



International Energy Agency

Implementing Agreement on Geothermal Energy

End-of-Term Report 2007-2013

July 2012



CONTENTS

	Page
Introduction	1
1. Strategic Direction.....	1
2. Scope of Activities.....	3
2.1 Nature of Work	3
2.2 Membership.....	10
2.3 Contribution to IEA Activities.....	11
2.4 Participation in and Co-sponsorship of International Activities.....	12
2.5 Participation in Working Groups and Other International Cooperation.....	12
2.6 Funding.....	13
3. Contractual and Management Requirements	14
3.1 Executive Committee Meetings	14
3.2 Annex Meetings.....	16
3.3 Annual Report.....	16
3.4 IEA Framework and IA Legal Document	16
4. Contribution to Technology Evolution and Deployment.....	16
5. Policy Relevance	18
6. Contribution to Environmental Protection.....	19
7. Contribution to Information Dissemination	19
8. Outreach to IEA non-Member Countries	20
9. Added Value.....	21
10. Outlook and Plans for 2012 and Beyond.....	22
11. References	22
12. List of GIA Publications, Presentations, Etc.	22
Available at: GIA 3rd Term Publications	

Introduction

The International Energy Agency Geothermal Implementing Agreement, or IEA-GIA (GIA), was founded in March 1997 with an initial operating period of five years. Since then, with the support of the IEA Renewable Energy Working Party (REWP) and approval of the IEA Committee on Energy Research Technology (CERT), the GIA's operations have been extended for two further terms: 2002-2007 (2nd Term) and 2007-2012 (3rd Term), the latter being approved by IEA CERT at their 46th Meeting on 14 February 2007. The current (3rd) Term of the GIA was to end on 31 March 2012; however, as a consequence of CERT's decision to standardize all Implementing Agreement end-of-term dates, the end of the GIA's 3rd Term was adjusted to 28 February 2013.

On 1 March 2012, the GIA Executive Committee (ExCo) unanimously agreed, by e-mail ballot, to request extension of the GIA's operation for a 4th five-year term to cover the period 1 March 2013 to 28 February 2018. Consequently, this End-of-Term (EoT) report was prepared to provide information on the organization's 3rd Term (1 April 2007 to 28 February 2013) activities and achievements to assist the REWP and the CERT assess the GIA's request for a 4th Term extension. The ExCo notes that the GIA's 3rd Term Strategic Plan and objectives were designed in late 2006, so are not directly aligned with the CERT's current Strategic Plan (CERT, 2007), against which we report here.

The GIA ExCo unanimously approved this EoT report via e-mail ballot on 14 July 2012. The report was submitted to the IEA Secretariat via e-mail on 15 July 2012, with the GIA ExCo's request that the Implementing Agreement be extended for another five-year term. In conjunction with the production of the GIA EoT, the GIA ExCo has prepared a revised Strategic Plan to guide the organization's activities through its 4th Term (2013-2018). This 4th Term Strategic Plan, unanimously approved by the GIA ExCo via e-mail ballot on 18 July 2012, is being submitted as a separate document.

1. Strategic Direction

When originally established in 1997, the primary goal of the GIA activities aimed "at the coordination of the ongoing national [geothermal] activities in participating countries" to encourage wider use of geothermal energy (Rybach and Garnish, 2002). The fundamental objectives of the organization were also incorporated within Article 1 of the GIA's [IA document](#), and consist of international scientific collaborative efforts to:

- Compile and exchange information on geothermal energy research and development worldwide concerning existing and potential technologies and practices
- Develop improved technologies for geothermal energy utilization
- Improve the understanding of the environmental benefits of geothermal energy and ways to avoid or ameliorate environmental impacts
- Coordinate activities with other IEA Implementing Agreements as well as with those of other competent bodies

During its 2nd and 3rd Terms, the GIA has continued to pursue the abovementioned objectives and concentrate its efforts on encouraging, supporting and advancing the development and use of geothermal energy worldwide both for power generation and direct-heat applications (GIA, 2003); though recognizing the importance of energy security and more explicitly identifying "actions" and stressing the importance of sustainable development and climate change in its 3rd Term:

Vision: For the IEA-GIA to become a multinational forum with sufficient governmental and industrial strength to positively influence the design of Participants' RD&D plans, to optimize Participants' returns on RD&D investment by coordinating joint projects and sharing information, and to effectively support and complement IEA's efforts to promote geothermal as a clean, economic, renewable energy resource which will contribute significantly to global energy needs and security, and at the same time protect the environment.

Mission: 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, and thereby contribute to the mitigation of climate change.

In addition to the abovementioned basic intentions, the GIA developed a [Strategy](#) (GIA, 2006), which directly supported both its Mission and the CERT Strategy (CERT, 2002) in effect at the time. Six strategic objectives and associated actions were defined to help guide its efforts during the 3rd Term:

- To actively promote effective cooperation on geothermal ‘Research Development and Demonstration’ (RD&D) through collaborative work programmes, workshops and seminars
 - Review and evaluate RD&D topics for effectiveness and achievement, and initiate new collaborative studies where needs are recognized
 - Hold technical workshops and seminars to discuss RD&D and encourage new participation
 - Work with industry to help make contacts and develop the large and important markets in non-Member countries
- To collect, improve/develop and disseminate geothermal RD&D policy information for IEA Member and non-Member Countries
 - Provide national policy overviews
 - Develop geothermal RD&D position and policy papers
 - Develop and promote financial policies/schemes that will support/favour geothermal investment and development
 - Effectively disseminate all of the above to the appropriate audiences
- To identify geothermal energy RD&D issues and opportunities and improve conventional and develop new geothermal energy technologies and methods to deal with them
 - Continue the activities of current Annexes I, III, VII and VIII
 - Hold Annex meetings to identify RD&D issues and opportunities
 - Expand research topics (i.e. add new Annexes and Subtasks) where the needs and opportunities arise, e.g. sustainability of geothermal energy utilization (draft Annex V), geothermal power generation cycles (draft Annex VI), and financing geothermal development
 - Update geothermal energy development costs
 - Expand opportunities by stressing the benefits of geothermal energy
- To increase membership in the GIA
 - Identify potential new Members (countries and industry) and establish contact with appropriate representatives. Place emphasis on those countries that have significant RD&D and potential (e.g., Indonesia, the Philippines, countries in Central and South America, Africa, and Central and Eastern Europe).
 - Inform perspective new Members of GIA activities and on the benefits of their participation
 - Invite potential Members to attend ExCo and Annex meetings and possibly IEA GIA sponsored workshops and seminars held in association with national and international conferences
- To encourage collaboration with other international organizations and appropriate implementing agreements
 - Identify appropriate collaboration opportunities at both the ExCo (International Geothermal Association, Geothermal Resources Council, Geothermal Energy Association, World Bank, World Energy Council) and Annex (other IEA Implementing Agreements) levels and explore joint efforts
 - Continue to provide up-to-date information to the IEA
 - Continue to participate in IEA sponsored REWP meetings and seminars
 - Consider establishing a ‘Trade Association Committee’ to work with the major geothermal trade associations to maximize the synergy between their interests and the GIA programme’s activities
 - Investigate participation with the Renewable Energy Technology Deployment IA
- To broaden and increase the dissemination of information on geothermal energy and the GIA’s activities and outputs to decision makers, financiers, researchers and the general public
 - Expand development of the GIA website
 - Continue to produce and improve the quality of the annual report
 - Encourage the production of technical reports by the Annexes

- Expand participation at international geothermal and renewable energy conferences, and IEA REWP meetings and seminars
- Consider holding IEA GIA sponsored workshops and seminars for both technical and general audiences (decision makers, financiers, public)
- Provide the IEA with good geothermal energy statistics
- Produce more GIA information material such as policy statements, brochures, IEA OPEN Bulletin articles and contributions to IEA reports and publications
- Investigate starting a Public Awareness and Education Annex as an ExCo initiative
- Target information circulation to appropriate government departments and agencies, and financial institutions
- Expand the transfer of geothermal know-how through technical visits, workshops, seminars and exchange of personnel

Although the GIA's 3rd Term Vision, Mission and Strategy were developed around the CERT and REWP Strategies in effect in 2006, the GIA believes that they are reasonably situated to support the current CERT and REWP Visions, Missions and Strategies, and that the GIA's 3rd Term (2007-2013) outputs and achievements will still do a good job of meeting the current CERT criteria against which this document reports.

2. Scope of Activities

2.1 Nature of Work

The GIA provides a flexible and powerful framework for wide-ranging international cooperation on geothermal research and technology. It connects important national and industry programmes for exploration, development and utilization of geothermal resources, and establishes direct cooperative links among the geothermal experts in the participating countries, industries and industry organizations. The GIA's 3rd Term activities have been chiefly directed towards the sharing of results and information gained from national, industry and industry organization Members' geothermal programmes, the production of authoritative information and establishment of best practices. Significant emphasis is placed on information dissemination.

The GIA Secretariat conducts the regular administrative work for the organization, including: communication with GIA participants and IEA Secretariat, organization of the ExCo meetings and preparation of extensive minutes, as well as maintenance of the website, preparation of the annual reports, support to the ExCo's information dissemination programme (publications/presentations describing and promoting GIA activities), and contribution/review of IEA publications (see [GIA 3rd Term Publications](#)).

Information is disseminated through networking activities at Executive Committee meetings and associated workshops, conferences and exhibitions; Annex meetings; IEA events; and through IEA, GIA and international journal publications. The GIA annual report remains the organization's premier product in which comprehensive information is provided on the work of the ExCo, the Annex research and the activities in Member countries and industries. In 2010, the ExCo decided to also produce a specific annual report on geothermal utilization and development in GIA Member countries through Annex X. The ExCo meeting minutes have become substantial and valuable documents through the inclusion of detailed Annex and Country update reports and presentations from invited observers and guests. The GIA website, which is undergoing re-development in 2012, provides a large variety of information for Members, non-Members and the public.

The GIA's 3rd Term effort began with four diverse research topics continued from the 2nd Term: Annexes I, III, VII and VIII (Table 1); with Annexes I, III and VII extended for a further four years, from 2009-2013, and Annex VIII extended for two years, from 2011-2013 (2013 corresponds to the GIA's end-of-term date). About mid-way through the Term, new Annex X Data Collection and Information was initiated. In addition, induced seismicity became a significant international issue during the Term, leading the ExCo to create new Annex XI Induced Seismicity, which incorporated Annex I Task D Seismic Risk and parts of Annex III. Rapid growth of international interest and effort in enhanced geothermal systems (EGS) deployment also led to re-structuring of Annex III EGS.

