



IEA Geothermal

# Research, Development and Deployment Advancing Deep Geothermal Energy Utilisation and Geothermal Technology

GeoTHERM 2024



# Your presenter

## Samantha Alcaraz

- Co-Executive Secretary of the IEA Geothermal
- Geothermal Geology and Modelling Team Leader at GNS Science
- Secretary of the New Zealand Geothermal Association
- Treasurer of the Asia Pacific Geothermal Association



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# IEA Geothermal – Who we are

**A framework for international collaboration and networking among nations, industries and industry organizations on geothermal energy and resources.**

- Mandated under the International Energy Agency Technology Collaboration Programme
- Fostering geothermal for >25 years (since 1997)
- Participants: Contracting Parties / Sponsors / Limited Sponsors

Technology Collaboration Programme  
by IEA

- Variously named:
  - IEA Geothermal
  - Geothermal TCP
  - IEA Geothermal Implementing Agreement: IEA-GIA ([www.iea-gia.org](http://www.iea-gia.org))

# IEA Geothermal – Who we are

Our strength is not as an individual but as a collective

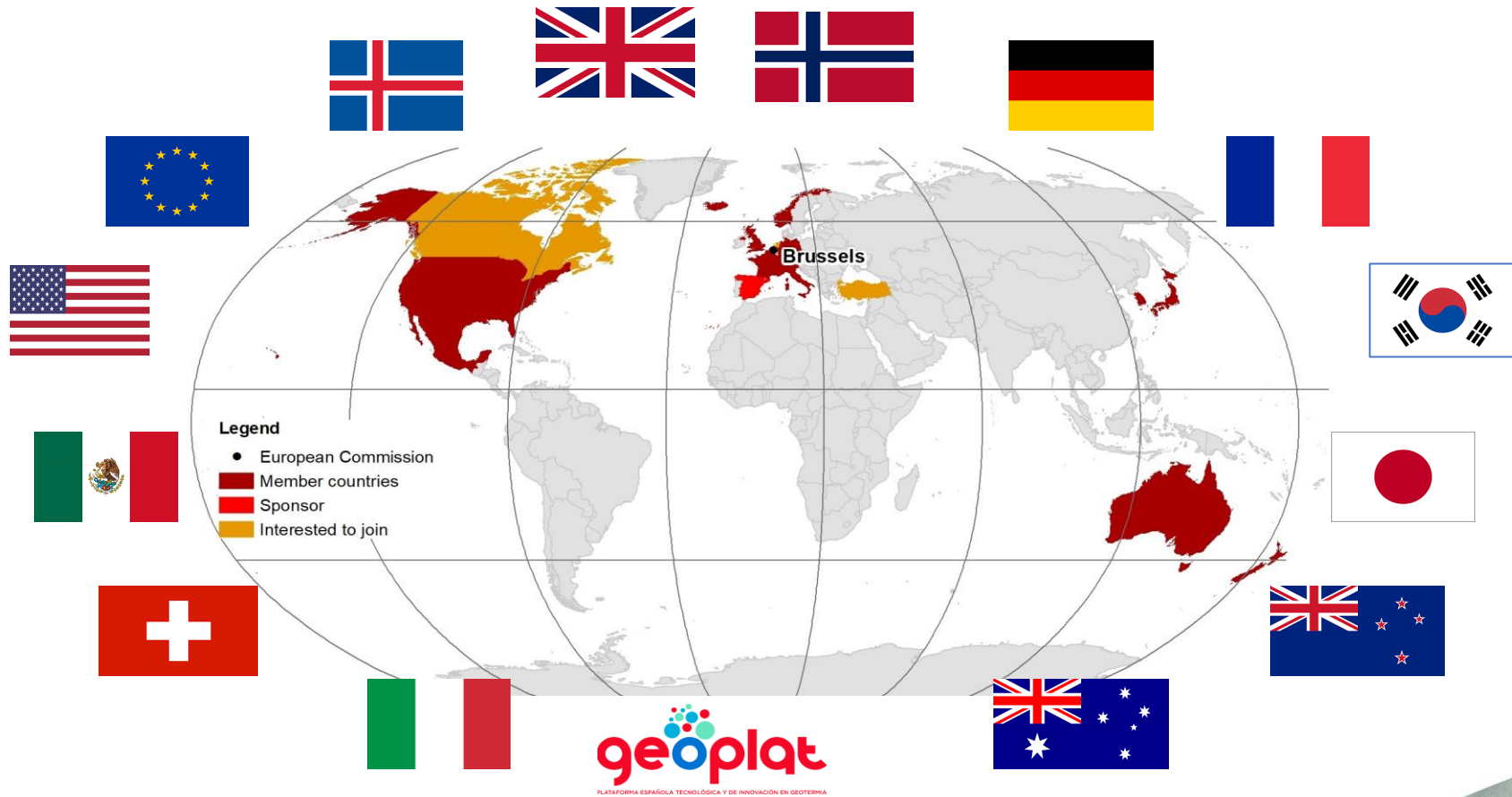


IEA Geothermal

[www.iea-gia.org](http://www.iea-gia.org)

# IEA Geothermal – Who we are

## Our Participants



### 15 Members

- European Commission
- 13 Countries
- 1 Sponsor


### Interest to join:



# IEA Geothermal – Who we are

## Participant representatives



 Kasumi Yasukawa



 Melanie Jans-Singh



 Manuela Richter



 Chris Bromley




 Yoonhoo Song



 Jose Manuel Romo Jones




 Luca Giovannelli



 Jiri Muller




 Sara Montomoli



 Lauren Boyd




 Florence Bégué



 Margarita de Gregorio



 Virginie Schmidle Bloch

