

## **Annex 7: The IEA's Role in Advanced Geothermal Drilling**

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### ***Keywords***

*Advanced drilling, International Energy Agency, IEA, collaboration, database, handbook*

### **ABSTRACT**

This paper describes an “Annex”, or task, that is part of the International Energy Agency’s Geothermal Implementing Agreement. Annex 7 is aimed at improving the state of the art in geothermal drilling, and has three subtasks: an international database on drilling cost and performance, a “best practices” drilling handbook, and collaborative testing among participating countries.

### **Introduction**

In 1997 the International Energy Agency approved an “Implementing Agreement for a Cooperative Programme on Geothermal Energy Research and Technology” that has been previously described to the GRC (Rybach, 1998). One of the four active Annexes to this Implementing Agreement is Annex 7, which was approved by the GIA Executive Committee in March 2001, and is aimed at improvement of geothermal drilling. Current participants in Annex 7 are Mexico, New Zealand, Iceland, Japan, the European Commission, and the United States. The rationale for inclusion of drilling as a separate Annex flows from the fact that, in many locations, drilling cost is a serious barrier to geothermal development.

### **Description of Annex 7**

Drilling is an essential and expensive part of geothermal exploration, production, and maintenance. High temperature, corrosive fluids, and hard, fractured formations increase the cost of drilling, logging, and completing geothermal wells, compared to, say, oil and gas. Cost reductions are critical because drilling and completing the production and injection well field can account for approximately half the capital cost for a geothermal power project.

Geothermal drilling cost reduction can take many forms, e.g., faster drilling rates, increased bit or tool life, less trouble (twist-offs, stuck pipe, etc.), higher per-well production through multi-laterals, and others. Annex 7 will address all aspects of geothermal well construction, including developing a detailed understanding of worldwide geothermal drilling costs, understanding geothermal drilling practices and how they vary across the globe, and development of improved drilling technology.

Objectives for Annex 7 include:

1. Quantitatively understand geothermal drilling costs and performance from around the world and identify ways to improve costs, performance, and productivity.
2. Identify and develop new and improved technologies for significantly reducing the cost of geothermal well construction.
3. Inform the international geothermal community about these drilling technologies.

4. Provide a vehicle for international cooperation, collaborative field tests, and data sharing toward the development and demonstration of improved geothermal drilling technology.

The path to these objectives lies through the three major sub-tasks that make up the Annex. These sub-tasks and their leaders are described below with direct quotes from the Annex sub-task definitions, followed by brief updates on status of each sub-task.

### **Sub-task Description and Status**

**Subtask A:** Compile geothermal well drilling cost and performance information

Subtask Leader: The New Energy and Industrial Technology Development Organization (NEDO), Japan

“The participants shall compile actual costs associated with the development, construction and operation of geothermal wells in their countries and elsewhere. This information will be maintained in a single database for use by all participants. Data may include, but is not limited to R&D cost, project cost, operation and maintenance cost, and overall cost of energy. It will include information on wells for electricity and direct-use applications (including geothermal heat pumps), and include information from 1990 to date.”

**Status/A:** Collection of cost and performance data from varied geothermal reservoirs will allow researchers to identify common problems, assess those problems’ costs, and focus development efforts on high-payoff projects. Actual construction of a database, however, faces three major questions: how much data will be available from operators and governmental agencies; in what format should the data be presented; and how will the database be evaluated to achieve the objectives? The problem of cost data availability stems from operators’ reluctance to share cost data and from the incomplete nature of much cost information that is publicly available. In light of this situation, the Annex 7 working group has decided to focus effort on collection of performance data, augmented with cost data when available.

For useful comparison of information from various sources, it is essential that the data collection format be uniform. Well records with substantial cost data will be collected in a spreadsheet format showing performance data and associated costs. An example sheet that describes the pre-drilling phase of three Japanese wells is shown in Figure 1.

An alternative display when little cost data is available is the curve of depth versus time, with flat time periods annotated to identify their causes. An example of this display is shown in Figure 2.

Several Participants have agreed to supply the sub-task leader with data for sample wells from their countries, so that the sub-task leader can construct a prototype database for the working group’s consideration. In addition to the information shown on the sample pages, the contributors will also provide as much information as possible about the rock types, the temperature profile in the well, and the pore pressure. The prototype database will be displayed and discussed at the Fall 2003 Annex 7 meeting.

