Proceedings World Geothermal Congress 2023
Beijing, China, September 15 - 17, 2023

Geothermal Collaboration through the International Energy Agency Geothermal Technology Collaboration Programme

B. Carey and K. Yasukawa

IEA Geothermal Technical Collaboration Programme c/- GNS Science, Wairakei Research Centre Taupo, New Zealand

iea-giasec@gns.cri.nz

Keywords: Technology Collaboration Programme, Geothermal TCP, IEA Geothermal, IEA-GIA, international collaboration, geothermal, geothermal energy, shallow geothermal, deep geothermal, super-hot geothermal, supercritical geothermal.

ABSTRACT

The International Energy Agency Geothermal Technology Collaboration Programme (Geothermal TCP) has thirteen nations, the European Commission, and GEOPLAT regularly meeting to share advances occurring in geothermal technology: from shallow low temperature geothermal utilisation to high temperature super-hot supercritical geothermal research.

The Geothermal TCP has operated for some 26 years since March 1997 with the paper canvassing the strengths of the TCP and sharing recent highlights.

Working Group activity is focused on:

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

High quality geothermal data, for electrical and non-electrical (direct) uses, is collected, collated, and shared through activities of the IEA Geothermal Technology Collaboration Programme. This sharing is the basis of the IEA Technology Collaboration Programmes which see independent, world leading experts and agency representatives collaborating to advance research, development, deployment, and commercialisation of energy technologies.

Seminars and workshops are organised for groups or nations where there is seen to be potential to promote the use and uptake of geothermal energy. The Geothermal TCP is active at conferences in delivering papers and exhibiting at booths that freely disseminate information on geothermal energy. Country experiences are shared and collaborative networks established. Much of the Geothermal TCP engagement activity over 2020 and through to mid-2022 was virtual because of the COVID-19 pandemic, with an exception being the WGC 2020+1 Congress in Iceland on the 24th – 27th October 2021 where IEA Geothermal exhibited at a booth. The presentations from symposia and workshops are made available through the IEA Geothermal website.

There is much to be gained in sharing and working together on energy as the world transitions to low carbon energy.

INTRODUCTION

Geothermal energy use is growing around the globe as many nations transition to low carbon energy. There is a real focus on using geothermal energy in heating and cooling applications with this sector experiencing growth rates in recent years of up to ~10 % per annum, whilst geothermal electricity generation has grown more modestly year on year by ~2% per year in recent times.

Geothermal energy for heat supply is increasing rapidly in a number of sectors such as green housing and smart district energy networks. In ground heat storage is being used to balance energy loads with rock and groundwater both able to store energy with the heat transfer physics well understood. With sound management, heat is usefully stored underground, with storage becoming a significant component of geothermal energy systems enabling energy to be used at a later time, reducing the requirement for the supply of primary energy and in doing so lowering carbon emissions.

Research and innovation programmes exploring very high temperature and supercritical geothermal conditions underground are seeking to realise the energy potential from these geothermal sources. Challenges to be overcome include obtaining a reasonable casing life from a well given the high temperatures and pressures that the casings are exposed to and being able to withstand corrosion and geochemical related issues.

Geothermal energy is a sound contributor to global clean energy as a reliable renewable source providing cost-competitive electricity, heating and cooling, with much scope for broader deployment particularly in heating, cooling and direct use. As an indigenous energy source geothermal energy fundamentally assists nations with their energy security. The Geothermal TCP promotes international cooperation in the sector linking agencies, organisations, industries and geothermal experts in research and technology, producing authoritative information on geothermal energy and documenting best practice. Activities focus on sharing results and information gained from participant members' government and industry geothermal programmes.

There is significant expenditure ongoing as part of upcoming geothermal energy research and innovation. For instance, the European Commission Strategic Energy Technology (SET) Plan was revised in 2020 with the eight geothermal research and innovation workstreams revised and two cross cutting workstreams established:

- Knowledge transfer and training, and

- Open-access policy to geothermal information.

Of the research and innovation workstreams, four are flagship programmes:

- Geothermal Heat in Urban Areas (€73.3m),
- Integration of Geothermal Heat and Power in the Energy System and Grid Flexibility ((€11.5m),
- Full Reinjection Electric and Heating and Cooling Plants Integrated in the Circular Economy (€123.4m), and
- Development of Geothermal Resources in a Wider Range of Geological Settings (€382.5m).

Some of these programmes have activity out to 2030 with substantial innovation in geothermal energy technology expected.

This paper provides a perspective from the International Energy Agency Geothermal Technical Collaboration Programme as to activity occurring in the geothermal sector, and activities the group are undertaking to foster the uptake of geothermal energy around the globe.