Annexes V and VI were carried-over from the 2nd Term with "in preparation" status and remain so at this time. Annex V Sustainability of Geothermal Energy Utilization is designed to study the long-term economic sustainability of production. During the 3rd Term, sustainability studies have been effectively conducted in

Annex I Task E. If the need arises it can expand to Annex level. Annex VI Geothermal Power Generation Cycles is designed to address all aspects related to the performance, environmental impact and economics of the geothermal power cycles in order to establish guidelines for the best selection. Though there is currently no plan to initiate this Annex, it is ready if needed; only awaiting commitment of at least two participants.

Table 1. GIA Annex management, participation and operational period information.

Annex Number	Annex Title Operating Agent (OA) Annex Leader (AL); Affiliation; Contact E-mail Participants	Status
I	Environmental Impacts of Geothermal Development OA: GNS Science (GNS), New Zealand AL: Chris Bromley; GNS, New Zealand; c.bromley@gns.cri.nz Participants: Australia, EC, France, Iceland, Italy, Japan, Mexico, New Zealand, Switzerland, USA	Initiated: 1997, Extensions: 2005-2009; 2009-2013* (Ongoing)
II	Shallow Geothermal Resources	Closed
III	Enhanced Geothermal Systems OA: Geodynamics Limited, Australia, to September 2011; then US Department of Energy (DOE) ALs: Jay Nathwani; jay.nathwani@ee.doe.gov and Doone Wyborn; Doone.Wyborn@geodynamics.com Participants: Australia, CanGEA, EC, France, Geodynamics, GG-APPA, Germany, Green Rock Energy, Italy, Japan, Norway, ORMAT, Republic of Korea, Spain, Switzerland, UK, USA	Initiated: 1997, Extensions: 2005-2009; 2009-2013* (Ongoing)
IV	Deep Geothermal Resources	Closed 2006
V	Sustainability of Geothermal Energy Utilization	Draft
VI	Geothermal Power Generation Cycles	Draft
VII	Advanced Geothermal Drilling and Logging Technologies OA: Sandia National Laboratories, for US DOE, United States AL: Stephen Bauer; Sandia National Laboratories, USA; sjbauer@sandia.gov Participants: Australia, CanGEA, EC, Iceland, Mexico, New Zealand, Norway, USA	Initiated: 2001, Extensions: 2005-2009; 2009-2013* (Ongoing)
VIII	Direct Use of Geothermal Energy OA: Federation of Icelandic Energy and Waterworks, Iceland AL: Einar Gunnlaugsson, Reykjavik Energy, Iceland; einar.gunnlaugsson@or.is Participants: CanGEA, France, GG-APPA, Iceland, Japan, New Zealand, Norway, Republic of Korea, Spain, Switzerland, UK, USA	Initiated: 2003, Extensions: 2007-2011; 2011-2013* (Ongoing)
IX	Geothermal Market Acceleration	Closed
X	Data Collection and Information OAs: Leibniz Institute for Applied Geophysics, Germany, and Federal Office of Energy, Switzerland AL: Britta Ganz, Leibniz Institute for Applied Geophysics, Germany; britta.ganz@liag-hannover.de Participants: Mandatory country membership; Australia, CanGEA, EC, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Spain, Switzerland, UK, and USA	Initiated: 2009, Continuing through 2013* (Ongoing)
XI	Induced Seismicity OA: Lawrence Berkeley Laboratory, for US DOE, United States AL: Ernie Majer, Lawrence Berkeley Laboratory, USA; ELMajer@lbl.gov Participants: Australia, France, Germany, Iceland, New Zealand, Republic of Korea, Switzerland, USA	Initiated: 2010, Continuing through 2013* (Ongoing)

* All active Annexes have an identified “end date” coincident with the End-of-Term (28 February 2013), but will be requesting extension into the 4th Term in 2013, hence “Ongoing”.

A summary of active Annex descriptions and achievements is provided below. Member participation in the Annexes, funding sources, Annex operation dates are shown in Table 1. Annex management, participation and status are presented in Table 2. All six active Annexes are indicated to “continue to” the end of the current 3rd Term (28/2/2013) since the Annex term cannot extend beyond the term of the IA (IEA Handbook, ver. 3/2/2011, p. 23). However, these Annexes have no fixed end-date, and will request continuation into the 4th Term.

Annex I- Environmental Impacts of Geothermal Energy Development

Annex I goals are to encourage the sustainable development of geothermal energy resources in an economic and environmentally responsible manner; to quantify and balance any adverse and beneficial impacts that geothermal energy development may have on the environment; and to identify ways of avoiding, remedying or mitigating adverse effects. The activities were initially spread over four Tasks: A, B, C and D; but during the Term Task D was incorporated into a new Annex XI, and a new Task E was created: Sustainable Utilization Strategies.

Table 2. Contracting Parties, Sponsors and funding sources (status at July 2012).

			Annex	I	III	VII	VIII	X	XI
Country/Industry	Year Joined	Year Withdrew	Contracting Party/Sponsor	Environmental Impacts of Geothermal Development	Enhanced Geothermal Systems	Advanced Geothermal Drilling Techniques	Direct Use of Geothermal Energy	Data Collection and Information	Induced Seismicity
Australia	1997		Department Manufacturing Innovation Trade Resource and Energy (DMITRE), State Government of South Australia	G	G	G		G	G
Canadian Geothermal Energy Association (CanGEA)	2008		Canadian Geothermal Energy Association (CanGEA)		IO	IO	IO	IO	
European Union (EU)	1997		DG Research and DG-Energy, Belgium		G	G		G	
France	2007		Bureau de recherches géologiques et minières (BRGM)		G		G		
Geothermal Group of Spanish Renewable Energy Association (GG-APPA)	2008		Spanish Renewable Energy Association (APPA)		IO		IO	IO	
Germany	2000		Forschungszentrum Jülich GmbH		G			OA, G	G
Geodynamics	2006		Geodynamics Limited, Australia		I			I	
Greece	1997	2004	Centre of Renewable Energy Sources (CRES)						
Green Rock Energy	2006		Green Rock Energy Limited, Australia		I			I	
Iceland	2000		Orkustofnun	G, I		G	OA, G	G	
Italy	2000		ENEL Green Power	I	I			I	
Japan	1997		New Energy and Industrial Technology Development Organization (NEDO)	R	R		R	R	
Mexico	1997		Instituto de Investigaciones Electricas (IIE)	G		G		G	
New Zealand	1997		GNS Science	OA, R, I		I	R	R	R
Norway	2010		Norwegian Science Research Council (NFR)		R, I	R, I	R	R	
ORMAT Technologies	2006		ORMAT Technologies, Inc, United States		I			I	
ORME Jeothermal	2008	2010	ORME Jeothermal, Inc., Turkey				I		
Republic of Korea	2005		Korea Institute of Geoscience & Mineral Resources (KIGAM)		R		R	R	R
Spain	2008		Institute for Diversification and Saving Energy (IDAE)		G		G	G	
Switzerland	1997		Swiss Federal Office of Energy (BFE)	G	G		G	OA, G	G
United Kingdom	1997; 2011	2003	Department of Energy & Climate Change (DECC)		R		R		
USA	1997		United States Department of Energy (US DOE)	N	OA, N	OA, N	U	N	OA, N

G = Government; I = Industry; R = Research Institute (government funded); N = National Laboratory (government funded);
U = University; IO=Industry Organization; OA = Operating Agent

Task A: Impacts on Natural Features focuses on documenting impacts on natural geothermal features and devising methods to accurately monitor changes and to avoid or mitigate adverse impacts of development.

Task B: Discharge and ReInjection Problems investigates methods for avoiding adverse effects of gas emissions on air quality; the effects of toxic chemicals in discharged fluid; and the effects of ground subsidence.

Task C: Methods of Impact Mitigation and Environmental Procedures aims to develop an effective, streamlined environmental analysis process; reducing compliance costs and identifying mitigation options.

Task D: Seismic Risk from Fluid Injection into Geothermal Systems investigated the occurrences of felt induced seismic events, to better understanding triggers, and find avoidance or mitigation measures.

Task E: Sustainable Utilization Strategies investigates case histories of reservoir models to see what strategies were successful; assesses long-term reservoir behaviour and identifies sustainable utilization strategies.

Major achievements for Annex I (2007-2012)

- Papers were presented on improved environmental sustainability strategies at the annual New Zealand Geothermal Workshops, annual Stanford Geothermal Workshops in San Francisco, annual Geothermal Resource Council meetings in Nevada & California, the First European Geothermal Review in Mainz Germany, RE2008 in Busan, Korea, PNOC-EDC Geothermal Conference in Manila, Philippines, and renewable energy investment seminar in Santiago, Chile (see [GIA 3rd Term Publications](#)).
- Longer-term research and development needs were discussed with industry, including research into: induced seismicity, monitoring natural CO₂ and convective heat flux, using injection to reduce CO₂ and H₂S emissions, classifying thermal feature vulnerability, testing mitigation and remediation methods, and developing bio-remediation methods to remove toxic elements from geothermal water discharges.
- Published improved methods to monitor, avoid or mitigate environmental effects such as subsidence, gas and heat emissions.
- Developed cost effective mitigation, best-practice government policy options, and strategies to protect geysers from development effects, to assist countries that are new to geothermal development (e.g., Chile).
- Developed a protocol for dealing with induced seismicity.
- Published IEA Open Energy Technology Bulletin article on induced seismicity in fractured reservoirs.
- Contributed geothermal environmental aspects to Inter-governmental Panel on Climate Change, Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC SRREN).
- Convened joint IEA-GIA/IGA workshop on “global development potential and contribution to the mitigation of climate change” in Madrid, Spain.
- Convened sustainability workshop in New Zealand (NZ) and completed special issue of Geothermics.
- Convened workshop in NZ on mitigating environmental impacts for regulators & developers.
- Presented papers on global environmental research, improved environmental sustainability strategies and monitoring methods at the 2010 World Geothermal Congress in Bali, Indonesia.

