaporates water from brines in large ponds and large waste dump areas are necessary to store salt residues. In the case of the lithium direct extraction process, lithium depleted brine is returned back to natural environment. Impact on the hydric balance is significantly reduced.

Finally, the innovative process would be much more efficient in terms of lithium recovery than the conventional process. Lithium recovery from brine is expected to be more than 80% with the innovative process. This figure is to be compared with recovery ratios of less than 50%, resulting from the conventional process. Lithium resources would be managed more appropriately, better preserved and valued in the long run.

Expected innovation outcomes:

New processes
New technologies

Comments:

The targeted process relies on several technological breakthroughs and innovative approaches, as summarized below:

- Identification of potential lithium deposits in Europe in the form of geothermal brines with chemical composition suitable for a lithium direct extraction technology.

- Development of a new stable and active compound with a high affinity for lithium and selective from impurities (magnesium, sulfates, boron),

- Production of active compound at pre-industrialization scale under strict health, safety and environmental conditions and under optimized yield conditions (recycling of effluents, reduced product losses),

- Development of a direct lithium extraction process at demonstration scale and evaluation of optimized process parameters that combines low energy consumptions, low contamination of depleted brine, low reagent consumptions, low impact on the hydric balance, reduced evaporation areas and limited amounts of waste products,

- Product innovation driven by end-consumer thanks to close cooperation with raw material producer.

Name of the coordinating organisation:
ERAMET SA
Country: France
Entity profile: Private sector - large company
Role within the commitment:

ERAMET is a mining and metallurgical company operating beneficiation, pyrometallurgy and hydrometallurgy plants worldwide. At ERAMET Research, the performance of operating processes are being improved and new extraction processes are being developed.

ERAMET will capitalize on its experience and know-how to coordinate the project and ensure the following tasks:
- Proceed with experiment at laboratory scale to assess active compound performance
- Draft performance and/or technical specification to design the demonstration unit of direct extraction of lithium process and
- Operate the demonstration unit in Argentina and produce lithium carbonate salt
- Proceed with marketing study and financial analysis, assess economic viability.
- Collect environmental data to improve the impact assessment of the process

Other partners:

Name of partner: Bestec
Country: Germany
Entity profile:
Private sector - SME

**Role within the commitment:**
Identify, characterize lithium rich geothermal brine fields in Europe (this may include sampling and analysis of brine) and assess suitability of geothermal reservoirs to the process developed by the partnership and recommend targets.

**Name of partner:**
IFPEN

**Country:**
France

**Entity profile:**
Governmental/public body

**Role within the commitment:**
IFP Energies Nouvelles is a public-sector research, innovation and training center active in the fields of energy, transport and the environment. Its mission is to provide public players and industry with efficient, economical, clean and sustainable technologies to take up the challenges facing society in terms of climate change, energy diversification and water resource management. It boasts world-class expertise. According to its know how, IFPEN will ensure the following tasks: - Develop synthesis formula for active compound samples at the laboratory scale - Produce active compound at laboratory scale - Develop and optimize shaping of active compound in agreement process requirements - Draft technical specifications of active compound (for partner 3) - Simulation and extrapolation of laboratory tests to bench scale and demonstration scale (for partner 4)

**Name of partner:**
To be determined

**Country:**
Europe

**Entity profile:**
Other

**Role within the commitment:**
Partner 3 will study the industrialization of the compound and will produce compound at demonstration unit level Partner 3 will study the industrialization of active compound, i.e. - select best technology to produce active compound at industrial scale - Assess industrial cost of production of active compound - proceed with the production of representative e samples of pre-industrial compounds - supply coordinating partner and partner 4 from several kilograms to 1 ton samples

**Name of partner:**
To be Determined

**Country:**
Europe

**Entity profile:**
Other

**Role within the commitment:**
Design, build and commission demonstration unit. Ensure scoping study of industrial plant Partner 4 will ensure the engineering of the demonstration unit - design and build demonstration unit in Europe - proceed with commissioning of demonstration unit to meet performance criteria in Europe - export demonstration unit to Argentina and re-build in Argentina - proceed with scoping study of industrial plant for economic assessment of overall process

**Name of partner:**
To be Determined

**Country:**
Europe

**Entity profile:**
Other

**Role within the commitment:**
Define specification of commercial products and qualify lithium product suitable for commercial use - define technical specification of final product as well as analysis methodologies - test samples of final product (lithium carbonate) at lab scale and demonstration scale to ensure that final product meet with li-ion battery required performances.

**Existing EU contribution:**
No

**Period to implement the commitment:**
Wednesday, 1 January, 2014 to Monday, 31 December, 2018