Combined Heat, Power and Metal extraction from ultra-deep ore bodies - CHPM2030

2nd Periodic Report

Deliverable D8.4

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PART B

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1 Explanation of the work carried out by the beneficiaries and overview of the progress

1.1 Objectives

General objectives

The strategic objective of CHPM2030 is to develop a novel and potentially disruptive technological solution that can help satisfy the European needs for energy and strategic metals in a single interlinked process. In the CHPM technology vision, 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.

Specific objectives

Below the specific objectives of the project are listed. For several of the objectives described, work towards achieving them started in the first reporting period and was completed in the last reporting period.

Objective 1: Deliver proof of concept for the technological and economic feasibility of mobilisation of metals from ultra-deep mineral deposits using a combination of geo-engineering techniques to enhance the interconnected fracture systems within the orebody.

In the first reporting period, *Tasks 1.1* and *1.3* provided a background for reaching this objective. The internal qualities, the mineralogy, the geochemistry, the geometry, the extent, the structure and the textural characteristics of the ore bodies were examined, as they influence the magmatic/hydrothermal processes and the fluid-rock interaction. These processes define the metal content and the possible ways of metal mobilisation.

The achievement of *Objective 1* was carried out mostly in the frame of WP2. This work package included four Tasks. It started in the first reporting period and ended in M24, December 2017. Within this work, only the technological feasibility was examined. The economic feasibility studies started recently, in M28 and results are expected by M40, April 2019.

Figure 1: Experimental setup during laser treatment.

Work within *Task 2.1* involved a combination of laboratory experiments and predictive computer modelling for the simulations for integrated reservoir management. A number of laboratory investigations were completed, including heat conductivity measurements on rock samples, rock mechanics studies to determine the stress field of different metal-bearing rocks, fracture enhancement studies by laser treatment *(Figure 1)*, and elevated pressure fluid flow experiments on rocks treated

to different levels of artificial fracture enhancement. A three-dimensional stochastic fracture model was built and described, and then a 3D fluid, heat- and mass-transport model was used to define the extractable amount of heat and metallic minerals regarding different scenarios. The main achievement in this Task was determining the magnitude of possible metal production of an envisioned CHPM plant.

Task 2.2 investigated whether relatively 'mild', environmentally benign leaching agents are capable of liberating metals into the recirculating fluid within an EGS. Activities included the high temperature lab experiments aimed at understanding and enhancing metal leaching under in-situ pressure/temperature conditions and analyses of reacted solids and liquids. The overall conclusion of the work was that some degree of enhanced metal mobilisation could be achieved. Dilute mineral acids liberated the most metals, and classical complexing agent such as EDTA kept them in solution *(Figure 2).*

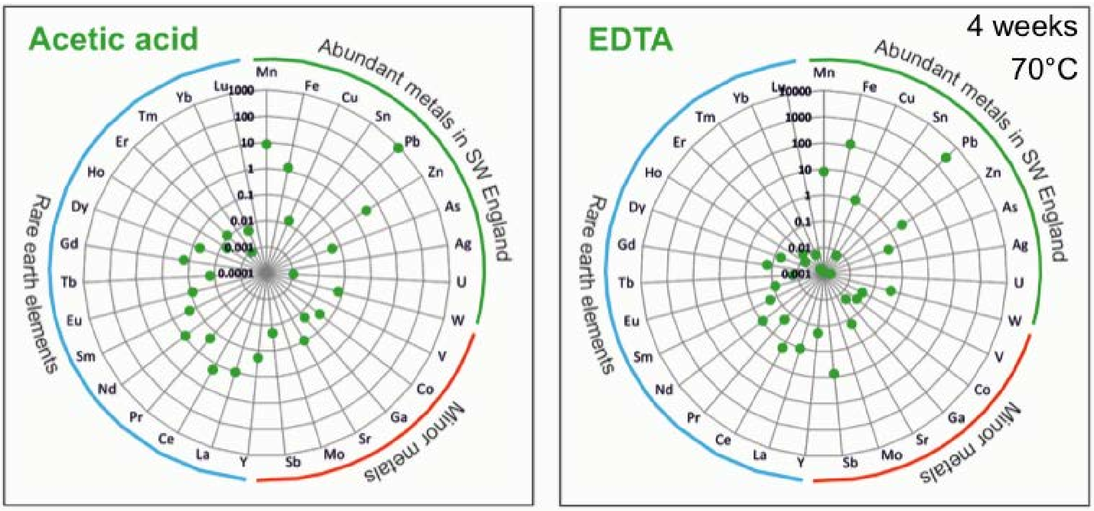

Figure 2: Amounts of metals released after 4 weeks of reaction at 70°C. The centre of each plot represents 0 ppm, and the outer part of the plot 1000 ppm (left) and 10 000 ppm (right) for dilute acetic acid or dilute EDTA solution.

Dilute simple organic acids (such as acetic acid) were also quite effective (Figure 3), and they had the benefit of mobilising lower concentrations of less desirable elements (such as aluminium and silica) which could reduce the potential for precipitation of permeability-reducing secondary minerals such as clays. For the rock samples studied, only lead was found to be mobilised relatively easily, with more important critical metals occurring at lower concentrations. Copper and silver appear to have been mobilised, but reprecipitated.

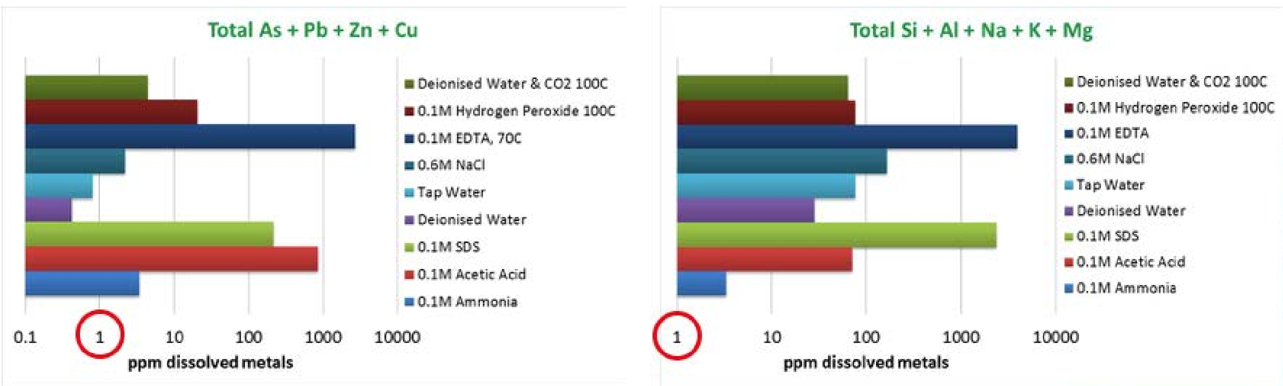

Figure 3: Combined concentrations of a range of ore-forming metals (on left) and other elements (on right) released in laboratory experiments after 4 weeks of reaction at 70-100°C. Note the higher mobilisation of ore-forming metals and other elements with dilute EDTA solution and dilute SDS solution, but the more specific mobilisation of ore-forming metals with dilute acetic acid solution.

The achievement of *Task 2.3* was extended by six months, to M30. It involved the selection and screening of carbon nano-materials for metal mobilisation. This included the modification of selected materials for improved metal sorption selectivity/capacity under different temperature and pressure conditions (i.e. towards targeted recovery of individual metals) *(Figure 4).* One of the findings was that functionalisation changed the nature of the sorption performance. In some cases this resulted in lower overall sorption, but it occurred over a broader pH range over which metal sorption occurred, which might facilitate metal capture over a wider range of natural environments. The impact of nanoparticles on permeability was also studied using ceramic disks as 'artificial' rocks. Even though the particle size distribution was smaller than the pore size of the samples, a layer of particles built up on the surfaces of the samples, and permeability dropped drastically. This could be important in terms of focussing on the most appropriate particle sizes for different rocks, and controlling the surface charges on the particles.

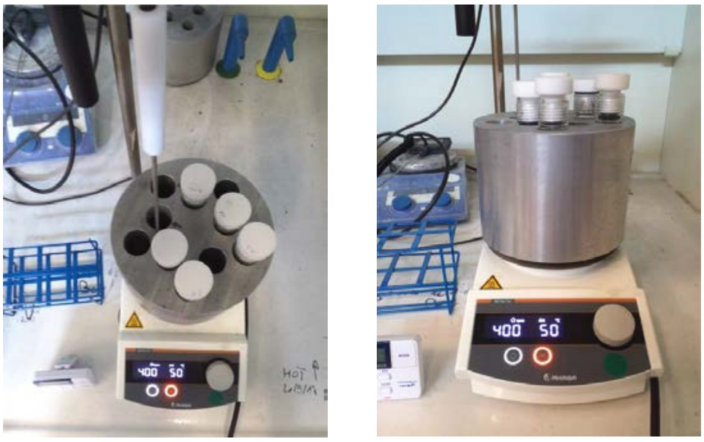

Figure 4: Experimental set-up for measuring the sorption performance at higher temperatures.

The overall system dynamics and environmental assessment methods were studied in *Task 2.4 (Figure 5).* This Task integrated the results of activities within WP2, identifying key parameters for the CHPM technology, and fed them into WP4 (optimisation and performance) and WP5 (environmental impacts). A schematic overview of an envisioned CHPM facility was developed, identifying the locations of the critical parameters, drawing up data-capture tables for each critical parameter. Results were summarised in the recommendations for the integrated reservoir management.

Figure 5: Potential environmental impacts of CHPM based on technological elements.

According to the achievement of Objective 1, results in the reporting period are laid down in the following deliverables:

- D2.1: Recommendations for Integrated Reservoir Management (M24),
- D2.2: Report on metal content mobilisation using mild leaching (M24),
- D2.3: Report on metal content mobilisation with nanoparticles (M30),
- D2.4: Report on overall system dynamics (M24).

The following Milestone was also completed:

- Milestone 1: Methodology framework for orebody EGS is defined (in the first reporting period, M10).

Related to this objective, economic feasibility studies will be carried out in WP5. *Objective 1* will be finally completed by the submission of the following deliverable:

- D5.2: Economic feasibility assessment methodology. D5.2 will bring comparison of proposed CHPM technology with the most similar technologies (extraction from geothermal brines) with known costs, allowing theoretical assessment in which conditions (costs, brine concentrations etc.) would be the feasible.

Objective 2: Develop innovative pathways for leaching strategic metals from the geological formation and corresponding electrochemical methods for metal removal and recovery on the surface.

This complex objective is supported by *Tasks 2.2, 2.3, 3.1* and *3.2*. The results of *Tasks 2.2* and *2.3* were discussed in the previous section. Investigations within WP2 proved that metals can be leached from the orebodies over a prolonged period of time and may influence the economics of EGS. The continuous leaching of metals will increase the performance of the system over time in a controlled way.

WP3 aims to prove that the dissolved metal content of geothermal fluids (naturally present or leached within the proposed concept) can be removed on surface by electrochemical methods. Within *Task 3.1* metals are recovered by high-temperature, high-pressure geothermal fluid electrolysis. Since the start of this task in M10, an electrochemical reactor system has been designed and constructed to operate at temperatures up to 250 °C and pressures up to 200 bar, to evaluate kinetics and mechanistic aspects of electrochemical reactions at HTP *(Figure 6)*.

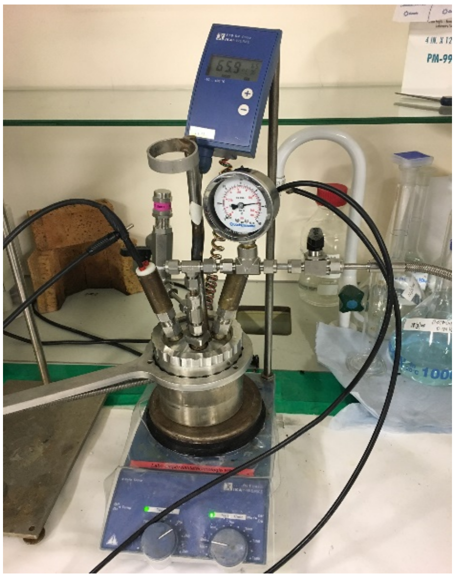

Figure 6: Elevated temperature and pressure stationary electrode reactor used for metal recovery studies.

Related to *Task 3.2*, experiments on metal recovery take place by electroprecipitation and electrocrystallization. The preparation of the experimental setups was carried out and first tests with three relevant model geothermal brine compositions started in the first reporting period. Analysis of the performance of the gas-diffusion electroprecipitation and electrocrystallization (GDEx) process with respect to different operational parameters also started in the first reporting period as well as the analysis of the products formed through the GDEx process.

In the recent reporting period, based on the relevant brine compositions obtained from the literature study, experiments with simulated Li-Al brines were conducted, as well as with real brines containing these metals *(Figure 7)*. The formation of mixed metal hydroxides was obtained, which have commercial relevance. It was pointed out, that different compounds can be formed at different temperatures, and the increase of the electrode resistance during the treatment is smaller when operating at higher temperatures. Higher salt content results in higher current and shorter process time, and higher metal content results in longer process time. Higher temperature results in a current increase and experimental design has to be adapted to perform experiments at higher temperatures.

Figure 7: Precipitates formed during the GDEx treatment of three different simulated geothermal brines at two different temperatures.

During the long term performance of the GDEx system at high temperatures, the main components of the fouling correspond to salts but not the metals, and alternating cleaning cycles of the electrode increases its performance for the long term. It was also concluded that aluminium precipitates at pH 5-7 and re-dissolves at pH 9-11, Li combined with Al precipitates at pH 5-7 and does not re-dissolve, the incorporation of Li in the product does not require a consumption of electrons (charge) while the incorporation of Al does, spending more charge during the process. Higher working electrode potential results in shorter process time but no increase in the charge consumption. Higher salt content results in higher current, shorter process time and a decrease in the energy consumption. The charge and the energy consumed by the process increases with the Ca and Mg concentration. This effect is more pronounced when increasing Mg concentration rather than Ca.

Objective 2 was partly completed by the work in WP2, but will be completely realised by August 2018 by the following additional deliverables:

- D3.1: Report on performance, mass and energy balances and design criteria for high-temperature, high-pressure electrolysis (M32),
- D3.2: Report on performance, mass and energy balances and design criteria for gas-diffusion electroprecipitation and electrocrystallization (M32).

Objective 3: Develop metallic-mineral formation specific solutions for the co-generation of electricity using salt-gradient power reverse electrodialysis.

This objective is addressed by Task 3.3. The implementation of this task started in M18. The fulfilment of the objective will be carried out by the submission of D3.3 in M32 and the following work until the end of the Task 3.3 in M36. The preparation of the experimental setup to measure performance of ion exchange membranes with a single pair of membranes, and the first experiments with pure NaCl at different concentrations were achieved in the first reporting period.

In the recent reporting period, different ion-exchange membranes were tested, and it was found that FUJI RP1 CEM/AEM membranes have the best performing in ultrasaline conditions, and performance drops significantly in moderate salinity. The FumaSep FKE/FAS membranes produced the best performing in moderate salinity, and relatively low drop in performance when decreasing high concentration. The in influence of divalent cations was also examined, and pilot scale experiments started to be carried out, and these experiments are still ongoing. In *Figure 8*, the instrumentation side of the pilot plant is shown.

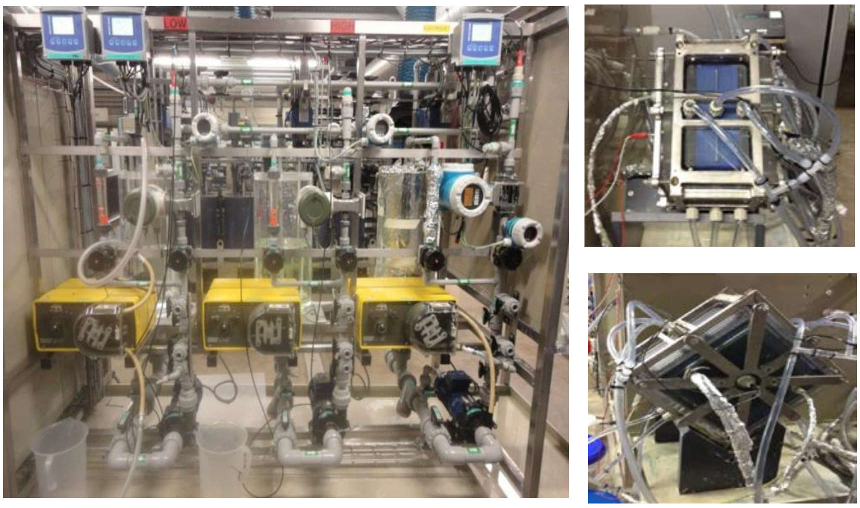

Figure 8: Picture of the SGP-RE (salinity gradient power extraction via reverse electrodialysis) pilot unit at VITO. The installation can accommodate RE (reverse electrodialysis)-stacks up to 10m² of cell pair surface and is able to run standardized experiments for evaluating the power output in different conditions such as varying salinity, brine composition, flow rate and temperature.

Results of the research related to *Objective 3* will be published in the following deliverable:

- D3.2: Report on performance, energy balances and design criteria for salt gradient power reverse electrodialysis (M32).

Milestone 2 'Salinity gradient power generation experiments start' was completed in M18.

Objective 4: 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.

This objective will be realised by the implementation of *Tasks 4.2*, which will start in M32. The task will be developed through a mathematical model which integrates the different system components (sub-models) into a single system and use it to develop optimisation strategies for energy and metal production. The main components in the model are two different metal recovery units, a geothermal binary power plant and a salinity gradient power plant. A model framework will be created based on component level models which enables linking downstream and upstream geothermal engineering subsystems.

As for preliminary work, a workshop on WP4 was organised in March 2018, in Lanzarote *(Figure 9)*. The aim of the workshop was to prepare for developing the mathematical model described above. A model approach was presented to the consortium and several issues were discussed and clarified. Different options of modelling tools were considered. Based on the evaluation, it was decided to use the python programming language for the modelling work.

Figure 9: Workshop on the WP4 strategy in March 2018.

The objective will be completed by the submission of the following deliverable:

- D4.2: Report on CHPM Process Optimisation (M41).

Objective 5: Develop a new conceptual framework that increases the total number of economically viable geothermal resources in Europe below the depth of 4 km and deeper including high-enthalpy resources.

This objective will be achieved by the implementation of Task 4.1, which started in M28. Task 1.4 already provided initial methodological framework, which defines both the overall concept for converting different types of orebodies into an EGS reservoir and the series of experiments and measurements that will need to be conducted in order to validate the concepts to TRL4 in a laboratory environment.

Task 4.1 started in M28 and will convert outputs of WP1-WP3 into an overall architecture design of the envisioned CHPM facility. The development of the conceptual framework will build on existing component level models of geothermal power plants, but will be highly dependent on the outcomes of WP2 and WP3 to add metal recovery to the overall process flow.

Objective 5 will be achieved by the submission of the following deliverable:

- D4.1: Conceptual Framework for CHPM power plant (M33).

Milestone 3 'Systems integration work initiated' was completed in M28.

Objective 6: Turn the inherent characteristics of these new resources (extreme content of dissolved metals and often very high temperatures) into an advantage by proposing a new type of geothermal facility.

This objective will be addressed by *Task 4.3* which will start in M36. The technical specifications will be finalised and design specifications will be provided.

The objective will be completed by providing the following deliverable:

- D4.3: CHPM schematics and blueprints (M42).

Objective 7: Develop an economic feasibility assessment model to be applied for such new facilities.

This objective is addressed by *Tasks 5.1, 5.2* and *5.3.* Within *Task 5.1,* the elaboration of the integrated sustainability assessment framework started in M18. Economical, social and environmental aspects of the proposed CHPM technology were considered, and guidelines were developed for the other tasks within the work package, suggesting possible routes to compile the necessary framework documents that could be further developed when the current technology will be applied at a larger scale. The structure of the proposed framework was inspired by those industry standard documents that were conceived to ensure the sustainable operation of this specific field of industrial activity. Baseline economics for energy and mineral raw materials, and decision support for economic feasibility assessment will be provided in the later phase of the implementation of WP5. *Task 5.2* started in M24 and *Task 5.3* in M28.

Objective 7 will be completed by the submission of the following deliverables:

- D5.1 Integrated sustainability assessment framework (M24),
- D5.2 Economic feasibility assessment methodology (M32),
- D5.3 Self Assessment Tool (M40).

Objective 8: Develop an integrated feasibility assessment framework for evaluating the environmental and socio-economic impacts of the proposed new technology line.

This objective will be achieved by *Task 5.4*, *5.5* and *5.6. Task 5.4* and *Task 5.5* started in M24, *Task 5.6* will start in M36. However, work in *Task 2.4* also provided input by data collection throughout WP2 for the subsequent assessment of the environmental impacts of the system in WP5. *Task 2.4* also defined the parameters that would need to be measured and collected in order to execute WP5. Emerging phenomena that can have relevance from an environmental footprint point of view, or that could affect systems optimisation and performance were also considered in *Task 2.4.* Particular interest is on the fate of leaching fluids, by-products of chemical reactions or level of self-containment. The results of the work in *Task 2.4* were laid down in the following deliverable:

- D 2.4 Report on overall systems dynamics (M24).

The achievement of *Objective 8* will be performed by the completion of the following deliverables:

- D5.4 Report on policy implications (M42),
- D5.5 Environmental Impact Assessment Framework (M38),
- D5.6 Ethics Assessment Report (M42).

Objective 9: Combine metallogenic models with geothermal datasets to develop a database of suitable areas in selected case-study areas in Europe where such developments could be feasible

Task1.1 and Task *1.2* already supported the achievement of this objective. Four potential case-study areas had already been selected in the preparation phase of the proposal. The implication of these test areas in the metallogenic belts of Europe was examined in Task 1.1. Within Task 1.2, an overview of the four test sites (four major ore districts in Europe, namely in SW England, southern Portugal, NW Romania and central and northern Sweden) was made. It was completed with a survey of existing boreholes in the European countries, where temperatures at depth in access of 100°C are observed. The geological settings were described, attempts were made to estimate their geothermal potential.

Results of this work were described in the following deliverables:

- D 1.1 EGS-relevant review of metallogenesis (M6),
- D 1.2 Report on data availability – compiled from 5 reports (M10).

Objective 9 will be completed by the implementation of *Tasks 6.1* and *6.2,* which started in M24. *Task 6.1* involves a technology visioning process for the further development of the CHPM concepts against the backdrop of different socio-economical-technological scenarios and expected policy developments. *Task 6.2* aims to support the development of technology and economic feasibility plans for pilot implementation of the CHPM plants.

Task 6.1 focuses on the long-term planning and includes different foresight elements for different postposes. Horizon scanning will provide the present technological baseline for CHPM today, the Delphi survey will inform on what the future may be at important but uncertain areas, and the vision will describe what the desired destinations are in the future for the CHPM technology. The main result so far is the development and implementation of the Delphi survey, with the involvement of the consortium partners and AB members. The preparation started with a small-scale Horizon Scanning exercise, including a literature review and a workshop in Lanzarote in order to identify relevant factors, drivers, trends, issues, to be further investigated in the Delphi survey *(Figure 10)*.