Annex III- Enhanced Geothermal Systems (EGS)

The goals of the EGS Annex are to address new and improved technologies to access the huge heat resources present at depth in continental land masses, by engineering heat exchangers in order to allow the extraction of geothermal energy at commercially viable rates. The objective is to generate base load power, supply heat for industrial and domestic applications, and provide environmental benefits. Techniques developed should also help sustain and expand hydrothermal systems through the use of stimulation. The work in this Annex was extensively restructured during the Term, with current effort being pursued in five Tasks.

Task A: Geothermal Energy Resource, Reserve and Depletion (Production Profile) Estimates seeks to foster international consistency (through standards) for assessing and reporting geothermal resources and reserves to promote transparency, and confidence.

Task B: Technology Crossover between Hydrothermal and EGS aims to modify conventional hydrothermal development technology, such as horizontal drilling, fracture mapping, and pumping, for EGS applications and vice-versa. The objective is to enhance energy recovery from both high and low permeability systems. Desert Peak EGS project, USA, is used as a case study. Objectives include defining common technology terms, testing and assessment procedures, applicable drilling and high temperature logging tools.

Task C: Data Acquisition and Processing involves the collection of information from research EGS projects, as needed for the realization of commercial EGS projects, and for each stage of reservoir characterization, design, construction and operation. Data will be collected and archived at a central location.

Task D: Reservoir Evaluation involves devising standard procedures to characterize EGS reservoirs. Characteristics such as heat transfer area, size of the stimulated volume, total flow impedance, and likely thermal draw down, are necessary for robust commercial valuation. Procedures relate to: well testing models, borehole measurements, water management, numerical methods, micro-seismic data acquisition, and tracer studies.

Task E: Field Study of EGS Reservoir Performance conducts and compares EGS research developments with an emphasis on reservoir-management and reservoir-enhancement technologies. Projects include Soultz (France) and Coso (USA). Work includes tracer tests to: determine heat transfer surface, reservoir rock volume, and identification of preferential flow paths. Other tests will assess: thermal drawdown, flow-rate stability, long-term geochemical dissolution and precipitation, long-term stability of casing and other materials, and the possible growth of the stimulated reservoir during circulation and its possible effect on water losses.

Major Achievements of Annex III (2007-2012)

- A protocol for the assessment of EGS heat resource potential was developed & published (Beardsmore et al., 2010). International standards with recognised codes provide a firm basis for resource comparisons.
- Demonstrated (at Desert Peak, USA) that power output from the high-temperature, low permeability margins of a conventional hydrothermal system can be increased by using fracture stimulation techniques developed for EGS technology. Improved our understanding of fluid flow processes. Showed the importance of knowledge about in-situ stress regime.
- Collating available data from previous EGS projects to reduce the risk and enhance future success. Establishing the database is taking longer than planned. Some of the existing available data has been used to help understand the processes that generate larger seismic events and flow/pressure transients.
- Trials are continuing at Soultz (France), Landau (Germany) and Innamincka (Australia) to test EGS reservoir characterisation methods for consistency and stability, in order to build confidence in their usage.
- Work is continuing to better understand the generation of induced seismic events during circulation and stoppages at Soultz. During circulation, the reservoir is continuing to grow below the injection well, likely due to the change in the stress regime at this depth from normal faulting to strike slip. A prototype submersible pump and a long-shaft pump are being tested for reliability and longevity.
- Collaborative workshop papers and presentations by participants (see [GIA 3rd Term Publications](#)) have addressed the commercial, economic and technical issues of EGS deployment. Papers have also discussed issues related to compliance with the geothermal reporting code for resource assessment; methods of reducing costs of EGS power; an EGS potential assessment for the USA; and evaluating fluid flow from induced micro-seismic clusters. IFE in Norway held an international workshop on corrosion, scale and tracer technology (22 May 2012). IEA-GIA participants have attended 4 meetings and collaborated as lead authors of the geothermal chapter of the IPCC SRREN report, which assessed the technical potential for global EGS deployment by 2050.

Annex VII- Advanced Geothermal Drilling and Logging Technologies

The goal of advanced drilling and logging technologies is to promote ways and means to reduce the cost of geothermal drilling through developing an understanding of drilling and logging needs, elucidating best practices, and sharing methods to advance the state of the art. Drilling is an expensive part of geothermal development because of the high temperatures and formation types encountered. Cost reduction can take many forms. Task activities address aspects of geothermal well construction and logging and include developing a detailed understanding of worldwide geothermal drilling costs, compiling a directory of geothermal drilling practices and how they vary across the globe, and developing improved drilling and logging technologies.

Task A: Compile Geothermal Well Drilling Cost and Performance Information is a database task to help identify key cost components that might be reduced by new technology or by different drilling practices. Drilling depth-time data allows performance to be estimated where cost information is confidential.

Task B: Identification and Publication of “Best Practices” for Geothermal Drilling identifies and catalogues the technologies that have been most successful for drilling, logging and completing geothermal wells. Production of a Handbook of drilling practices covers: design criteria, cost avoidance, problem diagnosis avoidance and remediation, well testing, geophysical logging, and wellbore preservation.

Task C: Advanced Drilling and Logging Collaboration aims to monitor and exchange information on drilling and logging technology development and new applications. Participants identify and develop activities and projects for collaboration, e.g., opportunities to field-test new technology in a collaborating country.

Major achievements for Annex VII (2007-2012)

- The major achievement was publication of the Handbook of Best Practices for Geothermal Drilling (Finger and Blankenship, 2010), with financial support from the US DOE. Another important achievement was the significant increase in size of the well-cost database, with much of this information being used to develop, evaluate, and improve a well-cost model. The interim results of the model are already being used by the US DOE and shared through the publication of well-cost analyses. When completed, the well-cost model will provide a means to identify opportunities for technology improvement by examining how they impact on well-construction costs (i.e., identifying high cost aspects that may be worth investing more research effort).
- Recognizing that communication of technology developments is paramount to progress, Annex VII has pursued a very successful programme of technical talks as an integral part of biannual Annex meetings. A recent highlight was the seminar, Norwegian Drilling Technologies Expo, at which three invited experts spoke on new drilling technologies (Tonstad, Hestevik and Grindhaug, May 2012). Annex participants have spoken about Sandia National Laboratories' advancements in geothermal drilling and logging (Bauer, 2007; 2009), high temperature tool developments (Normann, 2008) and recent successes and plans for downhole tools (Henfling, 2009). There have also been talks about new drilling technologies such as: Georigg (supported by the Norwegian Government; Muller, April 2010); percussion [resonator] drilling (research by Statoil and Resonator AS; Muller, May 2011, May 2012); and spallation (plasma/electrical) drilling technology being developed by a Slovak company (Geothermal Anywhere; Kocis and Kristofic, October 2011).
- Efforts under Task C, Advanced Drilling and Logging Collaboration, are supported by Sandia's lead role in the biannual organization of the HiTEN (High Temperature Electronics Network) conference, which represents international interaction and exposure to cutting-edge high-tech advancements in the world of high temperature electronics. Annex VII also facilitated talks at Sandia about enhanced geothermal systems (Baria, 2008) and about geothermal energy in Australia (Goldstein, 2010).

Annex VIII- Direct Use of Geothermal Energy

Direct use of geothermal fluid has increased significantly and is now used for many different applications that require heat, such as buildings/towns, greenhouses, crop drying, fish farming, snow melting, bathing/spa, and industrial processes such as paper manufacturing, timber curing and milk drying. Annex VIII was established with the goals of promoting and expanding the direct use of geothermal fluid worldwide. The anticipated outcomes are improvements in systems and equipment, reduction in cost of delivered heat and an increase in the number of direct use applications.

Specific results anticipated are: development of an international database on direct use applications; standardized instruments and reporting techniques; reports on state-of-the-art and status of R&D in new technology, including areas needing improvement; and cooperative research to accomplish improvements. The major work of Annex VIII is performed in six Tasks.

Task A- Resource Characterization aims to define the available geothermal resources in participating countries. Chemical, temperature and flow data were collected and evaluated. Information dissemination included presentations describing the results at Annex meetings, conference papers & journal publications.

Task B- Cost and Performance Database focuses on collecting, analyzing and disseminating the characteristic cost and performance data for installations, with emphasis on establishing a baseline and then validating the improvements from innovative components and better designs. A "Questionnaire for Direct Use of Geothermal Energy" was developed and sent to participants resulting in information from 12 countries regarding Tasks B and C being collected and compiled. Results were presented at Annex meetings and international conferences.

Task C- Barrier and Opportunity Identification uses the information obtained in Tasks A and B to define the barriers which must be overcome to gain widespread use of geothermal heat. The research activities necessary to take advantage of these opportunities will be defined, reported and, where possible, initiated.

Task D- Equipment Performance Validation aims to define and test critical and innovative equipment; such as submersible and line shaft pumps, compact heat exchangers, down-hole heat exchangers, non-metallic piping, and heat pumps, to characterize performance for various applications and for various geothermal brines.

Task E- Design Configuration and Engineering Standards develops and characterizes standardized designs for various applications, with the goal of minimizing the engineering costs related to various applications.

Task F- Publication and Geographic Presentation on the Web seeks to define a suitable form to present data on direct use of geothermal water geographically on the web. Tests have been performed to present geothermal direct use data in files which can be opened on the web using Google Earth.

Major achievements for Annex VIII (2007-2012)

- International standards and regulations for geothermal heat pumps were collected. Information on barriers and opportunities were obtained through questionnaire responses.
- Activities and results were presented at several international workshops and conferences, but in particular:
 - Renewable Energy 2008, 13-17 October 2008, Busan, Korea, at special geothermal energy session, participants presented papers about direct use of geothermal energy, contributed to a lecture course on geothermal development and utilization, and prepared a poster for the IEA-GIA exhibition booth.
 - World Geothermal Congress 2010, 25-30 April 2010, Bali, Indonesia. Participants prepared a poster and presented papers on Annex work at five sessions dealing with: direct use, geothermal heat pumps, health tourism and balneology, district heating and agriculture, and integrated energy systems.

Annex X- Data Collection and Information

The main objective of Annex X, which began in 2011, is to collect essential data on geothermal energy uses, trends and developments in member countries and to publish these data in an annual report in hardcopy form and on the GIA website for wide public distribution. This report will become the GIA's significant information dissemination source, providing a brief overview of data trends such as installed capacities and produced electricity and heat, as well as relevant political and economic information. All Country members (14 as of May 2012) are required to participate in this Annex, and all Sponsor members support this effort by providing supplementary material. There are plans to extend this data collection to include non-GIA member countries, with emphasis on the remaining leading geothermal nations (where reliable data can be obtained): Kenya, the Philippines, Indonesia, Turkey, Russia, China, El Salvador, Nicaragua, and Russia.