# IEA Geothermal – Who we are

## Executive Committee

- **2024 Officers**

Chair:



 Kasumi  
Yasukawa

Vice-Chairs:



 Jiri  
Muller



 Lauren  
Boyd



 Christian  
Minnig

- **The Executive Committee meets twice a year and include:**

- All participants: members and alternate members
- Task leaders
- Guests
- Exec-Secretary

- **The Secretariat:**

Taupo,  
New Zealand

[iea-giasec@gns.cri.nz](mailto:iea-giasec@gns.cri.nz)



Brian  
Carey



Samantha  
Alcaraz

# IEA Geothermal – What we do

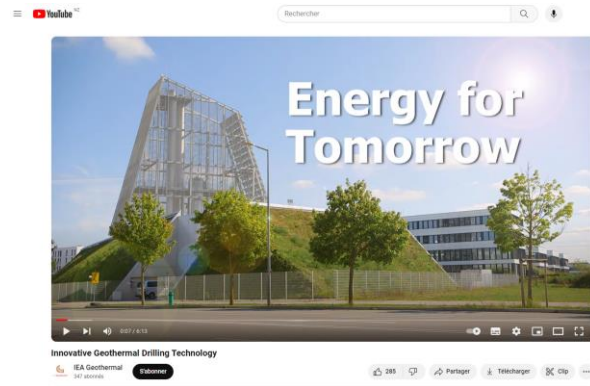
## Five Pillars of Strategic Activity





# IEA Geothermal – What we deliver

## Some examples



**WGC2023**

**IEA GEOTHERMAL CASE STUDIES OF MINE WATER HEAT SCHEMES IN EUROPE**

**RESEARCH FACILITY**

**UK Geoenery Observatories (UKGEOS): Glasgow Observatory**

At Scale Mine Water Research Facility

**INDUSTRIAL BUILDINGS**

**Lanchester Wines, Gateshead, UK**

Mine water heating washhouses

**HEAT NETWORKS**

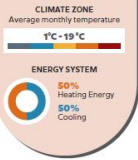
**Mine Water Geothermal**

Heales, District Energy Scheme

**MINE THERMAL ENERGY STORAGE (MTES)**

**Underground Heat Storage**

### UK Geoenery Observatories (UKGEOS): Glasgow Observatory



#### At Scale Mine Water Research Facility

The Glasgow Observatory is an at-scale research facility designed for investigating shallow, low-temperature, mine-water heat energy and heat storage resources. It is located in an urban area on the eastern side of the city in a geological and environmental setting typical of former coalfields. There is no one dedicated heat user; boreholes can be used in flexible combinations to test and trial techniques and products. The boreholes are screened across a variety of types of flooded mine workings from pillar and stall, mine waste and open voids.