Figure 10: Workshop in Lanzarote for the identification of the statements to be used in the Delphi survey.

The CHPM2030 Delphi survey also served as a dissemination tool, since ~250 Experts were contacted personally, hundreds through EFG EurGeol mailing list, the survey was posted CHPM2030 website and social media channels, on IGA (International Geothermal Association) social media, circulated internally in IGA Resources & Reserves Committee, and ThinkGeoEnergy websites. Gathering Experts' input in the 2nd round survey is in progress.

Figure 11: The EFG LTP Orientation Workshop in Brussels.

In April 2018, an orientation workshop was held for the EFG LTPs in Brussels in order to explain what they have to achieve in WP6 *(Figure 11).* In the first part of the workshop a short area selection exercise was carried out, and then discussion was made about the area evaluation template.

Task 6.2 will support the development of technological and economic feasibility plans for the pilot implementation of the CHPM systems. This work is carried out with the involvement of the geological surveys representing the study areas.

In order to understand better the geology and CHPM potential of the selected study areas, a field visit to Cornwall was organised by BGS. The fieldtrip covered a number of localities and gave an overview of the geological and mineralisation history of the region. The mine water treatment plant at Wheal Jane, and the EU-funded geothermal energy drill site for Geothermal Engineering Limited at United Downs were also visited *(Figure 12)*.

Figure 12: Visiting the United Downs geothermal project site in Cornwall.

Another study site visit in Romania started to be planned in the reporting period and will be carried out in July 2018.

Objective 9 will be achieved by the submission of the following deliverables:

- D6.1 Report on Emerging and Converging Technologies (M42),
- D6.2 Report on Pilots – compiled from 5 reports (M40).

Objective 10: Develop a roadmap in support of the pilot implementation of such system before 2030, and the full-scale commercial implementation before 2050.

This objective will be achieved by *Task 6.3*, which will start in M33. Two roadmaps will be created, a practical and goal oriented one, and a technology vision oriented one. The objective will be achieved by the submission of the following deliverable:

- D6.3 Roadmap for 2030 and 2050 (M42).

1.2 Explanation of the work carried out per WP in the reporting period

1.2.1 Work Package 2

WP title:	**Laboratory experiments and orebody investigations**		
Lead beneficiary:	NERC-BGS	Participants:	UNIM, USZ, ISOR, VITO
Start date:	01.10.2016	End date:	31.12.2017

Objectives of the WP

Ultra-deep (>4 km deep) orebodies contain networks of naturally-formed, hydraulically-conductive features such as fractures. These can be used within an engineered geothermal system (EGS), to allow flow of fluid from an injection borehole, through the orebody, to a production borehole, and then to the surface for heat/energy recovery/use. Heat will transfer from the rock to the fluid at a rate dependent upon the contact surface area and residence time of the fluid in the rock. In a similar way, metallic minerals lining the flow features within the orebody will dissolve, transferring metals to solution, and then these can be carried to the surface for extraction. In the technology envisioned by CHPM2030, advantage will be taken of these features to facilitate co-production of heat and metals. There are however, several uncertainties/knowledge gaps within this concept, and it is these that this WP2 aimed to address through two main objectives:
Objective (1): To develop the tools and methods for orebody EGS reservoir management.
Objective (2): To test and validate the methods using simulations and laboratory experiments reaching and exceeding TRL-4.
In order to meet these objectives, three hypotheses were proposed and tested:

- The composition and structure of orebodies have certain features that could be used to our advantage when developing an 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 the performance of the system 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.

Synthesis of work done and results achieved

The work in this WP is organised into 4 Tasks, which do not exist in isolation, and there has been active exchange of information between all of them. This includes in-depth discussions at 6-monthly project meetings, and shorter information exchange during the approximately monthly telephone conferences. Other project partners not identified below have also actively contributed comments and information to Tasks within this work package. There has also been exchange of rock samples from pilot areas between partners. This allows the same testing equipment to be used on multiple samples, resulting in larger and more comparable datasets, and ultimately higher quality outputs from the project.

Task 2.1 *Concepts and Simulations for Integrated Reservoir Management* (completed December 2017)
This Task was led by, and largely conducted by USZ. However, was notable co-operation with other project partners, in particular UNIM who contributed lab experiments on rock stress measurements. This Task has been completed, and progress was in-line with that anticipated. Activities included:

- A number of laboratory investigations were completed. These included: heat conductivity measurements on rock samples *(Figure 13)*, rock mechanics studies to determine the stress field

of different metal-bearing rocks (uniaxial compressive strength, triaxial compressive strength and indirect tensile strength), fracture enhancement studies, and elevated pressure fluid flow experiments on rocks treated to different levels of artificial fracture enhancement.

Figure 13: Thermal Conductivity Meter TK04 with HLQ probe used for measuring the heat conductivity of rocks.

- A parallel modelling sub-task was also completed. Within this, a three-dimensional stochastic fracture model was built and described, and then a 3D fluid, heat- and mass-transport model was used to define the extractable amount of heat and metallic minerals regarding different scenarios.
- *Deliverable D2.1* completed, report entitled *'Recommendations for Integrated Reservoir Management'* was submitted on time *(Figure 15).*

The main achievement in this Task was determining the magnitude of possible metal production of an envisioned CHPM plant. Rock mechanical studies point at granitoid formations as prime candidate rock types to host an enhanced communicating fracture network (relatively hard and brittle rock). 3D stochastic fracture network modelling (RepSim) and finite element flow and transport modelling (FeFlow) determined that fluid production at 3500 m^3/day (40 L/s) is a sustainable possibility. Mineralised samples from granitoid rocks leached in elevated temperature and pressure experiments show enhanced release of lead, zinc and lithium. Projecting flow and solution chemical parameters to a metal recovery pilot site, gives production estimates in the order of several kg/day.

There was a conference presentation on the work: M. Osvald, J. Szanyi, T. Medgyes and B. Kóbor. 'Metal leaching in geothermal systems', presented at the 17^{th} Alps-Adria Scientific Workshop, Hnanice, Czech Republic, 9-14 April 2018.

Task 2.2 *Metal content mobilisation using mild leaching* (completed December 2017).
This Task specifically investigated whether relatively 'mild' leaching agents (i.e. those that are relatively environmentally benign, see Task 2.4) are capable of liberating metals into the recirculating fluid within an EGS. Metal enhancement was observed, though the amount of this varied with metal and type of fluid. This Task was led by the NERC-BGS, and the experiments were conducted in the BGS labs. However, there were close linkages with USZ (Task 2.1). Activities included:

- Finalisation of the high temperature lab experiments aimed at understanding and enhancing metal leaching under in-situ pressure/temperature conditions. This included reacting mineralised rocks from other project partners at 100°C to compare with results from UK derived material, plus reacting mineralised UK material at up to 200°C *(Figure 14)*. A total of 6 samples from the SW England were studied, plus 6 from project partners (2 from Hungary, 2 from Romania, and one each from Portugal and Sweden).

Figure 14: Dickson-type rocking autoclave used for high temperature experiments up to 200°C at BGS.

- Finalisation of analyses of reacted solids and liquids, compilation of all data, and interpretation of the results to aid reaction process understanding. Geochemical modelling of the analysed solutions was also undertaken – mainly to examine pH changes and mineral saturation states.
- Metal liberation was aided by: higher temperatures, lower pH, the presence of ligands (e.g. acetate, chloride ions) and pyrite dissolution.
- Pyrite dissolution liberated some Fe^{3+}, and this appears to have played an important role in the dissolution of other sulphide minerals (it facilitates their oxidation). Hence there are benefits of having a mixed sulphide mineral assemblage in the rocks (e.g. pyrite and chalcopyrite, though in the experiments we mainly saw the effects of pyrite and galena).
- There was evidence for copper and silver mobilisation, albeit temporarily, followed by precipitation around the sites of dissolution (etch pits). Whilst there is some uncertainty about the precise mechanism driving this, it is consistent with competition between metals for ligands in the relatively dilute solutions used. This effect may become less of an issue in the case of highly saline deep brines.
- Subsamples of reacted partner samples were sent to UNIM in case they were needed for future studies.
- The overall conclusion of the study was that some degree of enhanced metal mobilisation could be achieved. Dilute mineral acids liberated the most metals, and classical complexing agent such as EDTA kept them in solution. However, dilute simple organic acids (such as acetic acid) were also quite effective, and they had the benefit of mobilising lower concentrations of less desirable elements (such as aluminium and silica). However, for the rock samples studied, only lead was found to be mobilised relatively easily, with more important critical metals occuring at lower concentrations.
- Deliverable D2.2 completed, report entitled '*Report on metal content mobilisation using mild leaching*' *(Figure 15)*. This report has joint authorship between the BGS and the University of Miskolc.

There was a conference presentation linked to the work: P.A.J. Lusty, C.A. Rochelle, R.A. Shaw, A. Kilpatrick and the CHPM2030 team (2017). Combined extraction of energy and metals from ultra-deep ore bodies: The potential of Cornwall, UK. Abstract in the proceedings of the 2017 Goldschmidt conference, 13-18 August 2017, Paris, France. Goildschmidt Abstracts 2017, 2486.

Task 2.3 *Metal content mobilisation with nanoparticles* (completed June 2018).
This Task involved the selection and screening of carbon nano-materials for metal mobilisation. This included the modification of selected materials for improved metal sorption selectivity/capacity under different temperature and pressure conditions (i.e. towards targeted recovery of individual metals). It was led and conducted by VITO, but there has been information exchange with other project partners. There is also a close connection of this task to activities within WP3. Activities included:

- Functionalising the surface of carbon nanoparticles with acidic or alkaline groups - as such, a wider variety of metals or pH conditions could be targeted.
- Given the current strategic importance of rare earth elements, it was decided to focus on neodymium (Nd) as a representative element of that group. This involved the use of acidic functionalised carbon nanoparticles. The best performing powder had adsorption percentages above 90 %. It was also demonstrated that the trends observed for Nd were also valid for other rare earth elements.
- The competition for sorption sites by other metal ions present in higher concentration was also investigated. Using lead as an example, as its concentration increased the sorption capacity for rare earth elements decreased, although not to the same extent for all powders. Under mild conditions, the functionalised powder had still a significant sorption capacity (~40 %) at relevant lead concentrations (1000 ppm). However, a more negative impact was observed at a combination of high temperature (80 °C) and high salinity (0.5 M), with sorption percentages in the range of 20 – 30 %.
- Functionalisation also changed the nature of the sorption performance. In some cases this resulted in a broader pH range over which metal sorption occurred, which might facilitate metal capture over a wider range of natural environments. However, in some cases this also resulted in a decrease in overall sorption capacity.
- Initial lab tests to study the impact of nanoparticles on permeability were conducted on ceramic disks having a range of pore sizes ('synthetic rocks'). Even though the particle size distribution was smaller than the pore size of the samples, a layer of particles built up on the surfaces of the samples, and permeability dropped drastically. This could be important in terms of focussing on the most appropriate particle sizes for different rocks (flow paths are larger in fractured rock) and the number of particles within each litre of fluid ('loading density').
- By prior agreement with the Project Officer, the timeline for *Deliverable D2.3* was extended by 6 months until the very end of the reporting period. A report entitled *'Metal content mobilisation with nanoparticles'* was produced by the revised deadline *(Figure 15)*.

Task 2.4 *Overall system dynamics and data for environmental assessment* (completed December 2017).
This Task integrated the results of activities within WP2, identifying key parameters for the CHPM technology, and fed them into WP4 (optimisation and performance) and WP5 (environmental impacts). It was led by, and was been largely conducted by UNIM. However, there was input of data from all project partners, though within this WP especially BGS, ISOR, VITO and USZ. This Task has been completed, and progress was in-line with that anticipated. Activities included:

- Discussions at project meetings in order to capture observations coming out of Tasks 2.1-2.3, plus other parts of the CHPM2030 project. Synthesis of this information to identify the most important information for each of the technology steps.
- Developing a schematic overview of an envisioned CHPM facility, identifying the locations of the critical parameters, drawing up data-capture tables for each critical parameter, and then engaging with other project partners to source missing data.
- Deliverable D2.4 completed, report entitled *'Recommendations for Integrated Reservoir Management' (Figure 15)*.

Figure 15: Deliverables 2.1-2.4 as outcomes from Work Package 2.

Status of ongoing and finalised deliverables			
Deliverable no. and name:	**D2.1 Recommendations for integrated reservoir management**		
Due date:	31.12.2017	Delivered to the EC on 30.12.2017	Status: submitted
Contributors:	USZ, UNIM		
Summary:	Heat conductivity measurements were carried out on rocks with high potentiality to form a basis of an orebody-EGS system. The same samples were investigated in a pressure chamber to determine which metals and minerals can be mobilized in such a system and at what fluid flow levels. Results from stress field determination of various metallic rocks by rock mechanics and fracture enhancement were used to build 3-dimensional stochastic fracture, fluid flow, heat and mass transport models. These models aimed to define the extractable amount of heat and metallic minerals in different scenarios. During these investigations, a novel laser-technology was introduced and thoroughly tested to enhance permeability and fractures in rocks of interest on a laboratory scale. Rock mechanical studies point at granitoid formations as the prime candidate to host an enhanced communicating fracture network. Elevated pressure and temperature leaching tests of samples of granite-related mineralisation indicate enhanced release of lead, zinc and lithium. 3D stochastic fracture network modelling (RepSim) and finite element flow and transport modelling (FeFlow) determined that fluid production at 3500 m3/day (40 L/s) is a sustainable possibility. Projecting these parameters to a pilot site metal production may reach magnitudes in the order of kg/day.		
Deliverable no. and name:	**D2.2 Report on metal content mobilisation using mild leaching**		
Due date:	31.12.2017	Delivered to the EC on 27.12.2017	Status: submitted
Contributors:	NERC-BGS		

Summary:	Leaching experiments used samples from a variety of mineralisation types: lead-zinc mineralisation from the UK, porphyry copper mineralisation from Hungary and Sweden, skarn from Romania, and massive sulphide mineralisation from Portugal. The experiments simulated a range of potential in-situ conditions: temperatures of 70-200 °C, and pressures from atmospheric to 200 bar. Leaching solutions were mainly 'environmentally benign': de- ionised water, tap water, dilute brine (0.6 M sodium chloride), de-ionised water with 20 bar Pco2, 0.1 M ethylenediaminetetraacetic acid (EDTA), 0.1 M acetic acid, 0.1 M sodium dodecyl sulfate (SDS), 0.1 M ammonia (NH3) and 0.1 M hydrogen peroxide (H2O2). However, for comparative purposes, experiments were also run with more aggressive leaching agents: 0.1 M hydrochloric acid (HCl) with 0.03 M nitric acid (HNO3) and, 0.01 M HCl with 0.003 M HNO3. Enhanced metal leaching was observed (relative to water or dilute brine), reaching steady-state concentrations in the first few tens of hours. Not all metals behaved in the same way – lead was leached relatively easily (up to 1000 ppm) whereas others proved much harder to mobilise (e.g. tin and tungsten, which did not rise above 1 ppm). The mixture of mineral acids was the most effective solution used for liberating a range of metals, however solutions containing organic compounds (EDTA, acetic acid, SDS) also proved effective. However, EDTA and SDS (like mineral acids) led to higher concentrations of dissolved aluminium and silica (increased potential to form clays, potentially blocking flow pathways), whereas acetic acid did not. A key control on metal release from the sulphide mineral-dominated samples studied was oxidative dissolution, the presence of Fe3+ being most useful in this regard. A tentative relative order of reactivity for the ore minerals studied is: galena ≈ chalcopyrite > sphalerite ≈ pyrite ≈ magnetite > bournonite. Of the other minerals observed: calcite ≈ dolomite > chlorite > szaibelyite ≈ quartz. Dissolution caused pitting of mineral surfaces, which was often severe (e.g. for galena). Within and around etch pits were enrichments in copper and silver - suggesting that galena dissolution caused localised competition for ligands between lead and silver/copper ions – with lead winning and staying in solution, and silver/copper precipitating. Hence, a geothermal fluid rich in ligands might aid metal recovery.		
Deliverable no. and name:	**D2.3 Report on metal content mobilisation with nanoparticles**		
Due date:	31.12.2017	Submission deadline postponed by prior agreement to 30.06.2018	Status: submitted
Contributors:	VITO		
Summary:	Experiments were conducted to demonstrate the feasibility of using carbon nano-particles in suspension as sorbent materials for important metals. Four commercially available types of particles were chosen for study, and their surfaces were 'functionalised' by treatment with strong acids and alkalis. This helped tune their metal retention properties – both in terms of enhancing metal uptake, and making it specific to the type of metal. Experiments focussed on neodymium as a representative of the rare earth elements (key elements on the European list of critical raw materials).		

	Acidic functionalisation of the best performing carbon particles gave adsorption percentages above 90%. Surface functionalisation also changed the nature of the sorption performance. In some cases this resulted in metal sorption over a broader pH range (i.e. facilitating metal capture over a wider range of environments), though in some cases this also resulted in a decrease in overall sorption capacity. Factors impacting efficient sorption were also investigated. This included competition with other metal ions in solution - as the concentration of the other metal ions increased, the sorption capacity for Nd (and by inference, other rare earth elements) decreased. However, significant sorption capacity remained (~40 %) at lead concentrations of 1000 ppm. The impact of a combination of high temperature (80°C), high salinity (0.5 M) and high competition with other metals (e.g. lead) caused sorption capacities to decrease further (in the range of 20 – 30 %). Preliminary tests on the impact of the suspended particles on host matrix permeability used man-made materials (very well-constrained pore size distributions) to simulate porous rock. Even though the particle size distribution was smaller than the pore size of the simulated rocks, there was a significant drop in permeability as a layer of carbon particles built up on the surfaces of the porous solids. This could be important in terms of focussing on the most appropriate particle sizes for different rocks (flow paths are larger in fractured rock) and the concentration of particles in the fluid.		
Deliverable no. and name:	**D2.4 Report on overall system dynamics**		
Due date:	31.12.2017	Delivered to the EC on 29.12.2017	Status: submitted
Contributors:	UNIM		
Summary:	This Task is a key point in the critical path of the project workflow - collecting and managing data from WP1 and WP2, and using this to provide baseline information to WP3, WP4 and WP5. This has involved collecting, organizing and archiving data generated during WP2 and identifying data needs or data gaps that have to be measured to successfully complete successfully complete WP5. It has also created the basic linkages of the CHPM technology elements to establish the foundation for system optimisation (WP4). Finally, it has also identified potential environmental impacts (including any emerging phenomena) that have relevance in terms of environmental footprint for the envisioned CHPM plant. A key part of this deliverable is the metadata archive 'CHPM_DataArchive.xls'. Deliverable 2.4 shall serve as reference document for WP4 and WP5. At the same time, the subsequent WPs creating data and system integration knowledge must contribute to the data archive that is an integral part of this document. For the most efficient data backup, this document (at least some of its annexes) must be considered as a dynamic document, being constantly updated and added to with information generated in the subsequent measurement and analysis WPs.		

1.2.2 Work Package 3

WP title	**Metal recovery and electrochemical power generation**		
Lead beneficiary:	VITO	Participants:	KU Leuven
Start date:	01.10.2016	End date:	31.12.2018

Objectives of the WP

Natural networks of hydraulically-conductive metallic mineral veins could readily function as "heat-exchanger surfaces" in a novel type of EGS system designed to tap into both the geothermal and ore potential of these structures at depths of 4 km and more. In the technology envisioned by CHPM2030, large-scale intelligent geoengineering of the geological structure will take place, strictly configured to take advantage of the natural characteristics of the particular metallic deposit. The objective of this WP is to develop the tools and methods for orebody EGS reservoir management and test and validate the methods using simulations and laboratory experiments. There are three hypotheses to be tested in this WP:

- The composition and structure of orebodies have certain advantages that could be used to our advantage when developing an 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.

WP3 will implement the methodology framework research programme defined under Task 1.4 that will also provide initial quantitative targets.

Synthesis of work done and results achieved

The work in this WP is organised in 3 tasks. A summary or the work carried out by the beneficiaries involved in each of them, for the reporting period in which the WP has been active (M10-M18), is presented below. Progress within this WP is in-line with that anticipated.

Task 3.1 *Recovery of the metal content by high-temperature, high-pressure geothermal fluid electrolysis* (HTP) (ongoing)
This Task is led by KU Leuven. Work started in the first reporting period, in M10. First the design criteria were defined based on data obtained from literature and the parameters provided by WP1 and WP2. Potential-pH diagrams were estimated for electrochemically active metals: Cu, Pb, Ag, Ni, Sb, and Zn, at temperatures up to 250 °C and pressures up to 200 bar. The purpose of the study was to understand the chemistry of metals in the presence of sulphur and water, and the changes in reduction potentials at elevated temperatures and pressures.

A rotating disk electrode reactor with a maximum allowable working pressure of 271 bar at 300 °C was designed and constructed, to study the kinetic and transport properties of metal recovery using electrochemical deposition. Successfully performed rotating disk electrode at room temperature and pressure was established by estimating the Levich curve for Cu2+/Cu in aqueous solutions at rotation speeds up to 800 rpm.

In the recent reporting period, the reactor was tested for safe operation, the required safety instruments were sized, procured, and assembled as shown in *Figure 16*. The design pressure for the pressure vessel, based on the European Union's Pressure Equipment Directive (EU-PED) was estimated to be

477 bar and 238 bar with a safety factor of 0.5, while the maximum allowable working pressure, based on American Society of Mechanical Engineers (ASME), was estimated to be 271 bar at 300 °C.

