



IEA GEOTHERMAL

IEA Geothermal Implementing Agreement

United States of America Country Report 2014

1.1 Introduction and Overview

The U.S. Department of Energy (DOE) Geothermal Technologies Office (GTO) is committed to developing and deploying a portfolio of innovative technologies for clean, domestic power generation. The GTO researches, develops, and validates innovative and cost-competitive technologies and tools to locate, access, and develop geothermal resources in the United States.

Our goals:

Accelerate Near Term Hydrothermal Growth

- Lower risks and costs of development and exploration
- Lower levelized cost of electricity (LCOE) to 6 cents/kWh by 2020
- Accelerate development of 30 GWe of undiscovered hydrothermal resources

Secure the Future with Enhanced Geothermal Systems (EGS)

- Demonstrate 5 MW reservoir creation by 2020
- Lower LCOE to 6 cents/kWh by 2030.

1.2 Highlights and Achievements

Technological Advancement: Awarded for developing a new, innovative or pioneering technology to further geothermal development.

- **Baker Hughes** developed a prototype directional drilling system capable of operating at 300°C in Enhanced Geothermal Systems wells which provides the ability to actively steer a high-temperature production well into the optimum position to realize an efficient heat transfer mechanism, maximizing potential geothermal energy generation.
- **POWER Engineers** designed an advanced triple-flash cycle to overcome the limitations that accompany typical flash or binary cycles at the Kizildere II Geothermal Power Plant in Turkey.

- **Ormat Technologies, Inc.** used a new, innovative, low temperature ORC cycle utilizing a butane working fluid that is capable of producing affordable, utility scale power using a resource with a reservoir temperature as low as 260 degrees Fahrenheit (125°C).
- **Dewhurst Group/Group Dewhurst** was awarded an Economic Development for a substantial contribution to the development of local, regional or national markets through the development of geothermal systems.
- **Environmental Stewardship:** Awarded for fostering outstanding environmental stewardship through the use of geothermal systems was given to **Salton Sea Restoration & Renewable Energy Initiative** for siting renewable energy projects on the exposed lakebed which would mitigate environmental impacts, fund wildlife habitat and air quality management projects, and spur local economic development and job creation.

1.3 National Program

The Geothermal Technologies Office portfolio invests in activities along the span of technology readiness to facilitate the growth of installed electrical capacity:

- **Research and Development** invests in innovative technologies and techniques to improve the process of identifying, accessing, and developing geothermal resources.
- **Demonstrations** enable technologies and techniques to be field tested and validated.
- **Deployment** activities focus on reducing non-technical barriers and conducting analysis on the impact of our investments.

The United States Geological Survey (USGS) estimates that the electric power generation potential from identified geothermal systems is 9,057 Megawattselectric (MWe), distributed over 13 states. The mean

estimated power production potential from undiscovered geothermal resources is 30,033 MWe. Additionally, another estimated 517,800 MWe could be generated through implementation of technology for creating geothermal reservoirs in regions characterized by of EGS potential, which could meet nearly a tenth of America's vast energy needs.

The GTO works in partnership with industry, academia, and DOE's national laboratories on research and development activities focused on these areas:

- Enhanced Geothermal Systems
- Hydrothermal and Resource Confirmation
- Low-Temperature Resources
- Systems Analysis

1.4 Research, Development and Demonstration/Deployment

1.4.1 Enhanced Geothermal Systems

- In 2013, Desert Peak (project in Nevada) completed an 8-month, multi-stage stimulation of an existing yet underperforming well, making it the **first grid-connected EGS project in America to generate commercial electricity** by providing an additional 1.7 MW at the existing well-field.
- The Geysers EGS Demonstration in the United States successfully yielded a clearly **demonstrated, commercial-strength 5 MW resource**. Far greater additional potential exists at this site.
- Industry partner Foro Energy partnered with DOE to design a new **high-power laser tool** for well completion for geothermal reservoir engineers that will allow them to increase fluid circulation and extend the available heat extraction resource per well. This engineering prototype matures the core technology platform originally developed with a DOE Advanced Research Projects Agency–Energy (ARPA-E) award that enables the potential to decrease hard-rock drilling costs.