Major achievements for Annex X (2011-2012)

- Since commencing Annex operation, a comprehensive questionnaire (spreadsheet) for the collection of data on geothermal energy use in GIA member countries was developed and accepted by the ExCo following its presentation at the 25th ExCo meeting in May 2011.
- The first comprehensive report, Geothermal Applications Data 2010, including results from detailed trend analyses, was prepared using information provided in the completed questionnaires received from country members, with initial results presented at the 26th ExCo meeting (London) in September 2011. Following amendments based on member feedback, a revised report is to be published in 2012.
- A poster presentation including information about the IEA-GIA Annex X activities was presented at the LIAG & BGR exhibition booth at the Hannover Messe industrial fair (23-27 April 2012).

Annex XI- Induced Seismicity

Annex XI was initiated in late-2010 when the ExCo recognized that the topic of induced (or triggered) seismicity was of such international importance that it required effort at an Annex level. [Note that in Annex XI's studies the term "induced" includes all seismic events that result from fluid injection, while the term "triggered" is used in situations where in-situ tectonic stresses are a predominant factor]. Consequently, the induced seismicity work of Annex I Task D (Seismic Risk from Fluid Injection into Geothermal Systems) and of Annex III (EGS) were shifted to Annex XI. The goal of Annex XI is to determine the steps needed to be taken to make EGS/fluid injection a safe, useful and economic technology that is publically acceptable. Specific objectives are to reduce the uncertainty associated with both technical and public acceptability issues in order to facilitate and to accelerate the development of geothermal energy by: developing accepted risk assessment protocols; identifying areas of research collaboration; and identifying key roadblocks.

Annex XI has been developed to work in cooperation with the International Partnership for Geothermal Technology (IPGT) Induced Seismicity Working Group, whose members, the United States, Australia, Iceland, Switzerland and New Zealand, are also members of the IEA-GIA. The IPGT provides a forum for government and industry leaders to coordinate their efforts and collaborate on projects, mainly to accelerate EGS

development. Partners share information on results and best practices to avoid blind alleys, limit unnecessary duplication, and efficiently accelerate the development of geothermal technologies. The work of Annex XI has been reorganized into two Tasks:

Task A: Mitigating the Effects of Induced Seismicity aims to i) develop a set of risk mitigation strategies and best practices to help stakeholders in all phases of a project; ii) create a functioning website for the Annex and iii) identify what should be communicated at each stage of a project.

Task B: Using Induced Seismicity for Optimizing Production from Geothermal Reservoirs seeks to i) identify terms and definitions based on significant published reports and create a glossary; ii) evaluate centralized data access and availability and develop a common understanding of an open data policy; and iii) establish the conditions by which a site can be defined as a global “demonstration” site, meeting a threshold of data quality, quantity and availability, and adherence to protocols.

Major achievements for Annex XI (2010-2012)

- Although Annex XI is relatively new, beginning in late-2010, through working with the IPGT significant progress has already been achieved with the development of its two Tasks.
- Annex XI meetings have been held in association with ExCo meetings in May 2011 (Paris) and May 2012 (Oslo).
- Joint Annex XI-IPGT meetings were held in October 2010 (Reykjavik) and November 2011 (Melbourne).
- Annex XI participants have met at special session meetings (AGU, SSA and GEYSERS) on seismicity.
- Papers by Annex participants have been published in international journals and in the IEA OPEN bulletin, and presentations made at international meetings (see [GIA 3rd Term Publications](#)). Additionally, Annex XI’s activities and results are available in the IEA-GIA Annual Report and on the GIA’s website, which is also linked to other induced seismicity websites such as that of the US DOE Lawrence Berkeley National Laboratory.

2.2 Membership

2.2.1 Current Status of Membership

During the 3rd Term, strong growth in GIA membership continued, increasing by 40% compared to that at the close of the 2nd Term. When the GIA formed in 1997, there were five founding country members (Japan, New Zealand, Switzerland, the United Kingdom and the United States) and the European Commission. During the 1st Term, six new countries joined (Australia, Germany, Greece, Iceland, Italy and Mexico). During the 2nd Term (2002-2007), four joined, the Republic of Korea and GIA’s first three industry members (ORMAT Technologies Inc., Green Rock Energy Ltd. and Geodynamics Ltd.). Greece and the UK withdrew in the 2nd Term because they were unable to meet the financial commitments of the GIA Common Fund (established in 2003 to support operation of a permanent GIA Secretariat). During the current Term, six more members joined: countries, Spain, Norway and the United Kingdom; industry organizations, the Canadian Geothermal Energy Association [CanGEA] and the Spanish Renewable Energy Association [APPA]; and an industry member (ORME Jeotermal, later withdrawn). As of July 2012, there were 20 Members, comprising 15 Contracting Parties and 5 Sponsors (three industries and two industry organizations) (Table 2). The long-term membership of non-IEA Members, Iceland and Mexico, contributes to IEA outreach activities.

2.2.2 Industry and Industry Organization Participation

The GIA has pursued industry membership since 2005, with first success in 2006, when three companies joined as Sponsor Members (Table 2). The GIA continued to encourage growing industry participation during the 3rd Term, recognizing their experience and the guidance they can provide for identifying studies needed to encourage and expand geothermal deployment. This Term, two industry organizations, CanGEA and APPA joined; and ORME Jeotermal (Turkey) became the fourth industry member (withdrawn in 2010, Section 2.2.5). Currently, industries/industry organizations comprise 25% of GIA membership. Sponsors are represented on the Executive Committee and are required to participate in at least one Annex, as are Contracting Parties (Table 2).

2.2.3 Non-GIA Member Participation and Membership Encouragement

The GIA ExCo has a policy of inviting representatives from potential member countries and industries to ExCo and Annex meetings as Observers and Invited Guests, and to participate in associated workshops. This Term, the ExCo formally invited representatives from China, Hungary, Indonesia, Norway, the Philippines, Russia, Spain, Turkey and Kenya and from industry/organizations APPA, CanGEA, Alta Rock Energy Ltd. (USA),

Statoil (Norway) and Geothermal Anywhere (Slovakia), to participate. Invitations to join the GIA were also sent to all in this group, except the last two because Statoil joined with NFR to represent Norway and Geothermal Anywhere need more time to investigate the membership of Slovakia. Of the invitees, representatives from China, Indonesia, Norway, Spain, Geothermal Anywhere, APPA, CanGEA and Alta Rock Energy, attended ExCo and Annex meetings; and of these, Norway, Spain, APPA and CanGEA eventually joined.

Though GIA membership growth has remained strong, there are still several countries with significant geothermal power and direct use experience that the ExCo would like to join because they could both contribute to, and benefit from, GIA membership; these include: China, Indonesia, the Philippines, Russia, Turkey, Kenya, Hungary, Nicaragua and Costa Rica. To date, China, Indonesia, the Philippines and Russia have shown keen interest, but claim “lack of funds” necessary for their GIA Common Fund contribution as the major constraint. Assistance from the IEA REWP and the CERT in identifying the appropriate organizations/people to contact in the abovementioned countries would be greatly appreciated.

In 2011, the GIA ExCo decided to expand its efforts to encourage new membership by holding some ExCo and Annex meetings and associated workshops in potential member countries. Experience in holding ExCo and Annex meetings in association with the WGC 2010, in Bali, Indonesia, highlighted one of the major problems related to this approach—obtaining meeting venues without local assistance. However, the ExCo has decided to pursue this targeted approach from 2013, with Turkey and Hungary, where contacts have been identified and communication initiated.

2.2.4 Changes in Contracting Parties and Operating Agents

During the 3rd Term, there have been several replacements in the Member and Alternate representatives, and two changes in Contracting Parties. For Australia, the Contracting Party changed its name from Primary Industries and Resources South Australia (PIRSA) to Department Manufacturing Innovation Trade Resource and Energy (DMITRE). For Italy, the Contracting Party changed from ERGA Spa (ENEL Group) to ENEL Green Power.

The Operating Agent for Annex III changed from Geodynamics Limited to the United States Department of Energy in September 2011 due to Geodynamics’ resourcing difficulties resulting from the large growth in their geothermal activities. The Operating Agent for Annex VIII, the Federation of Icelandic Energy and Waterworks, resigned in May 2012 due to financial constraints; a possible replacement is being investigated.

2.2.5 Deemed Withdrawals

During the 3rd Term, one Sponsor, ORME Jeotermal, Turkey, was deemed to have withdrawn from the GIA due to non-payment of its Membership Common Fund contributions. Several attempts were made to communicate with ORME, without response. As a consequence, the GIA Executive Committee voted unanimously to withdraw ORME Jeotermal membership on 27 May 2011.

2.2.6 Organization of Executive Committee

The GIA Executive Committee (ExCo) manages the work programme of the organization. Each Member Country and Sponsor has a seat on the ExCo. The Executive Committee elects a Chair and three Vice-Chairs annually. None of these positions is paid, though modest funding is available for travel on official GIA business through the Chair’s discretionary fund of US\$ 5,000/yr, via the GIA proposal funding procedures, and through ExCo vote on special requests. A permanent Secretariat, supported by a part-time Secretary, was established in 2003, and has since operated under contract by GNS Science in Taupo, New Zealand. The Secretary deals with ongoing administration, assists with the management of the organization and contributes a significant part of the information dissemination, including the preparation of the GIA Annual Reports. Though most of the GIA work is conducted through the Annexes, the ExCo has remained very active this Term, especially through its participation in IEA events and its information dissemination activities (Sections 2.3-2.5).

2.3 Contribution to IEA Activities

The GIA has maintained strong support for, and coordination and information exchange with, the IEA during the current Term. Table 3 presents a list of IEA workshops at which the GIA participated and a list of reports that the GIA contributed to in the form of written contributions, reviews and comments. In several cases, reviewing and commenting extended over long periods of time, with reports frequently not published until the following year. Of particular note is the appointment of GIA Sponsor member, Lucien Bronicki, CTO Ormat Technologies Inc., to membership on the Renewable Energy Industry Advisory Board (RIAB).

Table 3. GIA participation in IEA workshops, seminars and contributions to IEA publications (as of July 2012).