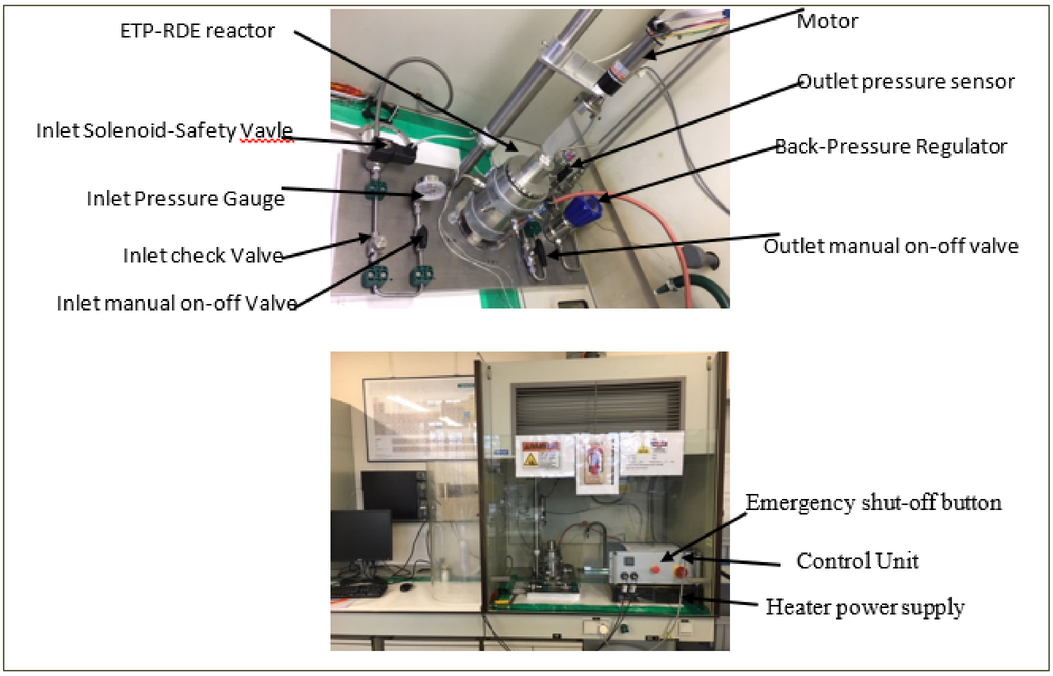

Figure 16: ETP-RDE setup, with safety instruments used for estimating kinetic and transport properties of electrochemical reactions at temperatures up to 300 °C and 238 bar (design 1).

Among electrochemically active metals, Cu was identified as the major metal to be targeted for recovery. Effects of temperature, pressure, silica concentration, Pb concentration on the recovery of Cu was studied. Metal recovery studies were performed using carbon foam electrodes in a stationary electrode reactor.

A model of a hydrocyclone electrochemical reactor was developed using Comsol, to simulate the recovery of various metals by using the rate constants for electrodeposition obtained from experiments at elevated temperature and pressures. The results of the simulation will yield the mass and energy balance and input to WP4.

Based on the results in the reporting period the following conclusions can be drawn:

- Copper can be successfully electrodeposited at elevated T and P. The energy requirement to recover copper at such conditions were lower when compared to recovery at room T and P.
- High pressure offers a controlled deposition, resulting in a uniform distribution of faceted deposits over the substrate.
- Elevated temperatures result in smaller sized deposits, which could be attributed to an instantaneous nucleation mechanism as opposed to the progressive nucleation mechanism that is observed for deposition conducted at room temperatures.
- Elevated T and P also result in a higher yield and a higher recovery rate compared to that of the deposits at room T and P.
- Lower initial concentration and the presence of silica tend to reduce the Faradaic efficiency, % metal recovered, yield, and recovery rates.

Status and pending tasks: 70% of the recovery study experiments have been completed. The completed experiments have been highlighted. Once the experimental matrix has been completely performed, a clear idea on the effect of the evaluated parameters on the metal recovery should be apparent.

***Task 3.2** Recovery of the metal content of geothermal fluids by gas-diffusion electroprecipitation and electrocrystallisation (GDEx)* (ongoing)
This task is led by VITO. Experiments on metal recovery were carried out by electroprecipitation and electrocrystallization. In the first reporting period, of the experimental setups were developed and first tests with three relevant model geothermal brine compositions (i.e., England, Iceland, and Belgium) were performed. Analysis of the performance of the gas-diffusion electroprecipitation and electrocrystallization (GDEx) process with respect to different operational parameters (i.e., temperature and long term performance) were evaluated and the obtained products were analysed.

In the second reporting period a literature survey has been completed on geothermal brines characterization. Lithium and aluminium have been identified as relevant compounds within the brines compositions and experiments to study the performance of the GDEx process for the recovery of these metals under different operational conditions (i.e., Li:Al ratio, working electrode potential, salinity, temperature and presence of Ca and Mg) have been performed. In addition, experiments using real geothermal brines (i.e., from Romania) have been carried out using the GDEx technology. Energy and mass balances, and the characterisation of the obtained products have been analysed from these experiments *(Figure 17).*

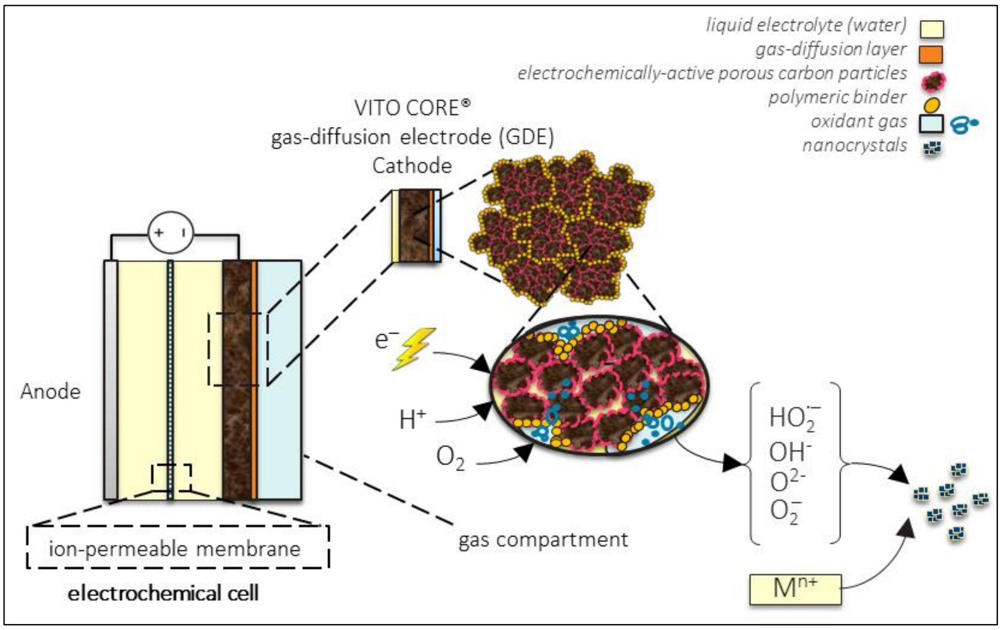

Figure 17: GDEx experimental setup for metals recovery from geothermal brines.

The main conclusions than can be stated from the results obtained from these experiments are:

- Different metallic products can be formed at different temperatures, with a broader variety of compounds at higher temperatures.
- When operating GDEx at different temperatures for the recovery of metals from geothermal brines, higher temperatures favors the formation of smaller particles and avoids an increase of the electrode resistance during the treatment, enhancing the performance of the system.
- Higher salt content and higher temperatures result in higher current densities and shorter process time, while higher metal content results in longer process time.
- Energy consumption per unit of weight of product increases and current efficiency decreases when operating at higher temperatures due to the increased solubility of metals.
- Alternating cleaning cycles of the electrode would be recommended to increase its performance in the long term, to remove the precipitated salts on the surface of the working electrode.
- Preliminary experiments for the recovery of Li and Al using the GDEx technology showed that: (1) Al alone precipitates at pH 5-7 and re-dissolves at pH 9-11, (2) Li alone does not precipitate,

and (3) when Li and Al are combined during the process, a precipitate is formed at pH 5-7 that does not re-dissolve.
- The main products precipitated in the GDEx process when combining Li and Al are lithium aluminium chloride hydroxide hydrate (i.e., Li/Al LDH) and impurities of aluminium hydroxide.
- Higher working electrode potential, higher salt content, and lower presence of Ca and Mg, result in shorter process time and less charge consumption.

Task 3.3 *Salinity-gradient power from pre-treated geothermal fluids* (ongoing)
Reverse electrodialysis converts the difference in chemical potential to electrical energy. Electrode reactions induce electric current and result in ions being transported through ion exchange membranes due to the difference in concentration gradients. The electrochemical cell potential is generated by selective diffusion of ions. Geothermal brines are in the range of salinities applicable to this concept, regarding the high-end concentration stream. However, the theoretical and experimental potential that can be generated by these brines is unknown, as it is site-specific and depends on the composition and temperature of the stream, among other factors.

During the membrane testing, the system consisted of three separate compartments: two high concentration streams, and in the middle, between the two of them, a low concentration stream *(Figure 18).* The membrane potentials are measured as bulk potential.

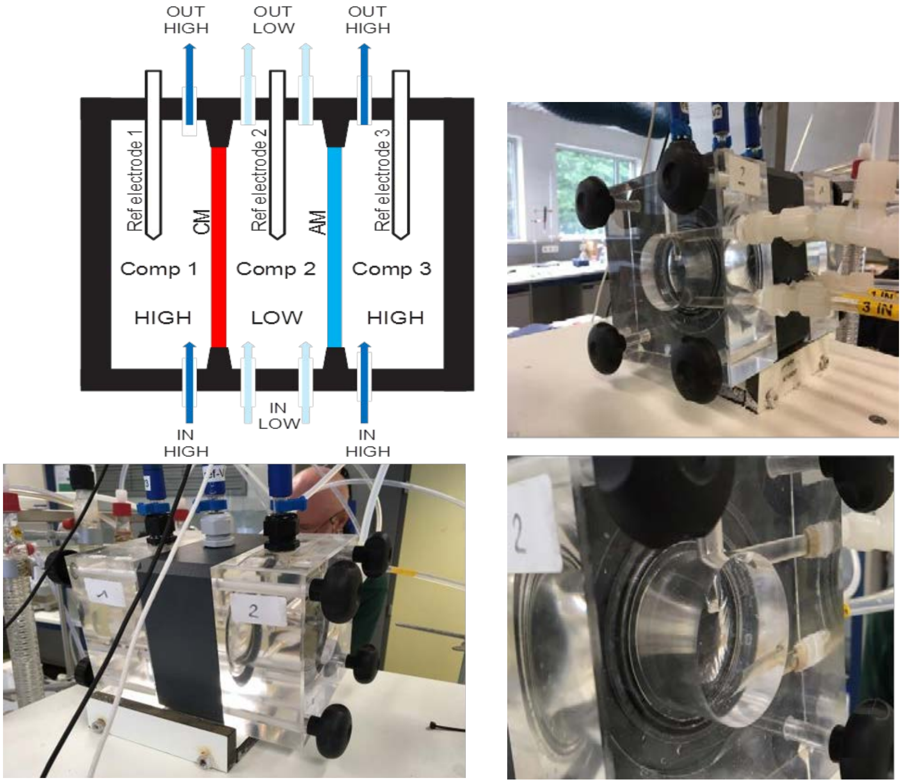

Figure 18: Single cell-pair SGP-RE setup for lab-scale experiments.

The high concentration stream is kept constant, while the low concentration stream is measured continuously. The system includes temperature control. Two ion-exchange membranes were tested:
- FUJI RP1 (160µm)
- Fumasep FAS/FKS (20µm)

The highest power densities were obtained with the FUJI membrane (~7 W/m^2), which exhibited the highest net water transport. The best performances with FUJI RP1 membranes at 25°C were obtained in extreme salinities (5M). The best performances with Fumasep FAS20/FKE20 membranes at 25°C were obtained in moderate salinities (2M).

The pilot scale experiments (multiple cells) are ongoing. The experimental tests are being performed connecting the stack to a galvanostat (AMEL 2044) controlled by the software Junior Assistant, or in a later stage by setting the steps of current in MeFiAS in each program line together with the other process parameters.

Status of ongoing and finalised deliverables

Deliverable no. and name:	**D3.1 Report on performance, mass and energy balances and design criteria for high- temperature and high-pressure electrolysis**		
Due date:	31.08.2018		
Responsible:	KU Leuven		
Summary:	Experiments are ongoing and on time to complete this deliverable (no deviations are anticipated).		
Deliverable no. and name:	**D3.2 Report on performance, mass and energy balances and design criteria for gas- diffusion and electroprecipitation and electrocrystalization**		
Due date:	31.08.2018		
Responsible:	VITO		
Summary:	Experiments are ongoing and on time to complete this deliverable (no deviations are anticipated).		
Deliverable no. and name:	**D3.3 Report on performance, mass and energy balances and design criteria for salt gradient power reverse electrodialysis**		
Due date:	30.06.2018	Postponing the submission to 31.08.2018 was approved	
Responsible:	VITO		
Summary:	Experiments are ongoing and on time to complete this deliverable (no deviations are anticipated).		

1.2.3 Work Package 4

WP title	**Systems integration**		
Lead beneficiary:	ISOR	**Participants:**	UNIM, USZ, VITO, KU Leuven
Start date:	01.04.2018	**End date:**	30.06.2019

Objectives of the WP

The aim of WP4 is to integrate downstream and upstream processes into a single system and develop optimisation strategies for energy and metals production. This task will combine the past experience of the consortium members with the design of medium and high-enthalpy geothermal systems and the outcomes of WP2 and WP3 to create a novel technology line that will produce energy and valuable metals in a single, interlinked process. This knowledge will be utilised to adapt contemporary power plant design to the expected temperature and extreme salinity conditions that will occur under the CHPM2030 scheme.

Synthesis of work done and results achieved

Task 4.1 *Conceptual framework(s) for CHPM power plant* (ongoing)
This Task started in M24. ISOR carried out several consultations on planning the workflow in WP4. An online meeting dedicated to WP4 was also held in February 2018 in order to clarify the work

distribution between the participating partners. Connecting to the Consortium Meeting in March 2018 in Lanzarote, a workshop on WP4 was also held. In the Lanzarote workshop, it was decided that the different CHPM system components will be integrated into a single system by a mathematical model. This model will be used to develop optimisation strategies for heat, energy and metal production.

A model framework is being created based on component level models which enables linking downstream and upstream geothermal engineering subsystems. The following distinct components are considered:
1) underground heat exchanger,
2) production wells,
3) electrolytic metal recovery,
4) geothermal binary power plant,
5) gas diffusion electro-precipitation,
6) salt gradient power generation and
7) injection wells.

Sub-models within the components will describe the behaviour of each component and these will be combined in one overall mathematical model. Each component has an input from the previous component in the chain and an output to the following component *(Figure 19)*.

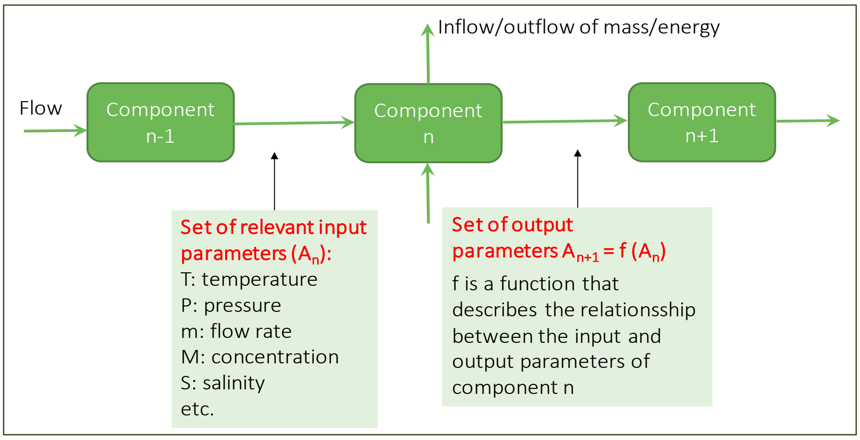

Figure 19: Schematic presentation of a component model.

Task 4.2 *Process optimisation and simulations*
According to the time schedule described in GA Annex I, this task will start in M32. However, there have been some preliminary works described in the followings.

At this stage the type and scope of the mathematical model is being developed at ISOR with inputs from other partners. The approach in the overall model is to consider each component as a "black box" into which a list of parameters is feed and out comes a new list where the list has been altered according to the inner workings of each component. Also from the input parameters the energy input or output of each component is calculated. The current list of parameters is composed of the following fluid properties: temperature, pressure, acidity/basicity, salinity, flow rate, along with the concentration of carbon dioxide, calcium, magnesium, and various metals such as gold, silver, copper, etc.

This list of parameters at this stage is not considered to be fixed and parameters can be added or removed as deemed necessary. Most of the components are still in active development and data is being accumulated. Detailed knowledge on the interplay of various parameters within most of the components is therefore missing. Due to this uncertainty the model approach in consideration is a probabilistic Monte Carlo model. In a Monte Carlo model each parameter is given a probability distribution according to the certainty of its value. The model is then run multiple times using

randomly selected set of parameters for each run. In the end a probability distribution for energy use and metal extraction is created. As a simple example in *Figure 20* the input and output probability distribution for the current version of the geothermal binary plant component are shown. Here the temperature range is taken to be in the range from 70°C to 200 °C with the probability distribution taken to be a triangular distribution with the mode at 120°C. The output distribution shows the range of power to be expected from the input temperature distribution and the most likely value, which in this case is around 8 MW.

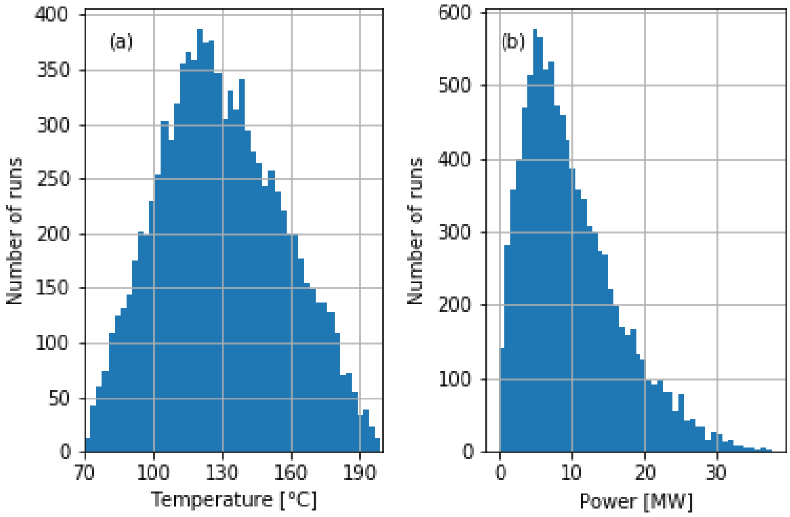

Figure 20: (a) Input probability distribution for temperature for the binary power plant component. (b) Output probability distribution for power production for the binary power plant component.

The models for each component relating the input and the output values can also involve uncertainty. For example for the relation of energy use as a function of Ca and Mg concentrations and salinity for the Gas diffusion electro-precipitation component is currently based on the blue data points in *Figure 21*.

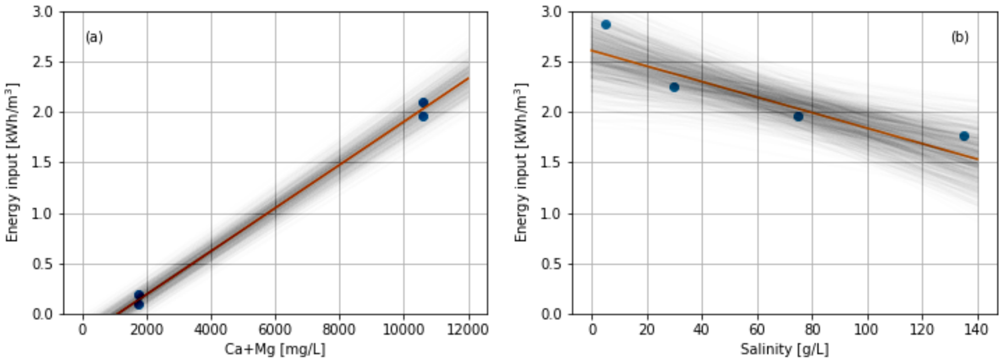

Figure 21: Relation between energy use of the Gas diffusion electro-precipitation component as a function of (a) Ca and Mg concentration and (b) salinity.

The relation for energy use as a function Ca and Mg concentrations and salinity is deduced from a linear regression analysis, shown as an orange solid line in *Figure 21*. With more data points nonlinear regression would also be considered. The linear regression analysis gives uncertainty ranges that can be used in the Monte Carlo modelling. In *Figure 21* one thousand lines that are randomly selected from the uncertainty range of the parameters from the linear regression analysis are drawn in black. For each run in the Monte Carlo modelling one such line would be randomly chosen.

Currently the status of the modelling work is collection of data for each component so that a probabilistic model can be constructed in the python programming language using the approach described above.

The work on Task 2.4, led and largely conducted by UNIM, on collection of critical parameters for the technological elements and the overall system dynamics provides important inputs to the work on system integration in WP4. It integrates the results of activities within WP2, identifying key parameters for the CHPM technology, and feeds them into WP4 (optimisation and performance). UNIM has also established a data archive excel sheet on the Google Drive, which can serve as a base for the work in WP4.

KU Leuven has developed a model of a hydrocyclone electrochemical reactor using Comsol, to simulate the recovery of various metals by using the rate constants for electrodeposition obtained from experiments at elevated temperature and pressures. The results of the simulation will yield the mass and energy balance, which will provide important inputs to WP4.

In the M18 – 30 period, VITO had a number of discussions with ISOR and the other consortium partners on the approach that will be used to model CHPM plants. In order to prepare the development of code to do the modelling, VITO set-up a git repository. The repository is web-based and allows easy transfer of code between different partners. It included detailed versioning, allows efficient planning of code writing and facilitated comparison of (piece of) codes that are being developed by different partners. VITO has also created code to calculate the performance and costs of a binary cycle based on the input temperature and mass flow rate of the geothermal brine.

Future activities at VITO in WP4 will be focused on more specific modelling work. Thus, they will evaluate the usefulness of the pySOT optimizer and upload a commented version of the simple binary plant model that VITO has developed.

Task 4.3 *CHPM schematics and blueprints.*
According to the time schedule described in GA Annex I, this task will start in M36.

Status of ongoing and finalised deliverables

Deliverable no. and name:	**D4.1 Conceptual Framework for CHPM power plant**		
Due date:	30.09.2018		
Responsible:	ISOR		
Summary:	Work is ongoing and no delays with the submission of the deliverable is expected.		
Deliverable no. and name:	**D4.2 Report on CHPM Process optimisation**		
Due date:	31.05.2019		
Responsible:	VITO		
Summary:	According to the time schedule in GA Annex I, work on this deliverable hasn't started yet.		
Deliverable no. and name:	**D4.3 CHPM schematics and blueprints**		
Due date:	30.06.2019		
Responsible:	ISOR		
Summary:	According to the time schedule in GA Annex I, work on this deliverable hasn't started yet.		

1.2.4 Work Package 5

WP title	**Integrated sustainability assessment**		
Lead beneficiary:	USZ	**Participants:**	UNIM, EFG, ISOR, NERC-BGS, LNEG, LPRC, MINPOL, IGR, SGU
Start date:	01.06.2017	**End date:**	30.06.2019

Objectives of the WP

Work package 5 will assess the expected environmental and socio-economical impacts for each component of the proposed CHPM technology followed by an overall systems-level performance assessment. This will include a preliminary LCA and investigations concerning the environmental footprint of the envisioned technology scenarios. Comparison will then be made with existing systems (both for power generation and mineral extraction) to have a good understanding of the relation of CHPM2030 to existing solutions from an environmental and economics performance point of view. Performance indicators will consider the fact that CHPM envisions the integration of two, insofar independent processes for improved economics: the production of energy and the production of metals. Work will focus on the socio-economics, environmental and life-cycle issues, risks, risk ownership and possible risk mitigation, performance and cost targets together with relevant key performance indicators and expected impacts.