HISTORY

International Energy Agency

The Technical Collaboration Programmes (TCPs) of the International Energy Agency (IEA) are about sharing knowledge and information, accelerating energy technology innovation, assisting nations to meet energy and climate goals, enhancing energy security, and supporting economic growth. The underlying ethos of a TCP is that stakeholders from the public and private sectors share knowledge and work collaboratively to deliver effective outcomes to energy and climate challenges. These multilateral technology collaborations are established through the IEA Implementing Agreement framework where networks of professionals work together. 2023 marks the 48th anniversary of the establishment of the TCP framework with thirty-nine operating TCPs now involving ~6000 experts from around the world. An IEA video introducing TCPs provides insight into the framework and the approach to collaborative activity. The breadth of expertise which can be accessed for relatively modest cost by nations or organisations is a significant asset for the global community. More information is available from the individual TCP web sites accessible through the IEA TCP web pages.

IEA Geothermal

IEA Geothermal was established on 19th June 1996 as a TCP by the Governing Board of the IEA. The TCP commenced its activities in March 1997. At the time of WGC 2023 the programme will have been operating for 26 years under the Implementing Agreement, formally mandated by IEA Paris and periodically renewed for specific time periods (terms). At the end of each term a summary of activity is recorded and participants in the TCP determine if they are going to apply for renewal to IEA or conclude activity. The Geothermal TCP end of term reports are available from the IEA Geothermal website. IEA Geothermal is now into its sixth term and Table 1 identifies the term periods mandated.

Table 1 IEA Geothermal mandated for 6 terms as at WGC 2023

Term	Start	End	Years
1	7 March 1997	6 March 2002	5
2	6 March 2002	31 March 2007	5.1
3	1 April 2007	28 February 2013	5.9
4	1 March 2013	28 February 2018	5
5	1 March 2018	28 February 2023	5
6	1 March 2023	28 February 2028	5

IEA Geothermal is managed by an Executive Committee (ExCo) comprising members that are participating for their nation, the European Commission, or as a sponsor member representing a national organisation or a company. Participants pay their own expenses associated with participation in the ExCo and Working Group activities. The Geothermal TCP Executive Committee meets twice yearly and looks to hold symposia, workshops and other meetings in conjunction with the committee meetings.

Expenses associated with operating the Secretariat are funded from members contributions. During the 1st Term the administrative work of the organisation was performed on a voluntary basis by the ExCo Members. As the activities grew the ExCo established a Secretariat to provide administrative support for the group. In March 2003 the IEA Geothermal Secretariat was moved to reside at GNS Science at the Wairakei Research Centre, Wairakei, New Zealand, under a contract with GNS Science. Dr Mike Mongillo was the Executive Secretary from March 2003 through until his resignation in August 2015 when Brian Carey took over the role.

The Executive Secretary can be contacted through the email address in the title block of this paper.

IEA Geothermal has been an active participant at a number of World Geothermal Congresses with papers on the work presented in 2005 (Mongillo et al 2005), 2010 (Mongillo et al 2010), 2015 (Mongillo and Bromley 2015) and 2021 (Carey and Wissing 2021).

IEA Geothermal Strategic Plan

As part of preparation for the 6th Term IEA Geothermal developed a concise plan around the five strategic pillars shown graphically in Figure 1. The text associated with the 2023 – 2028 Strategic Plan and those of three earlier plans are available from the IEA Geothermal web site.

Figure 1: Five Strategic Pillars of IEA Geothermal activity

Website

An important part of the IEA Geothermal contribution to the international geothermal sector and the uptake of geothermal energy globally is provision of information available from the IEA Geothermal web site. The website contains information on the activities of the TCP, provides access to geothermal data, information, publications, IEA Geothermal workshop and symposium presentations and details of upcoming events.

Membership

Membership of IEA Geothermal is as a Contracting Party or as a Sponsor. Contracting Parties include the European Commission, governments, and parties designated by their government. Sponsor members are organisations such as an industry organisation or a national association that choose to belong in their own right, not requiring government designation.

Membership currently stands at 15 participating members as shown in Figure 2. Membership peaked in 2011 to 2013 when a number of sponsor organisations were active in IEA Geothermal.

In 2020 the IEA introduced a Limited Sponsor membership category to the TCP Framework which provides for membership for up to three years working on one task. At the time of writing this paper the Geothermal TCP has no Limited Sponsor members.