Event/Publication	Location	Date
Energy Technologies at the Cutting Edge 2007	OECD/IEA 2007	2007
IEA Technology Fair at the IEA Ministerial Meeting	IEA, Paris, France	14-15 May 2007
Deploying Demand Side Energy Technologies Workshop	IEA Headquarters, Paris, France	8-9 October 2007
Renewables for Heating and Cooling- Untapped Potential	OECD/IEA 2007	2007
NEET Workshop in China	Beijing, China	1-2 November 2007
Global Renewable Energy Markets and Policies Programme Data	-	2007
Energy Technology Perspectives 2008	OECD/IEA 2008	2008
IEA OPEN Energy Technology Bulletin Issue No. 48	IEA	February 2008
NEET Workshop in Moscow	Moscow, Russia	30 Sept-1 Oct 2008
IEA RETD Climate Change, Security, Soaring Prices- Role of Renewables in Global Energy Models	Copenhagen, Denmark	22 October 2008
Cities, Towns & Renewable Energy	OECD/IEA	2009
Provision Geothermal Investment, O&M and Generation Costs Info.	-	May 2009
IEA Geothermal Roadmap Workshop I	IEA Headquarters, Paris, France	8 April 2010
IEA OPEN Energy Technology Bulletin Issue No. 68	IEA	June 2010
Energy Technology Initiatives 2010	OECD/IEA 2010	2010
Energy Technology Perspectives 2010	OECD/IEA 2010	2010
Energy Technology Network Workshop- Communication, Impact, Growth	IEA Headquarters, Paris, France	7 September 2010
IEA Renewable Energy Essentials: Geothermal	OECD/IEA 2010	2010
IEA Geothermal Roadmap Workshop II	Sacramento, USA	24 October 2010
IEA Geothermal Roadmap Workshop III	Bandung, Indonesia	29 November 2010
IEA REWP Renewable Energy from Analysis to Action	OECD, Paris, France, France	15-16 March 2011
59 th REWP Meeting	IEA Headquarters, Paris, France	17 March 2011
IEA Energy Technology Network Communication Workshop	IEA Headquarters, Paris, France	19 April 2011
IEA Technology Roadmap: Geothermal Heat and Power	OECD/IEA	2011
REWP Renewables- Policy and Market Design Challenges	OECD, Paris, France, France	27 March 2012

2.4 Participation and Co-Sponsorship of International Activities

The GIA participated in several international geothermal conferences and workshops, and co-sponsored many during its 3rd Term (Table 4).

2.5 Participation in Working Groups and Other International Cooperation

The GIA has links with several international organizations and programmes:

- **Intergovernmental Panel on Climate Changes' (IPCC) Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN)** - Four members of the Executive Committee were nominated by their governments to participate in the preparation of Chapter 4: Geothermal Energy of the IPCC SRREN, one as Coordinating Lead Author and three as Lead Authors. Another ExCo Member and the Executive Secretary were Contributing Authors. The full IPCC SRREN report was released on 9 May 2011 in Abu Dhabi, and is available at: <http://srren.ipcc-wg3.de/report>
- **International Partnership for Geothermal Technology (IPGT)** - The GIA, through Annex XI, is collaborating closely with the Induced Seismicity Group of the IPGT on activities that address important international issues associated with induced seismicity.
- **Australian Geothermal Energy Group (AGEG)** - The GIA has active links to the Technical Interest Groups (TIGs) in AGEG, which is the Australian whole-of-sector representative body for industry, research and government organizations interested in the use of geothermal energy with over 100 members. AGEG and its TIGs foster national and international sharing of information. Nine of the current 12 TIGs have direct links to Annexes I, III, VII, VIII, and XI. Two AGEG members (Green Rock Energy, DMITRE) are also members of the GIA. See: <http://www.pir.sa.gov.au/geothermal/ageg>.
- **US DOE Geothermal Technologies Peer Review 2011 and 2012-** Several GIA ExCo Members and the Secretary (C. Bromley, A. Larking, J. Ketilsson, G. Siddiqi, M. Mongillo) participated as invited geothermal experts on 6-10 June 2011; and again in 2012 (C. Bromley), to conduct an expert review of US DOE geothermal projects as part of the oversight and monitoring of its research, development and demonstration.
- **International Geothermal Association (IGA)-** The IGA holds a World Geothermal Congress every five years, most recently, the World Geothermal Congress 2010, Bali, Indonesia, 25-30 April 2010. The GIA

presented a keynote paper: *The IEA Geothermal Implementing Agreement: international efforts to promote global sustainable geothermal development and help mitigate climate change*, as part of a major round-table discussion. Additionally, the GIA had a significant presence through the presentation of Annex work with five papers, posters and presentations; and via its exhibition booth, at which 18 Country, Sponsor and Annex posters, and two general GIA posters were exhibited, an audio-visual display operated, and a multitude of GIA and IEA documents were distributed. Members of the ExCo and Annex Participants also held many discussions with > 100 visitors to the booth.

Table 4. GIA participation in and co-sponsorship of international events (as of July 2012).

Event/Publication	Location	Date
32 nd Stanford Geothermal Reservoir Workshop 2007	San Francisco, USA	Jan 31-Feb 2 2007
European Geothermal Congress EGC 2007	Unterhaching, Germany	30 May-1 June 2007
First European Geothermal Review	Mainz, Germany	29-30 October 2007
Geothermal Resources Council Annual Meeting 2007	Reno, USA	30 Sept-3 Oct 2007
33 rd Stanford Geothermal Reservoir Workshop 2008	San Francisco, USA	Jan 31-Feb 2 2008
Renewable Energy 2008 ♦	Busan, Korea	13-17 October 2008
Geothermal Resources Council Annual Meeting 2008	Reno, USA	5-8 Oct 2008
International Geothermal Sustainability Modelling Workshop*	Taupo, New Zealand	10 November 2008
34 th Stanford Geothermal Reservoir Workshop 2009	San Francisco, USA	Jan 31-Feb 2 2009
IPCC Meetings for SRREN ♦♦♦	Sao Paulo, Brazil	26-29 January 2009
PNOC-EDC 30 th Annual Geothermal Conference	Manila, Philippines	11-12 March 2009
IEA-GIA~IGA Workshop Geothermal Energy Global Development Potential and Contribution to Mitigation of Climate Change***	Madrid, Spain	5-6 May 2009
IPCC Meetings for SRREN	Oslo, Norway	1-4 September 2009
Geothermal Resources Council Annual Meeting 2009	Reno, USA	4-7 October 2009
35 th Stanford Geothermal Reservoir Workshop 2010	San Francisco	Jan 31-Feb 2 2010
IPCC Meetings for SRREN	Oxford, UK	2-5 March 2010
World Geothermal Congress 2010 ♦	Bali, Indonesia	25-30 April 2010
IPCC Meetings for SRREN	Mexico City, Mexico	20-24 September 2010
GEISER-IPGT-EERA Workshop on Induced Seismicity	Reykjavik, Iceland	4 October 2010
Geothermal Resources Council Annual Meeting 2010	Sacramento, USA	24-27 October 2010
36 th Stanford Geothermal Reservoir Workshop 2011	San Francisco, USA	Jan 31-Feb 2 2011
IEA-GIA~IPGT Induced Seismicity Workshop	IEA Headquarters, Paris, France	3 May 2011
US DOE Geothermal Technologies Program Peer Review ♦♦	Bethesda, USA	6-10 June 2011
IPGT Induced Seismicity Workshop	Bethesda, USA	10 June 2011
Geothermal Resources Council Annual Meeting 2011	San Diego, USA	23-26 October 2011
IEA-GIA~IPGT Induced Seismicity Meeting 2011	Melbourne, Australia	14-15 November 2011
Hannover Messe Industrial Fair****	Hannover, Germany	23-27 April 2012
Norwegian National Geothermal Conference	Oslo, Norway	21 May 2012
Geothermal Resources Council Annual Meeting 2012	Reno, USA	30 Sept-3 Oct 2012
How to Mitigate Environmental Impacts of Geothermal Development*	Taupo, New Zealand	15-16 June 2012
NZ Geothermal Workshops 2007, 08, 09, 10, 11, 12	New Zealand	Nov 2007-12
HiTEN conferences ♦♦♦♦ 2008, 09, 10, 11, 12	Santa Fe, USA	May (annually)
IFE International Workshop on Corrosion, Scale and Tracer Technology	Oslo, Norway	22 May 2012
Norwegian Drilling Technologies Expo****	Oslo, Norway	23 May 2012
International School of Geophysics- 39 th Course	Erice, Sicily	28-30 September 2012
37 th Stanford Geothermal Workshop 2012	San Francisco, USA	11-13 Feb. 2013

- * GIA (Annex I) co-sponsored workshop with GNS Science, Wairakei, Taupo, New Zealand
- ** GIA Co-sponsored workshop with the International Geothermal Association
- *** Convened by Annex VII
- **** Annex X/GIA poster at LIAG & BGR exhibition booth
- ♦ GIA sponsored 5-day long exhibition booths
- ♦♦ Several GIA ExCo Members and Secretary were invited to participate in the review of US DOE-funded geothermal projects
- ♦♦♦ IPCC SRREN: Intergovernmental Panel on Climate Change Special Report on Renewable Energy Sources and Climate Change Mitigation
- ♦♦♦♦ Sandia National Laboratories (Annex VII Operating Agent for US DOE) is the convener

2.6 Funding

The GIA's operation is supported by a combination of cost sharing, task sharing and knowledge sharing. All Contracting Parties and Sponsors make an annual financial contribution to the GIA Common Fund to support the operation of the GIA Secretariat, website costs, and common activities the ExCo chooses to pursue, such as

printing of GIA documents, participation of nominated representatives at international conferences, and since 2009, special project funding via a proposal procedure. The Fund is administered on behalf of the ExCo by a Custodian, the National Renewable Energy Laboratory (NREL), based in the USA. The annual contribution is based on the number of shares assigned to each member via unanimous decision of the ExCo. The value of a share has remained at US\$ 3,500/year for the past several years, though it may be changed with unanimous ExCo agreement. Sponsors from member countries are assessed half the number of shares of their member country. Based on current membership, the distribution for 2012 is presented in Table 5.

Table 5. GIA Common Fund share distribution as of July 2012.