Synthesis of work done and results achieved

The work in this WP is organised in 6 tasks. Task 5.1 started in M18, Tasks 5.2, 5.4 and 5.5 will start in M24, Task 5.3 will start in M28, and Task 5.6 will start in M36.

Task 5.1 *Integrated sustainability assessment framework* (ongoing)
Work on this task started in the first reporting period by building a model which is designed to be able to visualize the optimal composition of the produced heat, electricity and metals by the CHPM facility, depending on the world price of each produced metals, the price of the electricity and of the heat. This model would optimally be able to support decision to divert the production of each component if that is not feasible based on the world price. The sustainability of the ore extracting processes and geothermal energy production are crucial part of this task.

With D5.1 being successfully delivered to the EC in M24, this task is finished. The responsible partner was USZ, and the main contributor is Minpol with providing framework for task 5.2 and description of presently used economic models as well as self-assessment tool – a software simulation model, which is being developed for D5.3. In D5.1, among other socio-economic indicators, Social Impact Assessment (SIA) was described in detail. D5.4 will analyse SIA reports of previous similar energy infrastructure projects and infrastructural investments in the range of the proposed scale of the model CHPM plant and will formulate its own aspects delivering a model Social Impact Assessment that covers all potential fields that need to be addressed throughout the life-cycle of a model plan that eventually will be implemented in a real-life scenario.

Environmental Impact Assessment (EIA) Framework is the tool most widely used in environmental management to determine the potential environmental, social and health effects of a proposed development in order to provide decision-makers with an account of the implications of a proposed course of action before a decision is made. It is also an aid to decision-making and to the minimization or elimination of environmental impacts at an early planning stage. The basics, prior to task 5.5, were

also introduced and partially applied to in situ leaching (ISL), which technological process is the key difference between a conventional geothermal power plant and a CHPM facility.

During the combined production of heat, power and metals, many factors influence the economic balance between the productions. A model, developed by MinPol in an upcoming task is intended to determine the optimal composition of produced goods under given circumstances *(Figure 22).*

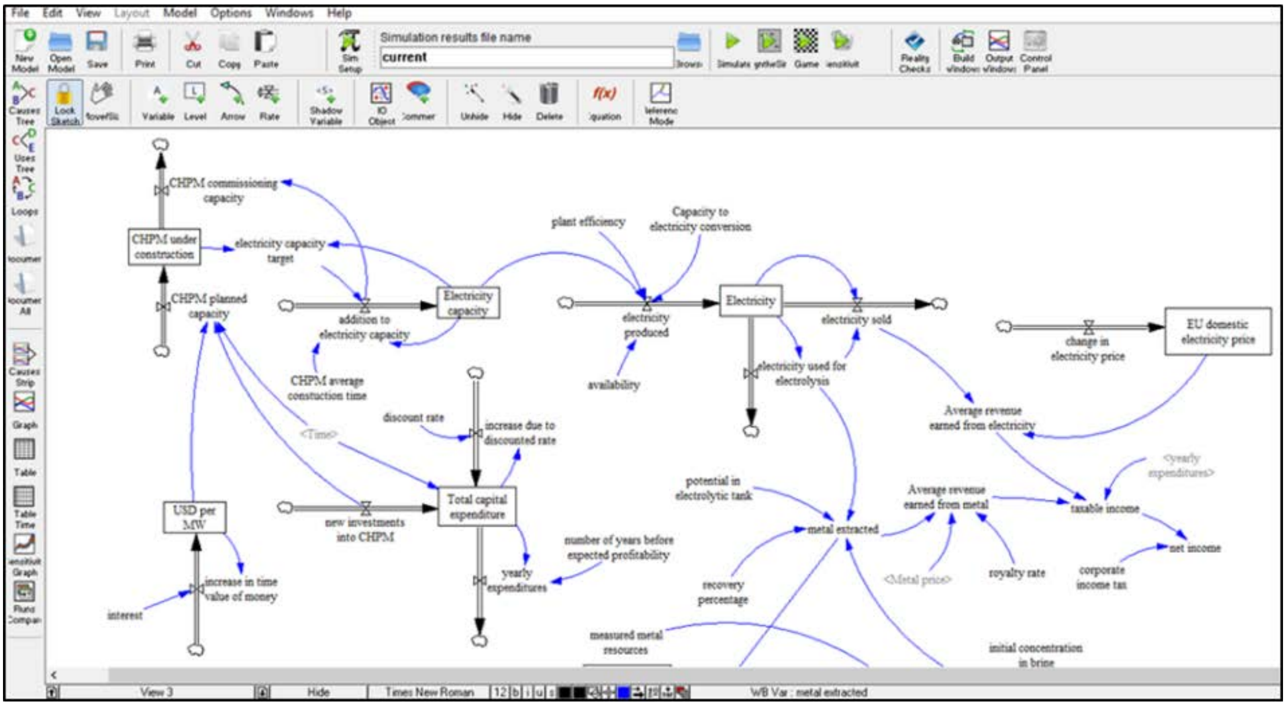

Figure 22: An example of the CHPM model in Vensim.

The System Advisor Model (SAM) developed by the National Renewable Energy Laboratory, U.S. Department of Energy, is capable of calculating with a variety of renewable energy projects including the geothermal sector. The fundaments of Self-Assessment Tool (SAT) and the Vensim modelling environment were laid down for upcoming tasks in WP5.

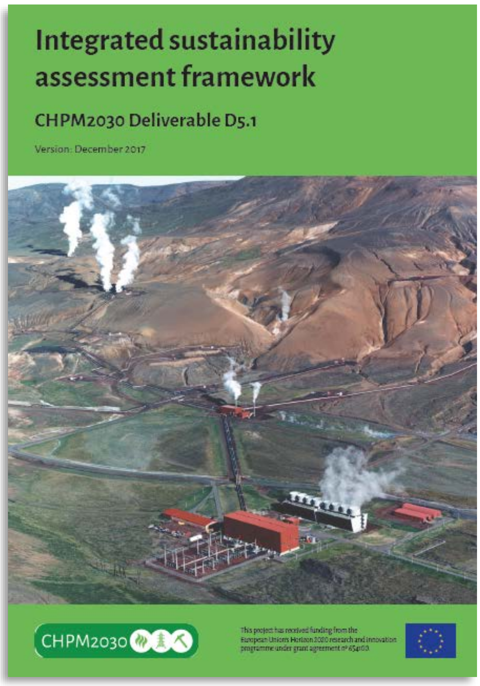

Figure 23: CHPM2030 Deliverable 5.1

D5.1 serves as a guideline for the individual sub-tasks, suggesting a possible route to compile the first draft of the necessary framework documents, that could be further developed as the current technology will be taken up to a larger scale *(Figure 23).* As a suggestion, it was mentioned that, close cooperation is anticipated between the CHPM2030 project and the developers of the Geothermal Sustainability Assessment Protocol (GSAP), cited in the report. It would be a good opportunity to join forces with them in developing a GSAP, that covers not only the needs of standard geothermal development but the needs of those initiatives that go beyond the current state of the art.

Task 5.2 *Baseline economics for energy and mineral raw materials* (ongoing)
Task 5.2 is in progress, Minpol is the responsible partner for D5.2, and the main contributor is USZ. D5.2 will include:
1) Description of Enhanced Geothermal System (EGS) projects, which have similar energy infrastructure as the proposed CHPM technology. Focus will be put on the economy and financial issues of the EGS projects.
2) Description of economic issues of the most similar mining method – in-situ leaching. This method, is presently used in uranium mining industry.
3) Comparison with other conventional and/or non-conventional energy sources and mining using different methods from economic, financial and investment point of view.
4) Overview and potential position of proposed CHPM technology at energy and raw material market.
5) Draft of the financial costs of proposed CHPM (investment, operating costs) and its questions of its economic feasibility.

Task 5.3 *Decision support for economic feasibility assessment* (ongoing)
Minpol is the responsible partner for D5.3, and the main contributor is USZ. There is progressive development of the self-assessment tool, which is due in M40. The economic model for CHPM facilities started to be developed in the first reporting period. The model uses a system dynamics approach and the Vensim simulation software. Data from other WPs as well as information, which will be gathered in Task 5.2, will be used for the specification and updating of the model.

Cooperation between USZ and Minpol on Task 5.2 and 5.3 was carried out via e-mail exchanges and personal meetings. Schedules, responsibilities, deadlines were agreed upon and the joint work started with the development of a first draft of the “list of content” of D5.2 and D5.3.

Task 5.4 *Social Impact Assessment and policy considerations* (ongoing)
The responsible partner for this task is Minpol. A search for the best practices to study the social impact has been started; the partners are discussing pros and cons of using a survey to recognise the opinion of the public. If a survey is used, it will have to be representative and not local, to sample opinions from a range as broad as possible. However, a CHPM facility will always be local, therefore local people need to be polled and informed beforehand, which information may shape their opinion.

Task 5.5 *Environmental Impact Assessment* (ongoing)
The responsible partner for this task is USZ. Work on this task started in the second consortium meeting, with the presence of the Advisory Board. During that meeting, a few companies and experts with possibly relevant experience were contacted for further co-operation and to gain access for the environmental impact assessment of a European EGS project. The works on the task are ongoing, the deliverable is expected to be provided on time.

Task 5.6 *Ethics Assessment*
As this task starts in M36, no activities have been taken yet.

Status of ongoing and finalised deliverables

Deliverable no. and name:	**D5.1 Integrated sustainability assessment framework**		
Due date:	31.12.2017	Delivered to the EC on 27.12.2017	Status: submitted
Responsible:	USZ		
Summary:	D5.1 discusses the economic, social and environmental aspects that have the potential to affect the long-term sustainability of CHPM systems. It also summarises the relevant concepts, methodologies and subsequent activities. The novel approach of CHPM2030 ventures to previously uncharted territories when it comes to energy production and mineral extraction within the frame of a single project. There are standard procedures to address individual components of such an initiative in terms of environmental, social or economic assessment. However, to understand the potential impacts of combining and EGS operation with an ISL mining program it takes a lot more than to combine the pros and cons of these two ventures. Careful and detailed planning is essential to identify those risks and medium-long-term impacts that have the potential either to benefit the local socio-economic setting while leaving a minor environmental footprint or wreack havoc on the neighbouring population, the regional economy or the local environment. The document provides a guideline for the further tasks, suggesting a possible route to compile the first draft of the necessary framework documents, that could be further developed as the CHPM technology is going to get taken up to a larger scale.		
Deliverable no. and name:	**D5.2 Economic feasibility assessment methodology**		
Due date:	31.08.2018		
Responsible:	MINPOL		
Summary:	The work on the task is ongoing, D5.2 is expected to be delivered on time.		
Deliverable no. and name:	**D5.3 Self Assessment Tool**		
Due date:	30.04.2019		
Responsible:	MINPOL		
Summary:	The work on the task is ongoing, D5.2 is expected to be delivered on time.		
Deliverable no. and name:	**D5.4 Report on policy implications**		
Due date:	30.06.2019		
Responsible:	MINPOL		
Summary:	The work on the task is ongoing, D5.2 is expected to be delivered on time.		
Deliverable no. and name:	**D5.5 Environmental Impact Assessment Framework**		
Due date:	29.02.2019		
Responsible:	USZ		
Summary:	The work on the task is ongoing, D5.2 is expected to be delivered on time.		
Deliverable no. and name:	**D5.6 Ethics Assessment Report**		
Due date:	30.06.2019		
Responsible:	USZ		
Summary:	This deliverable is not yet due.		

1.2.5 Work Package 6

WP title	Roadmapping and Preparation for Pilots		
Lead beneficiary:	LPRC	**Participants:**	UNIM, USZ, EFG (with LTPs), ISOR, NERC-BGS, LNEG, VITO, IGR , KU Leuven, SGU
Start date:	01.12.2017	**End date:**	30.06.2019

Objectives of the WP

CHPM technology is a low-TRL, which needs future oriented thinking. WP6 represents these forward-looking efforts and aims to set the ground for subsequent pilot implementation by working on three interlinked areas: (1) mapping convergent technology areas, (2) study pilot areas, and (3) develop research roadmaps. The three areas are represented by three tasks: Task 6.1 Horizon scanning & Visions, Task 6.2 Preparation for pilots, Task 6.3 Roadmapping.

The objective of Task 6.1 is to start up a technology visioning process for the further development of the CHPM concepts against the backdrop of different socio-economical-technological scenarios and expected policy developments. The outcome of the visioning process will be the definition of a wide array of convergent technologies that can support the implementation of more advanced and technologically challenging CHPM schemes by 2030/2050.

The aim of Task 6.2 is to support the development of technology and economic feasibility plans for pilot implementation of such system, being used for discussing their financing. The study areas are in England, Portugal, Romania and Sweden. In addition, a European outlook is also taken on perspective locations.

Task 6.3 focuses on the development of two roadmaps: 2030 (short term) and 2050 (long term). The short-term roadmap provides timeline and direct support to the first pilots. The long-term roadmap provides revision and updates in response to unforeseen, emerging phenomena and supports breakthrough research for future CHPM development.

Synthesis of work done and results achieved

WP6 started in December 2017 and it is coordinated by LPRC. The approach was to map expected results and outputs internally to have a clear vision on WP6 goals. The next step was to investigate how proposed foresight tools can deliver the results, which are outlined in the methodology. The implementation of Task 6.1, 6.2 and 6.3 are ongoing, working towards the previously identified goals.

Recently, the 2-round CHPM2030 Delphi survey was developed and the CHPM area evaluation template and framework is under creations to evaluate study areas and to select and evaluate European sites for CHPM potential, with parallel development at each study area.

Task 6.1 *Horizon Scanning and Visions* (ongoing)
This task represents the long-term planning and it includes different foresight elements for different postposes. Horizon Scanning (HS) will provide the present technological baseline for CHPM today, the Delphi survey will inform on what the future may be in important, but uncertain areas, and the Vision will describe the future for CHPM technology. In the Roadmap, T6.1 will be used to describe how to get from the present (HS), through the future development (Delphi), to the desired Vision.

The main activity so far was the development and implementation of the Delphi survey, with the involvement of the consortium partners and AB members. First the structure and topics were drafted by LPRC and it was refined/completed during the Lanzarote T6.1 workshop with the input from all partners. During this workshop, the partners were mapping key interest areas (geothermal drilling, scaling, metal recovery, etc.), identifying gaps (challenges, bottle necks, difficulties, enablers) within these areas, then coming up with ideas for statements to be used in the Delphi survey. Challenging issues were identified both in the mineral and the geothermal sectors *(Figure 24)*.

Figure 24: Workshop on Task 6.1 in Lanzarote, in March 2018.

Following the workshop, LPRC worked with the partner's input and created the Delphi forms, using Google Forms. The statements and the form were reviewed and corrected by VITO (Ben Laenen), UNIM (Éva Hartai), and EFG (Anita Stein). 5 statements were grouped in the geothermal sector and 4 in the mineral sector, and there were 3 overall statements like geothermal drilling depth/risk, corrosion, exploration techniques, Social Licence to Operate, etc., in order to mobilise expertise from the mineral and the geothermal research communities. Meanwhile a strategy was created for the Expert base, including a "Call for Experts", and contacting them was delegated to the most relevant partners, whenever it was possible, mostly to EFG, UNIM. In the first round, including the partners and the Advisory Board members, in total ~100 Experts participated worldwide, providing insights on emerging technologies, future trends and critical areas. The results of the 1st round were processed by LPRC and were integrated to the new 2nd form. It was then reviewed by UNIM (Éva Hartai). The 2nd round was sent to all previous participants and to the ones contacted later.

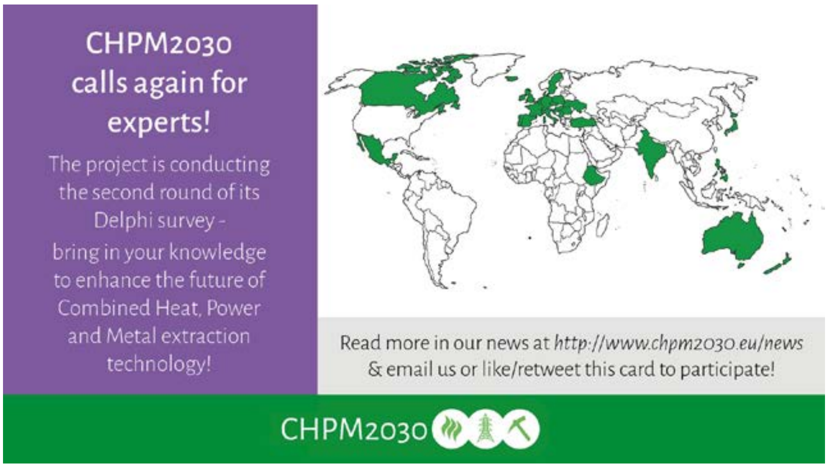

Figure 25: "Call for experts" social media card for the Delphi 2nd round, prepared by EFG.

The CHPM2030 Delphi survey also served as a dissemination tool, since ~250 Experts were contacted personally, hundreds through EFG EurGeol mailing list, the survey was posted CHPM2030

website and social media channels, on IGA (International Geothermal Association) social media, circulated internally in IGA Resources & Reserves Committee, and ThinkGeoEnergy websites (in English and in Turkish) *(Figure 25).*

LPRC is still in the process of gathering input in the 2nd round. The plan is to process all results of the Delphi survey during July/August 2017 and summarise the findings that will be input of further T6.1 and T6.3 activities.

Upcoming T6.1 activities include 1) preparation for the Visioning workshop with 20 participants, which has already started, 2) Horizon Scanning to use existing scenarios and relevant foresight studies as a baseline, starting in August, this year. T6.1 feeds into the research Roadmap: how to get to the future vision of 2050, from the baseline 2019, through the emerging technologies.

Task 6.2 *Preparation for pilots* (ongoing)
This task represents the short-term planning to 'set the ground for subsequent pilot implementation' and builds on the results of D1.2 Report on data availability and D2.4 Report on overall system dynamics. In Task 6.2 - Preparation for pilots, the focus is on Data Evaluation for CHPM potential of the study areas and elsewhere Europe-wide.

Recently, a template is being formulated for evaluating the CHPM potential of the study areas. Due to the novelty of the task, a common framework or template is required in order to 1) evaluate the areas according to the CHPM2030 consortium's collective knowledge, 2) harmonise work: structured reports and better area comparison. This template outlines the topics that are important to cover when evaluating an area for CHPM potential.

The objective was to gather ideas and strategies on the core question of T6.2: how to advance the study area evaluation from the solid baseline which has been provided in WP1. It was important to discuss these questions with the partners and build a common strategy. Beside the Task 6.1 workshop, another workshop was dedicated to Task 6.2 in Lanzarote. A draft template was presented by LPRC, and all partners participated in the refining of this template. The idea was to generate meaningful discussion between the technology developers (VITO, KU Leuven, UNIM, USZ, ISOR, MinPol) and the study area representatives (IGR, SGU, LNEG, BGS, EFG). The former represented a set of requirements on what they want to know about an area, before deploying CHPM technology, the latter represented data availability from a concrete site.

The results of the Lanzarote T6.2 workshop were used to update the template, which was presented at the Orientation Workshop for the EFG's Linked Third Parties in April 2018 in Brussels. An area selection exercise, and the discussion on the evaluation template were the main topics in the workshop which was facilitated by EFG and LPRC.

A fieldtrip to Cornwall was organised by BGS with participants from UNIM, IGR, EFG, LPRC, which was a good opportunity to further develop the evaluation template through informal discussion after the field activity (read more about the field activities on the project website). The conclusion is that it is important to integrate all available "geo" data into an existing/new 3D/4D model for better understanding the picture as a whole, to help the deeper extrapolation, for better conceptual understanding, test the theories we have from the area, visualize data, and create new and tangible results of the area. Partners are still discussing how to align 3D modelling methodologies in the different study areas.

The evaluation framework has been finished and it is ready to be used as:

- aid for evaluating the study areas;

- guideline for the EFG LTPs for the EU spatial database on prospective CHPM locations;
- assistance and instruction on how to select and assess any other location that, and to be used beyond the project for the first pilots;
- input for the Roadmap2030.

Considering that CHPM2030 is a research project at TRL 4-5 and the first pilots are set for 2030, this template is not expected to be completed with all details and aspects of the presented topics. Instead, the template is to set a common framework and direction to evaluate the study areas according to the available data, and then tackle the remaining gaps with structured recommendations.

Partners involved in WP6 contributed with the following input:
IGR:
- Data that need to be used in 3D models were inventoried and acquired.
- The license SKUA – GOCAD for the 3D model elaboration was acquired.
- The 3D model of Baita Bihor (which is one of the 3 sites described in WP1) started to be elaborated.
- Chemical analyses of the geothermal fluid from Stei, were realised.
- Information regarding the mining licenses of the study sites was collected.

BGS:
- Project planning and undertaking geoscience data compilation, review and analysis, in the context of its potential for a future EGS pilot plant.
- Review of analogous geological settings to South West England that have ultra-deep geological data available, to assess the validity of extrapolating surface structural observations to the depth of an EGS. Review of conceptual models for open space systems and fracture permeability at >4km depth. Consideration of scenario-based approaches to developing 3D models for South West England in discussion with BGS modellers.
- Preparation for, and leading a field visit to Cornwall for other project partners.

LNEG:
- Review of previous 3D geological models established for the Iberian Pyrite Belt Portuguese sector under the scope of the Promine and previous exploration projects, with focus on the Neves-Corvo mine area.
- Study of the possible prolonging of present day ore bodies to depths compatible with the CHPM technology.
- Revision of the current 3D structural models of the Neves-Corvo region built during the PROMINE project using GoCad and MOVE is currently underway. This revision will focus on possible deep targets based on the analysis of Promine 2D seismic reflection data, which reached more than 4 km and also on 3D inversion of available land gravity data. Results will be available by the end of the year/January 2019.

SGU:
- Preparing deliverable Task 6.2.4 (D6.2), assembling of literature and working material;
- Contacts to universities, exploration and mining companies.
- Preparing instrumentation for temperature measurements in deep boreholes.
- Contribution and participation to the workshop for EFG's LTPs in Brussels.

EFG:
- Taking over the task of the French Geological Society (SGF) in WP6 with the help of Veronique Tournis, as an expert.
- Organising the CHPM2030 Linked Third Party Orientation Workshop (12 April 2018, Brussels). Preparing a guideline and template for the selection of prospective CHPM areas.
- Preparing a framework and template for the evaluation of basic characteristics of prospective CHPM areas.
- Preparing a framework and template for the evaluation of CHPM characteristic of prospective CHPM areas.

- Coordinating the involvement and activities of EFG Linked Third Parties in WP6.