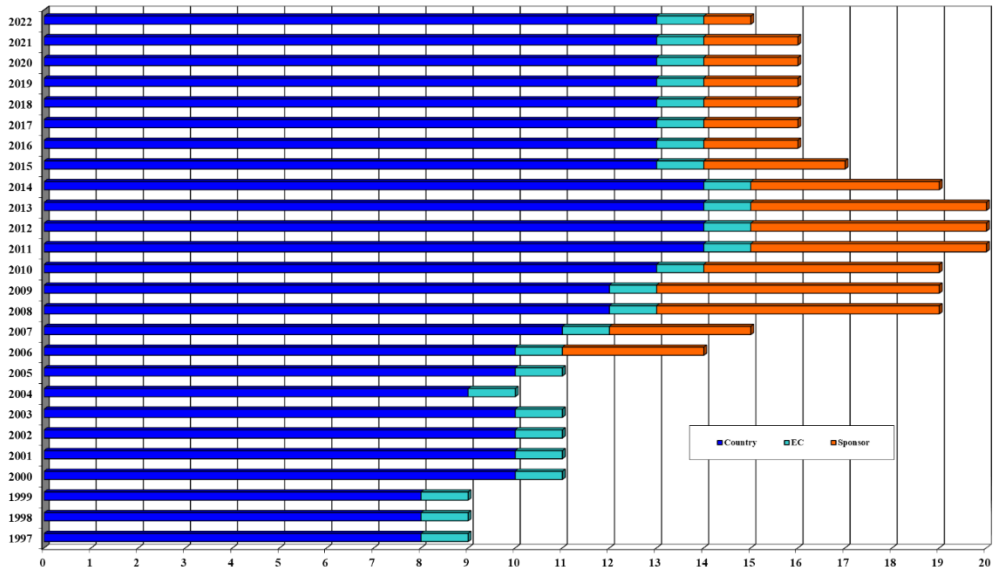

Figure 2: IEA Geothermal Membership by category - since 1997

At the end of 2022 there are 15 members: the European Commission, 13 nations; Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Switzerland, the United Kingdom and the United States, and one Sponsor; the Spanish Geothermal Technology Platform (GEOPLAT). The location of these are shown on a world map in Figure 3.

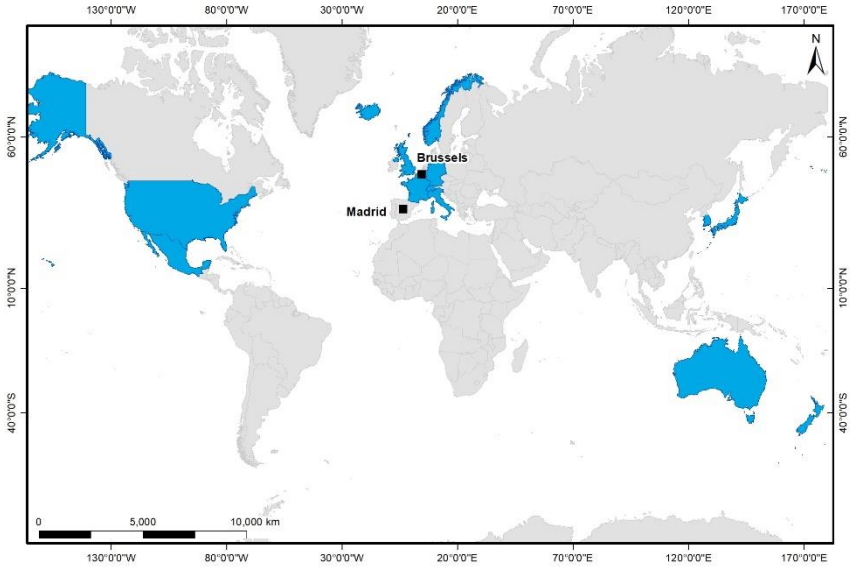

Figure 3 IEA Geothermal participant member countries in blue, Location of the headquarters of the European Commission and the sponsor organisation, GEOPLAT, are shown in black squares.

Working Groups

Working Groups (WG) focus on activity that participants wish to pursue. Participants scope up the work programmes producing task shared outputs, where participants resource and provide personnel time to conduct their portion of the work at their own expense. There are five WGs identified below, with each WG having a number of Tasks that they are working on.

- Environmental Aspects (WG1)
- Data Collection and Information (WG10)
- Deep Roots of Volcanic Geothermal Systems (WG12), and
- Emerging Geothermal Technologies (WG13)
- Geothermal Heating and Cooling (WG14)

Detail on the WG activity, the tasks underway and the outputs produced can be found in the Working Group section of the website.

