

**IEA-GIA- International Geothermal Cooperation  
Going from Strength to Strength**

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**ABSTRACT**

The global demand for energy continues to grow, with fossil fuels expected to remain the dominant sources well into the future. In 2008, the International Energy Agency (IEA) reported that if current government policies continue (Reference Scenario), the total global primary energy need in 2030 will be 45% greater than in 2006. This will likely lead to energy security problems and a large increase in greenhouse gas (GHG) emissions, with related significant climate change effects. However, if renewable energy options using current technology are implemented, GHG emissions could drop to about 20% lower than for the Reference Scenario; and with significantly more effort and technology development, the drop could be more than 35%. These outcomes provide a strong incentive for increased use of clean, renewable energy resources, including geothermal energy, which can make a significant contribution. Success, however, requires international cooperation.

The IEA Geothermal Implementing Agreement (GIA) is one of 10 IEA collaborative renewable energy technology projects. It provides a versatile scheme for international cooperation in geothermal R&D activities, with a focus on enhancing effectiveness through establishing direct cooperative links among geothermal experts in the participating countries, industries and organizations.

Since its establishment in 1997, the GIA has worked vigorously to have geothermal's capabilities recognized by energy planners, political and financial decision makers, and the public; and to support and advance the development of these vast and widespread energy resources for electricity generation and direct heat applications. Now well into its 3<sup>rd</sup> 5-year term (2007-2012), the GIA's key efforts are aimed at promoting and accelerating sustainable geothermal development and thereby contributing to the mitigation of climate change.

GIA's current activities continue to cover four broad topics, managed through Annexes: Annex I- Environmental Impacts of Geothermal Energy Development, Annex III- Enhanced Geothermal Systems (EGS), Annex VII- Advanced Geothermal Drilling Techniques and Annex VIII- Direct Use of Geothermal Energy. Recognition of new important issues has also led to the addition of several new investigations, including: induced seismicity studies (Annex I), examination of sustainable geothermal energy use (Annex I), and novel ways to present information/data to the public via the internet using Google Earth (Annex VIII). In addition, Annex III efforts have been completely revised and new studies added due to the recent concerted effort on EGS development in Australia, the USA and Europe. The GIA has expanded activities to non-Members by sponsoring international technical workshops on induced seismicity and sustainability modelling; and a joint GIA-IGA workshop on

geothermal's potential for climate change mitigation held in May 2009. GIA annual report content has grown, making it more informative and useful to participants and financial and government institutions. The GIA website continues to develop, with emphasis placed on information dissemination to both participants and the general public. Distribution of GIA information and research results has increased significantly.

The GIA maintains strong involvement with the IEA, through participation in their international workshops and seminars; and via contributions to their influential publications.

GIA's membership continues to grow, having nearly doubled to 19 Members in the past 3 years, and now includes: 12 countries (Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Republic of Korea, Spain, Switzerland and the United States), 4 companies (Geodynamics, Green Rock Energy, ORME Jeotermal and Ormat Technologies), 2 organizations (Canadian Geothermal Energy Association [CanGEA] and Geothermal Group of the Spanish Renewable Energy Association [GG-APPA]), and the European Commission (EC).

The GIA has grown from strength to strength, and sees a bright future ahead. This paper provides a brief description of the IEA and GIA, and discusses the GIA's achievements and future prospects.

## **I. Introduction**

The growth in global energy demand is expected to continue well into the future, with fossil fuels maintaining dominance in the supply. A 2008 IEA study (2008a), which incorporates the effects of current (mid-2008) government policies and measures (Reference Scenario), shows that the global primary energy demand will increase by 45% during the period 2006-2030, raising demand to 17,010 million tonnes of oil equivalent (Mtoe) [712 EJ] in 2030; with the fossil fuel contribution decreasing slightly from 80.9% to 80%. It is likely there will be sufficient fossil fuel to meet these demands; however, production will be controlled by fewer countries, many in "unstable" parts of the world, thus, creating energy security problems. In addition, GHG emissions will increase by 35%, from 44 billion tonnes (Gt) CO<sub>2</sub>-equivalent (CO<sub>2</sub>-eq) (2005) to 60 Gt CO<sub>2</sub>-eq (2030); leading to significant climate change effects. These global energy trends are socially, economically and environmentally unsustainable.