The upcoming T6.2 activities include:
- Romania fieldtrip with IGR, UNIM, BGS, LPRC. Beside visiting the study area, we plan to discuss on the 3D modelling and the implementation of the study area evaluation template at the Romania study area.
- Personal meeting for 3D modelling: it was concluded that a personal meeting would facilitate aligning and share knowledge on modelling methodologies. It is not yet decided on when and where to host the meeting.
- T6.2 feeds into the research Roadmap2030: how to get to the desired vision of 2030, from the baseline 2019, with the pre-assessed study areas and LTP CHPM prospective locations.

Task 6.3 *Roadmapping*
This Task will start in September, 2018. In T6.3 two roadmaps will be created, short term for 2030 practical goal oriented, long term for 2050 technology vision oriented. 2030 direct support for the first pilots, 2050 support breakthrough research for future CHPM development.

1.2.6 Work Package 7

WP title	**Dissemination and stakeholder involvement**		
Lead beneficiary:	EFG	**Participants:**	UNIM, USZ, ISOR, NERC-BGS, LNEG, VITO, LPRC, MINPOL, IGR, KU Leuven, SGU
Start date:	01.01.2016	**End date:**	30.06.2019

Objectives of the WP

This Work Package seeks dialogue and engagement as well as dissemination of thematic WP outputs towards the stakeholder communities, research organisations, universities, SMEs and large companies, investors, R&D funding organizations, relevant technology platforms, NGOs, professional associations and the general public.

Synthesis of work done and results achieved

Within this Work Package, the work is organised in 3 tasks, which last from the beginning to the end of the project.

Task 7.1 *Dissemination management* (ongoing)
During the first months of the project, a communication and dissemination plan has been developed by EFG and presented to the consortium for approval. The communication and dissemination plan defines and prioritises the key objectives for dissemination of CHPM2030. Furthermore, it details the steps to be taken during the project's lifetime to achieve maximum impact and reach relevant audiences, combining timing and different media supports with consistent message content, structure and format. It also sets the framework to facilitate communications among the consortium members, between the consortium and stakeholders or the general public. This communication and dissemination plan is reviewed periodically to ensure that project objectives are communicated with optimum results.

__Task 7.2__ Dissemination support services (ongoing)

To help raise awareness to industry stakeholders, both within the partner countries and in other EU countries, the consortium generates at least four electronic **newsletters** during the project's duration. So far, two newsletters - one in June 2016 (https://mailchi.mp/58fc3d36c592/chpm2030-project-news) and one in June 2017 (https://us13.campaign-archive.com/?u=59ac88eda18fe61fc3cb6422c&id=16e4bde5ee) - have been prepared by EFG. The newsletters provided information about the project aims and the current status of work. During the reporting period, the second newsletter has been disseminated, in July 2017, to the project's mailing list. EFG also disseminated the newsletter via its own communication channels (website news section, newsletter and social media) reaching approximately 48,000 geoscientists all over Europe. The next issue of the newsletter is currently under preparation and will be published in July 2018 (due in M32).

Two project **brochures** have been designed so far by EFG and disseminated by all project partners. The text of these brochures was prepared by UNIM. The first version of the brochure was designed to provide a general overview of the project objectives; the second one introduced interim project results and provided an overview of the current status of work. Both versions have been translated by the EFG Linked Third Parties into 14 European languages (Czech, Dutch, Finish, French, German, Greek, Hungarian, Italian, Polish, Portuguese, Romanian, Serbian, Slovenian, Spanish) and made available on the project website. The third version of the brochure is currently under preparation and will be issued in August 2018 (M32). It will also be translated by the EFG LTPs.
In June 2017, EFG has designed a **poster** *(Figure 26)*, providing general information about the project for partners' use during the reporting period to promote CHPM2030 at conferences or exhibitions.

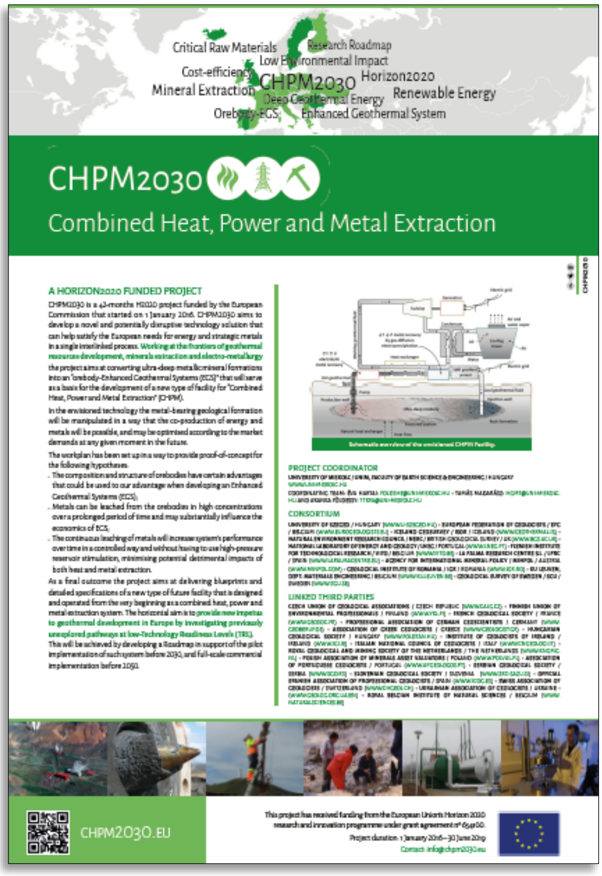

Figure 26: CHPM2030 poster.

All promotional materials are available to partners via the project's shared Google drive.

In December 2017, EFG has produced four A4 **factsheets about the CHPM technology** *(Figure 27)*. The purpose of these factsheets is to disseminate basic information on CHPM2030 to a broad audience. The following fact-sheets have been produced:

- Fact-sheet 1 (based on D1.1, D1.2): Ore deposit formation across Europe.
- Fact-sheet 2 (based on D.1.3, D 1.4, D 2.1): Enhanced Geothermal Systems.
- Fact-sheet 3 (based on D2.2, D2.3): Metal mobilisation.
- Fact-sheet 4 (based on D2.4, D5.1): Environmental aspects.

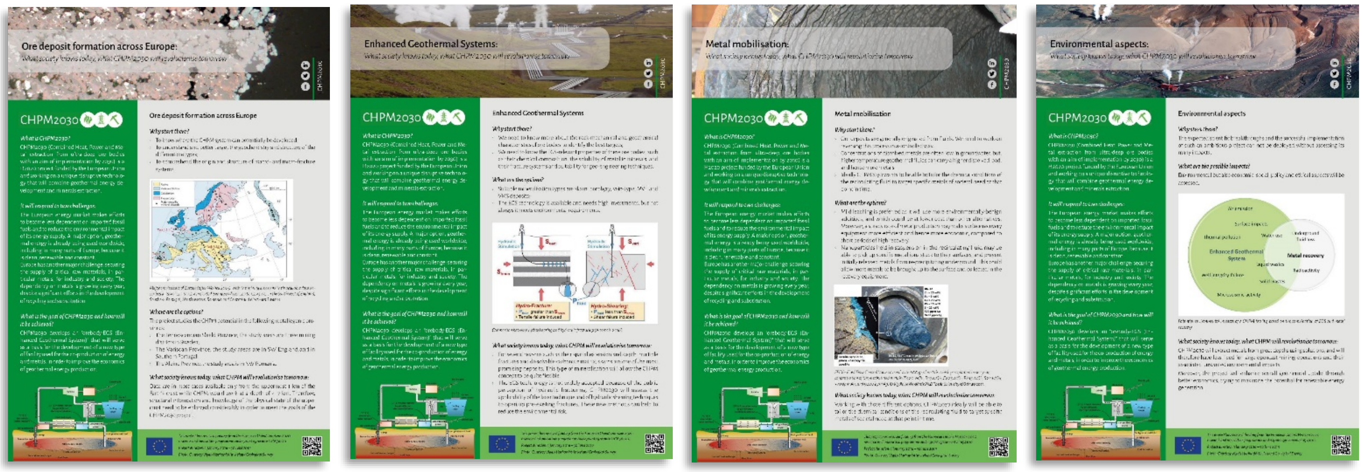

Figure 27: Factsheets about the CHPM technology.

All factsheets are available through the website's outreach page (http://www.chpm2030.eu/outreach/). They have been promoted via a social media campaign in January/February 2018 which has increased the number of followers and reach (more than 20,000 impressions on Twitter).

In total, more than 130 **social media posts** relating to CHPM2030 have been published in the last reporting period on the project's and EFG's Twitter, Facebook and LinkedIn accounts.

In autumn 2017, a general promotional **video** has been produced *(Figure 28)*. The video was released on the project's **YouTube Channel** on 19 January 2018 and broadly disseminated through the social media. It can be accessed via the following link: https://youtu.be/GrZ3cmGFUf4. As of 8 June 2018, the video has been viewed 280 times on YouTube, 227 times on Twitter and 299 times on Facebook.

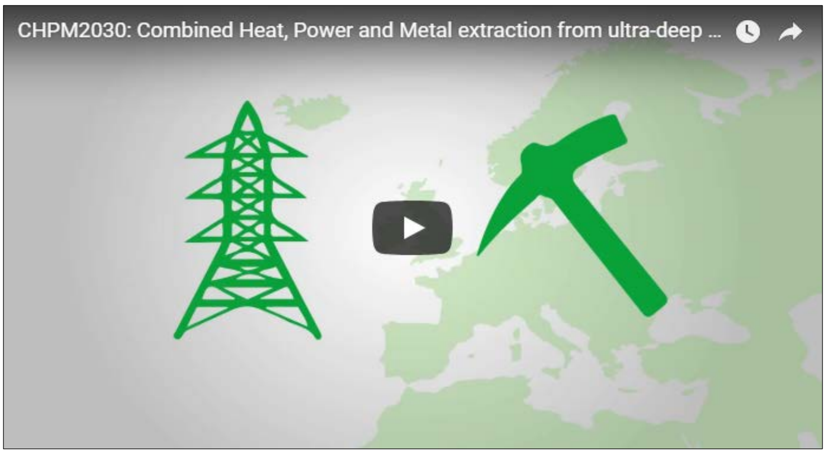

Figure 28: Screenshot from the CHPM2030 promotional video.

A **second project video** is currently under preparation with a length of 2 to 5 minutes and will present the content of the different work packages.

In July 2017, EFG has also been involved in the production and the promotion of a **joint press release** issued together with other H2020 projects in the field of geothermal energy which can be accessed at the following link: http://www.chpm2030.eu/2017/07/17/press-release-joint-efforts-to-strengthen-geothermal-energy/

As part of WP7, the EFG office also disseminated project news using the weekly EFGeoWeek newsletter, the monthly GeoNews and the trimestral EFG Project newsletter. Several articles were published on the EFG website and in the bi-annual European Geologist Journal. The approximated audience size of these online and print publications is ~50,000 people covering mainly geoscience professionals, scientists and policy makers through the national member associations.

EFG's efforts in disseminating the project towards the European geoscientists' community are supported by the **LTPs**, national member associations of EFG. They disseminate the results of the CHPM2030 project at national level in web portals, newsletters, magazines, articles, conferences, workshops, educational activities, exhibitions or any other relevant means. They also translate the three project brochures into the national languages (the first brochure has been translated in 2016, the second one in autumn 2017). Seven EFG member associations do not take part in the project, but they also disseminate the project results at a basic level in their own countries (newsletter, website) as a part of the usual communication channel between EFG and the national professionals. One of the LTPs, the Royal Belgian Institute of Natural Sciences (RBINS) doesn't take part in the dissemination. Dissemination materials have been provided to the LTPs in English language by EFG.

The CHPM2030 project partners contributed to Task 7.2 with the following actions:
IGR:

- Two interviews were given which included the description of the CHPM2030 project. One for 'Libertatea' paper in which Diana Persa besides referring to the geothermal energy potential in Romania, presented the objectives and the activities of the CHPM2030 project. The other one was given by Stefan Marincea, during the Night of the Museum event.
- Short descriptions of the goals of the project were published on the IGR's website and on the website of the National Geological Museum.

LNEG:

- LNEG has linked its website (www.lneg.pt) to the website of CHPM2030 project.

LPRC:

- CHPM2030 Delphi survey 1st round: contacting ~300 experts, introducing the project and referring to the website.
- CHPM2030 Delphi survey 2nd: planning to contact ~200 experts in June, introducing the project and referring to the website, although with overlap with the previous round.
- Regular website posts with CHPM2030 topics: http://www.lapalmacentre.eu/tag/chpm2030/
- Websites news items are shared on LPRC's LinkedIn (https://www.linkedin.com/company/la-palma-research-centre-sl/) and Facebook (https://www.facebook.com/lapalmaresearch/)
- Regular tweets about CHPM2030 events from https://twitter.com/lapalmaresearch and https://twitter.com/miktamas accounts.

MINPOL:

- MINPOL linked its website to the website of CHPM2030 project.

SGU

- SGU has contributed to and reviewed dissemination materials.

UNIM

- Éva Hartai and Tamás Madarász contributed to the preparation of the CHPM2030 factsheets.

Task 7.3 *Leveraging dissemination and dialogue* (ongoing)

In the reporting period, the CHPM2030 project partners contributed to Task 7.3 with the following actions:

EFG:

During the reporting period, EFG has presented the project and disseminated promotional material at different conferences and workshops:

- 3rd Meggen Days of natural resources, September 2017, Germany;
- EU Raw Materials Week, November 2018; Belgium;
- GeoTHERM Offenburg, March 2018; Germany;
- EUSEW Policy conference, June 2018, in Belgium.

EFG has also supported the organisation of the “Geochemistry of geothermal fluids” workshop held in Miskolc, Hungary, in October 2017 by setting up a dedicated page on the CHPM website (http://www.chpm2030.eu/workshop-geochemistry-of-geothermal-fluids/). Promotion of the workshop took place through EFG’s dedicated communication tools.

BGS:

- Preparation of two conference presentations stemming from BGS activities within CHPM2030, and one at a workshop,
- Meeting industry representatives during the Cornwall field visit.

IGR:

- Brochures of the project were distributed during 2 events organised at the National Geological Museum: The Night of the Museums and The Science Festival.
- Two posters presenting the project were displayed during the above- mentioned events.

KU Leuven:

- The team is currently preparing a review manuscript, in partnership with VITO, for metal recovery from geothermal brines.
- They are also preparing two original research manuscripts – (1) Challenges and perspectives of studying transport and kinetic behaviour of electrochemical reactions at elevated temperature and pressures – preliminary results. (2) Recovery of Copper from geothermal brines at elevated temperatures and pressures.

LPRC:

- FEMP annual reunion, 31 August 2017: at the annual reunion of the Federation of European Mineral Programs (FEMP), in Sopron, Hungary, the CHPM2030 project was shortly introduced by LPRC.
- EU Raw Materials week 6-10 November. LPRC brought CHPM2030 brochures to the event.
- CHPM2030 Delphi survey 1st round: contacting ~300 experts, introducing the project and referring to the website.
- EUSEW18, 07 June: during the European Sustainable Energy Week, EFG and LPRC co-organized a session where CHPM2030 was presented.
- Upscaling blue energy, 07 June: side event of EUSEW. LPRC presented the project.
- Conference participation at the ETIP-Deep Geothermal Annual Conference 19.06.2018 and distribution of CHPM2030 brochures.

MINPOL:

- Maria Kehrer and Blazena Hamadová disseminated the CHPM leaflet at the first consortium meeting of the MINFUTURE project at TU Wien, 7-9 June 2017.
- Angelika Brechelmacher displayed the CHPM leaflet at the AIMS Mining in Europe, 7-8 June 2017.

UNIM:

- UNIM organised and hosted the workshop on Geochemistry on Geothermal fluids (http://www.chpm2030.eu/workshop-geochemistry-of-geothermal-fluids). Representatives of the running H2020 geothermal projects were invited. Éva Hartai, Tamás Madarász and Péter Szűcs made presentations.

– Éva Hartai participated in the Raw Materials Week organised by the EC in Brussels on 6-10 November 2017, distributed printed promotion materials
– Péter Szűcs with co-authors presented the CHPM2030 project at the Annual Meeting of the Hungarian Academy of Sciences in Budapest on 17 May 2018.
– Tamás Madarász presented the CHPM2030 project at the MINEX Europe 2018 Conference "Sustainable development of the Western Tethyan metallogenic resources" in Skopje, Macedonia on 13 June 2018.
– Tamás Madarász presented the newest results of the CHPM2030 project at the INEA clustering workshop in Brussels on 18th June.
– Tamás Madarász participated in the roundtable discussion of the ETIP-DG (European Technology and Innovation Platform on Deep Geothermal) in Brussels on 19th June.

USZ:
Representatives of USZ have presented the results of the CHPM2030 project at two events:
- High Level Conference of the Global Geothermal Alliance, 11-12.09.2017, Florence, Italy
- 17th Alps-Adria Scientific Workshop, 9-14.04.2018, Hnanice, Czech Republic

The results achieved within WP7 in the reporting period can be resumed as follows:

The consortium has produced additional electronic and printed deliverables that support the efforts made by all partners to promote the project:
- Brochure 2 has been produced (M18), translated by LTPs into 14 languages and disseminated at national and international level;
- Newsletter 2 has been produced (M18) and disseminated broadly;
- Brochure 3 and Newsletter 3 are under preparation;
- Fact-sheets about the CHPM-technology have been produced (M24) and disseminated through a social media campaign;
- A promotional video has been produced and disseminated;
- A second project video is under preparation and will be released in summer 2018.

On the other hand, an extensive list of dissemination activities has been achieved, including:
- Presentations (oral and posters) at various conferences and workshops both at national and international level;
- Articles submitted to peer reviewed journals;
- Publication of news articles on websites and newsletters.

The full list of dissemination activities may be consulted on the project's Google drive at https://docs.google.com/document/d/1RWPSYMdrFvYQkXrF_ccmPK31PvMdOVOJi7uA5MfIfQc/edit?usp=sharing

Status of ongoing and finalised deliverables

Deliverable no. and name:	**D7.1 Basic project website**		
Due date:	01.02.2016	Delivered to the EC on 01.02.2016	Status: approved
Responsible:	EFG		
Summary:	The CHPM2030's basic website (http://mfk.uni-miskolc.hu/chpm2030) was launched in January 2016, in the month of the project's start. The website supported the implementation of the project, providing a project overview, dissemination materials, and links to the project's social media channels.		
Deliverable no. and name:	**D7.2 Final project website**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved

Contributors:	EFG		
Summary:	The final version of the project website includes more detailed information about the project's objectives, approach, dissemination material and links to the project's social media channels. The website elements evolve with time, to ensure the best possible interaction with users during the project lifetime.		
Deliverable no. and name:	**D7.3 Project image and stylebook**		
Due date:	30.04.2016	Delivered to the EC on 20.04.2016	Status: approved
Responsible:	EFG		
Summary:	The project image and stylebook includes the logo, the project-specific design elements and templates which create a uniform appearance in the project, and is always used for project-related communication by all consortium members.		
Deliverable no. and name:	**D7.4 Communication and Dissemination Plan**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	EFG		
Summary:	This document defines and prioritises the key objectives of dissemination of CHPM2030 and details the steps to be taken during the project's lifetime in order to achieve maximum impact and reach relevant audiences. It also sets the framework to facilitate communications among the consortium members and between the consortium and stakeholders or the general public.		
Deliverable no. and name:	**D7.5 Brochure First edition**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	EFG		
Summary:	The first version of the project brochure provides basic data about the project, a general overview of the project objectives and expected impacts. It is available not only in English but also in further 14 languages (Czech, Dutch, Finish, French, German, Greek, Hungarian, Italian, Polish, Portuguese, Romanian, Serbian, Slovenian, Spanish).		
Deliverable no. and name:	**D7.6 Brochure Update 1**		
Due date:	30.06.2017	Delivered to the EC on 17.06.2017	Approved
Responsible:	EFG		
Summary:	The second version of the brochure provides updated information on the current status of the project. It will also be translated by EFG's Linked Third Parties to facilitate promotion at national level.		
Deliverable no. and name:	**D7.7 Brochure Update 2**		
Due date:	31.08.2018		
Responsible:	EFG		
Summary:	This deliverable is under preparation, it will be provided in due time.		
Deliverable no. and name:	**D7.8 Newsletter 1**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	EFG		
Summary:	Newsletter 1 provides information on the project data, the aims, and the ongoing activity in Work Package 1. It has been disseminated to the project's mailing list and via the EFG communication channels reaching approximately 50,000 geoscientists all over Europe.		

Deliverable no. and name:	**D7.9 Newsletter 2**		
Due date:	30.06.2017	Delivered to the EC on 19.06.2017	Approved
Responsible:	EFG		
Summary:	Newsletter 2 provides information on the current status of the project, focusing on the ongoing activities.		
Deliverable no. and name:	**D7.10 Newsletter 3**		
Due date:	31.08.2018		
Responsible:	EFG		
Summary:	This deliverable is under preparation, it will be provided in due time.		
Deliverable no. and name:	**D7.11 Newsletter 4**		
Due date:	30.06.2019		
Responsible:	EFG		
Summary:	This deliverable is not yet due.		
Deliverable no. and name:	**D7.12 Press-releases and media-kits related to CHPM2030 initiatives and outcomes**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	EFG		
Summary:	Press-releases are issued whenever an important milestone is reached. In the reporting period a joint press release has been produced and disseminated together with other Horizon 2020 projects in the field of geothermal energy: "Joint efforts to strengthen geothermal energy", 7 July 2018.		
Deliverable no. and name:	**D7.13 Fact sheets on the CHPM technology**		
Due date:	31.12.2017	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	EFG		
Summary:	In December 2017, EFG has produced four factsheets about the CHPM technology on Ore deposit formation across Europe; Enhanced Geothermal Systems; Metal mobilisation; and Environmental aspects The purpose of these factsheets is to disseminate basic information on CHPM2030 to a broad audience. All factsheets are available through the website's outreach page (http://www.chpm2030.eu/outreach/) and they have been promoted via a social media campaign in January/February 2018.		
Deliverable no. and name:	**D7.14 International Conference**		
Due date:	31.05.2019		
Responsible:	EFG		
Summary:	This deliverable is not yet due.		

1.2.7 Work Package 8

WP title	**Project management**		
Lead beneficiary:	UNIM	**Participants:**	USZ, EFG, ISOR, NERC-BGS, LNEG, VITO, LPRC, MINPOL, IGR, KU Leuven, SGU

Start date:	01.01.2016	End date:	30.06.2019

Objectives of the WP

The objective of WP8 is to ensure a smooth and on-time execution of the project for the entire consortium, based on the description of work and in accordance with the European regulations. Work includes project planning, monitoring of the project progress, maintenance of effective communication and exchange of relevant information within the Consortium. The coordination work is shared among the three members of the Coordinating Team.