- GE Global Research developed a **first-of-its-kind, high-temperature** (575°F, 300°C), U.S.-made, logging and wellbore pumping system, now **deployment-ready**. Technologies include a Geothermal Ultrasonic Fracture Imager, electronic submersible pump, and downhole orientation module, representing **best-in-class temperature-rated systems**.
- GTO's \$2.2 million investment in FastCAP succeeded in the commercialization of a **cutting-edge power system for geothermal exploration in high vibration, extreme drilling environments** to 575°F (300°). An additional \$5.5 million in private investment was announced to support expansion of production capabilities for extreme environment power systems.



1.4.2 Hydrothermal Exploration

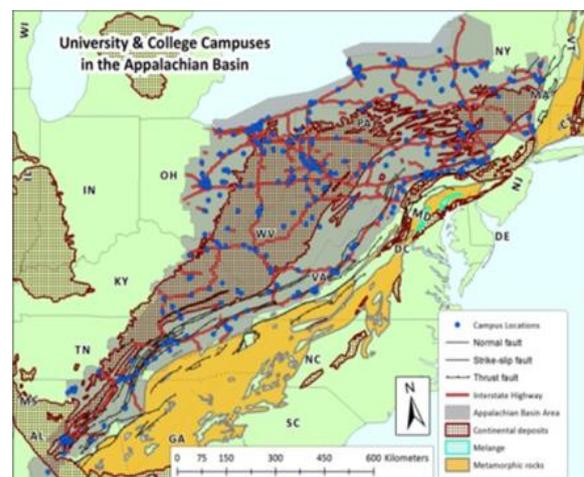
- Caldwell Ranch in California **confirmed an initial 11.4 MW of equivalent steam—50% more than early estimates**—from three previously abandoned wells. This was the first geothermal project where an abandoned steam field has been successfully re-opened for production after approximately 20 years of thermal regeneration.
- Sandia National Laboratory (SNL) has developed a **first-of-a-kind, high-temperature (480°F, 250°C), elastomer-free drilling motor** for use with pneumatic down-the-hole-hammers, for drilling in high temperature geothermal formations. SNL is licensing this technology to Ditch Witch (a part of Charles Machine Works) for work in horizontal well drilling and ground source heat pump installations.
- As a result of American Recovery and Reinvestment Act of 2009 (ARRA) investments of \$100 million, the GTO confirmed **~170+ MW** of new hydrothermal capacity with **innovative exploration methods**.



- A DOE project in Surprise Valley, Oregon funded a **non-profit rural cooperative utility to produce 3 MW geothermal power at 239°F (115°C)**, set for commissioning summer 2014. Funded with \$2M in GTO Recovery Act funds and matched by a \$3M Oregon Department of Energy Business tax credit, the project sets a model for grassroots community involvement and is proposed to capture waste heat for aquaculture, green house farming, and district heating.
- The Oregon Institute of Technology (OIT) commissioned **1.5 MW** of newly-installed geothermal power **on campus**, from a \$1 million GTO award with \$4 million match by Johnson Controls. Historical GTO investment of \$3.5 million was equally cost shared by OIT to fund production and injection drilling.

