Geothermal Emission Control

Reporting

Project Information

GECO

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Project website

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Project closed

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€ 15 599 842,88

Coordinated by
CARBFIX OHF
Iceland

This project is featured in...

20 September 2022

Periodic Reporting for period 3 - GECO (Geothermal Emission Control)

Reporting period: 2021-04-01 to 2023-03-31

Summary of the context and overall objectives of the project

GECO is an innovative project aiming at providing clean geothermal energy with a lower cost. It builds upon the success of the recently completed Carbfix project.

This past project has advanced our ability to clean the exhaust gases emitted by geothermal power plants based on a novel water dissolution method in a dedicated scrubbing tower. The injection of these gas charged waters into the subsurface disposes the captured gases within precipitated minerals that remain stable over geologic time. This method has been running at the Hellisheidi power plant in Iceland for the past three years. It has been demonstrated to; 1) offer considerable cost savings compared to other approaches to capture and dispose of acidic carbon and sulphur bearing gases, 2) be far more environmentally friendly compared to other available technologies, and 3) aid in the long-term viability of geothermal systems by enhancing the permeability of fluid injection wells.

The goal of this GECO Innovation Action is to adopt this approach, together with emission gas reuse schemes, to become a standard to the geothermal power industry worldwide through its application to three new sites across Europe. Moreover, the detailed monitoring and chemical modelling of this injection has provided novel insights into the reactions that occur in the subsurface in response to flowing fluids in geothermal systems. By consistently monitoring the reactions that occur in the four GECO field sites, each with distinct geology, we will be able to generalise these findings to create a tool for predicting the chemical behaviour of a large number of other systems before they are developed for geothermal energy. Such tools have the potential to decrease both the risk and the cost of future geothermal energy projects.

GOAL 1
To lower emissions from geothermal power generation by capturing them for either reuse or storage. This will be done by; 1) further optimizing gas capture and injection infrastructure at Hellisheidi and

thereby further lowering emissions, 2) implementing lessons learned at Hellisheidi at three other field site demonstrations across Europe, and 3) combining the success of the Carbfix approach with corresponding gas re-use approaches.

GOAL 2
To turn captured emissions into commercial products, allowing for cost reductions through increased revenues. By producing pure enough gas streams for utilisation processes, products like hydrogen gas and pure CO2 can be used as an added value to help offset the costs of cleaning exhaust gases.

GOAL 3
To demonstrate cost competitiveness of developed gas capture and injection methods through a comprehensive economic analysis of gas capture, injection and monitoring at each field site.

GOAL 4
To characterise and model the geology, geochemistry and infrastructure of the four distinct geothermal systems located throughout Europe with the aim of optimising the injection experiments. By applying our approach successfully at four diverse locations we will aid in the public acceptance of geothermal energy throughout the continent.

GOAL 5
To quantify the rate and extent of subsurface reactions occurring in response to induced fluid flow during and after the injection of fluids into the subsurface.

GOAL 6
To integrate new technology, such as detecting CO2 fluxes via remote sensing, in-situ laser isotope analyser and corrosion monitoring system, for improved monitoring of the injections leading to decreased risks associated with leakages etc. for safer injection procedures.

GOAL 7
To generate an improved understanding of the response of subsurface rocks to induced fluid flow in the subsurface. Notably by combining the results of a consistent chemical monitoring and a modelling program on a diverse set of geothermal systems, we will generate computational tools to predict the behaviour of other systems.

GOAL 8
To help train the next generation of scientists and engineers in the current best practice work-flow for lowering emissions from deep geothermal operations and thereby moving the GECO technology into the future.

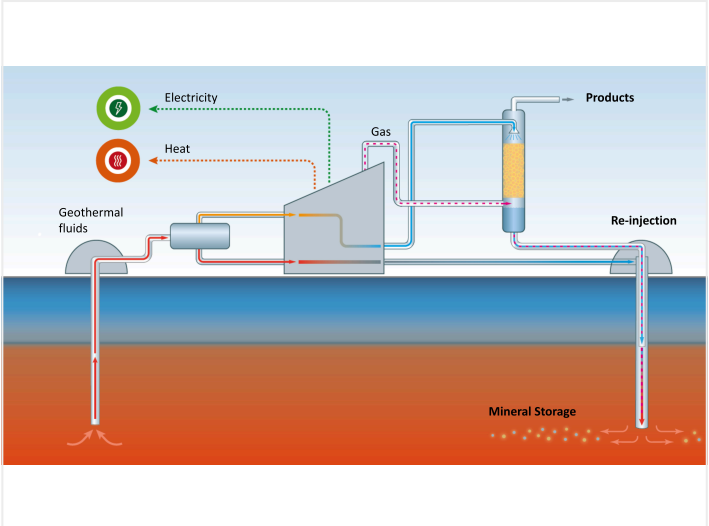
Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The results of the GECO project include a newly developed extensive site characterization workflow that was demonstrated on the demo sites within the project as well as being replicable for other sites in the future. Following site characterization, diverse methods of capture, injection and monitoring systems were tested under field conditions in Hellisheiði, Nesjavellir, Hveragerði, Kizilidere and Bochum.
Key results/impacts:
WP2:
A workflow has been developed that allows for an efficient characterization of new demo sites
WP3:
Road map to zero emission geothermal power plants & circular economy produced
WP4:
New thermodynamics/dissolution data for NCG/water injection system
Precipitation/Dissolution effects of CO2 on rocks at different T-P conditions over time in different geologic settings.
Surface design for power plant for zero emission project with high NCG content
WP5:
The demonstration of CO2 water capture at higher pressures in Nesjavellir increases the applicability of the Carbfix method in water scarce areas.
An improved kinetic database can advance future modelling work using different modelling software.
WP6:
The first installation and commissioning and demonstration of The Closed Loop Well Flow Testing Unit (CLWFTU) for the total geothermal fluid reinjection in a single well carried out successfully.
WP7:
During the demonstration campaign in Turkey, 980 tons of CO2 was injected. A drastic increase of injectivity (from 95 t/h to 190 t/h) has been observed during the injection of CO2-charged water.
In terms of the trapping mechanism, most of the injected CO2 remains in the reservoir (i.e. solubility-trapping) and is transported as bicarbonate.
WP8:
Fluid-Gas Reactor (FGR) successfully designed and commissioned in order to create different brines/fluid mixtures and bring them at T-P test conditions.
The fluid (CO2-water) was successfully injected from FGR to the well in Bochum under controlled conditions.
No seismic signal could be correlated with the injection or extraction.
WP9:
Results show that when reducing the NCG in the pilot plants there are already environmental, cost and environmental cost benefits for the global warming and terrestrial acidification impact categories

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

Below are key results from the project advancing the technologies beyond state of the art.

The Carbfix capture technology has been optimised to reach over 95 % CO2 capture efficiency. These results will feed directly into the design of future Carbfix capture plants.
A workflow has been developed that allows for an efficient characterization of a new demo site as was illustrated for the Hveragerdi test site in Iceland.
New thermodynamics/dissolution data for NCG/water system enabling more accurate predictions of injection well behavior in operation.
New corrosion monitoring systems have been demonstrated under operational environment
Sulphur isotope monitoring system has been demonstrated under operational environment
A fluid gas reactor has been successfully designed and commissioned to create different brine/fluid mixtures and bring them to T-P test conditions
Results show that when reducing the NCG in the pilot plants there are already environmental, cost and environmental cost benefits for the global warming and terrestrial acidification impact categories for the case of the environmental impacts and costs.



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