Synthesis of work done and results achieved

The work in this WP is organised in 6 tasks. Below the activities and the results are listed by tasks.

Task 8.1 *Coordination and supervision of project activities* (ongoing)
University of Miskolc set up the project coordination team during the GA preparation phase. The team includes the Project Coordinator (Éva Hartai), the Project manager (Tamás Madarász) and the Financial and Technical Assistant (Aranka Földessy). The project coordination and supervision structure was introduced to and approved by all partners during the kick off meeting.

The Coordinator maintains contact with the Project Officer and the consortium members. A Google Groups Forum was established for changing e-mails. The group (chpmpartners@googlegroups.com) involves all project participants (research and administrative). The Coordinator regularly informs the consortium members about any project related news and events, controls and harmonises the project implementation, checks the financial completion and the deadlines, and monitors the duties of partners and the submission of deliverables. No major deviations related to the deliverables and the financial completion occurred so far. The Project Manager is responsible for the planning and implementation of the tasks at University of Miskolc, and supervises all administrative and financial matters at the institution. The Financial and Technical Assistant controls the financial matters at institutional and project levels, and provides technical assistance to the Coordinator and the Manager.

A Google Drive Account was created in order to share project related documents. The uploaded documents are organised in folders and they are continuously updated. A special folder is dedicated to the Advisory Board where all information and documents they may need are uploaded. The main folders are as follows *(Figure 29)*:

- Advisory Board
- Contact lists
- Deliverables
- Dissemination
- EU administrative guidelines
- Literature
- Logo
- Meetings
- Official internal documents
- Periodic reports
- Photos
- Templates
- Work Packages

Within the main folders, the documents are organised in subfolders.

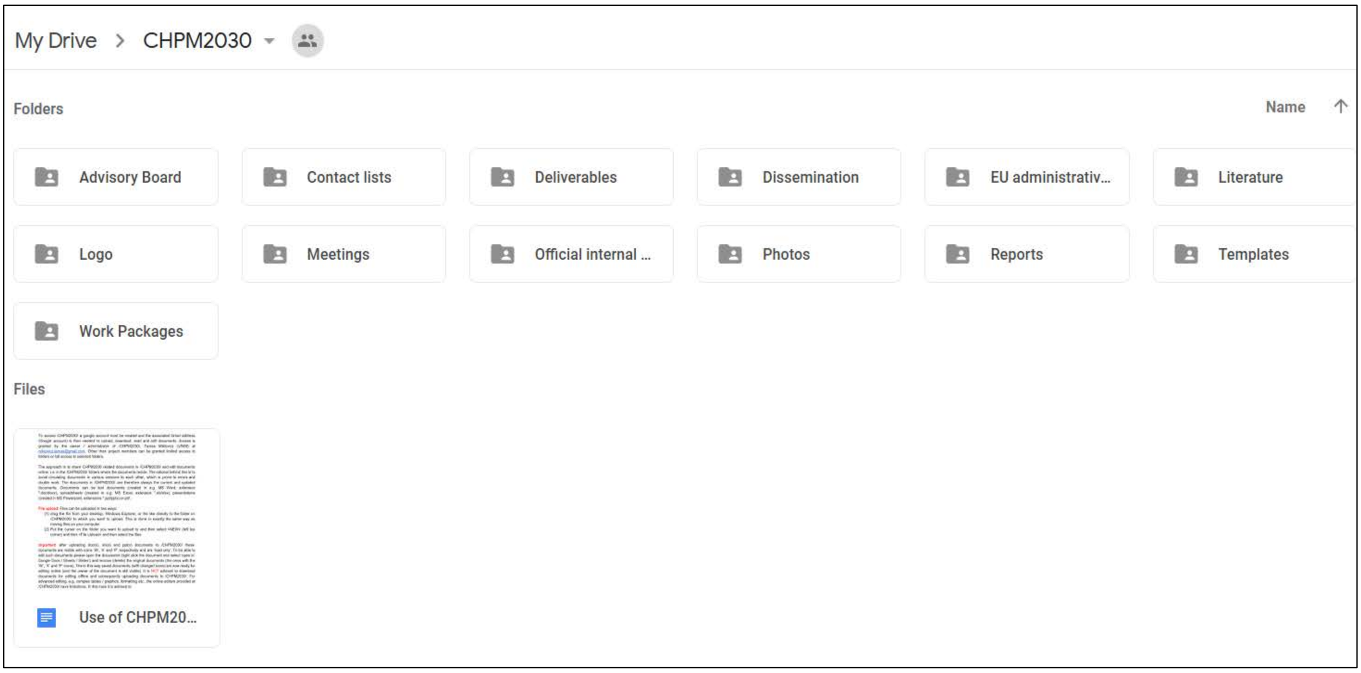

Figure 29: Main folders of the CHPM2030 Google Drive.

The project activities are arranged into work packages, and all major activities of the project are managed through this structure. The Coordinator continuously monitors activities through email communication, consortium meetings and monthly online meetings. Minutes of the consortium meetings and the online meetings are circulated among the partners and uploaded to the Google Drive. In the minutes, the due actions, the responsible partners and the deadlines are indicated.

Task 8.2 *Administrative project management* (ongoing)

This Task involves the administrative actions covering the following fields:

- Ensuring the implementation of the Grant Agreement and the Consortium Agreement,
- Controlling the completion of tasks by the partners,
- Controlling finances and budgets,
- Monitoring and managing the deadlines, milestones, deliverables and emerging risks,
- Keeping contact with the Project Officer and informing her about any issues,
- Organising project meetings and workshops,
- Uploading the deliverables to Sygma and submitting them to the EC,
- Assessing the internal reports,
- Preparing and submitting the Periodic Reports.

In the reporting period, an amendment process was carried out. The amendment was needed because one of the EFG' LTPs, the French Geological Society (SGF) left the project. Its budget was allocated to EFG, which will cover all activities and duties SGF should have performed. The amendment was completed in May 2018.

Task 8.3 *Administrative project reporting* (ongoing)

The reporting system is composed of two main components:

- Internal reports to the Coordinator,
- Periodic reports to the EC.

Internal reports

It was agreed already at the kick-off meeting that the Consortium would submit internal reports to the Coordinator at the half of each reporting period. The internal reports cover both the professional and the financial aspects of the reporting period. The Coordinator provides a template for these reports. In the report, the partners are asked to describe the activities carried out in the reporting period, and they also indicate the resource consumption both in terms of person-months and personnel costs. They also report the other costs incurred in the reporting period.

The first internal reports covered the period M1-M9 (January-September 2016). The reports were submitted on time and data were assessed and summarised by the coordinator. No major deviations were identified in this period.

The second internal reports covered M19-M24 (July-December 2017). The use of PMs was summarised by partners and by WPs. Minor deviations (both underuse and overuse) were identified and it was discussed with the partners. It was also pointed out that a few partners had underspending in personnel and other costs *(Figure 30)*. This was discussed with the relevant partners and they were asked to compensate the deviations in the following phases of the project.

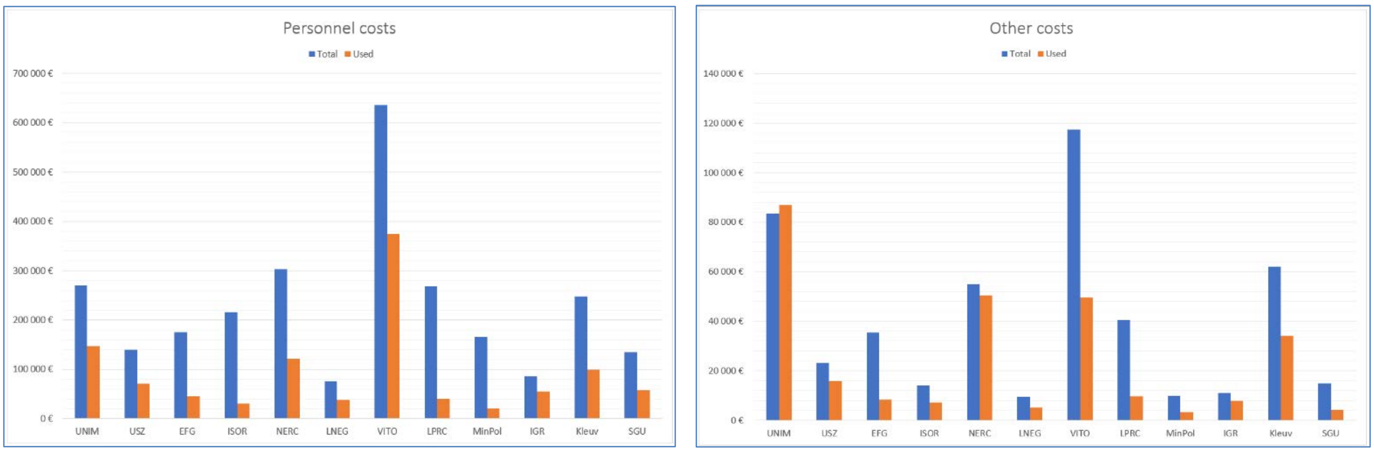

Figure 30: Use of personnel and other costs in the internal reporting period M19-M24.

Periodic Reports

The first Periodic Report covered M1-M18 (January 2016-June 2017). The report was submitted on time and reviewed and assessed by the Project Officer. The first Review Meeting was on 13th September is Brussels. The Project Officer found the status of the project satisfactory but recommendations were made in order to improve the implementation.

The second Periodic Report covers M19-M30 (July 2017-June 2018). Preparation for this report started in May 2018. Templates for gathering data for both Part A and Part B of the Technical Report, as well as template for the Financial Report were prepared by the coordinator and sent to the partners. Deadlines for preparing each type of reports were set up.

First, the consortium members sent their Partner Reports to the WP Leaders. Based on these inputs, the WP Leaders prepared the WP reports and submitted them to the Coordinator. The Coordinator summarises the WP reports and inserts them to Part B of the Technical Report. Partners were also asked to provide data for Part A.

A template for the financial report to the Coordinator was also sent to the partners. They provide the requested data, and if the coordinator doesn't find any major deviations, they submit their Financial Statements through Sygma.

Task 8.4 *Organisation of project meetings* (ongoing)

CHPM2030 related events organised by the project partners are grouped into three types:
- Consortium meetings,
- Online project meetings,
- Other project related events.

Consortium meetings
A draft schedule of project consortium meetings was agreed by the Consortium during the kick-off meeting. With some minor modifications, the meetings were organised according to this schedule in compliance with the proposal. All meetings are co-organised by the coordinator and the hosting partner institution. The meeting agenda is prepared/initiated by the coordinator carefully observing contractual obligations and project progress actualities, however logistics, venues, other events were recommended and arranged mainly by the hosting partner. The preliminary agenda is circulated among partners about 2 months before the meetings, and all partners (but specially WP leaders) had their active contribution in the content of the working programme of the events.

All partners are requested to be represented at all project meetings. Special attention is paid to provide reasonable solutions in terms of logistics and costs. Minutes of the meetings are prepared by the assistance of the coordinator and are distributed within the partnership for approval. Attendance list of meetings are signed by all participants and the original documents are filed in the project archive.

From the beginning of the project, the following personal consortium meetings have been organised:
- 28-29 January 2016: Kick-off Meeting, Miskolc, Hungary;
- 11-14 October 2016: 2nd Consortium Meeting and 1st Advisory Board Workshop, Älvkarleby, Sweden;
- 28-29 March 2017: 3rd Consortium Meeting, Nottingham, UK;
- 11-14 September 2017: 4th Consortium Meeting, 2nd Advisory Board Workshop and 1st Review Meeting, Brussels, Belgium;
- 21-23 March, 2018: 5th Consortium Meeting, Lanzarote, Spain.

Online project meetings
UNIM purchased the GoToMeeting software in order to use it for regular online meetings. It was agreed by the Consortium that these online meetings would be held in every month (except the months when there are personal consortium meetings). These are usually one hour long meetings, where the project progress, the status of the ongoing Tasks, the due deliverables and other topics are discussed. The online meetings are recorded. The minutes of the meetings with the due actions and the deadlines are circulated within the partnership and also uploaded to the Google Drive together with the recording.

Dates of online project meetings in the former and the recent reporting periods:
- 19 December 2016,
- 27 January 2017,
- 23 February 2017,
- 09 May 2017,
- 15 June 2017,
- 27 July 2017,
- 2 November 2017,
- 6 December 2017,
- 22 January 2018,
- 27 February 2018,

– 8 May 2018
– 20 June 2018.

Beside the above mentioned meetings, there were two online meetings, one is dedicated to WP4 and the other is related to WP6.

Other project related events
Several other project-related meetings and workshops were organised by the partners in the reporting period. In timing order, these are as follows:

– 17-19 June 2017: 'Geothermal – the Energy of the Future'. International workshop, organised by EFG with the involvement of the LTPs, in Santorini, Greece;
– 26-27 October 2017: 'Geochemistry of Geothermal Fluids'. Workshop with the involvement of running H2020 geothermal projects, organised by UNIM in Miskolc, Hungary *(Figure 31);*
– 22 March, 2018: Interactive workshops on WP4 and WP6 with the participation of the project partners, connecting to the 5th consortium Meeting in Lanzarote, Spain;
– 12 April, 2018: 'CHPM2030 Orientation Workshop for EFG Linked Third Parties'. Organised by EFG and LPRC, with the participation of UNIM, SGU and the LTPs in Brussels, Belgium;
– 21-24 May 2018: Fieldtrip in Cornwall, UK for studying the mineralisation and geothermal potential of the Cornwall area as a potential pilot site. BGS was the organiser of the fieldtrip, UNIM, EFG, LPRC and IGR were represented.

Figure 31: Participants of the 'Geochemistry of Geothermal Fluids' workshop at University of Miskolc

Upcoming events under organisation

– 24-27 July, 2018: Fieldtrip in the Beius area and the Bihor Mountains, Romania for studying the mineralisation and geothermal potential of the area as a potential pilot site. IGR is the organiser of the fieldtrip, UNIM, LPRC and BGS will be represented;
– 4-7 September 2018: 6th CHPM2030 Consortium Meeting and 3rd Advisory Board Workshop;
– 4 October 2018: 2nd Review Meeting.

Task 8.5 *Risk management and conflict resolution* (ongoing)
Risk management and conflict resolution protocols were worked out in details in the first reporting period, in Deliverable 8.1. The protocols were approved by the consortium. The approach for the risk management is as follows:

– Identification of risk,
– Risk assessment,
– Response to issues.

The identification of risks is the duty of each partner within the consortium with their responsibility to inform their WP-leader. The risk identification represents a proactive task for the Coordinator for the entire project and for the WP-leaders within the framework of their WP activities. Risk management issues and conflicts were not raised during the former and the recent reporting periods.

Task 8.6 *Technology exploitation, innovation management and IPR.* Due to the rather low TRL level of the project technology exploitation issues were not considered to be relevant by the Consortium yet. IPR inputs by partners were documented for further steps of innovation progress in case of successful project implementation.

Status of ongoing and finalised deliverables

Deliverable no. and name:	**D8.1 Risk Management Strategy**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	UNIM		
Summary:	This document includes a risk assessment of CHPM2030 and details risk mitigation mechanisms to be embedded in the work implementation. It details the risk initially foreseen and also new risks are described. It also contains control measures for each risk identified, timing for action and corresponding responsible. This strategy will be updated as the project evolves.		
Deliverable no. and name:	**D8.2 Data Management Plan**		
Due date:	30.06.2016	Delivered to the EC on 28.06.2016	Status: approved
Responsible:	UNIM		
Summary:	This deliverable defines the data management policies to be applied by the project partners during the implementation of CHPM2030 project, in accordance with the Guidelines on Data Management in Horizon 2020.		
Deliverable no. and name:	**D8.3 Project report 1**		
Due date:	30.06.2017 (31.08.2017)	Delivered to the EC on 20th August 2017	Status: approved
Responsible:	UNIM and all partners		
Summary:	Project Report 1 includes the technical and financial report of the whole consortium. The report was prepared and submitted according to schedule.		
Deliverable no. and name:	**D8.4 Project report 2**		
Due date:	30.06.2018	Delivered on 24th August 2018	Status: submitted
Responsible:	UNIM and all partners		
Summary:	Project Report 2 includes the technical and the financial reports.		
Deliverable no. and name:	**D8.5 Project report 3**		
Due date:	30.06.2019		
Responsible:	UNIM		
Summary:	This deliverable is not yet due.		

1.2.8 Work Package 9

WP title	Ethics requirements		
Lead beneficiary:	UNIM	**Participants:**	USZ, EFG, ISOR, NERC-BGS, LNEG, VITO, LPRC, MINPOL, IGR, KU Leuven, SGU
Start date:	01.01.2016	**End date:**	30.06.2019

Objectives and implementation of the WP

In this Work Package, the partners and linked third Parties from countries which are not members of the EU, must confirm that the ethical standards and guidelines of Horizon 2020 will be rigorously applied, regardless of the country in which the research is carried out. These declarations were provided by ISOR and the Swiss, the Ukrainian and Serbian LTPs. The Coordinator submitted the declarations to the EC as Deliverable 9.1 on 20th April 2016.

1.3 Impact

In the first reporting period, the focus was on screening Europe's mineralised belts in relevancy with their EGS potential, and identifying the data gaps with the detailed examination of the four study sites. In addition, the EGS relevant geochemical and rock mechanical properties of the ore bodies were determined and the conceptual framework for the orebody-EGS was developed.

In the recent reporting period, more emphasis was put on the technological aspects of the project within WP2 and WP3, as well as developing an integrated feasibility assessment framework in WP5 and a visioning process for the further development of the CHPM technology within WP6. There were also extensive activities with significant impact on the dissemination of the project within WP7.

According to the developments in the mentioned work packages, the main impacts of the project during the months 19-30 are as follows:

- A 3D stochastic fracture model was built and the extractable amount of heat and metallic minerals in different scenarios were defined.
- It was proved that relatively 'mild' leaching agents were capable of liberating metals into the recirculating fluid within an EGS.
- It was proved that surface modification of nanocarbon particles allowed metals to be adsorbed, both in acid and alkaline pH regions.
- Recommendations were provided for the integrated reservoir management, defining the overall system dynamics and data for environmental assessment.
- It was proved that metals can be successfully electrodeposited at elevated pressure and temperature (up to 300°C and 238 bar), high pressure offers a controlled deposition, and elevated temperatures result in smaller sized deposits.
- It was proved that elevated pressure and temperature resulted in higher recovery rate.
- It was proved that different metallic products can be formed at different temperatures, with a broader variety of compounds at higher temperatures. When operating GDEx at different temperatures for the recovery of metals from geothermal brines, higher temperatures favors the formation of smaller particles and avoids an increase of the electrode resistance during the treatment, enhancing the performance of the system

- It was proved that the presence of multivalent ions in the geothermal brine matrix does not eliminate the potential for SGP-RE. Furthermore it was proven that the extraction of electrical energy is enhanced by increasing the brine temperature.
- A mathematical model framework started to be built up based on component level models which enables linking downstream and upstream geothermal engineering subsystems.
- An integrated sustainability assessment framework was worked out considering economic, social, environmental and ethical aspects.
- A two-round Delphi survey was carried out related to the CHPM technology foresight. With the survey, about 2000 experts in the mineral and the geothermal sectors was reached and 133 of them participated in the survey.
- An area evaluation framework was developed in order to guideline the assessment of an area for CHPM technology potential, including a set of topics to be covered during the investigation, for the study areas, EFG LTPs, and any other area of interest.
- In the frame of a social media campaign, four factsheets on the project results were promoted. In total, more than 130 social media posts relating to CHPM2030 have been published in the recent reporting period on the project's and EFG's Twitter, Facebook and LinkedIn accounts.
- The project promotional video has been viewed 280 times on YouTube, 227 times on Twitter and 299 times on Facebook (data from 8 June 2018).
- Due to the extensive dissemination activities by the partners and the EFG's linked third parties, the project concepts and the results in the period M19-M30 have reached about 50 000 scientists and professionals in Europe.

2 Update of the plan for exploitation and dissemination of results

The plan for exploitation and dissemination of results is described Deliverable 7.4 - Communication and Dissemination Plan, submitted in June 2016. This deliverable defines and prioritises the key objectives of dissemination and communication and details steps to be taken during the project's lifetime in order to achieve maximum impact and reach relevant audiences. The exploitation and dissemination of results are designed to mobilise the international community, informing them about the project objectives, achievements and results.

EFG is planning to review the dissemination and communication plan in autumn 2018. The review will focus on increasing communication towards stakeholders relevant for the future development of the CHPM technology.

3 Update of the data management plan

The CHPM2030 project has committed itself to the Open Research Data Pilot with the aim of improving and maximising access to and the re-use of data generated by the project. For this purpose the project consortium has prepared Deliverable 8.2 - Data Management Plan (DMP) containing the main elements of the data management policy to be applied by the project partners for handling datasets generated during the project, as well as upon completion. The DMP has been prepared in accordance with the ‘Guidelines on Data Management in Horizon 2020’ and it defines procedures regarding data quality, sharing and security.

CHPM2030 has generated substantial volume of data especially within WP 1, 2 and 3, some of them quite unique that could be used to fuel basic/applied research including updates of existing geological models. Some of these data are considered as intermediate results, partners requesting limited accessibility for third parties. Partly for confidentiality reasons and partly for better tracking project samples and data, the consortium has created the CHPM project data archive described in detail in D 2.4.

The main goal of the database is to organise the key information from lab experiments, but it was also needed to be easily handled, and should be dynamic in such a sense that it accommodates adding newly generated data types in a later phase of the project. It was also expected that each partner can have access to the scope and structure of the generated data and could use them for his/her own research tasks. It is not the goal of the data archive however, to collect and archive all lab measurement data and their details – as agreed by the consortium. Each partner is responsible for the orderly and safe maintenance of the generated project data. It is our goal to provide the necessary metadata (link to the data holder) and the key features of previously accomplished lab measurements for parties both inside and outside the CHPM2030 consortium.

Two Google forms were prepared to collect information about lab measurements performed during the project (WP1 and WP2). The first form is called ‘CHPM Lab Experiment Metadatabase’, which contains the basic information on measurements, especially the type of parameters that were measured by the partners during the lab experiments. The second one is called ‘Data Attribute Table’, which focuses on the features and attributes of measured parameters. The two forms were filled in by the project partners who performed lab experiments, and UNIM was the responsible partner to do follow up work and compile the database.

The metadata archive of the CHPM2030 project will best serve its purpose if it contains information (metadata and parameter features) on all data generated during the project. Therefore, subsequent WP data must be incorporated into the database. WP4-6 shall be beneficiaries of this effort to provide as wide a knowledge on the data as possible.

Other types of documents, presentations and public access reports, such as scientific publications, public deliverables related to the implementation of the Action as defined by the GA are stored on the Google Drive account in an organised file structure. Deliverables and public dissemination materials (such as project brochure, introductory video, fact sheets and newsletters) of the project and are published on the website of the CHPM2030 project, under Outreach menu.