"designed for investigating shallow, low-temperature, mine-water heat energy and heat storage resources."

#### In Brief

**Facilities**  
Mine water heating, cooling and storage research infrastructure.

**Location**  
Glasgow, Scotland, UK

**Years In Operation**  
Boreholes from 2020, geothermal sealed open-loop infrastructure from late 2022.

**General Setting**  
Urban Glasgow: made ground, glacial and post-glacial superficial deposits, Carboniferous Coal Measures.

**Infrastructure**  
Twelve boreholes, four fenced surface compounds and a flexible geothermal sealed open loop.

**Flow Rate**  
Mine workings for abstraction and re-injection of 3-12 L/s, tested at up to 25 L/s.

**Water Temperature**  
Around 12°C

**Ambient Temperature Ranges**  
Maximum July average 19°C, minimum January average 1°C (Met Office, Springfield).

**Heat Infrastructure**  
Flexible system with 4 mine water boreholes, 3 types of heat exchangers, heat pump/drier, downhole submersible pumps.

**Heat Pumps Capacity**  
c.200 kW and can operate at 25/50/75/100% of capacity.

**Total Cost**  
£9 million including sensing/monitoring systems, IT for open data etc. – not indicative of a commercial scheme.

**Funding**  
UK Government, through UK Research and Innovation.



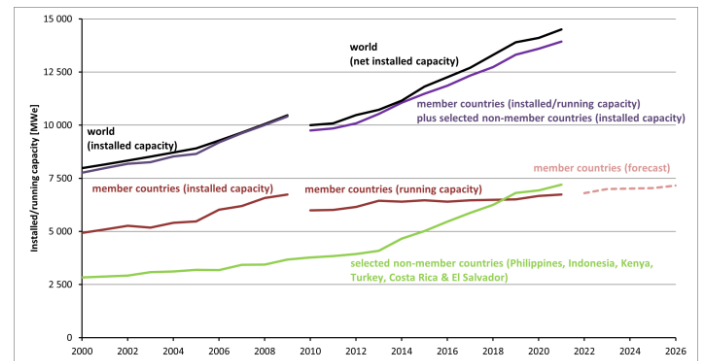
Most of the boreholes are located within Cuningher Loop park in Rutherghlen, South Lanarkshire. © British Geological Survey.



Borehole locations. Contains Ordnance Survey data © Crown copyright and database rights. All rights reserved (2022). Ordnance Survey (10001290 EAL).



Mine water monitoring. © British Geological Survey.



Free International Symposium on  
**Underground Thermal Energy Storage (UTES)**

**Storage is key!**

28.02.2024, Messe Offenburg, Germany  
GeoTHERM side event

# IEA Geothermal – What we do

## Working Groups

- Environmental Impacts
- Data Collection and Information
- Deep Roots of Volcanic Geothermal Systems
- Emerging Geothermal Technologies
- Geothermal Heating and Cooling



<http://iea-gia.org/areas-of-activity/>

# WG - Environmental Impacts

*To encourage sustainable development of geothermal energy resources in an economically and environmentally responsible manner.*



**Lead:** Chris Bromley (New Zealand)

**Focus areas:**

- Impacts on natural features
- Discharge and reinjection problems (chemicals, gas, subsidence)
- Methods and costs of adverse impact mitigation (successful policies and strategies)
- Sustainability

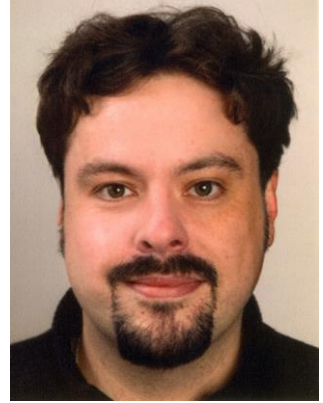
**Participating countries:** Australia, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Switzerland, United States (some active since 1997, 25 years)