Two alternative climate-policy based scenarios have been developed to stabilize GHG concentrations at 550 and 450 ppm CO<sub>2</sub>-eq, thereby containing global temperature increases to about 3°C and 2°C, respectively (ibid.). In both scenarios, the total emissions are significantly less in 2030 than in the Reference Scenario. However, both scenarios require major efficiency gains; CO<sub>2</sub> capture and storage (CCS) deployment; a marked decrease in the contribution of fossil fuels, to be replaced by nuclear and renewables; as well as considerable public and private RD&D spending. We are truly at a global energy supply and climate change crossroads, which only international cooperation can overcome.

## **II. The IEA and Its Implementing Agreements**

The International Energy Agency (IEA), based in Paris, France, is an autonomous intergovernmental organization created in 1974 in response to the 1973-74 oil crisis. It is the energy forum for 28 member countries of the Organization for Economic Cooperation and Development (OECD), plus the Commission of the European Communities (EC). The IEA

provides energy policy advice to its members, with its current focus on climate change policies, market reform, energy technology collaboration and outreach. For more information about the IEA and its activities, go to: [www.iea.org](http://www.iea.org).

Only international technology cooperation can provide a cost-effective way to help guarantee energy security and address climate change issues. To encourage such collaboration, the IEA created the Implementing Agreement (IA)- a management structure and legal mechanism for guiding the activities of the IEA's collaborative multilateral programmes. Participants typically comprise research institutions, utilities, industries and organizations. The IAs have two categories of Participants: Contracting Parties (represent countries) and Sponsors (industries and organizations). Of the current 41 Implementing Agreements, 10 cover renewable energy topics, of which the GIA is one.

The activities undertaken in the IAs are defined and organized in *annexes*, which consist of specific studies, or *tasks*. The annexes specify study objectives, schedules and funding provisions (if any); and identify participants and define their obligations. An Executive Committee (ExCo), consisting of one Member and one Alternate from each Contracting Party and each Sponsor, coordinates and manages the operation of the IA and is also responsible for disseminating results and reporting to the IEA. New annexes, as well as new tasks within annexes, may be added when needs are identified. Funding for IA activities can be of two types: *task-sharing*, whereby the participants provide resources and personnel to conduct a portion of the annex work at their own expense; or *cost-sharing*, in which participants contribute to a common fund that is used to pay for its activities. A combination of these funding mechanisms may also be used to finance IA studies.

### **III. The IEA Geothermal Implementing Agreement (GIA)**

The GIA was founded in 1997, and is currently starting the 3<sup>rd</sup> year of its 3<sup>rd</sup> 5-year term of operation, which takes its activities to 2012. It provides a flexible framework for extensive international cooperation in geothermal R&D by allying national, industry and organization programmes for exploration, development and utilization of geothermal resources. The focus is on improving effectiveness through creating direct cooperative links among geothermal experts in the participating countries, industries and organizations. The GIA's general scope of activity comprises international collaborative efforts to: *compile and exchange improved information* on worldwide geothermal energy R&D, *develop improved technologies* for geothermal energy use, and *improve the understanding of the environmental benefits* of geothermal energy and ways to avoid or reduce its environmental impacts. GIA collaboration provides opportunities for information exchange through meetings, workshops and networking, as well as an international perspective on geothermal issues. Members can participate in R&D projects, and in the development of databases, models and handbooks. For further details see: Mongillo and Rybach (2007); and GIA 2002-2007 End of Term Report, the GIA Strategic Plan 2007-2012 and GIA annual reports (available on the GIA website: [www.iea-gia.org](http://www.iea-gia.org)).