Australia	2	Mexico	1	United States	4
European Commission	4	New Zealand	1	CanGEA	1
France	4	Norway	2	Geodynamics	1
Germany	4	Republic of Korea	2	GG-APPA	1
Iceland	1	Spain	2	Green Rock Energy	1
Italy	2	Switzerland	2	ORMAT	2
Japan	4	United Kingdom	2	-	-
<i>Total = 43 shares; US\$ 150,500/year</i>					

The Chair and Secretary prepare an Annual Work Plan and Budget that is approved by the ExCo. Accounts are prepared and reviewed by the Custodian. The GIA is financially secure with the Common Fund having had significant surplus for the past several years. As a consequence, in April 2009, the ExCo established a mechanism to fund ExCo approved supplementary activities; proposals may be submitted requesting funding from the Common Fund for ExCo initiatives and Annex efforts to stimulate more joint activity by participants, and create more tangible products, particularly those that would otherwise be stifled by lack of funding from other sources. To date, four successful proposals have been funded: the Secretary's Co-Editorship (with the Annex I Task E Leader) of a *Geothermics Special Issue on Sustainable Utilization of Geothermal Energy* (published Dec 2010); participation of the Chair and Secretary, as GIA representatives, in the Peer Review of the US DOE Geothermal Technologies Program (June 2010); GIA contribution for the IEA Technology Roadmap for Geothermal Heat and Power (2011); and support for participation at the GEISER-IPGT-EERA Workshop on Induced Seismicity in Reykjavik, Iceland. Total GIA operating cost for 2011 was US\$ 141,000, comprised of: Secretariat operation: US\$ 114,800, GIA project costs: US\$ 5,500; and proposal funding costs: US\$ 20,000.

To date, all Annex activities have been conducted through task sharing, i.e., Annex participants provide resources and personnel to conduct their portion of the work at their own expense, including the work of the Operating Agents. Participants also pay their own expenses associated with participation and attendance at ExCo and Annex meetings. By arranging Annex meetings in conjunction with the ExCo meetings, or other events, travel costs are minimized. Though exact figures are not available, the total Annex "in-kind" efforts in 2012 are estimated at over 6 person-years/year.

3. Contractual and Management Requirements

3.1 Executive Committee Meetings

The GIA ExCo meets twice each year, generally rotating the meeting locations among the member countries, though aiming to meet at IEA Headquarters in Paris, France, at least twice/Term (Table 6). Attempts are made to hold ExCo meetings at locations of important international events where possible; this was done for the 18th ExCo meeting in Kandel, Germany (First European Geothermal Review held in nearby Mainz); the 20th ExCo meeting held in conjunction with the Renewable Energy 2008 Conference in Busan, Korea; the 21st ExCo meeting held along-side the IGA Board meeting to support the joint GIA~IGA Madrid Workshop (Section 2.5); the 22nd ExCo meeting held in association with the 2009 GRC Annual Meeting in Reno, USA; the 23rd ExCo meeting held in conjunction with the 2010 World Geothermal Congress, Bali, Indonesia; the 24th ExCo meeting held in association with the Reykjavik Geothermal Week; the 26th ExCo meeting held in association with the EGS Energy Symposium in London, UK; and the 27th ExCo



Participants at the 27th ExCo meeting, 24 May 2012, Statoil Office, Oslo, Norway

meeting held in association with the Oslo Geothermal Week. Meetings are well attended, and for the current Term the total number of participants ranged from 18-33 (average 26/meeting), with an average attendance of 67% of voting ExCo Members/Alternates (Table 6). Low ExCo meeting attendance by some GIA members led to the ExCo decision (28th ExCo meeting) to send a letter of concern to participants who miss three consecutive meetings. Non-GIA members are frequently invited to attend ExCo meetings to increase information dissemination and to encourage new membership.

The ExCo has also maintained its very active information dissemination programme, mainly with the support of the GIA Secretariat. Many papers and presentations describing and promoting the activities of the GIA were given at international conferences (Tables 3 and 4).

Table 6. Executive Committee Meetings and Attendance for the period 2007-2012 (July 2012).

ExCo Meeting	Location	Host	Date	Number of Members & Alternates (% Members♦)	Number of Observers* & Others	Total Number of Attendees
# 17	Nice, France	ADEME & BRGM	22-23 Mar 2007	18 (85%)	13	31
# 18 **	Kandel, Germany	Bestec	25-26 Oct 2007	14 (75%)	9	23
#19	Paris, France	IEA HQ	17-18 Apr 2008	12 (60%)	19	31
# 20**	Busan, Korea	Korean Institute of Geosciences and Mineral Resources	9-10 Oct 2008	12 (60%)	6	18
# 21**	Madrid, Spain	Institute for Diversification and Saving Energy	7-8 May 2009	15 (65%)	14	29
# 22**	Reno, USA	Ormat Technologies	1-2 Oct 2009	17 (75%)	16	33
# 23**	Bali, Indonesia	None	22-23 Apr 2010	15 (65%)	6	21
# 24**	Reykjavik, Iceland	Reykjavik Energy	7-8 Oct 2010	16 (65%)	11	27
# 25	Paris, France	IEA HQ	5-6 May 2011	12 (50%)	11	23
# 26**	London, UK	EGS Energy	29-30 Sept 2011	16 (65%)	7	23
# 27**	Oslo, Norway	Institute for Energy Technology and Statoil	24-25 May 2012	18 (75%)	10	28
# 28	Pisa, Italy	ENEL	20-21 Sept 2012	-	-	-

* Includes participating Annex and Task Leaders, except where one of these is also an ExCo Member.

** Meetings held in association with international conferences and workshops

♦ This is % of voting members, since Alternates sometimes attend in place of Members.

3.2 Annex Meetings

Annexes organize their own meetings, workshops, fieldtrips, etc., and typically have one or two meetings per year, with significant business conducted between times via e-mail. The Annex meetings are usually held in association with ExCo meetings (typically the day prior) or other events. Annex VIII has held two Skype meetings, but the large time differences due to the geographical spread of participants proved challenging. Task Leaders report at the ExCo meetings, Annex meeting minutes are distributed, and summaries of Annex activities are included in the GIA annual reports.

Table 7. ExCo and Annex average meeting attendance during the 3rd Term (as of July 2012).

Meeting	Number Meetings/year	Number Participants	% Members
<i>Executive Meetings</i>	2	25	67
<i>Annex Meetings</i>	-	-	-
Annex I	2	>20	85
Annex III	1	>20	70
Annex VII	1-2	>20	85
Annex VIII	1-2	15	65
Annex X	2	>20	70
Annex XI	2	>15	90

3.3 Annual Report

The GIA's Annual Report is comprehensive, including an Executive Summary (with numerous summary statistics), a review of the GIA programme and ExCo activities, details of Annex work and achievements, and full Contracting Party and Sponsor member reports. Due to its size (~300 pages in 2010), the annual report is available only in electronic form on the GIA public website and on CD-Rom, with an Executive Summary being the printed representative. The Annual Report is compiled by the Secretary using contributions provided by all Contracting Parties, Sponsors and Operating Agents, and reviewed by the Chair. The total cost for producing the Annual Report, CD-Roms and printing the Executive Summary are a standard part of the annual budget paid from the Common Fund and amounts to ~US\$14,000/year. Copies are provided to all GIA participants and the IEA Secretariat, who distribute them appropriately; and distributed at international conferences and to potential members for recruiting purposes.

3.4 IEA Framework and IA Legal Document

The IEA Framework for International Energy Technology is available to all GIA participants as an appendix to the GIA IA legal document, and in the Member's area of the GIA website along with the current version of the IEA Implementing Agreement Handbook.

The GIA legal text was updated with the assistance of the IEA Legal Office in 2010 and accepted unanimously by the ExCo on 11 February 2011. The major changes included the addition of a glossary at the beginning of the document and revision of ExCo meeting voting procedures. The updated version allows the "unanimous" vote at an ExCo meeting with a quorum, to be the final decision, without reference to absent parties. This facilitates quicker decision making by active members. The option of a "super majority" vote (two-thirds of the voting ExCo representatives present at a meeting plus one) was also added. Annex definitions were also updated.

4. Contributions to Technology Evolution and Deployment

The contribution by GIA to technology evolution or deployment is difficult to assess, since technology research and development, e.g., development of new components and processes, are not directly a part of the organization's work. The GIA is able, however, to contribute through the involvement of its five Sponsor members and two government delegated private sector Contracting Parties (Enel, Italy; IIE, Mexico) and through its national energy agency and national laboratory members (Tables 1 and 2), thus insuring research, industry and government representation. In addition, it contributes through its collaborative efforts to develop protocols and best practices, identify environmental issues and mitigation options; and by publicizing its member countries' and industries' newly developed tools, techniques, R&D, and country support policies. Important, too, are GIA's "spill-over" effects, such as the education of financial institutions (USB, IFC, EXIM) about the value of geothermal energy.

The May 2009 joint GIA~IGA Workshop on Geothermal Energy- Global Development Potential and Contribution to Mitigation of Climate Change, held in Madrid, Spain, attracted >40 attendees (national laboratories, industry, government bodies) from 18 countries. Results contributed to the IEA geothermal roadmap and IPCC SRREN report; both extremely valuable for supporting global geothermal deployment.

Participation in WGC2010 through presentations of papers and a week-long GIA sponsored exhibition booth (>100 visitors) provided the opportunity to speak directly with industry, financial and government representatives about topics such as global potential, sustainable development, and deployment.

The GIA also participated in the Renewable Energy 2008, Busan, Korea, where 700 participants (28 countries) from industry, universities, government research bodies, met for a week, with the major goal to “grow the market” for renewable energies, including geothermal. ExCo and Annex participants not only presented papers, but discussed geothermal technology and deployment with >100 visitors at a GIA sponsored an exhibition booth.

The IEA Roadmap for Geothermal Heat and Power (IEA, 2011), to which the GIA contributed, has potential for great influence on geothermal deployment, because of IEA’s high regard internationally and its extensive, high level communication capability. It has been cited extensively by CanGEA in 2011/12.

Australia has contributed significantly toward the acquisition of financing for geothermal exploration and development with the development of *The Australian Code for Report of Exploration Results, Geothermal Resources and Geothermal Reserves*. This is the world’s first uniform code to guide the reporting of geothermal data to the market and is designed to underpin the quality of the industry’s relationship with the market. The CanGEA has used it as a basis to develop a similar code for Canada.