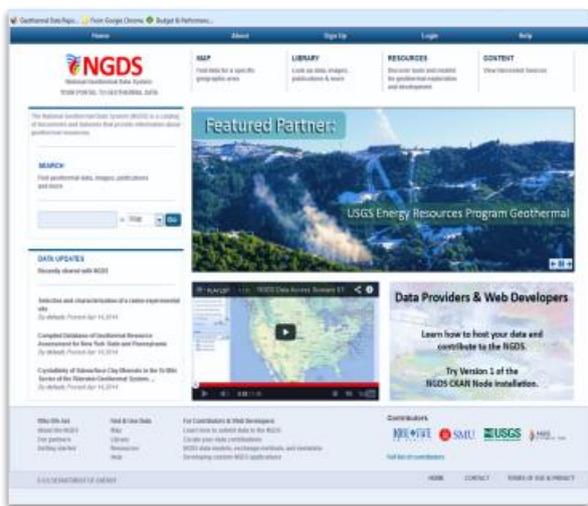
1.4.3 Low-Temperature & Coproduced

- GTO completed a project that takes advantage of **emission-free geothermal power generation**—as a thermal byproduct of gold mining—to generate electricity for **less than 6 cents/kWh**. This was a first-of-its-kind for additive geothermal power.
- A California industry partner will break ground to develop ways to extract valuable materials from geothermal brines. A 40MW demonstration plant could produce **5,400 metric tons of lithium carbonate annually**. The DOE project demonstrated the potential to produce enough lithium to power half a million electric vehicles per year.



1.5 National Geothermal Database System (NGDS)

To facilitate the discovery and use of data to locate the heat resource and estimate heatflow, GTO deployed the [NGDS](#) in May 2014, a best-in-class data collection effort that aggregates geoscience information from all 50 states and DOE-funded projects into a free, open-source platform for sharing. Interoperable data will provide geothermal developers worldwide with research tools that help to visualize and map the subsurface and drive down costs of subsurface exploration.



1.6 Industry Status and Market Development

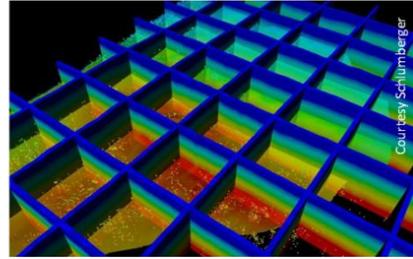
The United States remains the world leader in installed geothermal capacity, at approximately 3.7 GW¹. Ninety-five percent of this capacity is in the states of California and Nevada. According to the Geothermal Energy Association, another 1,000 MW are under development among 124 projects nationwide, with the predominance of activity being located in the western states. The U.S. geothermal industry continues to grow gradually. In 2014, 47.5 MW of new capacity was added to the grid.

Multiple agencies are involved in advancing the U.S. geothermal sector. Leading the sector are the U.S. Department of Energy's Geothermal Technologies Office (GTO), which engages in research, development,

and demonstration (RD&D); the Geothermal Energy Association (GEA), who advocates for expanded use of geothermal resources for power and direct use; and the Geothermal Resources Council (GRC) as a scientific, educational and cultural organization and US affiliate of the International Geothermal Association.

To address environmental permitting process, GTO – in partnership with the Department of Interior's Bureau of Land Management, the federal agency responsible for managing environmental permitting – developed a Regulatory Roadmap to align regulatory processes and timelines at the local, state, and federal levels, providing a working guide for industry and policymakers. In an Energy Department report published in 2011, industry stakeholders identified the permitting timeline as one of the greatest obstacles to accelerating geothermal power plant development. The roadmap is intended to strengthen collaboration between federal and state agencies, speed review of proposed projects, and advance efficient and responsible evaluation. Streamlining the permitting process would help lower development costs and reduce financial risk for developers. The Bureau of Land Management estimates 340MW of potential capacity additions on public lands from a total of six projects are anticipated to come online soon. Royalty revenues for existing geothermal resource use on public lands exceed \$12 million annually, with revenue from rents accounting for roughly \$3M more. These revenues are shared 50% with the states, 25% with local counties and 25% to the federal Treasury.

Industry faces real financial obstacles in transitioning to full commercial deployment even with the successful deployment of RD&D investment from GTO. To help address these challenges for new technology, the ARRA expanded the original DOE Loan Guarantee Program. It amended a 2005 law creating a new section to allow loan guarantees for renewable technologies, known as Section 1705. This program made three geothermal awards that were brought online between the years of 2009-2012.



