The GEO-ENERGY EUROPE project was funded by the European Union’s COSME Programme under Grant Agreement N° 951195.

GEE II – CHILE
Training session
Tuesday 8th of March
# Agenda

<table>
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<th>Time</th>
<th>Event</th>
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| 15:00 CET| **Introduction:**  
- Overview of Geoenergy Europe project (GI)  
- Presentation of capacity building activities (Virginie BLOCH - GEODEEP)  
- Presentation of Chilean geothermal council (Carlos JORQUERA – Chilean geothermal Council) |
| 15:15 CET| Presentation of Chilean Country Fiche (Christian BOISSAVY - GEODEEP)  
- global structure of the energy market  
- geothermal market (regulation and risk mitigation scheme if existing, market barriers, structure of the competition, key stakeholders) |
|          | Presentation of GEE Collaborative tool (CAPES)                                                                                                  |
| 15:45    | **Coaching of our SMEs (Sylvain BROGLE – Halfway / GEODEEP)**  
- Key aspects when working with Chilean geothermal companies  
- Identification of specified know-how developed by our SMEs to fit to market country specificities  
- If needed, identification of proper expertise / competencies to develop outside the consortium, to reach key target markets? |
| 16:45    | **Roundtable with participants**  
- Share experience  
- SME’s expectations in coherence with training contents?  
- If not, what are the main areas where GEE SMEs require capacity building |
|          | **Conclusions of the Training session - (Virginie BLOCH - GEODEEP)**  
- Presentation of Market visit content (4, 5 & 6th of April 2022 March in Santiago) |
What’s GEO-ENERGY EUROPE?

The GEO-ENERGY EUROPE metacluster is a voluntary, open alliance of complementary clusters focusing on sustainability and the transition to a decarbonised and sustainable use of geo-energy.

GEO-ENERGY EUROPE aims to create a European Strategic Cluster Partnership in geothermal energy and to develop a joint internationalisation strategy to help the clusters access worldwide geothermal markets.

The overarching vision for the GEO-ENERGY EUROPE metacluster is to develop a stronger and more integrated European sustainable geo-energy sector, especially for Small & Medium Enterprises.
Why has GEO-ENERGY EUROPE been created?

Europe is a leading continent in geoscience and subsurface engineering but has a limited level of integration between different subsurface industries. It also has limited visibility in worldwide geothermal markets, which are currently expanding.

GEO-ENERGY EUROPE provides a platform for knowledge transfer, technology transfer, marketing, and other networking services.
GEO-ENERGY EUROPE
Strand 2 project.

The GEO-ENERGY EUROPE project was funded by the European Union’s COSME Programme under Grant Agreement N° 951195.

It is the continuation of the GEE Strand 1, a 2-year capacity building programme funded project.

It runs from September 2020 until August 2022.

The main goal of GEO-ENERGY EUROPE is to provide a platform for knowledge transfer, technology transfer, marketing, and other networking services between the cluster members and clusters/SME’s/organisations from Chile and other target countries.
Training of our SMEs to better access our targeted countries

Objectives and proposed methodology

- To coach our SMEs and assist them to have a strong positioning when targeting export markets.
- 4 target countries: Chile, Canada, Kenya, Costa Rica

Example of typical CAPACITY BUILDING session planning

PHASE 1:
Collection and target country data update-through diffusion of questionnaire to GEE’s SMEs

PHASE 2:
Training session content preparation, identification of specific market objectives and possible cross-technologies partnership-Proposition of agenda, registration of GEE SMEs

PHASE 3:
Feedback from training sessions Market visit preparation, liaise with key stakeholders diplomatic representations, national geothermal associations...

PHASE 4:
Debriefing time – analyse of market visit relevance and eventual improvement of training program

Source: deliverable 2.7.
PRESENTATION OF CHILEAN COUNTRY FICHE
Introduction

Chile has the potential to valorize up to 3800 MW of geothermal energy for electricity generation which is still largely unexploited. The potential for low temperature applications is important but more geographically limited.

The country sits in the middle of the “Ring of Fire”, a set of tectonic plates in the Pacific with the greatest seismic and volcanic activity in the world.

With access to these sources around the country, geothermal energy could become widespread in the coming years, as outlined in Chile’s national plan to reduce greenhouse gas emissions.