Annex I contributes to deployment through its investigations into methods for mitigating/ameliorating effects of fluid withdrawal on natural features and subsidence; and through its work on sustainable development. In 2008, Annex I co-sponsored the International Geothermal Sustainability Modelling Workshop (Taupo, NZ), where 40 participants from eight countries focussed on numerical modelling of long-lived geothermal developments and examined various development scenarios. An international journal special issue on sustainable utilization resulted (Geothermics, 2010), illustrating the longevity of sustainably operated developments, hence encouraging geothermal power and direct-heat use deployment. A June 2012 workshop on How to Mitigate Environmental Impacts of Geothermal Development targeted regulators and developers, covered practical mitigation options and case studies that are directly useful to encouraging deployment.

Under the umbrella of Annex III, a protocol for the assessment of the EGS heat resource potential anywhere in the world was developed with funding from Google.com (Beardsmore et al., 2010), with further development planned to foster international standards with recognised codes to provide a firm basis for comparisons. Also in Annex III, the US DOE and Ormat Technologies have been exploring the use of the hydro-fracturing stimulation technique, developed for EGS technology, for increasing the power output from the Desert Peak hydrothermal system, with encouraging results. The associated induced seismicity (IS), though never having caused death or major damage in the geothermal environment, however, is becoming increasingly identified as a perceived problem, with the media sometimes exacerbating the issue, hence, an important barrier to EGS development and deployment. But, IS is necessary for creating and assessing the condition of reservoirs. Annex XI and other GIA participants are responding by providing unbiased scientific information to the public and media (e.g., IEA OPEN Bulletin and LBL Induced Seismicity and GIA websites), holding discussions with government representatives, and replying to media inquiries. In addition, Annex I and XI work led to the development of an IS protocol in 2007 (Majer et al., 2007), updated in 2011 (Majer et al., 2011). Information on progress in EGS technology development, made available through active participation in the GIA, made it possible to launch a pilot EGS power project in Korea at the end of 2010.

Drilling and well completion can account for up to half the capital cost of a geothermal power development, so Annex VII’s production of the *Handbook of Best Practices for Geothermal Drilling* (Finger and Blankenship, 2010) with the support of US DOE and Sandia Labs, has made a significant contribution towards helping reduce development costs. Annex VII is also developing a well cost model that will help with designing the most cost-effective drilling programme, again contributing cost savings.

Annex VIII contributed to an international course on geothermal development and utilization in association with the RE 2008 Busan conference that provided practical information on industrial applications, combined heat and power plants, technologies for geothermal heat pumps and success factors and environmental benefits of geothermal heat pumps.

The above described activities of the GIA and its participating countries and industries illustrate the range of the GIA's contributions to increasing deployment of geothermal around the world.

5. Policy Relevance

The GIA provides an environment and opportunities for 14 countries, the EU, and five industry/industry organizations to combine their efforts to advance the sustainable utilization of geothermal energy around the world. All of the country members have policies for reducing GHG emissions through reduction of fossil fuel use and/or increasing renewable energy (RE) use to help mitigate climate change. Geothermal energy is incorporated as part of the policy for several country members (Australia, Germany, Iceland, Italy, Japan, Korea, New Zealand, Spain, Switzerland and the USA), with nine (Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand and the USA) using geothermal for power generation and all 14 using it for direct-heat applications.

Discussion of RE policies in member countries, at ExCo and Annex meetings, at international conferences and workshops, and in GIA's comprehensive annual reports, influences government policies towards RE, especially geothermal development. These efforts also raise awareness of RE, and in particular, all forms of geothermal energy use (power and direct-heat applications), and where they can be used; thus providing important information that allows them to be taken into account in the RE policy of each country.

RE policies are discussed in the country chapters of GIA annual reports, including geothermal where it exists. Policies are also discussed at ExCo meetings. This allows members to compare the various types of support mechanisms, absolute amounts (\$-terms) of subsidies, feed-in tariffs, etc. This information is also shared with the public through their access to the annual reports on the GIA website. The distribution of hardcopy GIA annual report executive summaries by ExCo Members and Annex Leaders helps directly target government agencies/officials to feed GIA's results to policy makers, as do the electronic versions of all annual reports available on CD-Roms and website. Also, Annex X has just produced its first annual geothermal applications trend report for member countries that includes policy information and will be made widely available.

More specifically, the GIA's sustainability work has assisted attempts to incorporate sustainability into laws and regulations concerning geothermal development in Iceland; and in Korea, information about the recent progress in EGS technology development obtained through GIA participation made it possible to launch a pilot geothermal power plant project in 2010. In the USA, the important policy decision to pursue EGS as a significant RE for providing power across the country was in peril due to issues being raised by the public and media about induced seismicity. Several GIA participants held discussions with, and provided information (defining induced seismicity, the induced seismicity protocol) to government representatives, valuable in helping overcome these problems. Raising awareness and knowledge of GIA member countries R&D programmes led to Switzerland's increased coordination with and collaboration on specific projects with Australia (induced seismicity), USA (induced seismicity, thermal spallation drilling), Iceland (thermal effects in hydraulic stimulation, dynamic reservoir modelling in particular geochemical effects), France (shallow use standards, exploration activities in the canton of Geneva and adjoining French Departments), and Germany (field-based R&D in Mauerstetten) Policy.

A few ExCo Members (Australia, Spain, Switzerland and USA) are in senior government posts, thus assuring that GIA results feed into the policy-making process. The ExCo Chair and the Secretary are peer review panel members who utilize GIA information/results to advise New Zealand regional councils in the sustainable operation of several geothermal developments, thus directly influence regional policy. Membership of three major companies and two national industry organizations ensures development issues (barriers such as induced seismicity and mechanisms for raising finance) are raised with government policy-makers, influencing effective policy decisions (e.g., feed-in tariffs, RE portfolios, tax relief). Several GIA participants also contributed to the IPCC SRREN Report (2011), which is an extremely important policy contribution on the global scale.

The GIA also provides current geothermal data and information to the IEA and participates in IEA events on a regular basis; hence, contributes to IEA's policy efforts. The GIA contributed two posters and several documents describing the IA's activities and results for the IEA Ministerial Fair (Paris, May 2007). GIA also participated in IEA workshops (NEET China, 2007; Moscow, 2008), three IEA Geothermal Roadmap workshops (2010), REWP meetings and through the GIA's provision of articles to the IEA OPEN Bulletin; and contributed to, and commented on important IEA reports, such as the IEA Technology Roadmap-Geothermal Heat and Power (2011) developed as a consequence of the G8 request for development of roadmaps for key energy technologies and the Renewable Energy Essentials: Geothermal brochure (Table 3).

Recent decisions by Germany, Switzerland and Japan to reduce dependency on nuclear power following the Fukushima disaster (March 2011) has led these countries to change policy and place more significant emphasis on geothermal development to provide replacement power within their policy of growing RE use to reduce GHG emissions and to help mitigate climate change. Very significant is Japan's decision to re-initiate government support for geothermal development following the stifling effects on geothermal development caused by the halt of incentive policies >20 years ago.

6. Contribution to Environmental Protection

GIA Annex I Environmental Impacts of Geothermal Development deals directly with environmental issues (Section 2.1). In November 2008, Annex I held a joint GIA-GNS International Geothermal Sustainability Modelling Workshop in Taupo, NZ, in association with the 50th Anniversary of Wairakei Geothermal Power Station, at which over 40 participants, from nine countries attended. The success of this event led to the publication of a special international journal issue co-edited by Annex I Task E Leader and the GIA Secretary: *Geothermics Special Issue on Sustainable Utilization of Geothermal Energy* (Dec 2010) with 11 articles covering power and direct-heat geothermal developments from 10 countries. In June 2012, Annex I co-sponsored, with GNS, a workshop for technical staff and managers on How to Mitigate Environmental Impacts of Geothermal Development. Annex I has also assisted with development of geothermal environmental mitigation costs, best-practice government policy options, and strategies to protect geysers from development effects, to assist countries that are new to geothermal development, e.g., Chile.

Induced seismicity (IS), or small earthquakes caused by manmade activities, is associated with some geothermal endeavours, including fluid injection for disposal of separated water (hydrothermal developments) and rock fracturing in EGS reservoir creation. Initially, Annex I Task D dealt with IS, and produced the *Induced Seismicity Protocol*, a general guide that identifies steps a geothermal developer can take to address IS issues and adopted in several GIA countries. However, IS has recently grown to major international importance, resulting in the early effort expanding to the new Annex XI Induced Seismicity in 2010, which aims to encourage international cooperation to determine the steps needed to make EGS/fluid injection a safe and economic technology accepted by the public and useful to industry. Annex XI is collaborating with the IPGT, the Australian Geothermal Energy Group and GEISER, all working to arrange centralized data access, development of a set of risk mitigation strategies and best practices.

The GIA also initiated discussion on the role and possible contribution that geothermal energy might make to the mitigation of climate change; which led to a two-day joint GIA-IGA Workshop on Geothermal Energy- Its Global Development Potential and Contribution to the Mitigation of Climate Change (May 2009; Madrid, Spain). Over 50 experts, from 17 countries, participated. Results from this workshop provided input to the geothermal chapter of the IPCC SRREN Report (2011), a document widely distributed and used by governments to fashion policy on RE use.

One of GIA's Sponsor members (Ormat Technologies), designs, manufactures and sells power units and other equipment for recovered-energy electricity generation as well as for geothermal power generation. In addition, a joint US DOE-Ormat project validated for the first time, commercial electricity production using hot water co-produced with oil and gas at Rocky Mountain Oil Test Center (RMOTC).

GIA participants, mainly from Annexes I and XI, have participated in many international meetings/workshops (Table 4) at which the environmental benefits of geothermal power and direct use are described.

7. Contribution to Information Dissemination

During the 3rd Term, the GIA continued to emphasize and further develop its information dissemination and exchange, with the aim of communicating its activities and results to as wide an audience as possible. The target audience includes the lay-public, government and financial institutions, industry and the engineering and scientific communities. Results from Annex activities are presented in reports and papers published in scientific and technical journals, and presented at conferences, meetings and workshops (Tables 3 and 4). A wide range of promotional and less technical material produced by the ExCo and GIA Secretariat for the public, and government and financial institutions, including: annual reports and associated executive summaries, the end-of-term Reports and Strategic Plans, non-technical presentations, colour posters and reports are available from the GIA Secretariat on CD-Rom, with many also accessible on the GIA website. A complete list of GIA material disseminated during the current Term is available at: [GIA 3rd Term Publications](#).