#### **IEA-GIA Strategy, Mission and Activities**

Provision of the massive quantities of renewable energy required to overcome the world's current energy-climate change predicament presents the international community with an enormous challenge. One significant source of such energy is the heat residing within the earth; estimated to be  $\sim 10^{13}$  EJ, it would take well over  $10^9$  years to exhaust at the average

terrestrial heat flow rate of 44 million  $\text{MW}_{\text{th}}$  (1,400 EJ/year), almost 3 times the world's 2006 total primary energy supply of 492 EJ/year (IEA, 2008b). Though the portion of this enormous and ubiquitous geothermal heat resource that can be economically realized remains uncertain, estimates indicate that it is substantial: 1) for hydrothermal resources alone, technical potentials for power generation of up to 65 EJ/yr and direct heat use of 1,400 EJ/yr (Stefansson, 2005) and 2) 140  $\text{GW}_e$  installed electricity capacity (hydrothermal and EGS) and total direct use capacity (predominantly GHPs) of 800  $\text{GW}_{\text{th}}$  by 2050 (Fridleifsson, et al., 2008). Clearly, geothermal energy can make a significant contribution to the world's current and rapidly growing energy needs, while contributing to the mitigation of climate change.

The GIA recognizes the importance of significantly expanding the sustainable development and deployment of geothermal energy worldwide and promoting it as a clean, economic and secure energy source. It sees itself as an organization that should take the lead in these efforts. To meet these challenges, the GIA developed the following guiding Mission for its 3<sup>rd</sup> Term:

***To promote the sustainable utilization of geothermal energy throughout the world by improving existing and developing new technologies to render exploitable the vast and widespread global geothermal resources, by facilitating the transfer of know-how, by providing high quality information and by widely communicating geothermal energy's strategic, economic and environmental benefits.***

To realize this mission, GIA participants now take part in two or more tasks of the current four major research areas (Annexes):

***Annex I: Environmental Impacts of Geothermal Energy Development-*** to identify environmental effects of geothermal development and develop and adopt methods to avoid or minimize their impacts. Five tasks include: to investigate the impacts on natural features; to study the problems associated with discharge and reinjection of geothermal fluids; to examine methods of impact mitigation and produce environmental guidelines; to investigate seismic risk from EGS fluid injection; and to develop sustainable utilization strategies.

***Annex III: Enhanced Geothermal Systems (EGS)-*** to investigate new and improved technologies that can be used to artificially stimulate a geothermal resource to allow commercial heat extraction. Five tasks include: to develop EGS economic models; to review/modify application of conventional or new geothermal technologies; to collect information necessary for designing a commercial EGS plant; to compile effective tools for reservoir evaluation that can be applied to new EGS sites; and to conduct EGS R&D with emphasis on reservoir management and enhancement technologies.

***Annex VII: Advanced Geothermal Drilling Techniques-*** to pursue advanced geothermal drilling research and investigate all aspects of well construction with the aim of reducing costs. Three tasks include: the compilation of geothermal well drilling cost and performance information; production of a geothermal drilling "best practices" handbook; and exchange of information on drilling technology development and new applications.

***Annex VIII: Direct Use of Geothermal Energy-*** to address all aspects of direct use technology with emphasis on improving implementation, reducing costs and enhancing use. Six tasks include: to define and characterize geothermal resources for direct use applications; to collect, analyze and disseminate cost and performance data and validate improvements; to initiate research to remove barriers, enhance economics and promote implementation; to identify, test

and characterize performance of innovative equipment; to develop engineering standards; and to develop methods for presenting geothermal data on the internet using Google Earth.

#### **IV. The GIA's Growing Success and Achievements**

The GIA ExCo and Annex efforts have grown throughout the 2<sup>nd</sup> and into the 3<sup>rd</sup> Term, as have their accomplishments. A few examples that demonstrate the range of GIA activities, their success, and most significant achievements are presented here. More details can be found on the GIA website at: [www.iea-gia.org/publications.asp](http://www.iea-gia.org/publications.asp).

**IEA Recognition-** The overall success of the GIA is clearly demonstrated by its initial 5-year mandate being extended twice, in 2002 and in 2007, following rigorous IEA reviews.

**GIA Secretariat-** In 2002, the GIA ExCo decided to increase its endeavours beyond those possible from its previous volunteer operations, and established a dedicated GIA Secretariat in 2003. Through the Secretariat, the ExCo has been able to effectively expand its information dissemination, international conference and IEA participation almost every year since.