Around 51% of the total electricity generation (26 GW installed) come from fossils resources. Chile's goal is to achieve electricity carbon neutrality by 2050.

They will be replaced with new additional sources of clean energy which at the moment are expected to be mainly solar but also wind energy plants.
Energy mix in Chile (IEA 2020)
Electricity mix in Chile (IEA 2020)
Electricity generation mix in 2020 (Statista)

Total RES at 48.7% and geothermal still marginal
Planned electricity generation mix in 2047 (40 000 MW installed)

At the moment “Hydro” is the main clean producer of electricity. In the next 20 years the solar CSP and PV will represent nearly 40% and wind power about 8%. In the best case the geothermal power will be at 5% in 2047 representing a total of 2100 MWe to be installed which is in line with the potential.

(Mesa Geotermia 2018)

The price of the energy is $34/MWh for the 415 MW solar project in the Atacama desert. The project includes 215 MW of CSP capacity, 12 hours of molten salt storage and 200 MW of PV, providing power generation 24 hours a day.
In relation with the climate of the country and the population density: geothermal electricity can be done everywhere because existence of the grid. For others application like heating and cooling, the resources have to be exploited at a very short distance of the potential consumers (maximum of some kilometers) which is limiting the main potential to the central part of the country for geothermal applications with or without heat pumps.
Due to the geological position of the country controlled by the convergence of the Nazca and South American Plates. In the country there are more than 300 geothermal areas associated with recent volcanism. Preliminary assessment of the geothermal volcanic-zones estimates a huge potential in the order of 16,000 MWe for at least 50 years from geothermal fluids with temperatures above 150ºC and located at a depth less than 3000 m. (Lahsen, 1986)
The potential good zones for electricity ($P_{50}$ at 2100 and maximum at 3800 MWe)

The installed geothermal powers are:

- Bathing and swimming - 14.7 MWth
- Geothermal heat pumps - 7.9 MWth
- Electricity – 48 MWe (only one plant)
El Tatio, a long history with exploitation bottlenecks

Geothermal exploration started in 1920. During the 70’s numerous wells were drilled and a desalination plant installed. A more ambitious plan after 1995 led to the drilling of numerous deep geothermal wells. At that time a strong influence on the natural Geysers field, which is a touristic spot, was already visible. In 2009, the company GDN was developing the geothermal production when an unexpected blow out in an old well was difficult to control. Since this period the geothermal production has been stopped even if the estimated potential is estimated by the Mesa de Geotermia at 175 Mwe.
One single geothermal plant in force

As of 2022, Cerro Pabellón is the only geothermal power plant in the country, the first in South America and the highest-altitude plant of its kind in the world, at 4,500 m above sea level.

The facility, inaugurated in September 2017, is located in the Atacama desert in the Antofagasta region. It is composed of two units with a gross installed power of 24 MW each, for a total capacity of 48 MW. A third, 33 MW unit will be built to be able to produce around 600 GWh per year once fully operational avoiding 470 000 T CO2/year.

Cerro Pabellón is owned by Geotérmica del Norte, a JV between Enel Green Power Chile, the local unit of the Italian corporation Enel and Chilean state-owned oil and gas company ENAP.
Legislative framework

In Chile, geothermal extraction is regulated by Law N° 19 657 (Geothermal Concession) and Decree N° 114 of year 2012. The law defines basic concepts and essential milestones in the licensing procedure, while Decree 114 was introduced to streamline the process for granting geothermal energy concessions.

The Ministry of Energy is in charge of issuing geothermal concessions. It is established that any Chilean or legal person established according to Chilean laws may request, or participate in a tender for a geothermal concession.

According to the law superficial ownership and exploitation rights are distinct
Concession rights are divided into exploration and exploitation ones

In 2019, the Ministry of Energy presented a bill to Congress that seeks to simplify the processing of permits for direct-use projects.
Concession system

Regulation of Geothermal Energy in Chile - Ley N°19.657

**Situation in May 2021**
(Ministry of Energy)

- 0 exploration concession,
- 8 concessions granted
- 4 applications

Maximum area: 100,000 ha

There are the obligation to pay a fee ~ 7.2 USD/ha
Many stakeholders

- Ministry of Energy
- Transmark renewables
- Infinergeo
- Fundacion Chile
- Energia Andina
- ENEL Chile
- ENAP
- Energy Development Corporation
- Chile Invest
- SERNAGEOMIN
- Chilean Association of Renewable Energies
- ACERA
- Adobera SpA
- GDF
- Comision National de Energia (CNE)
- Geothermal Council
Supporting programs for geothermal energy

- **National Geology and Mining Service (SERNAGEOMIN)** - Public Entity, responsible for executing projects for the promotion of geothermal energy.

