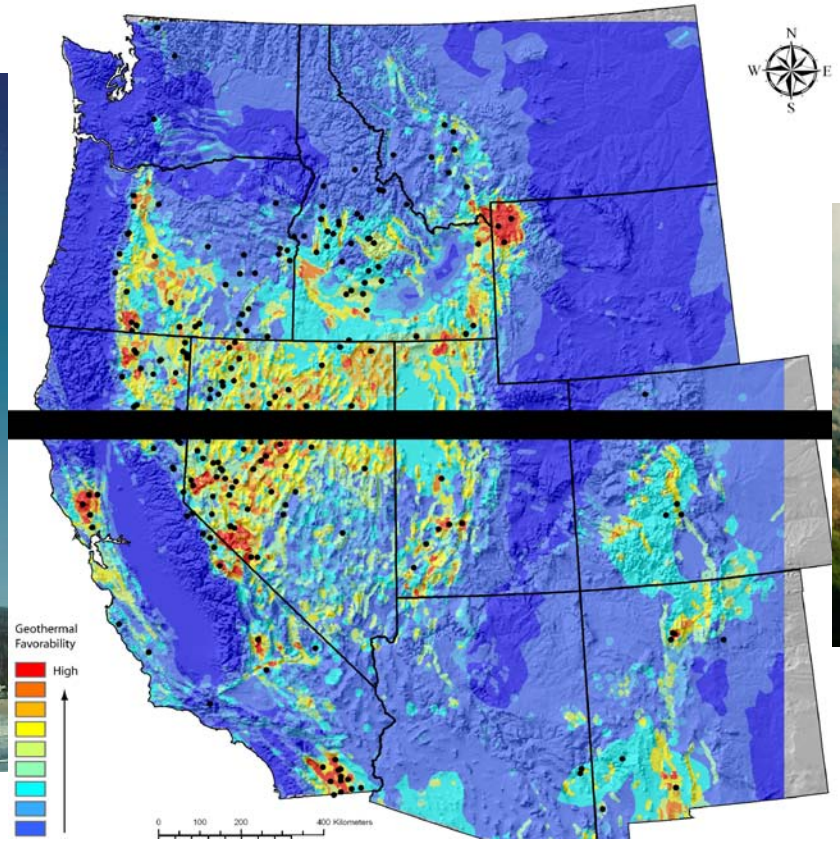

National Geothermal Resource Assessment and Classification

May 18, 2010

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U.S. Geological Survey

Track Name

Overview

- Timeline
  - March, 2010 to December, 2012
- Budget
  - $4,270,500 total from DOE
  - $2,025,400 FY10
  - Matched by USGS internal funding $1,500,000 each Fiscal Year
- Barriers
  - 3.1.2 Lack of Available and Reliable Resource Information
  - 3.2 Resource Assessment and Data Needs
- Partners
  - Temple University; University of Nevada, Reno; Boise State University and associated NGDS partners

Relevance/Impact of Research

Through this award USGS is

- Expanding geothermal resource assessments in cooperation with all 50 states
- Developing new geothermal resource classification standards
- Assisting in the establishment of the National Geothermal Data System.

The results of this work will enable lower risk/cost deployment of conventional and EGS geothermal power. USGS is also supporting GTP input to DOE National Energy Modeling by providing resource assessment data by geothermal region as input to GTP supply curves. USGS will produce a final report on the results of the assessment and the methodologies employed.

Scientific/Technical Approach

The Project is divided into four tasks -

1. Conventional Geothermal Resource Characterization and Assessment
2. Enhanced Geothermal Systems
3. Geothermal Resources in Sedimentary Basins
4. USGS Geothermal Data and National Geothermal Data System Collaboration

2008 National Resource Assessment

Identified Systems -
Mean = 9,057 MWe

Undiscovered Resources –
Mean = 30,033 MWe

EGS –
Mean ~500,000 MWe

USGS
science for a changing world

Assessment of Moderate- and High-Temperature Geothermal Resources of the United States

Scientists with the U.S. Geological Survey (USGS) recently completed an assessment of our Nation's geothermal resources. Geothermal power plants are currently operating in six states: Alaska, California, Hawaii, Idaho, Nevada, and Utah. The assessment indicates that the electric power generation potential from identified geothermal systems is 9,057 Megawatts-electric (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 high temperature, but low permeability, rock formations.

Geothermal power plants at The Geysers in northern California. Currently, the United States has an installed and utilized power production capacity of more than 2,500 Megawatts-electric (MWe) from geothermal plants located in Alaska, California, Hawaii, Idaho, Nevada, and Utah. (USGS photograph by Julie Donnelly-Nolan.)

Introduction

The U.S. Geological Survey (USGS) has recently assessed the electric power generation potential of conventional geothermal resources in the United States. These resources are concentrated in the States of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, which contain all 241 identified moderate-temperature (90 to 150°C; 194 to 302°F) and high-temperature (greater than 150°C) geothermal systems located on private or accessible public lands. (Geothermal systems located on closed public lands, such as national parks, were not included in the assessment.) Electric-power potential was also determined for seven low-temperature (less than 90°C) systems in Alaska for which local conditions make electric power generation feasible. In addition, the assessment also includes a provisional estimate of the power generation potential from the application of unconventional, Enhanced Geothermal Systems (EGS) technology in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. This assessment benefited from cooperation and coordination with the Department of Energy (DOE); Bureau of Land Management (BLM); the University of Nevada, Reno; the University of Utah; Idaho National Laboratory; Lawrence Berkeley National Laboratory; state and local agencies; and the geothermal industry.