Connections

Individual members of the Geothermal TCP are well connected into IEA activities and other international organisations that are working on geothermal energy. The list below illustrates some of those connections. It is structured so the organisation is identified, followed by the IEA Geothermal person(s) involved, followed by the country they represent on IEA Geothermal in brackets.

International Geothermal Association (IGA) – Kasumi Yasukawa (Japan), Virginie Schmidle-Bloch (France) and Peter Meier (Switzerland) are on the Board of Directors. Kasumi Yasukawa and Peter Meier chair the IGA Bylaws Committee and the IGA Audit and Risk Committee, respectively.

The European Union partnership on Clean Energy Transition Partnership (CETP) - – Various participants are members

SETplan Deep Geothermal Implementation Working Group– Luca Giovannelli (European Commission) is a member.

European Technology and Innovation Platform on Renewable Heating and Cooling - Margarita de Gregorio (GEOPLAT) member.

European Technology and Innovation Platform on Deep Geothermal (ETIP-DG) – Sara Montomoli (Italy) is Vice Chair of the ETIP-DG, Jiri Muller (Norway) is a steering group member.

European Geothermal Energy Council (EGEC) - Sara Montomoli (Italy) is a member of the board of directors.

International Partnership on Geothermal Technologies (IPGT) – Lauren Boyd (USA) and Peter Meier (Switzerland) are members of the steering committee. Australia, USA, Switzerland, New Zealand and Iceland are participants.

European Energy Research Alliance - Joint Program on Geothermal Energy (EERA JPGE Geothermal) - Jiri Muller (Norway) is a participant.

Geothermal Rising (formerly known as Geothermal Resources Council) – Various participants are members.

Geothermics – Chris Bromley (New Zealand) is Editor-in Chief.

Geothermal Energy – Inga S. Moeck (Germany) is Editor-in-Chief, Kasumi Yasukawa (Japan) is an Associate Editor, and Chris Bromley (New Zealand) is on the Editorial Board.

These connections and cross over are invaluable in sharing activity occurring in the various groups enabling IEA Geothermal to better understand how it might add value to that activity, embellishing achievements.

Data and Information

Sound and timely statistics are important to inform decisions, policies and expenditure. IEA Geothermal holds a repository for Geothermal Data that is regularly updated with trends analysed and outputs reported through the IEA Geothermal website. Working Group 10 manages this aspect of the IEA Geothermal work.

Annual Reports and Other Publications

Participating countries and IEA Geothermal produce Annual Reports which cover activity that has occurred on a calendar year basis. These publicly available reports can be downloaded from the Annual Report page or the individual Member pages of the IEA Geothermal web site. The most recent Annual Report covers the 2022 calendar year.

There are extensive reference listings in the Working Group chapters of the Annual Reports which provide ready access to scientific and technical material.

Through the 5th Term two special issues of the Geothermics Journal on selected geothermal topics have been completed:

- Environmental Aspects and Social Acceptability of Geothermal Developments
- Supercritical Geothermal in Japan

COLLABORATION

Collaboration as part of IEA Geothermal provides members with important benefits and produces opportunities for members to contribute to the international geothermal community. Strength derives from pursuing international cooperation, connecting and sharing geothermal technology and research activity through national and industry groups, and the networks established and maintained by the geothermal experts in IEA Geothermal or attendees at IEA Geothermal events. IEA Geothermal is active in partnering with a range of organisations in running symposia and workshops, with 4 being run (Table 2) since preparation of the WGC 2020+1 paper (Carey and Wissing, 2021). These are collaborative events that IEA Geothermal organises with other groups.

SYMPOSIA AND EXHIBITION BOOTHS

Symposia are a feature of the work undertaken by IEA Geothermal and the four tabulated in Table 2 have been run by IEA Geothermal since the end of 2020. These events are run free of charge to participants. Presentations from the events can be downloaded from the IEA Geothermal website using the link to the Workshop Presentation web page.

Table 2 Geothermal Symposia and Exhibition Booths organised / co-organised by IEA Geothermal since the end of 2020

Date	Symposia and Exhibtgion Booths	Collaborators	Location
March 2023	Mine Water Geothermal Energy Symposium	BGS, UK Coal Authority, BEIS	Virtual
March 2022	Mine Water Geothermal Energy Symposium	BGS, UK Coal Authority, BEIS	Virtual
February 2022	Ultra-hot Supercritical Geothermal Symposium Series	IPGT, GNG	Virtual
October 2021	IEA Geothermal Booth	N/A	Reykjavik, Iceland
March 2021	Mine Water Geothermal Energy Symposium	BGS, BEIS	Virtual

The 5 collaborators with whom IEA Geothermal have worked to deliver these workshops are tabulated in Table 3:

Table 3 Workshop Collaborators

Short Title	Organisation	City / Country
BEIS	Department of Business, Energy and Industrial Strategy	United Kingdom
BGS	British Geological Survey	United Kingdom
GNG	Geothermal the Next Generation	New Zealand
IPGT	International Partnership for Geothermal Technology	New Zealand
UK Coal Authority	United Kingdom Coal Authority	United Kingdom

IEA Geothermal at WGC 2020+1, Reykjavík, Iceland October 2021.