**Period:** 1997 – 2024. Concluding report in preparation.



# WG - Data Collection & Information

*Collate and share geothermal energy uses, trends and developments*



**Lead:** Josef Weber (Germany)

**Focus areas:** Reliable geothermal statistics  
Geothermal power and heat



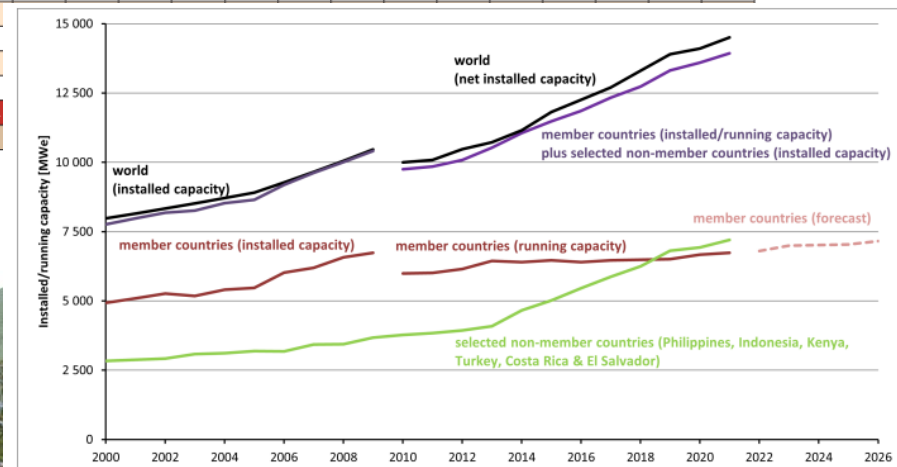
**Participating countries:** IEA Geothermal member countries

**Period:** 2010-current



Installed/Running Capacity [MWe] 2000 - 2021

Country	Installed capacity [MWe]			Running capacity [MWe]										
	2000	2005	2007	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
AUS	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
DEU	0.0	0.2	3.2	6.4	11.1	30.1	32.2	31.9	37.4	36.2	38.1	40.8	40.8	45.8
FRA	4.2	15.0	15.0	16.3	15.4	10.3	16.1	16.5	16.5*	16.5*	16.5	16.5	17.2	17.2*
ISL	170.0	202.0	485.0	575.0	665.0	663.0	661.0	663.0	662.4	707.6	707.6	755.0	755.0	755.0
ITA	785.0	791.0	810.0	728.1	766.0	767.0	807.0	807.0*	762.0	762.0*	761.2	761.2	761.2	761.2*
JPN														
MEX														
NZL														
USA														
Total GIA														
World														



# WG - Deep Roots of Volcanic Systems

*Advance knowledge on the nature and characteristics of deep heat sources, including heat transfer, in the roots of geothermal systems. Facilitate international collaboration.*



**Lead:** Gudni Axelsson (Iceland) & Chris Bromley (NZ)

**Focus areas:** Modelling Supercritical Resources, heat & flow processes, geochemical & engineering issues and permeability transients

**Participating countries:** International collaboration, especially USA, New Zealand, Iceland, Switzerland, Japan

**Recent advances:** Significant improvements in knowledge of the geochemical and physical conditions to be expected in these ultra-hot settings through experiments in fluid-rock interactions and advanced simulation models....

**Period:** 2014 – current



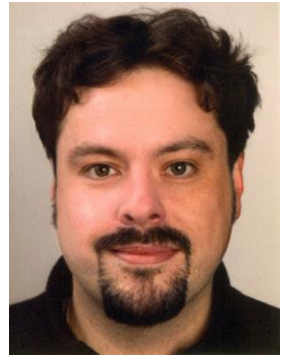
# WG - Deep Roots of Volcanic Systems

## Latest Events

- 2022 (Feb) :** **Ultra hot –supercritical geothermal symposium series**  
(IEA Geothermal, IPGT and Geothermal: The Next Generation)  
<https://iea-gia.org/workshop-presentations/2022-ultra-hot-supercritical-symposium-series/>
- 2022 (Nov):** **IAWPS (Rotorua, NZ) GNG supercritical geothermal research results on geophysics, geochemistry, modelling, & inventory assessment.** 15 presentations.  
<https://www.geothermalnextgeneration.com/updates/iapws-2022-symposium-on-supercritical-and-subcritical-geothermal-steam-chemistry>
- 2023 (March):** International online seminar **“Assessment approach / methodology for developing an Inventory of Supercritical resources”** organised by Brian Carey
- 2023 (Sept):** **Super-hot/supercritical EGS** video seminar (46 participants)
- 2023 (Sept):** **WGC 2023 presentations**