Identified Geothermal Systems

Currently, the United States has an installed and utilized power production capacity of more than 2,500 Megawatts-electric (MWe) from geothermal plants located in Alaska, California, Hawaii, Idaho, Nevada, and Utah. The nearly 15,000 Gigawatt-hours (GWh) of geothermal power generated in 2005 constituted 25% of domestic nonhydroelectric renewable electrical power generation. (Power generation of 1 MWe provides 8.77 GWh of electricity in 1 year.) The results of the new assessment for the power generation potential from identified geothermal systems yield a mean total of 9,057 MWe

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2008–3082
2008

Scientific/Technical Approach

1. Conventional Geothermal Resource Characterization and Assessment
    1. Conduct geophysical, geological and geochemical surveys for evaluation of identified and undiscovered geothermal resources. Publish reports on the results of the investigations and incorporate the results in revised assessments.
    2. Update the low-temperature geothermal resource databases, report on revisions to the low temperature geothermal resource assessment, and produce online databases and summaries of the results.
    3. Utilize coupled thermal-mechanical-chemical-fluid flow models to investigate the evolution of natural hydrothermal systems and to develop life cycle models for the creation and evolution of these systems that can be utilized in improved resource assessment methodology. Publish reports on the results and provide public access to all new or modified modeling software.

2. Enhanced Geothermal Systems
    1. Develop a provisional EGS resource classification system based on the current state of knowledge, and revise and update the classification system as required by the results of the field and modeling studies. Integrate EGS classification into a single comprehensive geothermal resource classification system.
    2. Modify high temperature borehole televiewer system to improve image log data acquisition capabilities.
    3. Conduct field studies of in situ stress, fault and fracture permeability, geologic structure, seismicity and heat and fluid transport at EGS research and development sites.
    4. Develop in situ stress, fracture permeability models and methods for EGS reservoir stimulation utilizing field measurements and observations.
    5. Incorporate the results of these investigations into improved methods for assessing potential EGS resources.

Scientific/Technical Approach

3. Geothermal Resources in Sedimentary Basins
    1. Compile data on subsurface temperatures, lithologies and reservoir characteristics for sedimentary basins and identify regions of significant geothermal potential.
    2. Conduct focused studies on the basins with greatest potential to determine the geologic constraints on geothermal development.
    3. Incorporate the results of these investigations in an expanded resource assessment, publish the results of the assessment and place the supporting data and reports online.
    4. Combine results of assessment and classification work conducted in Tasks 1, 2 and 3 with previous assessment results in summary report on the full spectrum of geothermal resources in the United States.

4. USGS Geothermal Data and NGDS Collaboration
    1. Complete compilation, review and publication of relevant geothermal databases assembled as part of the national geothermal resource assessment project.
    2. Work with NGDS staff to identify database requirements, place USGS data in formats compatible with those requirements, and transfer to the National Geothermal Data System.
    3. Consult with and advise the center staff on the format, structure and accessibility of geothermal databases.
    4. Continue to provide new data to the center from the results of new and ongoing field projects and industry collaborations.

Expected Outcomes

Milestones

1. Deliver revised and updated assessment of low-temperature geothermal resources by April, 2011.
2. Circulate provisional classification system for review and comment by December, 2010.
3. Publish report on comprehensive classification system by July, 2011.
4. Publish the results of the sedimentary basin resource assessment by July, 2012.
5. Publish the comprehensive summary resource assessment report by December, 2012.

Project Management

- Meetings – Regular monthly project meetings to track progress towards milestones.
- Budget – Monthly budget review. Expenditures coordinated with Federal procurement deadlines.
- Biweekly web conferences with NGDS staff on data acquisition and database topics, supplemented by personal meetings
- Internal Review – Annual internal review of project by USGS Energy Resources Program

Future Directions

- FY10
  - Release preliminary geothermal resource classification standards for community input
  - High temperature BHTV modifications
  - Field surveys in northeastern California, northern Nevada, and southern Oregon
  - Project staff attend Goldschmidt conference
- FY11
  - Final resource classification system report published
  - Compile and publish water chemistry data in support of low-temperature geothermal resource assessment update
  - Field surveys in the Imperial Valley, northern Nevada, Utah, Idaho and Alaska
  - USGS data deliveries to NGDS

Future Directions

In addition to the specific tasks and milestones described above, we expect the following products and investigations to evolve from the project work -

- Continent-scale maps of regional variations in thermal regime, rock type and the orientations and magnitudes of tectonic stresses at depths targeted for EGS.
- Improved models for the physics and chemistry of permeability creation and destruction in potential reservoir rocks, including effects of mineralogy, physical properties, fluid chemistry, temperature and state of stress.
- Identification of active faults and evaluation of potential for reservoir stimulation and production to trigger significant earthquakes.
- Requirements for and availability of water for EGS reservoir creation and operation.
- Maps of fault intersections, other geologic boundaries, and heat flow at a local scale for evaluation of exploration targets.
- Improved databases of water chemistry and flow properties for shallow thermal aquifers.
- Detailed information on in situ and surface temperatures, flow rates, wellhead spacing, and produced fluid characteristics for oil wells.
- Three-dimensional geospatial databases with information on the temperature, permeability, fluid composition and stratigraphic character of geopressured formations in deep sedimentary basins.

Summary

- USGS work under this project will provide a comprehensive portfolio of geothermal resource assessments for the entire United States, covering conventional and uncoventional resources from low-temperature to high-temperature applications.
- Field and modeling studies will support new and revised assessment methodologies that will be applied in developing progressively more reliable assessment results.
- In addition to stimulating geothermal development, results will be incorporated into latest series of energy and market penetration modeling.