FINAL PROJECT FACT SHEET
EUROPEAN UNION CO-FUNDED PROJECT

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Horizon 2020

GEOTHERMAL ENERGY

Project acronym:

CHPM2030

Combined Heat, Power and Metal extraction from ultra-deep ore bodies

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CHPM2030

1. SUMMARY

CHPM2030 aims to develop a novel and potentially disruptive technology solution that can help satisfy the European needs for energy and strategic metals in a single interlinked process. Working at the frontiers of geothermal resources development, minerals extraction and electro-metallurgy the project aims at converting ultra-deep metallic mineral formations into an "orebody-Enhanced Geothermal Systems (EGS)" that will serve as a basis for the development of a new type of facility for "Combined Heat, Power and Metal extraction" (CHPM). In the technology envisioned the metal-bearing geological formation will be manipulated in a way that the co-production of energy and metals will be possible, and may be optimised according to the market demands at any given moment in the future.

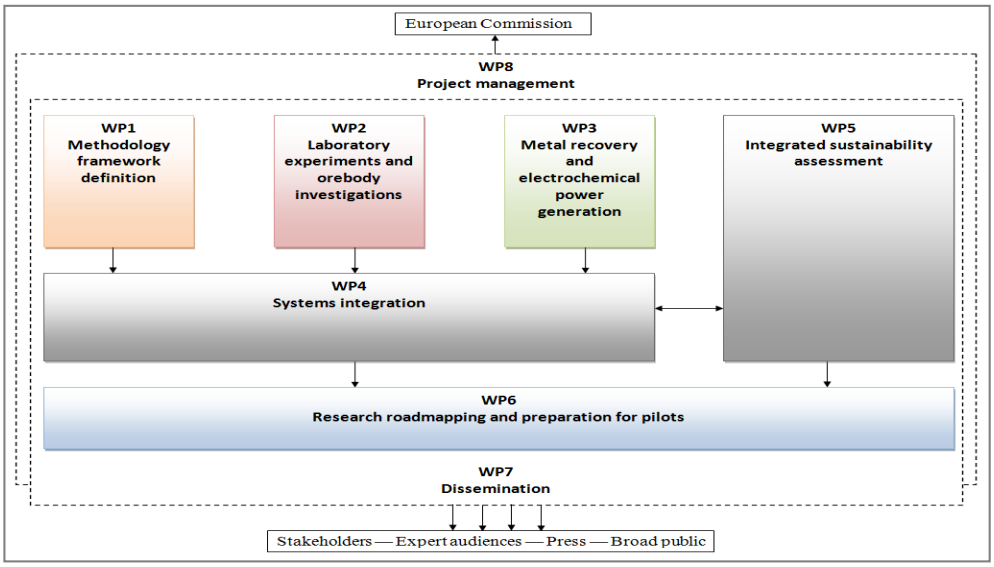
2. PROJECT SCOPE

The specific objectives of the CHPM2030 project are the followings:

- Develop selection criteria and conceptual models for the exploitation of novel metallic-mineral deposit-based geothermal systems, including novel solutions for EEGS (Electrochemically Enhanced Geothermal Systems) in these formations;
- Deliver proof of concept for the extraction of metals from ultra-deep mineral deposits using a combination of geoengineering techniques to enhance the interconnected fracture systems within the orebody, innovative approaches to leaching, ambient vs. high-pressure electro-chemical methods for in situ-situ metal complexation;
- Develop metallic-mineral formation specific solutions for the co-generation of electricity using salt-gradient power reverse electrodialysis;
- Develop conceptual designs of a new type of future facility that is designed and operated from the very beginning as a combined heat, power and mineral extraction system;
- Develop an economic feasibility assessment model to be applied for such new facilities;
- Combine metallogenic models with geothermal datasets to develop a database of suitable areas in Europe where such developments could be feasible;
- Develop a research roadmap in support of the pilot implementation of such system before 2030, and full-scale commercial implementation before 2050.