- **Geothermal Council** - The objective of the Geothermal Council is the promotion and development of geothermal energy in the Chilean market.

- **Geothermal Center of Excellence for the Andes (CEGA)** - Its mission is to promote geothermal energy in Chile and the Andean countries by improving scientific knowledge.

- **Technical Assistance for Sustainable Geothermal Development Project for Chile.** The project was performed from 2016 to 2021 by the World Bank. It was designed to help the Government of Chile improve geothermal energy market conditions and regulatory framework by removing barriers with a $3.5 million grant.

- **Chile Geothermal Risk Mitigation Program (MiRiG).** The program was established in by the government of Chile with the support of the Clean Technology Fund (CTF) in 2013 and the World Bank. It includes a risk mitigation component implemented by the Inter-American Development Bank.

- **Geothermal Development Facility (GDF)** is to encourage public and/or private investment in geothermal power development in Latin America. The RMS covers: geoscientific surface studies and drilling + testing of wells at the most promising prospects to assist developers in securing financing for subsequent development phases. 2016-2026. Fund size of 50 M€ main donors are German federal Ministry of Foreign affairs and EU.
De-risking for geothermal a key component

Geothermal project development has several risk components, the most important one being the resource risk and more precisely the ratio temperature/flowrate. Beyond exploration, the bankability of a geothermal project is threatened by this geological risk.

The geological risk is a common bottleneck all over the world preventing a strong deployment of geothermal energy. Chile has benefited of two existing tools for geothermal derisking: The Geothermal Development facility (GDF) for Latin America and the Chilean MiRig fund.

The establishment of such insurance all over the world to cover the geothermal exploration phase and the first drilling tests is the key for a quick development of geothermal for electricity and heat/cold production.

But it appears clear that a risk mitigation is not enough to deploy geothermal energy while the production cost of the energy is a key parameter.
MiRiG fund

First financed by the World Bank’s “Clean Technology Fund” with USD 53 million in 2013-2014.

The fund is based on conditional loans for production and exploratory drilling with the goal of providing project financing in the construction stage.

Fund is existing for de-risking of early drilling to help projects reach the stage of full development and operation. The conditional loan is limited to a maximum of US$ 30 million per project.

The fund has been implemented for the Cerro Pabellon project as the first beneficiary and two other projects, Mariposa (EDC) and Licancura III (Transmark), were also selected.
GDF fund – Application summary

- 6 Active GDF projects
- 4 Surface Study grants and
- 2 Confirmation Drilling grants*

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<th>Country</th>
<th># of selected Projects</th>
<th>Active GDF projects</th>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>Chile</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ecuador</td>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Central America</td>
<td>Guatemala</td>
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<td>1</td>
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<tr>
<td></td>
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<tr>
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<td>Nicaragua</td>
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<tr>
<td>North America</td>
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<tr>
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<td></td>
<td>25</td>
<td>6</td>
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GDF applications and grants awarded end of 2021

The main subject is the gap in between the grants awarded an the actual disbursement at only 10% at mid term.
Geothermal CAPEX and LCOE and comparison with solar

- The CAPEX to build a geothermal power plant in the country are estimated from 6 to 8 M€ per MWe installed for respective plant size at 20 to 50 MWe which is important compared with other countries in the world.

- The LCOE for this range of installed power is in between 70 and 130 €/MWh depending the size of the plant with a discount rate of 8%.

- The Chilean geothermal LCOE is acceptable because the resources are at very high temperature and at reasonable depth, even if the geothermal prospects are not very close from the existing grid and even if the accessibility in the Andes at high altitude is a disadvantage.

- The comparative LCOE for the last energy auctions (September 2021) proposed by the solar industry is around 22 €/MWh which is 27% less compared with the former tender in 2017 and about 3 to 6 times lower compared to geothermal.
Recommendations (some are already proposed by the Ministerio de Energía - May 2021)

• Modification of the Law 19,657 about geothermal concessions.