# WG - Emerging Geothermal Technologies

*Co-operative research and collaboration to foster innovative technical solutions.*



**Lead:** Josef Weber (Germany) & Christian Minnig (Switzerland)

**Focus areas:** Exploration  
Measurements and Logging  
Drilling Technology  
Reservoir Creation / Enhancement  
Seismicity  
Above Ground Technologies (includes corrosion, scale and tracers)

**Participating countries:** Most participants



# WG EGT - Drilling Technologies

**Lead:** Manuela Richter (Germany)



**Objective:** Updated and extended “Summary of New Drilling Technologies” report covering latest advancement for medium to ultra-deep drilling. Led by **Dr Andreas Reinicke**.

**Previous work:**

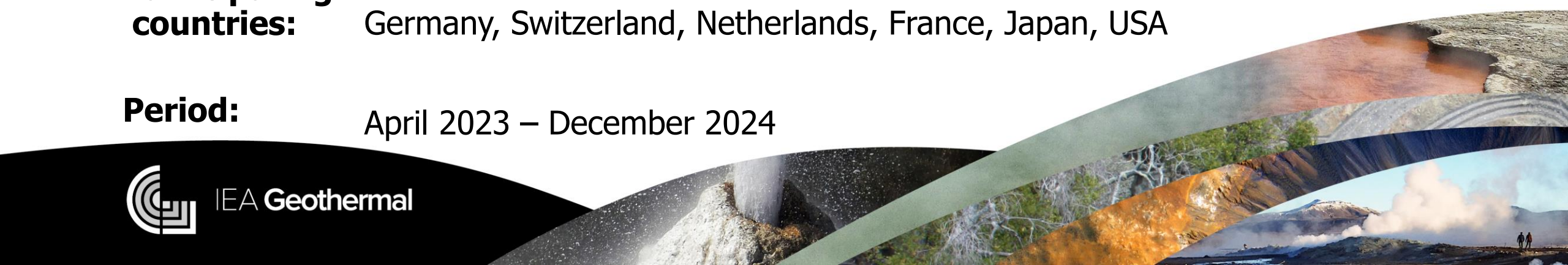
- Innovative Geothermal Drilling Technology video
- Summary of new drilling technologies report (2017)



**Participating countries:**

Germany, Switzerland, Netherlands, France, Japan, USA

**Period:** April 2023 – December 2024





# WG – Heating and Cooling

*Foster co-operation and provide information in heating and cooling applications.*

**Lead:** Stephan Bolay (Switzerland) & Virginie Schmidlé-Bloch (France)

**Focus areas:**

- Shallow Geothermal
- Deep Geothermal
- Mine Water Geothermal
- Underground Heat Storage

**Participating countries:** Principally Switzerland, France, Republic of Korea, United Kingdom



# WG – Heating and Cooling

## Underground Thermal Energy Storage

### **ATES Workshop 2023 – Scoping future workstream activities**

- IEA Geothermal, Geothermica, sponsored by Netherlands Enterprise Agency
- April 2023 - visit to Middenmeer and workshops
- Show casing existing projects, starting to scope useful workstream and working towards collaboration with the Energy Storage TCP
- <https://iea-gia.org/workshop-presentations/2023-aquifer-thermal-energy-storage-ates-workshop/>

### **Mine Water Geothermal**

- Led by British Geological Survey
- Symposiums 2021, 2022, 2023 and 2024 (more later) <https://iea-gia.org/workshop-presentations/>
- Case studies - <https://iea-gia.org/publications-2/case-studies/>

### **UTES Symposium – 28<sup>th</sup> Feb 2024 – here at GEOTHERM**

- Collaboratively organised IEA Geothermal and Geothermica
- 150 participants
- Presentations available once presenter approval received  
<https://iea-gia.org/workshop-presentations/>

# Investment in Innovation

## European Commission

- The European Green deal policy has been in place for a number of years now
  - targeting Net Zero emissions by 2050.
- Fit for 55 package: revised share of renewables from 32 to 40% by 2030.
- Under the REPowerEU (May 2022): raised to 45%.
- Commission activities associated with renewable energy are documented in the Strategic Energy Technology (SET) Plan which includes the **Geothermal Implementation Plan**.