3. PROJECT TECHNICAL DESCRIPTION & IMPLEMENTATION

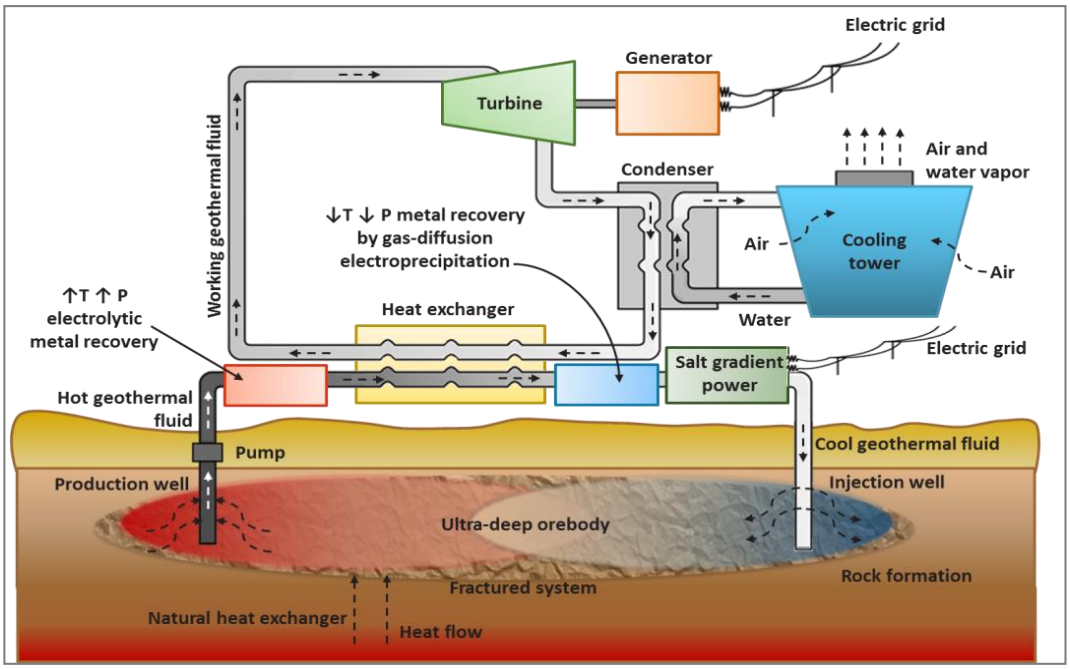
Work in CHPM2030 is structured in eight work packages:



The methodology of the technical part (WP1-WP6) contains the following steps:

- EGS-relevant review of metallogenesis and ore deposit formation, understanding the rock-mechanical characteristics of orebodies from an EGS perspective;
- Laboratory experiments and simulations for orebody characteristics, leaching metals from the orebody (metal content mobilisation using mild leaching and carbon nanoparticles);
- Laboratory experiments: recovery of the metal content by high-temperature, high-pressure geothermal fluid, recovery by electrolysis and by gas-diffusion electroprecipitation and electrocrystallization. Additional power generation by reverse electrodialysis;
- Conceptual framework for CHPM power plant, process optimisation and simulations, CHPM schematics and blueprints;
- Integrated sustainability assessment: economic feasibility, social impact, policy considerations, environmental impact, ethics concerns;
- Planning of pilots (South West England, Iberian Pyrite Belt, Romania, Sweden, European outlook), roadmapping (2030, 2050).

The sketch below represents the schematic overview of the envisioned CHPM facility:



4. RESULTS ACHIEVED

The project intends to provide proof-of-concept for the following hypotheses:

- The composition and structure of orebodies have certain advantages that could be used to our advantage when developing an Enhanced Geothermal Systems (EGS);
- Metals can be leached from the orebodies in high concentrations over a prolonged period of time and may substantially influence the economics of EGS;
- The continuous leaching of metals will increase system's performance over time in a controlled way and without having to use high-pressure reservoir stimulation, minimizing potential detrimental impacts of both heat and metal extraction.

As a final outcome, the project will deliver blueprints and detailed specifications of a new type of future facility that is designed and operated from the very beginning as a combined heat, power and metal extraction system. The horizontal aim is to provide new impetus to geothermal development in Europe by investigating

previously unexplored pathways at low-Technology Readiness Levels. This will be achieved by developing a Roadmap in support of the pilot implementation of such system before 2030, and full-scale commercial implementation before 2050.

5. IMPACT

The expected impacts of the project can be summarised as follows:

- Creating the scientific basis for the future CHPM facilities where novel concepts in electro-geochemistry and geological engineering will enhance a new generation of geothermal development in Europe;
- Merging two, so far unconnected, technology areas (renewable energy and minerals extraction) changing the landscape for geothermal development in Europe, and satisfying Europe's need for critical minerals;
- Addressing the energy challenge by investigating novel technology pathways for geothermal energy and also by the expected improvement of the economic feasibility of geothermal investments;
- Supporting other objectives of the EU Raw Materials Initiative (RMI) and its Strategic Implementation Plan beyond critical raw materials providing input for local, regional and national decision makers in charge of development planning;
- Helping decision makers in Europe to frame strategic choices concerning future energy technologies and integration to the future energy system through research roadmapping combined with economic feasibility modelling ;
- Increasing the number of potentially viable geothermal resources, not just in Europe, but all over the world, with the help of the co-production of valuable metals;
- Investigating alternative pathways to hydraulic fracturing through the development of the "leaching" approach;
- Connecting thousands of interested scientists, engineers, and decision-makers by establishing co-operative links to already running projects on critical raw materials, geothermal energy and other technology-driven projects.

CHPM2030 will thus increase the attractiveness of geothermal technologies by improving cost-competitiveness, reducing complexity and increasing reliability, also leading to significantly increased technology performance, reducing life-cycle environmental impact and improving EU's energy security.