**Membership-** The GIA has increased its efforts to grow membership in order to expand its expertise and increase its influence in support of sustainable geothermal utilization worldwide. Success is demonstrated by the increase from 11 Members at the end of 2005 to 19 at the start of 2009. The GIA also broadened its membership base to include both industry and organizations. In 2006, the GIA gained its first industry member, Ormat Technologies, Inc. (USA); soon to be followed by Green Rock Energy and Geodynamics (both based in Australia) in mid-2006; and ORME Jeotermal (Turkey) in mid-2008. In late-2008, GIA membership was extended to geothermal organizations, with the Geothermal Group of the Spanish Renewable Energy Association (GG-APPA) and the Canadian Geothermal Energy Association (CanGEA) joining. Since 2005, three new countries also joined: the Republic of Korea (2005), France (2006) and Spain (2008). As of June 2009, there were 19 GIA Members: the European Commission; 12 countries: Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, the Republic of Korea, Spain, Switzerland and the United States; 4 industry Sponsors: Geodynamics, Green Rock Energy, ORMAT Technologies and ORME Jeotermal; and 2 organization Sponsors: GG-APPA and CanGEA. At present, there is also interest from five prospective members: Norway, the European Geothermal Energy Council (Belgium), China, Russia, and Ireland.

**Information Dissemination-** The GIA ExCo and Annexes have been particularly successful in their information dissemination endeavours, as demonstrated by their participants contribution of over 170 publications (since 2002) and widespread participation at international conferences, meetings and workshops; including: the European Geothermal Congress (2007), many New Zealand Geothermal Workshops (2002-2008), and several GRC Annual Meetings, all of which allowed valuable opportunities for extensive discussion and information exchange. The GIA had a major presence at the World Geothermal Congress 2005 and the Renewable Energy 2008 Conference, with the presentation of many papers and sponsorship of exhibition booths that attracted wide attention. Participation at the large RE 2006 and RE 2008 conferences also provided opportunities for GIA to raise awareness of geothermal as an important renewable energy source, and explain and discuss it with non-geothermal participants, policy and decision makers, and the public.

Continued development of the GIA Annual Report and production of stand-alone Executive Summaries, have made these documents premier forms of information dissemination. Since 2006, CD-Roms including all GIA Annual Reports and Executive Summaries have been made available and distributed at international conferences, workshops, and on request.

The comprehensive GIA website, which went on-line in late-2004, is being continuously developed and updated. It provides a valuable and easily accessible means for distributing and commenting on GIA documents and other international publications, as well making available up-to-date information about the GIA and geothermal energy to GIA Members and the public.

Information exchange among GIA participants has grown and become more efficient through the detailed ExCo Meeting Minutes, which now link to meeting documents and presentations posted in the Member's area of the GIA website.

The GIA has also expanded its activities by sponsoring/hosting several international technical workshops (2005-2008) (see Annex I Achievements below); including one jointly sponsored with the International Geothermal Association (IGA) on global geothermal development potential and its contribution to the mitigation of climate change, and held in May 2009.

**IEA Participation-** The GIA maintains strong involvement with the IEA, and has increased its participation in IEA workshops, meetings and seminars, through GIA representative participation and the provision of GIA material for distribution. The GIA has participated in IEA Networks of Expertise in Energy Technology (NEET) workshops to encourage the use of renewable energy in China (2007) and Russia (2008). Information and data are provided for IEA reports, thus raising the profile of geothermal energy within the IEA, as well as on a global scale, and among the other renewable energy technologies. The GIA has also increased its contribution to the widely distributed IEA OPEN Bulletin (> 12,000 subscribers).

**Annex Activity Growth-** GIA research activities have grown since 2002. The investigation of induced seismicity associated with EGS reservoir development and production, and an examination of sustainable use strategies have been included in Annex I. Annex III has been redesigned, and includes investigations of economic guidelines for EGS reservoir economic models, and development of recommended procedures to create, test and evaluate EGS parameters. The development of new methods for the geographic display of data on the Internet (Google Earth) has been added in Annex VIII.