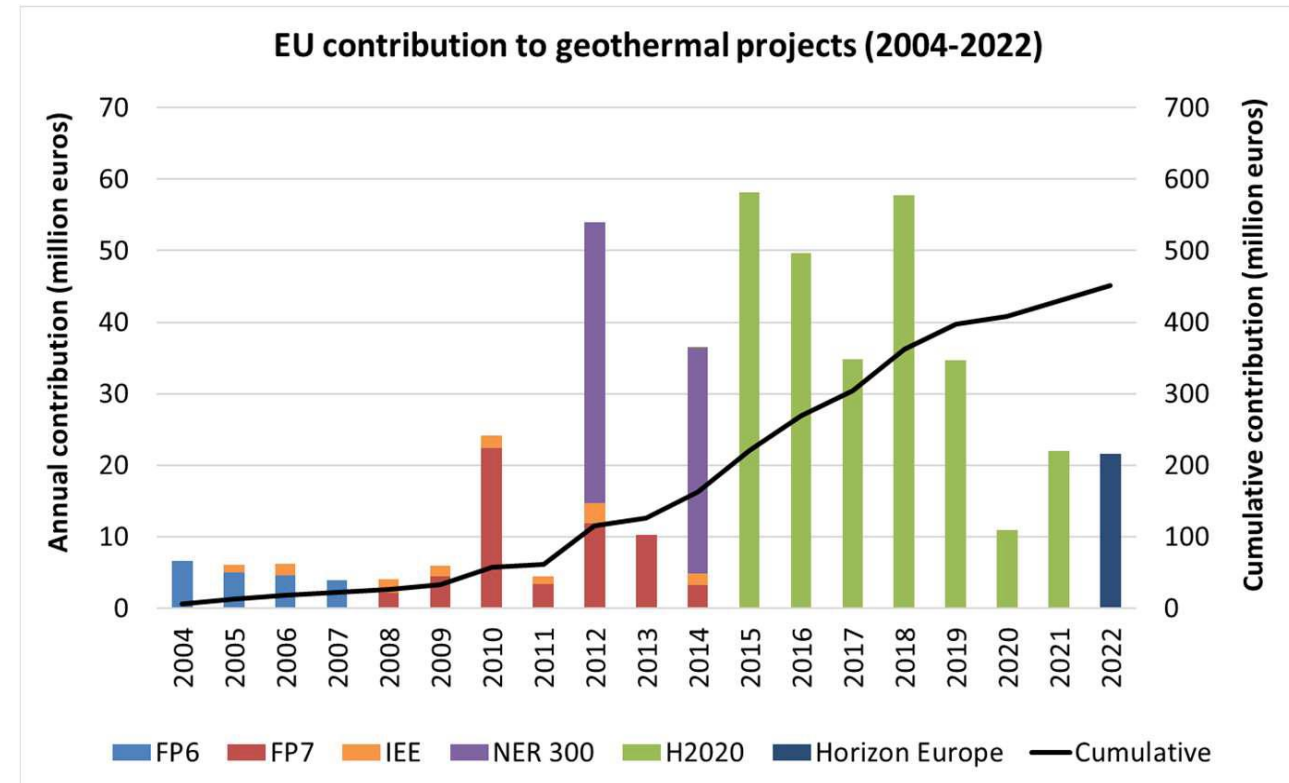
[https://setis.ec.europa.eu/implementing-actions/geothermal\\_en](https://setis.ec.europa.eu/implementing-actions/geothermal_en)

# Investment in Innovation

## European Commission

Financial support mechanisms:

- InvestEU programme
- The Connecting Europe Facility
- The Renewable Energy Financing Mechanism
- Recovery and Resilience Fund
- Innovation Fund, and
- Horizon Europe