4 Follow-up of recommendations and comments from previous review

The overall assessment of the project implementation after the submission of the 1st Periodic Report was positive and it was declared that the project had fully achieved its objectives and milestones for the period. However, there were recommendations by the Project Officer in order to improve the level of implementation. Below these recommendations and the relevant actions are listed:

Recommendation 1:
It is recommended that during the implementation of WP6 ('Roadmapping and Preparation for Pilots') the data set collected in WP1 is consolidated with higher contributions from all the Linked Third Parties, including the ones that provided less data than expected in Task 1.2.
Actions:
An interactive orientation workshop for the EFG LTPs was organised in April 2018 in Brussels and the participants were provided with detailed information about their tasks in WP6. A data assessment template was also prepared and the investigation framework was explained in details. Regular change of e-mails between the EFG's project manager and the representatives of the LTPs supports the smooth completion of their tasks.

Recommendation 2:
Despite the intrinsic differences between laboratory and field scale, the laboratory leaching tests should be run reproducing the natural conditions of temperature and pressure as closely as possible.
Actions:
Following these recommendation, the leaching tests were carried out at high pressures and temperatures as described in details in Section 1.2. Metal recovery experiments in Task 3.1 were also conducted at high pressures and temperatures, details are provided also in Section 1.2.

Recommendation 3:
The deliverable D8.3, Project Report 1, must be submitted before the end of November 2017.
Actions:
D8.3, Project Report 1 was submitted on 29th November.

Recommendation 4:
If it is decided to patent commercial applications of the high temperature and pressure electrochemical rotating disk electrode (HTPRDE) reactor then the consortium should examine carefully whether certain deliverables should be public or confidential and make a proposal to amend the grant agreement accordingly.
Actions:
At this stage of the project, no commercial applications of the high temperature and pressure electrochemical rotating disk electrode (HTPRDE) reactor is planned.

Recommendation 4:
According to Art. 33 of the GA, beneficiaries must aim — to the extent possible — for a gender balance at all levels of personnel assigned to the action, including at the supervisory and managerial levels. In order to verify the compliance with this obligation in the next reporting period the consortium is asked to provide explanations on the specific steps taken and measures put in place to support this requirement.
Actions:
Many efforts have been made by the partners to improve the gender balance in the project. At UNIM, the coordinating team and the administrative staff is female-dominated, although there are more male than female participants among the researchers. However, this is also caused by the traditional 'mining' character of the Faculty of Earth Science & Engineering.

The BGS works hard to utilise both its female and male staff in an equal and fair way. Traditionally the area of Earth Sciences has contained a higher proportion of males, though there is a progressive trend towards an increasing number of females. This is also reflected by gender distribution at the BGS, with younger staff having a higher female/male ratio.

EFG improved the gender balance in the CHPM2030 project in the reporting period with the involvement of a female researcher and two female staff members working on project coordination and communication/dissemination.

At MINPOL, the number of female and male staff members is relatively balanced. However, the responsibilities and fields of activity are rather classically distributed: considerably more men than women are active in research, and significantly more women than men are active in management and administration. In the latest months, MINPOL is actively looking for an additional female researcher.

In order to improve the gender balance, VITO hired a postdoc female researcher dedicated full time to the CHPM2030 project. She is involved mainly in Task 3.2.

The ratio between the female and the male CHPM2030 participants by partner is shown in *Figure 32*. In the figure, the gender distribution of the EFG LTPs are not represented. The total number of participating females at the LTPs is 17, the number of males is 24.

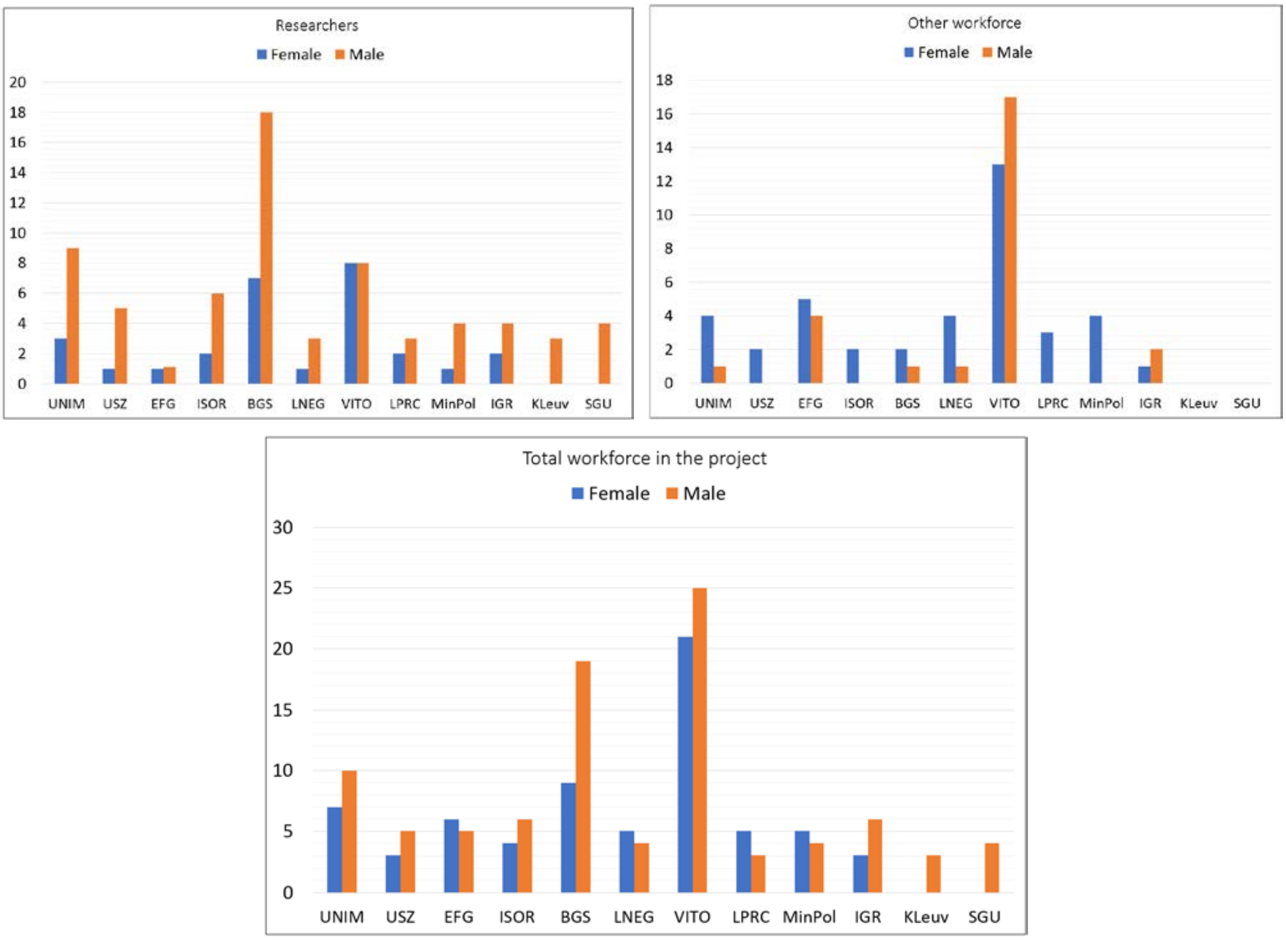

Figure 32: Female/male ratio at the partners in the CHPM2030 project. Project participants (except LTPs) in the period M1-M30 are considered.

5 Deviations from GA Annex 1

No significant deviations from GA Annex 1 occurred in the reporting period.

An amendment request was submitted in the reporting period because one of the EFG's LTP, the French Geological Society (SGF), left the CHPM2030 project. The work that was originally allocated to SGF, is carried out by EFG and the budget of SGF was redistributed to EFG. The amendment entered into force in May 2018.

In April 2018, there were changes in the legal status of NERC-BGS. Earlier, the parent organisation of BGS (British Geological Survey) was NERC (Natural Environment Research Council). From 1st April all Research Councils were brought together into UKRI (United Kingdom Research and Innovation), and the BGS became also part of UKRI. The universal takeover was applied from the day on which UKRI was created and this organisation took over all rights and obligations of the previously existing bodies on ongoing projects, including participation in the project activities as described in the grant agreement, reporting, etc. No amendment was necessary for the universal takeover. As in most of the reporting period the partner acted as NERC-BGS, we use this name in the report.

5.1 Tasks and deliverables

According to the GA, in the reporting period, deliverables from tasks in WP2, WP3, WP5, WP7 and WP8 had to be submitted. The submission deadline of two deliverables were extended:

- D2.3 originally was due in M24 (December 2017) but after the request for postponing the submission, the Project Officer approved the extension of the deadline to M30 (June 2018).
- D3.3 originally was due in M30 (June 2018) but after the request for postponing the submission, the Project Officer approved the extension of the deadline to M32 (August 2018).

There were no deviations in the submission of the other deliverables, all were provided on time. The deliverables and the relevant Tasks are listed in *Table 1*.

Table 1: Due and submission dates of the deliverables in the reporting period.

Deliverable	Task	Due date	Submitted	Comment
D2.1	Task 2.1	31 Dec 2017	30 Dec 2017	
D2.2	Task 2.2	31 Dec 2017	27 Dec 2017	
D2.3	Task 2.3	From 31 Dec 2017 postponed to 30 June 2018	01 July 2018	Extension of deadline approved by the PO
D2.4	Task 2.4	31 Dec 2017	29 Dec 2017	
D3.3	Task 3.3	From 30 June 2018 postponed to 31 Aug 2018		Extension of deadline approved by the PO
D5.1	Task 5.1	31 Dec 2017	27 Dec 2017	
D7.13	Task 7.2	31 Dec 2017	20 Dec 2017	
D8.4	Task 2.1	30 June 2018		Will be submitted before 31 August

5.2 Use of resources

Beneficiaries with no financial statement

The EFG LTP French Geological Society did not declare any costs as it left the project in the reporting period. The LTP was terminated in May 2018 but the amendment process started in January 2018 and they did not report working hours.

Use of financial resources

No significant deviations occurred in the use of financial resources in the reporting period. Spending on personnel and other costs was proportional to the duration of the period *(Table 2, Figures 33 and 34).*

Table 2: Use of financial resources in the former and the recent reporting period.

Partner	Planned total budget (€)	Planned total direct costs (€)	Personnel costs					Other costs					Total used (€) M1-M30	Total used % M1-M30
			Total personnel costs	Used (€) M1-M18	Used (€) M19-M30	Used (€) M1-M30	Used % M1-M30	Planned total other costs	Used (€) M1-M18	Used (€) M19-M30	Used (€) M1-M30	Used % M1-M30		
UNIM	442 000,00	353 600,00	270 100,00	118 592,00	63 833,50	182 425,50	67,54	83 500,00	76 062,00	20 089,50	96 151,50	115,15	278 577,00	78,78
USZ	203 750,00	163 000,00	140 000,00	52 952,36	37 591,79	90 544,15	64,67	23 000,00	9 302,09	18 181,15	27 483,24	119,49	118 027,39	72,41
EFG	275 875,00	220 700,00	183 500,00	31 893,62	43 471,03	75 364,65	41,07	37 200,00	6 777,11	7 400,00	14 177,11	38,11	89 541,76	40,57
ISOR	287 500,00	230 000,00	216 000,00	25 509,86	34 429,10	59 938,96	27,75	14 000,00	7 201,93	3 563,00	10 764,93	76,89	70 703,89	30,74
BGS	447 000,00	357 600,00	302 600,00	81 761,38	70 986,56	152 747,94	50,48	55 000,00	31 264,12	27 492,74	58 756,86	106,83	211 504,80	59,15
LNEG	107 500,00	86 000,00	76 500,00	28 224,73	17 816,05	46 040,78	60,18	9 500,00	3 939,37	1 958,16	5 897,53	62,08	51 938,31	60,39
VITO	940 717,50	752 574,00	635 122,00	110 912,66	294 682,23	405 594,89	63,86	117 452,00	16 728,58	68 345,16	85 073,74	72,43	490 668,63	65,20
LPRC	387 225,00	309 780,00	269 280,00	21 290,86	122 750,90	144 041,76	53,49	40 500,00	8 120,76	10 079,03	18 199,79	44,94	162 241,55	52,37
MinPol	218 750,00	175 000,00	165 000,00	15 780,58	25 476,28	41 256,86	25,00	10 000,00	2 655,95	1 733,09	4 389,04	43,89	45 645,90	26,08
IGR	121 250,00	97 000,00	86 000,00	49 716,79	15 687,88	65 404,67	76,05	11 000,00	5 683,75	9 954,68	15 638,43	142,17	81 043,10	83,55
KLeuv	388 000,00	310 400,00	248 400,00	50 589,38	90 455,54	141 044,92	56,78	62 000,00	27 580,66	13 977,87	41 558,53	67,03	182 603,45	58,83
SGU	187 500,00	150 000,00	135 000,00	54 409,38	13 823,78	68 233,16	50,54	15 000,00	2 801,74	4 992,56	7 794,30	51,96	76 027,46	50,68

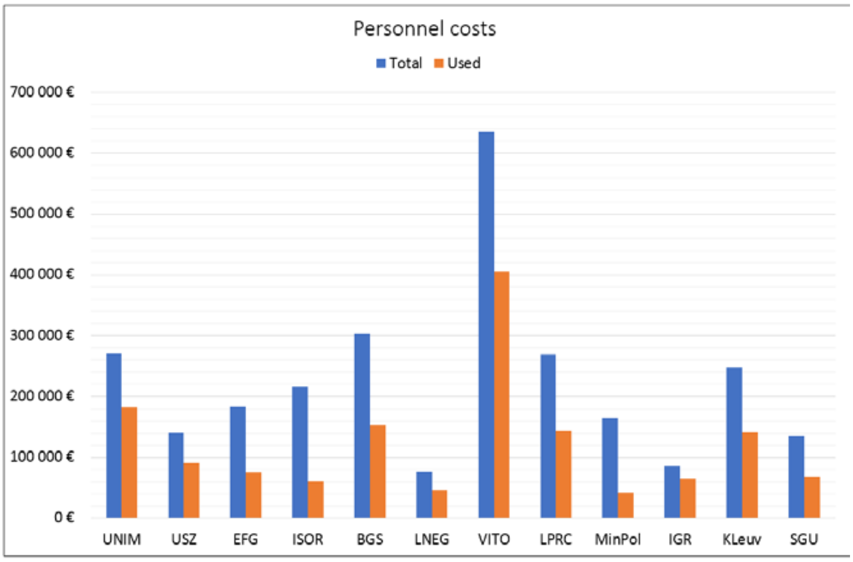

Figure 33: Use of personnel costs from the beginning of the project to M30.

Figure 33: Use of other costs from the beginning of the project to M30.

The minor deviations are justified below by partners:

UNIM:
UNIM slightly overspent the ‘Other costs’ budget. The reason is that the coordinator partner has to finance the travel and accommodation costs of the Advisory Board members. During the preparation of the proposal, these costs were underestimated and UNIM had to spend more for their participation in the Advisory Board workshops than expected. In addition, three more members were invited to the AB, as their expertise is needed for the successful implementation of the project. However, this overspending will be balanced at the end of the project as the partners were asked to leave a minor sum in their budget for this compensation.

USZ:
A minor overspending of the ‘Other costs’ budget happened in the first 30 months of the project. This is due to an underestimation of travel costs associated with attending bilateral meetings, field trips and consortium events. Under-spending of the ‘personnel costs’ budget line allows for a minor reallocation of funds and covers the excess within the approved budget.

Use of person-months

There were no major deviations in the spent working hours compared to the planned ones. The numbers are indicated in *Table 3* and they are presented in graphs in *Figure 35.*

Table 3: Use of person-months from the beginning of the project to June 2018.

Partner	WP1		WP2		WP3		WP4		WP5		WP6		WP7		WP8		Total		
	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Planned	Used	Used %
UNIM	25	27,27	15	15,90			6	4,17	5	3,52	6	3,65	4	4,79	10	7,63	71	66,93	94,27
USZ	10	12,76	15	61,00			2		20	21,80	2		1		1		51	95,56	187,37
EFG	4	1,09							2	0,45	5	3,13	19	11,30	2	3,51	32	19,48	60,88
ISOR	1	0,96	1	1,04			18	4,07	2	0,89	3	0,02	1	0,08	1	0,85	27	7,91	29,30
BGS	8	7,29	17	17,20					1		6	7,88	1	1,10	1	0,93	34	34,40	101,18
LNEG	8	8,17							1	0,67	6	2,97	1	0,17	1	0,98	17	12,96	76,24
VITO			10,60	8,88	28,35	32,10	15	4,08			1		1	1,26	1		57	46,32	81,33
LPRC									6	0,22	21	16,00	6	4,56	3	1,80	36	22,58	62,72
MinPol									16	5,11	4	1,70	1	0,35	1	0,65	22	7,81	35,50
IGR	9	13,20							1		8	4,35	1	1,35	1	1,20	20	20,10	100,50
KLeuv					32,00	26,80	11				1	0,01	1	0,15	1	0,56	46	27,52	59,82
SGU	8	8,70							1	0,15	7	1,85	1	0,07	1	0,20	18	10,97	60,94

The justifications for the minor deviations are as follows:

UNIM:
At UNIM, proportionally to the reporting period, there is a slight overuse of person-months in WP7. The reason is that the Geochemistry of Geothermal Fluids Workshop, which was not planned in the proposal needed a significant organisation work. However, the workshop provided a good visibility for the project and it was also an opportunity to find synergies with the other H2020 geothermal projects.

USZ:
In WP, originally 15 PMs were allocated to USZ. In the first reporting period USZ used 40.2 PMs, which was justified by the partner and approved by the Project Officer. In the 2nd reporting period, USZ used additionally 2.8 PM. The justification for this overuse is as follows: János Szanyi, Tamás Medgyes, Balázs Kóbor and Máté Osvald were involved in WP2 Task 2.1 from M10 to M24. They participated in and co-ordinated the execution of D2.1, in close contact with partners working on

D2.2. Regular meetings were held to select complementing methodologies and samples were cross-measured to ensure data reliability. Some of the results from leaching tests were so promising that based on these results an article is now submitted to a high ranking scientific journal. In the reporting period, USZ accepted, measured and worked with samples originating from the Portuguese partner and arriving very late in time, therefore not accepted by other partners in D2.2. This, and investigating the effect of laser-induced temperature gradient, as a novel technology, in reservoir stimulation and fracture enhancement also increased the amount of work done, which resulted in exceeding the planned man-months.

VITO:
VITO originally planned to involve largely senior researchers and experienced technicians. During the course of the project several personnel shifts caused the efforts to shift more towards younger, less experienced researchers and technicians. This resulted in more time spent on guiding and supervising the experimental work and reporting than initially envisaged. The overspending of time is compensated however by the lower hourly rates of the younger staff.

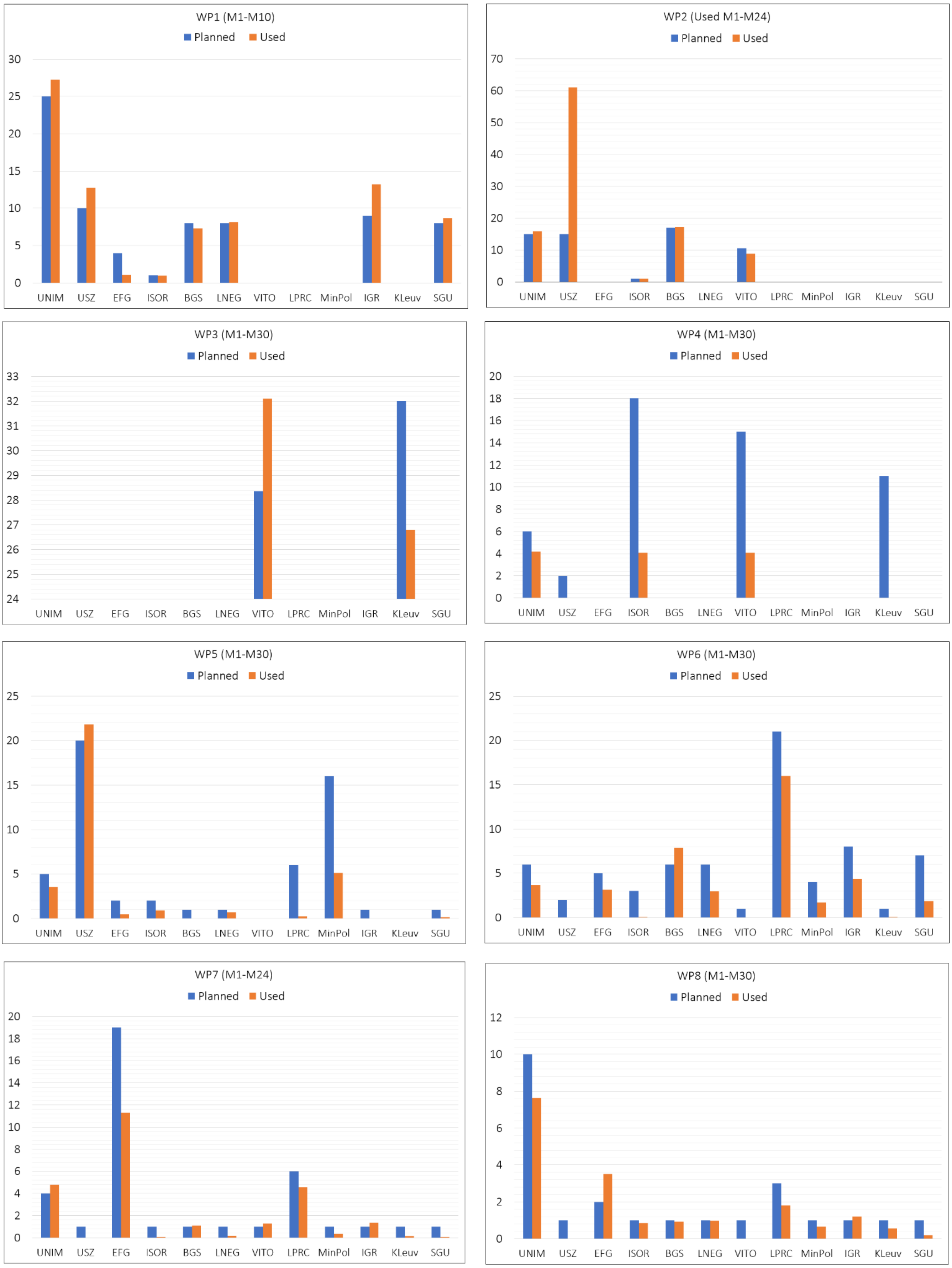

Figure 35: Use of person-months in the eight work packages from the beginning of the project to June 2018.

5.2.1 Unforeseen subcontracting (if applicable)

Not applicable.

5.2.2 Unforeseen use of in kind contribution from third party against payment or free of charges (if applicable)

Not applicable.