Annex X Data Collection and Information- is a new initiative which the ExCo created in order to expand its data and information collection and dissemination capabilities. It is a mandatory Annex in which all Member Countries participate through their provision of national geothermal heat and power data/information, data on geothermal employees, costs and investments, national policies, etc. The Annex will publish reports annually, the first being the **Trends in Geothermal Applications 2010** report (Ganz, et al., 2012), surveying power and heat utilization and development and including trends. These reports will stand along side the GIA Annual Report as a major information product of the GIA.

GIA Website- The GIA's website (<http://www.iea-gia.org>) is a key tool for information dissemination and promotion. It was initiated during the 1st Term (1997-2002), redeveloped during the 2nd Term (2004), and is currently being completely redesigned (new version expected July 2012) to provide easier navigation and access to information. The site provides public access to information about the GIA, Annexes and Country/Sponsor members; and to GIA annual and other reports, workshop proceedings and publications. A Member's Area, password protected, provides participants access to ExCo meeting presentations and minutes, and other non-public information. Links are provided to participants', IEA, and other useful geothermal sites.

ExCo Meetings and Minutes- The GIA ExCo meetings frequently include special presentations by invited guests, in addition to reports on Annex and Country/Sponsor activities. The IEA Secretariat submits a report, which the IEA Geothermal Desk Officer often presents. These reports are linked within the meeting minutes.

The GIA Annual Reports- The GIA Annual Report is the organization's premier document, and includes comprehensive Annex and Country/Sponsor contributions and an executive summary. The report has grown in content, especially with the addition of new Annexes and increased membership; consequently, the ExCo decided to print only a stand-alone executive summary for distribution. The annual reports and executive summaries are announced on the website and downloadable from there. In addition, the printed executive summary and CD-Roms with all annual reports and executive summaries are provided to GIA participants for targeting appropriate recipients, and are distributed at international conferences and provided at request.

Annex I Workshops 2008, 2012- Annex I co-sponsored two international workshops in 2008 and 2011 in New Zealand on environmental issues at which the Chair, the Executive Secretary, ExCo Members and other GIA participants made presentations about GIA activities.

Conference Participation- During the period 2007-2012, the Chair, Executive Secretary and Annex/Task Leaders made over 40 presentations on behalf of the GIA, describing its mission, objectives, activities and annex achievements at such international events as: the European Geothermal Congress 2007; RE 2008 (Busan, Korea) and WGC2010 (Bali, Indonesia), at which GIA exhibition booths were also sponsored (5-day events); IEA NEET Beijing (2007) and Moscow (2008); the IEA 59th REWP Meeting (2011); among many others.

IEA Events and OPEN Bulletin- The GIA has maintained an excellent communication and information dissemination relationship with the IEA Secretariat during this Term (Table 3). Material about GIA's efforts has been provided for: IEA Ministerial Fair (2007), IEA NEET Beijing (2007) and NEET Moscow (2008) Workshops, 59th REWP Meeting (2011); IEA publications: Energy Technology Initiatives (2010), IEA OPEN Bulletin #68 (2010), IEA RE Essentials- Geothermal brochure, and IEA Geothermal Roadmap III (Bandung, Indonesia, 2010).

See Tables 3 and 4 for IEA and other meeting/workshop participation. The GIA has produced over 90 publications and a complete list is provided at: [GIA 3rd Term Publications](#).

8. Outreach to IEA non-Member Countries

Currently, the GIA has two IEA non-Member country (NMCs) signatories, Iceland and Mexico. To encourage new IEA NMC membership, the GIA has frequently invited representatives from these countries to participate in ExCo and Annex meetings as Observers and Invited Guests including: China, Indonesia, the Philippines, Russia, India, and recently, Kenya and Malaysia. Of these, the first three have participated at two or more ExCo and Annex meetings and GIA international workshops. In addition, the GIA has participated in the IEA NEET Workshops in China and Moscow, with great IEA support provided in following up in the case of China. Two basic problems have been highlighted through these efforts 1) identification of the appropriate person/government ministry which to approach, 2) the "lack of funds" required to contribute to the GIA Common Fund.

9. Added Value

The GIA's work has provided high added value in many ways, including through:

- Providing the forum for national R&D groups and industry to combine efforts, increasing capabilities well beyond those of individual countries/groups
- Reducing national and industry costs by effective cooperation on recognized RD&D issues
- Developing best practices and protocols
- Providing easy access to key information, research results and technological capabilities
- Providing impartial information and analysis to help guide/develop national policies and programmes and address recognized problems
- Interaction with the IEA Secretariat

Some examples follow:

The GIA has grown its membership from 14 to 20 members during the 3rd Term, thus expanding its base for collaboration and information collection and dissemination. The GIA's activities bring together many of its participants' key national R&D laboratories/organizations (most designated by their Governments) and representatives with links to governments from most of the major geothermal countries, with major geothermal companies (Sponsors) from the USA and Australia and international industry organizations from Canada and Spain. This directly connects important geothermal R&D laboratories and researchers allowing discussion and information exchange, and establishment of collaborative projects. It also fosters important R&D/industry links, which help identify the needs of industry to research laboratories, and raise awareness of governments to what important R&D requires funding, thus leading to more targeted collaboration, hence, reduced R&D and development costs. One recent example is the joint US DOE/Ormat Technologies project to investigate the application of EGS stimulation (hydro-fracturing) to increase permeability in a hot, low permeability area, in Ormat's commercial Desert Peak development. Wider spread application of this stimulation technique will provide a more efficient means to increase production from existing geothermal developments at much less cost than pursuing development of new systems and allow provision of power and direct-heat use almost anywhere through EGS development.

Induced seismicity and sustainability have also become recognized as major international issues. Annex I has produced an *Induced Seismicity Protocol*, which provides procedures for dealing with induced seismic events during stimulation activities for EGS, and a special issue of *Geothermics* on long-term sustainability of resource utilisation. Both actions have helped encourage new geothermal investment.

The sharing and discussion of development issues, R&D data, information and results through GIA's the twice-yearly ExCo and Annex meetings and GIA publications also initiate new collaborative projects. During the 3rd Term, the GIA expanded its work programme by addition of two new Annexes. Annex X Data Collection and Information will increase the data/information collection and dissemination capabilities. Annex XI Induced Seismicity is working with IPGT and GEISER to develop ways to make induced seismicity acceptable to the public through better communication, provision of information, and development of methods to control occurrence/seize of events, and at the same time, provide a valuable tool to guide more cost effective development, hence encouraging EGS growth.

Geothermal drilling costs are a major contributor to the total cost of geothermal power development. In 2011, Annex VII produced the *Best Practices Handbook on Geothermal Drilling*, which describes the complex geothermal well drilling and logging processes and provides a guide on techniques and hardware that have proven successful around the world; this will contribute to more efficient, lower cost geothermal drilling and logging worldwide. Annex VII is also developed a "beta version" computer geothermal well cost model using well cost data provided by several members. The model will help with designing the most cost-effective drilling programme, again contributing important cost savings.

GIA's emphasis on information dissemination through its participation at international meetings/workshops, international Annex workshops, and multifarious publications has contributed to a wider global recognition of geothermal as a source for power and direct-heat applications. GIA's interaction with the IEA through contributions to various IEA reports, the IEA OPEN Bulletin (2008, 2010) and especially with the IEA geothermal technology roadmap has also raised geothermal's profile as a RE. An example is the IEA OPEN Bulletin article (#48, 2008) on geothermal energy from fractured reservoirs, which is referenced on the topic of

induced seismicity in Wikipedia. Additionally, GIA participated in two IEA NEET workshops (Moscow and China).

Several GIA members participated in the US DOE Geothermal Technologies Program Peer Review in 2011 and 2012, evaluating aspects such as the relevance/impact of research, scientific/technical approach, and accomplishments; the assessment contributing to guiding the direction of the USA's geothermal programme, so having important influence on international RD&D.

GIA's contribution to the geothermal chapter of the internationally important IPCC SRREN report (2011) through member participation as lead and contributing authors is extremely valuable in providing the governments and the public, the most current information on global geothermal energy resource potential, technology, current market status, environmental and social impacts, prospects, cost trends and potential deployment.

10. Outlook and Plans for 2012 and Beyond

The GIA has gained an excellent reputation through its international collaborative efforts during the past 15 years. GIA membership grew by 40%, from 14 to 20 Members, during the first five years of the 3rd Term, and the GIA intends to continue pursuing new membership. One mechanism the GIA plans to use to encourage new membership (to begin in 2013) is to hold future ExCo meetings and associated seminars/workshops in prospective member countries that have major geothermal potential/development (Indonesia, the Philippines, Kenya, Chile) and/or have indicated an interest in joining (Turkey, Hungary). This will contribute to IEA and GIA outreach activities, and encourage participation from non-IEA countries.

The GIA believes that its current activities still cover topics of significant importance to accelerate growth in the sustainable global deployment of geothermal utilization, so plans to continue its focus on them, while remaining open to changing/adding new efforts where the need is recognized. More emphasis will be placed on better and more frequent communication to policy makers through more specific information dissemination, especially through the IEA network. Details are provided in the accompanying IEA-GIA Strategic Plan 20013-2018 document.

11. References

CERT (2007) CERT Strategic Plan 2007-2011. OECD/IEA, Paris, France, 11p.

CERT (2002) CERT Strategy, International Energy Agency Committee on Energy Research and Technology report IEA/CERT(2002)01/REV1, 9th – 10th April 2002, 7p.

GIA (2006) IEA Geothermal Implementing Agreement Strategic Plan 2007-2012. 9 November 2006, 23p. Available at: [IEA-GIA Strategic Plan 2007-2012](#).

GIA (2003) IEA Geothermal Implementing Agreement Strategic Plan for 2002-2007. Revised December 2003, 15p. Available at: [IEA-GIA Strategic Plan 2002-2007](#).

REWP (2009) Request for extension of the mandate of the Working Party on Renewable Energy Technologies (2010-2012). IEA/CERT(2009)20/REV1, 4-5 November 2009.

Rybach, L. and Garnish, J. (2002) Geothermal Implementing Agreement (GIA) 1997-2002 End-of-Term Report. Revised draft February 2002, 19p. Available at: [IEA-GIA EoT 1997-2002](#).

12. List of GIA Publications, Presentations, Etc.

A complete list of GIA publications, presentations, etc. is available at: [GIA 3rd Term Publications](#).