# Horizon Europe Projects started in 2022

Acronym	Title	N. of participants	Start date	End date	Topic	EU funding [M€]
HOCLOOP	A circular by design environmentally friendly geothermal energy solution based on a horizontal closed loop	9	01/10/2022	31/3/2026	Solutions for more sustainable geothermal energy	5.0
COMPASS	Sustainable and cost-efficient Concepts enabling green power production from suPercritical/Superhot geothermal wells	7	01/11/2022	31/10/2025	Solutions for more sustainable geothermal energy	4.2
DeepU	Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation	6	01/03/2022	31/10/2025	EIC Pathfinder Open 2021	3.2
CEEGS	Novel CO <sub>2</sub> -based electrothermal energy and geological storage system	10	01/11/2022	31/10/2025	Next generation of renewable energy technologies	3.0
SAPHEA	Developing a single access point for the market uptake of geothermal energy use in multivalent heating and cooling networks across Europe	10	01/10/2022	31/07/2025	Market Uptake Measures of renewable energy systems	1.9
TWINN2SET	Twinning to sustainable energy transition	3	01/10/2022	30/09/2025	Twinning	1.5
Genies	Gas-water-mineral interfaces in confined spaces: unravelling and upscaling coupled hydro-geochemical processes	1	01/09/2022	30/09/2025	ERC Starting Grants	1.5
GEOHERM-FORA	Support stakeholders fora on geothermal systems	7	01/09/2022	30/09/2025	Support to the activities of the ETIPs and technology areas of the SET Plan	1
MixUp	Upscaling Mixing and Reactive Transport through Random Granular Media	1	01/09/2022	31/08/2024	MSCA Postdoctoral Fellowships 2021	0.2
COFFEE	Coupled Flow Processes in Fractured Media across Scales: Insights into Hydraulic Fracture Growth and Radiated Seismic Energy	1	01/10/2022	31/09/2024	MSCA Postdoctoral Fellowships 2021	0.2
PSGH CERB	Promoting shallow geothermal heating/cooling for existing residential buildings in the EU	1	01/10/2022	31/09/2024	MSCA Postdoctoral Fellowships 2021	0.2
TOTAL						21.9

Visit <https://cordis.europa.eu/> for more information

# Horizon Europe Work Programme 2023-2024

- Advanced exploration technologies for geothermal resources in a wide range of geological settings (EUR 8M)
- Smart use of geothermal electricity and heating and cooling in the energy system
- Innovative applications/integration of geothermal heating and cooling in industry

For more information:

[Horizon Europe Work Programme \(2023-2024\) – Cluster 5,  
Climate, Energy and Mobility](#)

# Investment in Innovation

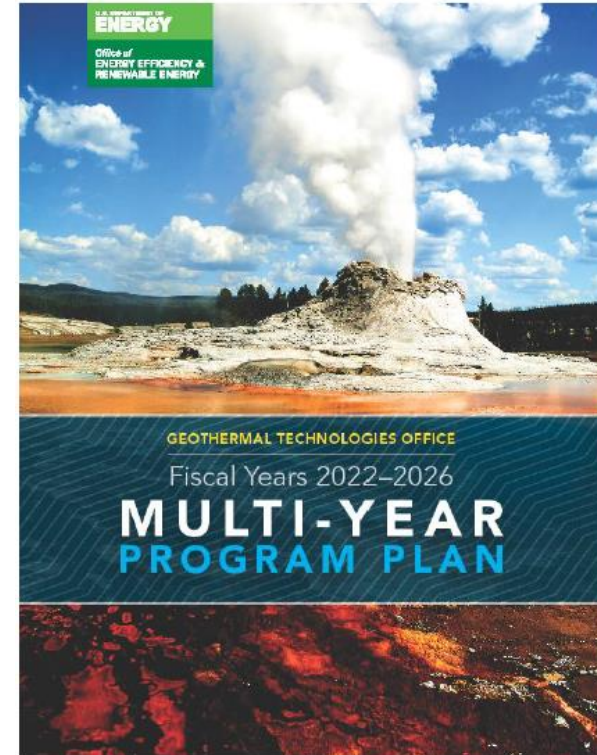
## USDOE Geothermal Technologies Office (GTO)



GTO's mission: "to increase geothermal energy deployment through research, development, and demonstration of innovative technologies that enhance exploration and production."