Annex 1: Dissemination activities by the project partners and the EFG LTPs in the period M19-M30

Dissemination by the project partners

International conferences and workshops

	Date	**Event details (name & place)**	**Partner involved**	**Type of dissemination activity (presentation, poster, exhibition, etc) Name of person involved**	**Type of audience**	**Estimated size of audience**	**Countries addressed**
1	17.08.2017	Goldschmidt conference, Paris	BGS	Oral presentation entitled "Combined extraction of energy and metals from ultra-deep ore bodies: The potential of Cornwall, UK. P.A.J. Lusty, C.A. Rochelle, R.A. Shaw, A. Kilpatrick and the CHPM2030 Project Team". Presented in the session 'Energy, Mineral and Resource-Recovery Nexus: Rare Earths, Uranium, and Other Critical Resources" *Paul Lusty*	Geoscientists	80 (in that session. Many more at the conference)	worldwide
2	19.09.2017	FEMP Annual Reunion	LPRC	H2020 best case examples *Tamas Miklovicz*	Industry, academics	100	Various from EU
3	11-12.09.2017	High Level Conference of the Global Geothermal Alliance, Florence, Italy	USZ	Unlocking geothermal investments: Challenges and opportunities panel discussion *Tamás Medgyes*	Presidents, Prime ministers, ministers and other high-level representatives	128	worldwide
4	19.09.2017	EU Process Industry Conference - 19 September 2017	LPRC	CHPM2030, Combined Heat, Power and Metal extraction *Tamas Miklovicz*		50	
5	26.10.2017	Geochemistry of Geothermal Fluids Workshop	UNIM	Combining energy production and mineral extraction – The CHPM2030 project *Éva Hartai*	Earth scientists	30	Various from EU
6	26.10.2017	Geochemistry of Geothermal Fluids Workshop	UNIM	Typical compositions of geothermal fluids in Hungarian concession areas *Péter Szűcs* Presentation of the CHPM2030 project *Éva Hartai* Metal leaching aspects	Earth scientists	30	Various from EU

				Chris Rochelle			
7	09.11.2017	EU Raw Materials Week	LPRC	Distribution of brochures *Éva Hartai*	Industry, policy makers	~1000	
8	01.03.2018	GeoTHERM trade fair	EFG	Presentation: What the future holds for geothermal *Vitor Correia*	Geoscientists, Industry	3500	
9	9-14.04.2018	17th Alps-Adria Scientific Workshop, Hnanice, Czech Republic	USZ	Presentation *Máté Osvald*	Geoscientists	50	Mainly EU
10	13.06.2018	MINEX Europe 2018 Conference	UNIM	CHPM2030 - A novel research concept of combined heat power and metal extraction from geothermal brines *Tamás Madarász*	Representatives of the mining sector	100	Worldwide
11	07.06.2018	Upscaling blue energy	LPRC	Multidisciplinary approach for geothermal resources *Tamas Miklovicz*	Industry, academics, policy makers	8	Netherlands, Germany, Belgium, Hungary, Italy
12	07.06.2018	EU Sustainable Energy Week	LPRC	Multidisciplinary approach for geothermal resources *Tamas Miklovicz*	Industry, academics, policy makers	100	Mainly EU
13	07.06.2018	EU Sustainable Energy Week	EFG	Participation in panel discussion *Anita Demény*	Industry, academics, policy makers	100	Mainly EU
14	18.06.2018	3rd Workshop of H2020 Geothermal Research and Innovation Projects	UNIM	*Tamás Madarász* presented the new results of CHPM2030	Representatives of INEA and the H2020 geothermal projects	30	Various from EU
15	19.06.2018	ETIP-DG Annual Conference 2018	UNIM	*Tamás Madarász* participated in the Roundtable discussion with representatives of geothermal projects	Representatives of the geothermal projects	30	Various from EU
16	19.06.2018	ETIP-DG Annual Conference 2018	LPRC	/Distribution of brochures *Tamas Miklovicz*	Representatives of the geothermal projects	30	Various from EU

National conferences & workshops

	Date	**Event details (name & place)**	**Partner involved**	**Type of dissemination activity (presentation, poster, exhibition, etc)**	**Type of audience**	**Estimated size of audience**	**Countries addressed**
1	07.09.2017	'Celebration of Cornish Mining' meeting, held at Heartlands, near	BGS	Distribution of CHPM2030 project brochure	Geoscientists, mining sector	100	UK

		Camborne, Cornwall, UK, 7th September 2017. A meeting to celebrate the centenary of the Cornish Chamber of Mines and Minerals, and supported by the Cornwall Mining Alliance.		*Eimear Deady and Andrew Bloodworth*			
2	16.10.2017	UK Geothermal Workshop, Geological Society of London, UK.	BGS	Presentation of the CHPM2030 project, and especially metal leaching aspects. *Chris Rochelle*	Earth Scientists	80	UK
3	25-27.11.2017	Salon of Romanian Research organised by the Ministry of Research at House of Parliament, Bucharest	IGR	Distribution of CHPM2030 project brochure Display of a poster about CHPM2030 project. *Diana Persa*	Scientists, wide public, politicians	200 000	RO
4	17.05.2018	Annual Meeting of the Hungarian Academy of Sciences	UNIM	Challenges and new possibilities in the geothermal energy utilisation (in Hungarian) *Péter Szűcs*	Earth Scientists	50	HU

Publications in journals or on internet

	Date	Journal/link	Author(s)	Title of publication	DOI
1	17.08.2017	Goldschmidt Abstracts 2017 2486. https://www.goldschmidtabstracts.info/abstracts/abstractView?id=2017003912	P.A.J. Lusty, C.A. Rochelle, R.A. Shaw, A. Kilpatrick and the CHPM2030 Project Team	Combined extraction of energy and metals from ultra-deep ore bodies: The potential of Cornwall, UK.	
2	16.10.2017	UK Geothermal Workshop, Geological Society of London, UK.	C. A. Rochelle, P.A.J. Lusty, R.A. Shaw, A. Kilpatrick and the CHPM2030 Project Team	Combined extraction of heat, power and metal: An introduction to the CHPM2030 project	
3	07.2018	Central European Geology, Vol. 61/2, 118–135.	Sas, J., Osvald, M., Ramalho, E. and Matos J. X.	Combined study of mineral deposits and deep geothermal for energy production or urban heating – Comparison between the Portuguese (Neves-Corvo) and the Hungarian (Recsk) case studies.	10.1556/24.61.2018.07
4	01.2018	Progress in Material Science Volume 94, May 2018, Pages 435-461	X. Dominguez-Benetton, J.Ch. Varia, G. Pozo, O.Modin, A.T.Heijne, J. Fransaer, K. Rabaey	Metal recovery by microbial electro-metallurgy	10.1016/j.pmatsci.2018.01.007
5	01.2018	RSC Adv., 2018, 8, 5321	Burgos Castillo Rutely C., Fontmorin Jean-M., Tang Walter Z., Dominguez-Benetton Xochitl	Towards reliable quantification of hydroxyl radicals in the Fenton reaction using chemical probes	10.1039/c7ra13209c

			and Sillanpaa Mika		

Other types of promotion

	Date	Means of promotion (event, publication, etc.)	Partner involved	Type of dissemination activity (newsletter, public event, promotional products, etc.)	Type of audience	Size of audience	Countries addressed
1	29-30.09.2017	‘The Festival of Science’ organised at National Museum of Geology, Bucharest	IGR	Distribution of CHPM2030 project brochure Display of 2 posters of the CHPM2030 project.	wide public	15000	RO
2	21-24.09.2018	Orientation field visit to Cornwall	BGS (lead), UNIM, USZ, IGR, LPRC, EFG	The field visit offered several opportunities to meet with UK industry, local council and university representatives	geoscientists, local industries in SW England, local council	15	Mainly UK
3	05.06.2018	Website	IGR	Presentation of the project published on the web-site of National Museum of Geology	wide public	10000	RO
4	12 May 2018	Website	IGR	Presentation of the project published on the web-site of IGR	wide public	5000	RO
5	19 May 2018	The night of the Museums	IGR	Interview given by Ștefan Marincea, for Canal D TV and for TVH, who, among other things referred to innovative research and projects mentioning CHPM2030 as an example.	wide public	10000	RO
6	06.11.2017	How much geothermal water costs	IGR	Interview for ‘Libertatea’ paper, which has an online version. The presentation of CHPM2030 project.	wide public	200 000	RO
7	30.01.2016 18.10.2016 04.04.2017 28.04.2017 16.05.2017 05.09.2017 20.09.2017 15.11.2017 04.04.2018 17.04.2018	LPRC website/social media news/posts	LPRC	Websites news items are shared on LPRC’s LinkedIn (https://www.linkedin.com/company/la-palma-research-centre-sl/) and Facebook (https://www.facebook.com/lapalmaresearch/) Regular tweets about CHPM2030 events from https://twitter.com/lapalmaresearchand https://twitter.com/miktamasaccounts.	wide public		EU

	28.05.2018 14.06.2018						

Dissemination by the EFG LTPs

Type of dissemination activity	Event details	Title of presentation/publication	Date	Place	Type of audience	Size of audience	Countries addressed
The Finnish Union of Environmental Professionals (LOUMI)- Finland							
Web	LOUMI website	Permanent link to the CHPM project website	01/07/2017-30/06/2018		Geoscience professionals, scientists, policy makers		Finland
Professional Association of German Geoscientists (BDG)- Germany							
Web	BDG's social media channels	Following EFG's social media channels	01/07/2017-30/06/2018		Industry, scientists, civil society, other	>8,000	EU, international
Web	BDG's website	Logo, project-description on BDG's website	01/07/2017-30/06/2018		Industry, scientists, civil society, other	>8,000	EU, international
Web	BDG's Facebook page	CHPM2030 project dissemination through Facebook	11/09/2017		Industry, scientists, civil society, other	>8,000	EU, international
Flyers	Congress "Meggener Rohstofftage 2017"	Distribution of CHPM2030 flyers	13-15/09/2017	Lennestadt-Meggen, Germany	Geoscience professionals, scientists, policy makers	500	Germany, EU
Flyers	Conference "VBGU-Tagung"	Distribution of CHPM2030 flyers	07/10/2017	Berlin, Germany	Industry, other	~50	Germany, EU
Flyers	Traid fair "GEC"	Distribution of CHPM2030 flyers	25-26/10/2017	Offenbach, Germany	Industry, scientists, civil society, media, other	~700	EU, international
Conferences	Annual assembly of BDG	Discussion of the tasks of BDG in CHPM, distribution of CHPM2030 flyers	27/10/2017	Offenbach, Germany	Industry, scientists, other	~50	Germany
Conferences	Meeting of the Board and Advisory Board of BDG	Discussion of the tasks of BDG in CHPM	27/10/2017	Offenbach, Germany	Industry, scientists, other	~10	Germany
Press releases	Contribution in BDG-Mitteilungen No. 130 (postal)		06/12/2017		Industry, scientists, other	~9,000	Germany
Flyers	Traid fair "GeoTHERM"	Distribution of CHPM2030 flyers	28/02-02/03/2018	Offenbach, Germany	Industry, scientists, civil society, media, other	~3,500	EU, international
Web	Newsletter	BDG e-mail newsletter	01/04/2018		Industry, scientists, other	~2,000	Germany

Web	BDG LinkedIn page	CHPM2030 project dissemination through LinkedIn	12/04/2018		Industry, scientists, civil society, other	~100	EU, international
Web	BDG Facebook page	CHPM2030 project dissemination through Facebook	12/04/2018		Industry, scientists, civil society, other	>8,000	EU, international
Conferences	Orientation Workshop for EFG Linked Third Parties	Participation on the Workshop, working on the contribution of the LTPs in WP6	12/04/2018	Brussels, Belgium	Scientists, EFG, other	21	EU
Press releases	Contribution in GMit-Magazine No. 72 (postal)		15/04/2018		Industry, scientists, other	~9,000	Germany
Association of Greek Geologists (AGG)- Greece							
Web	AGG's Facebook page	CHPM2030 project dissemination through Facebook-press releases, news, brochure	17/06/2017		Industry, scientists, policy makers, media, other	1876	Greece, EU, international
Press releases	AGG's website	Sharing the Press release (in Greek) about the 1st EuroWorkshop: "Geothermal - The Energy of the Future" (Santorini, 17-19 May 2017)	July 2017		Industry, scientists, policy makers, media, other	unknown	Greece
Web	AGG's website	Logo, project-description on AGG's website	July 2017		Industry, scientists, policy makers, media, other	unknown	Greece, Eu, international
Conferences	11th International Hydrogeological Congress of Greece, Agricultural University of Athens	Presentation of the CHPM2030 Project (session dedicated to the Association of Greek Geologists (AGG))	06/10/2018	Athens, Greece	Scientists	80	Greece
Conferences	2nd Energy Tech Forum, Eugenides Foundation, Athens	Presentation of the CHPM2030 Project	25/11/2017	Athens, Greece	Industry, scientists, policy makers, media, other	100	Greece
Press releases	AGG's website	Sharing the Press release (in Greek) about the presentation of the CHPM2030 Project in the 2nd Energy Tech Forum (Athens, 25 November 2017)	16/12/2017		Industry, scientists, policy makers, media, other	unknown	Greece
Web	AGG's Facebook page	Announcement (in Greek) on Facebook -Presentation of the CHPM2030 Project in the 2nd Energy Tech Forum (Athens, 25 November 2017)	15/01/2018		Industry, scientists, policy makers, media, other	1876	Greece
Web	AGG's Facebook page	Participation in the official social media campaign	17/01/2018		Industry, scientists, policy makers, media, other	1876	Greece, EU, international

Web	AGG's Facebook page	Sharing the CHPM2030 promotional video	12/02/2018 13/04/2018		Industry, scientists, policy makers, media, other	1876	Greece, EU, international
Web	AGG's Facebook page	Sharing the link on Facebook to the following publication: Combining energy production and mineral extraction - The CHPM2030 project, European Geologist Journal 43	21/03/2018		Industry, scientists, policy makers, media, other	1876	Greece, EU, international
Web	AGG's Facebook page	Sharing post on the CHPM2030 orientation workshop for the European Federation of Geologists Linked Third Parties	12/04/2018		Industry, scientists, policy makers, media, other	1876	Greece, EU, international
Hungarian Geological Society (MFT)- Hungary							
Web	MFT's website	Logo, project-description/news on MFT's website	01/07/2017-30/06/2018		Industry, scientists, civil society, other	unknown	Hungary, EU, international
Web	Newsletters	Printed and electronic newsletter: Information on the progress of the H2020 projects	01/09/2017 01/11/2017 25/12/2017 26/02/2018 30/04/2018		Scientists, higher education, civil society	1000	Hungary
Conferences	XIII. HUNGEO – World Meeting of Hungarian Geoscientists	Presentation and poster presentation on CHPM	16-20/08/2017	Pécs, Hungary	Scientists, higher education	129	Hungary, Romania, USA, Australia, Canada, UK
Press releases	MFT's website	Sharing the CHPM press release relates to the 4th consortium meeting, Brussels, September 2017	05/11/2017		Scientists, higher education, civil society	100,000	Hungary
Web	MFT's Facebook page	Sharing the poster of CHPM and post on the Interactive Geological Exhibition and Fair (11-12/11/2017, Budapest, Hungary)	11-12/11/2017		Civil society	unknown	Hungary
Press releases	Interactive Geological Exhibition and Fair	Dissemination of the CHPM brochures on the event	11-12/11/2017	Budapest, Hungary	Civil society	3,000	Hungary
Web	Website of Eger TV	Article on the Endless Story of Recsk, Conference - 50th anniversary of discovery of porphyritic ore body	08/02/2018		Scientists, higher education, civil society	unknown	Hungary

Conferences	Endless Story of Recsk, Conference - 50th anniversary of discovery of porphyritic ore body	Presentation on CHPM2030	08/02/2018	Recsk, Hungary	Scientists, higher education, civil society	119	Hungary
Institute of Geologists of Ireland (IGI)- Ireland							
Web	IGI's LinkedIn page	CHPM2030 project news dissemination through Linkedln	01/07/2017-30/06/2018		Industry, scientists, civil society, other	unknown	Ireland
Web	IGI's website	CHPM2030 project news dissemination on the website	01/07/2017-30/06/2018		Industry, scientists, civil society, members, other	unknown	Ireland, UK, USA, Canada
Conference	Geothermal Association of Ireland Conference, Energy Show 2017	Presentation on CHPM2030	06/04/2017	Dublin, Ireland	Scientists, policy makers	40	Ireland
Web	IGI's website	Dissemination of the project brochure	09/01/2018		Scientists, members, civil society, other	120	Ireland
Italian National Council of Geologists (CNG)- Italy							
Conferences	Conoscenze e prospettive nel campo delle risorse naturali minerarie	Organization of the workshop and conference, CHPM flyers dissemination	12/07/2017	Roma, Italy	Industry, scientists, members, policy makers, civil society, academia, other	50-100	Italy
Web	CNG's social media platforms	Video dissemination and promotion of the Conoscenze e prospettive nel campo delle risorse naturali minerarie	13/07/2017	Roma, Italy	Scientists, civil society	unknown	Italy
Royal Geological and Mining Society of the Netherlands (KNGMG)- the Netherlands							
Flyers	KNGMG Symposium on Science behind the Groningen field	Distribution of the leaflet from CHPM2030	01/12/2017	Technical University Delft, the Netherlands	Industry, scientists	100	the Netherlands
Flyers	KNGMG Symposium on Science behind the Groningen field	Distribution of the leaflet from CHPM2030	01/02/2018	Technical University Delft, the Netherlands	Industry, scientists	200	the Netherlands
Flyers	NAC - National Earth Conference	Distribution of the leaflet from CHPM2030	15/03/2018	Veldhoven, the Netherlands	Industry, scientists	500	the Netherlands
Web	KNGMG's website	Announcement of the CHPM promotional videos and the CHPM2030 orientation workshop for the European Federation of Geologists Linked Third Parties	30/03/2018		Industry, scientists	unknown	the Netherlands

Web	KNGMG's website	Announcement of the CHPM promotional videos, newsflash	15/04/2018		Industry, scientists	unknown	the Netherlands
Polish Association of Minerals Asset Valuators (PAMAV)- Poland							
Web	PAMAV's website	Dissemination of the translated CHPM 2nd brochure	18/11/2017-19/01/2018		Industry, scientists, civil society, other	unknown	Poland
Posters	4th Polish Mining Congress	Preparation and presentation of poster entitled "CHPM2030 – Combined Heat, Power and Metal Extraction"	21/11/2017	Kraków, Poland	Scientists, industry, civil society, policy makers	~450	Poland
Portuguese Association of Geologists (APG)- Portugal							
Web	APG's Twitter page	CHPM2030 project dissemination through Twitter (news, 2nd brochure)	04/07/2017-05/06/2018		Scientists, industry, civil society	>5,000	Portugal, EU, international
Web	APG's Facebook page	CHPM2030 project dissemination through Facebook (news, 2nd brochure)	21/07/2017-05/06/2018		Scientists, industry, civil society	>8,000	Portugal, EU, international
Web	Newsletter	CHPM2030 project dissemination through the mailinglist- EFGeoWeek	21/07/2017-05/06/2018		Scientists, industry, civil society	>5,000	Portugal, EU, international
Web	Newsletter	CHPM2030 project dissemination through APGNews	01/08/2017-29/05/2018		Scientists, industry, civil society	>5,000	Portugal, EU, international
Posters	PALOP Geochemistry Congress	CHPM poster dissemination	25-29/03/2018	Vila Real, Portugal	Scientists	>100	PALOP
Web	APG's blog	CHPM2030 project dissemination through the blog (news)	27/04/2018, 05/06/2018		Scientists, industry, civil society	>10	Portugal, EU, international
Web	APG's LinkedIn page	CHPM2030 project dissemination through LinkedIn (news, 2nd brochure)	27/04/2018, 05/06/2018		Scientists, industry, civil society	>1,000	Portugal, EU, international
Web	APG's ISSUU Platform	CHPM2030 project dissemination through the platform (2nd brochure)	05/06/2018		Scientists, industry, civil society	13	Portugal, EU, international
Web	APG's website	CHPM2030 project dissemination through the website (project update, 2nd brochure)	05/05/2018, 07/06/2018		Scientists, industry, civil society, other	2636	Portugal, EU, international
Slovenian Geological Society (SGS)- Slovenia							
Web	SGS's website	Dissemination of the 2nd brochure in Slovenian	19/01.2018		Scientists	unknown	Slovenia
Serbian Geological Society (SGS)- Serbia							

Web	SGS's website	Distribution of project news	01/07/2017-30/06/2018		Industry, scientists, policy makers, civil society, other	unknown	Serbia
Flyers	Conference- Meetings with mining companies, municipalities with geothermal sites potential	Distribution of project flyers	01/01/2018-30/06/2018	Serbia	Scientists, policy makers	30	Serbia
Conferences	Conference- Meetings with mining companies, municipalities with geothermal sites potential	Presentation on the CHPM project	01/01/2018-30/06/2018	Serbia	Scientists, policy makers	30	Serbia
Presentations	Students in Hydrogeology at the Belgrade University – Faculty of Mining & Geology	Teaching- Lectures on proposed project technologies	04/02/2018	Belgrade, Serbia	Higher education, scientists	18	Serbia
Web	Subotica Town local TV	Media news on the meeting with Town authorities	14/03/2018	Serbia	Media, other	15	Serbia, France, Hungary
Web	Newsletter	Publishing the informative text on CHPM 2030 (connecting to the presentation at the Serbian Geological Society Assembly)	03/03/2018		Scientist	40	Serbia
Conferences	Conference- Workshop - Geothermal site selection and utilization, experiences, case studies (Szeged Heating System)	Presentation of project CHPM	13/03/2018	Szeged, Hungary	Scientists	22	Serbia, Hungary
Flyers	XVII Serbian Geological Congress	Distribution of CHPM flyers	17-20/05/2018	Vrnjacka Banja, Serbia	Scientists	150	Serbia, Bulgaria, Bosnia & Herzegovina, Montenegro
Conferences	XVII Serbian Geological Congress	Short presentation on the CHPM project tasks	17-20/05/2018	Vrnjacka Banja, Serbia	Scientists	350	Serbia, Bulgaria, Bosnia & Herzegovina, Montenegro
Official Spanish Association of Professional Geologists (ICOG)- Spain							

Web	ICPG's webpage	CHPM2030 project dissemination through the website	27/03/2017-24/05/2018		Scientists, civil society, other	100	Spain, EU, international
Ukrainian Association of Geologists (UAG)- Ukraine							
Web	EAUAG's website	CHPM2030 project dissemination through the website (events, news, 2nd brochure)	01/07/2017-30/06/2018		Scientists, civil society, other	>100	Ukraine, EU, international
Web	EAUAG'S Facebook page	CHPM2030 project dissemination through Facebook (events, news, 2nd brochure)	18/08/2017-24/05/2018		Scientists, civil society, other	>100	Ukraine, EU, international