**Annex Achievements-** A few examples of the more important Annex achievements include:

**Annex I** convened 3 international induced seismicity workshops (2005-2006), from which a protocol for induced seismicity management and two discussion papers (Bromley and Mongillo, 2008; Majer et al., 2007) were published; sponsored a very successful international Geothermal Sustainability Modelling Workshop (2008) (> 40 international participants) from which will develop a *Geothermics* Special Issue on Sustainable Geothermal Utilization (2010); and published a *Geothermics* Special Issue on environmental topics (2005).

**Annex III** developed a Project Management Decision Assistant (PMDA) handbook, which incorporates 30-years' experience from most of the major EGS R&D projects, and is now available and widely distributed; and completed development of a group of software interpretational tools for hydrothermal and EGS systems.

*Annex VII* created a draft database of geothermal well drilling costs and performance information; prepared a draft handbook for geothermal drilling best practices; and has initiated collaborative efforts for using a downhole high-temperature logging tool.

*Annex VIII* assembled a significant database of temperature and chemistry data for geothermal features from several countries; and published results from studies of controls on hot spring discharge rates and temperatures, and on host rock controls on thermal water chemistry based on a global comparison.

## **V. Future Directions and Prospects**

Geothermal power and direct use development are experiencing major growth in many countries. However, there remain political, technical, financial and perceived barriers to their development. GIA international cooperation provides an important mechanism, with demonstrated success, that can help overcome these barriers and realize geothermal's huge global potential.

The GIA will focus its effort through its Annexes in several key areas, including: 1) refining global estimates of geothermal resource potential and development cost projections, to assist investment decisions on energy projects that will reduce atmospheric carbon emissions (Annex I); 2) improving sustainable fluid production and reinjection strategies to optimize long-term performance of resources (Annex I), 3) devising cost-effective EGS reservoir stimulation technologies that minimize the potential effects of large induced seismic events (Annex III); 4) completing development of a database of geothermal drilling costs and a best-practices handbook for geothermal drilling (Annex VII), and 5) collecting and providing geothermal direct-use data and information on the web (Annex VIII).

The GIA sees many opportunities for emphasizing and further developing information dissemination and exchange, with the goals of communicating the benefits of geothermal energy and the GIA's activities and results to as wide an audience as possible. The GIA will continue to participate at major international renewable energy and geothermal meetings/conferences/workshops (e.g. GRC 2009 (USA) and WGC2010 (Indonesia)) and will maintain emphasis on development of the GIA website. Possibilities are being explored for holding more regular international workshops and seminars, some in prospective Member countries and with other international organizations.

The GIA plans to build on the already strong ties with its IEA parent, and in the near future, will be producing an IEA Geothermal Technology Brief brochure.

The GIA recognizes the need for continued growth, especially aiming at several countries with significant geothermal resources/development whose membership would benefit both the GIA and them, including: Indonesia, the Philippines, and countries in Africa and Central and South America. And, continued growth seems likely, with confirmed interest received from: Norway, EGEC, Ireland, Russia and China.

## **VI. Conclusions**

Now, in the 3<sup>rd</sup> year of its 3<sup>rd</sup> 5-year term, the GIA has had considerable success and achieved much, and is well on-track towards accomplishing its current Mission of promoting the sustainable use of geothermal energy worldwide.

Though the effects of the current global financial upheaval are unknown, it is expected that worldwide demand for energy will continue its rapid growth for the next several decades. To meet this increasing demand in a sustainable manner will require a huge input from renewable energies, including that from the vast and ubiquitous geothermal resources.

However, for geothermal to realize its huge potential contribution, it is necessary to improve existing and develop new technologies; and to promote the benefits of geothermal energy, its sustainable utilization and the contribution it can make toward climate change mitigation. Success will require significant international effort.

The GIA is well placed to lead this essential international effort, and is confident that it can do so well into the future. The GIA sees a very bright future ahead, both for geothermal and for the organization.

For more information about the GIA, contact the IEA-GIA Secretary at: [mongillom@reap.org.nz](mailto:mongillom@reap.org.nz) and/or visit the GIA website at: [www.iea-gia.org](http://www.iea-gia.org).

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