Four programs:

- [Enhanced Geothermal Systems](#)
- [Hydrothermal Resources](#)
- [Low-Temperature and Coproduced Resources](#)
- [Data, Modeling, and Analysis](#)



# Investment in Innovation

## GTO - Enhanced Geothermal Systems Program

- **Enhanced Geothermal Shot Initiative:** target to reduce the cost of EGS by 90%, to \$45 per megawatt hour by 2035.
- **EGS Pilot Demonstrations (\$84M):** under the Bipartisan Infrastructure Law, to identify and develop EGS pilot demonstration projects in a variety of geologic formations and subsurface conditions. [DOE Feb 13, 2024 update](#)
- **FORGE (~\$44M):** Frontier Observatory for Research in Geothermal Energy dedicated site to develop, test, and accelerate breakthroughs in EGS technologies. Drilling / stimulations/testing. 10-17 projects across 5 topic areas to be funded.
- **ReAmplify (\$8.4M):** to establish the commercial viability of geothermal energy production in existing oil and gas wells.
- **Geothermal Geophone Prize (\$3.65M):** to address the challenges of operating seismic sensors in harsh geothermal environments.
- **GEODE (\$165M):** Geothermal Energy from Oil and gas Demonstrated Engineering Grant to leverage oil & gas subsurface assets, technologies, and expertise to help solve geothermal energy's toughest challenges.



# Investment in Innovation

## GTO – Other programmes

### **GTO - Hydrothermal Resources Program**

**Focus:** Improving geothermal exploration, subsurface characterization, and drilling to reduce [...] costs.

- Drilling Technology Demonstrations (Up to \$20M): 25% improvement in drilling rates. 2 projects.
- Hidden Systems: INGENIOUS, BRIDGE, GeoDAWN, GeoFlight projects

### **GTO - Low-temperature and coproduced resources Program**

**Focus:** Improving the efficiency of low-temperature geothermal systems and expanding their utility through value-added commercial opportunities—facilitating near-term development [...]

- Federal sites: Partnering with federal facilities to consider low temperature geothermal technology to heat and cool installations.
- Community Geothermal Heating and Cooling Design and Deployment: Direct use, heat pumps, innovative designs and tech.

### **GTO - Data Modelling and Analysis**

**Focus:** to identify and address barriers to geothermal adoption in the United States and validates and assesses technical progress across the geothermal sector.

- Permitting / Non-technical barriers / Hybrid plants

# IEA Geothermal Most Recent Events

- **World Geothermal Congress 2023**, Beijing, China, 15<sup>th</sup>-17<sup>th</sup> September 2023

[3 IEA Geothermal presentations](#)

- **Surface Geothermal Technologies Symposium**, Yokohama, Japan, 6<sup>th</sup> October 2023

Co-organised IEA Geothermal and JOGMEC

~ 60 people attended

Site visit to the Fuji Kawasaki Turbine Manufacturing

[Presentations](#)

- **UTES Symposium**, Offenburg, Germany, 28<sup>th</sup> February 2024

Co-organised by IEA Geothermal and Geothermica

~130-150 participants



Register for the Surface Geothermal Facilities Symposium and Site visit to the Fuji Kawasaki Factory (Site visit is for international participants) 5th & 6th October, Yokohama, Japan

Technology Collaboration Programme by IEA Access the draft programme

Logos: JOGMEC, IEA Geothermal, QR code



Free International Symposium on Underground Thermal Energy Storage (UTES)

**Storage is key!**

28.02.2024, Messe Offenburg, Germany  
GeOTHERM side event

Logos: IEA Geothermal, GEOTHERMICA

# IEA Geothermal Next Upcoming Event

## Mine Water Geothermal Energy Symposium 2024

- 24-25 April, Edinburgh, Scotland
- 26 April, Field Trip to Glasgow
- Collaborative event organised by:
  - The British Geological Survey,
  - the UK Coal Authority,
  - IEA Geothermal, and
  - the UK Department for Energy Security and Net Zero
- More details of the programme available shortly
- Registration opening soon



SAVE THE DATE

### 2024 MINE WATER ENERGY SYMPOSIUM

Wednesday 24 April  
Thursday 25 April  
Friday 26 April  
Online and in person

IEA Geothermal | The Coal Authority | BGS British Geological Survey



# Thank you....



## IEA Geothermal at GeoTHERM 2024

Find us at the PTJ Booth  
IEA Geothermal Members are here



### To Connect Up

Contact your [country](#) representatives

Contact the Secretariat: [iea-giasec@gns.cri.nz](mailto:iea-giasec@gns.cri.nz)



IEA Geothermal