Additionally, the U.S. Congress authorized the Energy Independence and Security Act of 2007 to give the DOE a broader definition of technical geothermal application. Clean energy technologies, including geothermal energy, have had access to multiple tax incentives through the U.S. Treasury Department. These include the Production Tax Credit (PTC), Investment Tax Credit (ITC), and briefly the Section 1603 Cash Grant, which could be applied in lieu of either the PTC or ITC. Geothermal was made fully eligible for these incentives starting in 2005, but recently the policy horizons for the ITC and PTC were allowed to expire on December 31, 2013, which followed the October 1, 2012 expiration of the 1603 cash grant. Prior to the expiration of the ITC and PTC, however, the enacted policy was modified to allow projects in development to remain eligible once they were qualified as under construction. Legislation pending in Congress and passed by the Senate Finance Committee known as the EXPIRE Act would extend the PTC and ITC for geothermal and other renewable energy projects for any under construction by December 31, 2015.

Pending legislation in the U.S. Congress could help with several improvements in leasing, permitting and exploration. Currently these include the Geothermal Production Expansion Act of 2013 ([S.363/H.R.2004](#)), the Geothermal Exploration and Technology Act of 2013 ([S.362](#)), and the Exploring for Geothermal Energy on Federal Lands Act ([H.R.1363](#)).

Beyond federal policy initiatives, U.S. states have been comparatively more active in 2013-2014. State legislation on geothermal energy/resources that has also been introduced and/or enacted is highlighted by California ([S.B. 1139](#), [A.B. 148](#)), Nevada ([S.B.](#)

[123](#)), Oregon ([H.B. 2435](#)), Washington ([S.B. 5369](#)), Hawaii (73 bills), and New Mexico ([H.B. 85](#)).

1.7 Future Outlook

The Geothermal Technologies Office (GTO) at the United States Department of Energy has undertaken a vision study—called *GeoVision*—to conduct a credible analysis of potential geothermal growth scenarios for 2020, 2030 and 2050 across multiple market sectors. By engaging the geothermal industry in this dialogue, GTO anticipates a product that will benefit the entire industry:

- Clearly articulated GTO investment strategies across different sectors, with a cohesive plan to attain near-term and stretch goals
- Relevant geothermal growth scenarios for 2020, 2030 and 2050, backed by robust data, modeling, and analysis
- Comprehensive approach, inclusive of all market segments: existing and potential hydrothermal, electrical and non-electrical uses, burgeoning EGS advances, and other value streams
- Accessible objectives and peer-reviewed industry data, supportive of and available to geothermal decision-makers in policy, permitting, and development capacities
- Aspirational and inspirational goals

The U.S. geothermal industry – including public and private stakeholders mentioned above – is advancing technical RD&D, working to reform current regulatory conditions and codes, expanding the technical viability of geothermal energy geographically east, and refining the use of financial subsidies available for future

project development. In summary, forwarding these agendas by expanding on recent successes and developments is the key to reducing risk and costs associated to deploying geothermal technologies in the U.S.

1.8 References and Websites

¹ EIA-860 data, project announcements in 2013-14.

<http://energy.gov/eere/renewables/geothermal>

<http://www.blm.gov/wo/st/en.html>

<http://energy.usgs.gov/OtherEnergy/Geothermal.aspx>

<http://www.geo-energy.org/>

<http://www.geothermal.org/home.html>

1.9 Author

Jay Nathwani

Geothermal Technology Manager,
Geothermal Technologies Program, EE-2C,
Office of Energy Efficiency and Renewable
Energy,
US Department of Energy,
1000 Independence Ave, SW,
Washington, DC 20585,
USA

Email: jay.nathwani@ee.doe.gov

To Find Out More

**If you are interested in learning more about the IEA Geothermal Programme,
or you wish to join the IEA-GIA:**

Contact:

IEA-GIA Secretary

c/o GNS Science

Wairakei Research Centre

Private Bag 2000

Taupo 3352

NEW ZEALAND

Tel: +64-7-374 8211

Email: iea-giasec@gns.cri.nz

OR

Visit the IEA-GIA Website

IEA Geothermal

***Supporting and Advancing Worldwide Sustainable
Geothermal Energy Use Through International Cooperation***

www.iea-gia.org

The IEA Geothermal Implementing Agreement (GIA), also known as the Implementing Agreement for a Cooperative Programme on Geothermal Energy Research and Technology, functions within a framework created by the International Energy Agency (IEA). Views, findings and publications of IEA GIA do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.