As noted in Table 2 above IEA Geothermal had a booth presence at the Harpa Conference Centre (24-27 October 2021). Figure 4 below is the back lit backwall graphics with the overarching thrust of IEA Geothermal activity of taking geothermal to the world.

Figure 4 Backlit wall of the IEA Geothermal Booth at the Harpa Conference Centre Iceland 24th – 27th October 2021

The IEA Geothermal papers and presentations at WGC 2020+1 can be accessed through the webpage https://iea-gia.org/workshop-presentations/2021-world-geothermal-congress/ on the IEA Geothermal website..

IEA Geothermal Contribution to WGC 2023, Beijing, China

Members of the Executive Committee of IEA Geothermal are attending the WGC 2023 congress. A web page (www.iea-gia.org/event) has been set up to allow access to information about IEA Geothermal congress activities. The members and experts are available to talk about geothermal energy – identifiable by the IEA Geothermal logo (Figure 5).

IEA Geothermal

Figure 5 : IEA Geothermal logo

Three papers by IEA Geothermal members, in conjunction with other geothermal experts, have been prepared for presentation at WGC 2023. Table 4 provides summary information on the papers, the WGC 2023 conference stream and a hyperlink to the paper reference. The papers will be downloadable from the IEA Geothermal website along with the slide pack of the presentations from https://iea-gia.org/workshop-presentations/.

Table 4 IEA Geothermal Papers presented at WGC 2023

Topic	WGC Conference Stream	Prepared by	Paper Reference
Overview of IEA Geothermal	International Collaborations	Executive Secretary	Carey and Yasukawa
Ultra Hot - Supercritical Geothermal	Advanced Technology	Working Group 12	Bromley and Carey
Mine Water Geothermal Energy	International Collaborations	Working Group 14	Monaghan et al

CONCLUSION

IEA Geothermal continues its activity around the globe of fostering the uptake of geothermal energy using the organisation's powerful collaborative networks. Joining IEA Geothermal enables participants to share information for mutual benefit, and to discuss geothermal energy opportunities with others from around the globe.

DISCLAIMER - Views, findings and publications of the IEA Geothermal TCP do not represent the views or policies of the International Energy Agency Secretariat (Paris) or of its member countries.

REFERENCES

Mongillo, M., and IEA GIA Participants. The IEA Geothermal Implementing Agreement - Its Goals, Status, Achievements and Prospects. *Proceedings* World Geothermal Congress 2005, Antalya, Turkey, 24-29 April 2005. (2005)

Mongillo, M., Bromley, C., and Rybach, L. The IEA Geothermal Implementing Agreement - International Efforts to Promote Global Sustainable Geothermal Development and Help Mitigate Climate Change. *Proceedings* World Geothermal Congress 2010. Bali, Indonesia, 25-29 April 2010. (2010)

Mongillo, M., and Bromley, C.: IEA-Geothermal - Reflecting on 18 years successful international collaboration. Paper 40001 (11 p.) *Proceedings*, World Geothermal Congress 19-24 April 2015. (2015)

Carey, B., and Wissing, L.. Geothermal Collaboration through the International Energy Agency Geothermal Technical Collaboration Programme. *Proceedings* World Geothermal Congress 2020+1, Reykjavik, Iceland, April - October 2021. (2021)

IEA Geothermal Papers to WGC 2023

General

Carey, B., and Yasukawa, K.. Geothermal Collaboration through the International Energy Agency Geothermal Technology Collaboration Programme. *Proceedings* World Geothermal Congress 2023, Beijing, China, September 15 - 17, 2023. (2023)

Working Group 12

Bromley, C., and Carey, B., Ultra Hot - Supercritical Geothermal - IEA Geothermal Collaboration. *Proceedings* World Geothermal Congress 2023, Beijing, China, September 15 - 17, 2023. (2023)

Working Group 14

A Monaghan, A., Jans-Singh, M., Abesser, C., Carey, B., Gonzalez Quiros, A., Global knowledge exchange - experiences and outputs from the IEA Geothermal Mine Energy Task Force. *Proceedings* World Geothermal Congress 2023, Beijing, China, September 15 - 17, 2023. (2023).