• Overcome entry barriers of renewable projects and encourage the development of heating and cooling projects with subsidies.

• Allow the development of flexibility in the electricity system and the decarbonation of the electricity matrix while continuing the development of the transmission system.

• Improve and spread information about renewable energy resources and technologies.

• Search for international cooperation funds to maintain a Permanent Geothermal Risk Mitigation System.

• Creation of a National Committee exclusively dedicated to geothermal energy.

• Development of skills and technical knowledge and improve formations about renewable energy resources and technologies.
PRESENTATION OF GEE collaborative tool
Development of the Advanced Skill & Collaboration Network Mapping Tool

The aim was to create a tool that would allow GEE metacluster members to find potential partners for their work and projects in an easy and fast, user-friendly way. To achieve this, a new database engine has been developed that can quickly and specifically search the data stored in the database for GEE members, touching their network of contacts and projects. All the collected informations are public and were taken manually from the members’ websites.

- The tool is user-friendly, easy-to-use,
- The database contains only publically available dates collected from the Internet,
- The access is restricted to the members of GEO-ENERGY EUROPE – external access can be granted for partner seeking, but further development is needed,
- It is designed to easlily find partners within GEE members for geothermal projects by using simple free word searches.
These data are added to the members and are searchable in the database.
GEO-CoLab – the Advanced Skill & Collaboration Network Mapping Tool

Members search
Search is done by typing free words (minimum 3 characters) with the logical AND relationship between them. The results can be filtered by cluster membership, type, scope of activity and position in value chain.
For example these are the search results for ‘Laboratory porosity’ keywords among the SME-s:

Project search
In the project menu, one can view the projects entered in the database, or one can use a free keyword search, which searches not only the name of the projects, but also within all their content.
These data are added to the projects and are searchable in the database.
Coaching of our SMEs
Training Session - Chile

Focus points for international business development:

1. Chilean upstream business development
2. Market know how
3. Information about energy market
4. Commercial strategy
5. Operational business
6. Sales organisation
1- Chilean upstream business development:

- Business intelligence and market studies
- Financing institution, funds & country strategy
- Investor, developers and operators
- Local & international public institution supporting the country
- Potential local partner, suppliers, engineering office, third party inspection
- Strategic event, seminar, webinar…
2- Market know-how:

- Country market studies
- Government directives
- Public and private actors in geothermal
- Identify potential local partners
- Joint the local Cluster
- Financial support mechanism
3- Information about energy market:

- Country general information
- Status of energy deployment
- Energy costs per technology
- Company market leader
- Legal environment, legislation, regulation (FIT, PAT, CA…)
- Standards, QHSE, health regulation
- Tax, fee, importation, custom regulation
Training Session - Chili

4- Commercial strategy:

- Country medium term business plan
- Country organisation and identification of kea players
- Developer, manufacturer of equipment
- Engineering, consultant, advisor
- Premises and objectives
Training Session - Chili

5- Operational business:

- Local setup
- Management
- Local partner and liaison with head sales
- Presence and proximity with client
- Local marketing & communication
- Center of excellence
- Organisation of training session and seminar
- Relation with universities and energy state companies
- Regular connection with Mining operators and potential end-users
6- Sales organisation:

- Setup sales team with local partner
- Cover the sales in neighbour countries: Latin and Central Americas
- Share the tasks and commercial planning
- Exchange and inform cluster members
- Organise technical update meeting with prospects
Questions / answers
Presentation of the market Visit
4th, 5th and 6th of April in Santiago

Chilean market visit offers you the possibility to:
• Meet with Chilean representatives of industry and ministry in the field of Energy transition
• Have an overview of Chilean geothermal context
• Take part in B2B meetings
• Visit the CEGA “Andean Geothermal Center of Excellence”
• Visit a geothermal operation

The market visit will be host by the CEGA / University of Chile
Please note that there is a budget to help GEE II SMEs in paying for their travelling expenses
If you're interested in receiving the agenda and for any registration, please contact us:
Virginie.schmidle@afpg.asso.fr
Contacts & resources

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GEO-ENERGY EUROPE ‘s Profile on the European Cluster Collaboration Platform

For media enquires, to receive logo, graphic resources and other information material contact: Valeria Mazzagatti (EGEC), v.Mazzagatti@egec.org

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