**Subtask B:** Geothermal Drilling Best Practices

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Co-Subtask Leaders: Comisión Federal de Electricidad (CFE), Mexico (Electricity);  
Orkustofnun – Iceland (Direct use)

“The Participants shall identify and catalogue the technologies that have been most successful for drilling, logging and completing geothermal wells. Practices from the various Participants’ countries will be compared and contrasted. This work will be published as a Handbook on Geothermal Drilling: Best Practices for use by the Participants. The study will include, but not be limited to: design criteria for the drilling and completion programs, drilling practices for least cost, problem diagnosis and remediation during slimhole drilling, trouble avoidance, well testing, geophysical logging, and wellbore preservation.”

**Status/B:** The Handbook, as originally envisioned, would comprise a great deal of material and would require significant effort to edit and assemble. To accelerate the production of a publication, the Annex 7 working group agreed to reduce the scope of the Handbook’s first draft and include only those topics related to drilling for high-temperature (power plant) resources. Many sources of literature are, or may be, available – Geothermal Resources Council (GRC) papers, Society of Petroleum Engineers (SPE) papers, publications from Sandia National Laboratories or other US DOE sources, the New Zealand Code of Practice for Deep Geothermal Wells, Proceedings of the New Zealand geothermal workshops, and GRC papers, solicited specifically for the Handbook, presented at the 2003 meeting.

Distribution of a Handbook can also be expensive, so the working group has agreed that only a few paper copies of the Handbook will be produced. Principal distribution means for the Handbook will be through a link on the GIA web site, where it will be posted for comments by the international geothermal community for approximately one year before completion of the Handbook. The sub-task leader has distributed a draft outline for the Handbook and has asked for comments about the outline and suggestions about topic priorities by mid-June 2003. The edited outline and resolution of copyright issues about the potential sources of literature will be discussed at the Fall 2003 Annex 7 meeting.

**Subtask C:** Advanced Drilling Collaboration  
Subtask Leader: Sandia National Laboratories – USA

“The Participants will endeavor to stay abreast of drilling technology development and application activities in their respective countries. Meetings to share information will be conducted at least twice annually. The meetings will be used to identify activities and projects for collaboration, and then collaboration plans will be developed. For example, it is anticipated that Participants will identify opportunities to field test in one country a technology/system that is being developed in another Participant’s country.”

**Status/C:** This sub-task is designed to facilitate drilling technology transfer among countries with established geothermal industries. The mechanism for this process will be solicitation of proposals for collaborative testing from the Participating Countries. Collaboration may take at least the following three forms: experiments in fields or reservoirs that are different from those in which a researcher has experience; use of drilling hardware or software in unfamiliar conditions; or data exchange for improved validation of various drilling models or simulators.

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This sub-task is least well defined, in the sense that it is about creating opportunities for collaborative testing. To date, the working group meetings have served as a forum for researchers to discuss their projects and to solicit Participants for collaboration. Examples of these opportunities include:

- The Iceland Deep Drilling Project (IDDP) is expected to penetrate extremely high temperatures and pressures, and there is still an opportunity to propose experiments or tests in support of advanced drilling technology. Any person or company interested in testing tools or technology in this rigorous environment should contact IDDP as soon as possible.
- A numerical model for estimation of formation temperatures has been developed at IIE (Instituto de Investigaciones Electricas) in Mexico. Although the model has been tested against measurements in a few wells, it would be useful to have data sets from other locations that could be used for additional validation. A request for this drilling data was distributed to the working group. This data would be very useful in possibly bringing to the industry a wellbore simulator that can estimate wellbore temperatures, even with the occurrence of lost circulation.
- Various items of advanced Japanese technology were described in a brochure, and a list of contact information for people associated with those projects was compiled; both of these were distributed to the working group. These descriptions and contacts should be useful in facilitating application of these technologies outside Japan.

### **Summary**

Annex 7 has the potential to be a significant driver in advancement of geothermal drilling technology. The Annex 7 working group represents a broad spectrum of research agencies, industry, and government, and it can leverage its connections within the participating countries to greatly expand the available knowledge base. Because the Annex is organized on a “task-sharing” rather than a “cost-sharing” basis, however, it is handicapped in some countries by the lack of manpower and budget dedicated to Annex goals. A solution to this obstacle is not clear, although access to the GIA common fund, or other support, would enable some of the sub-tasks to go forward more efficiently.

We should not forget, however, that the Participating Countries in Annex 7 represent five of the seven largest producers, and well over half the world’s production, of geothermal electricity, so that technology advances made under the Annex would be widely shared and effectively implemented in a majority of the world’s geothermal reservoirs.

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### **References**

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