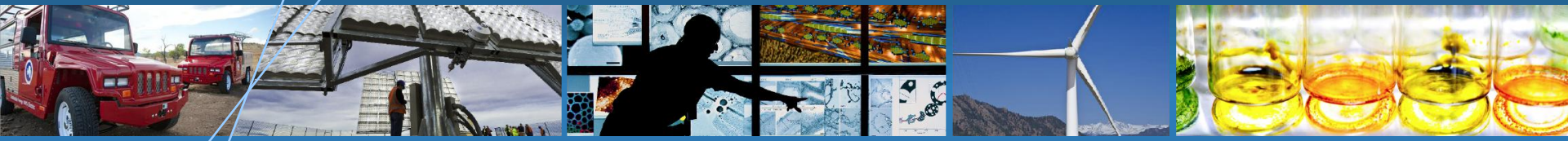
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

OpenEI and Linked Open Data



OpenEI: Open Energy Information

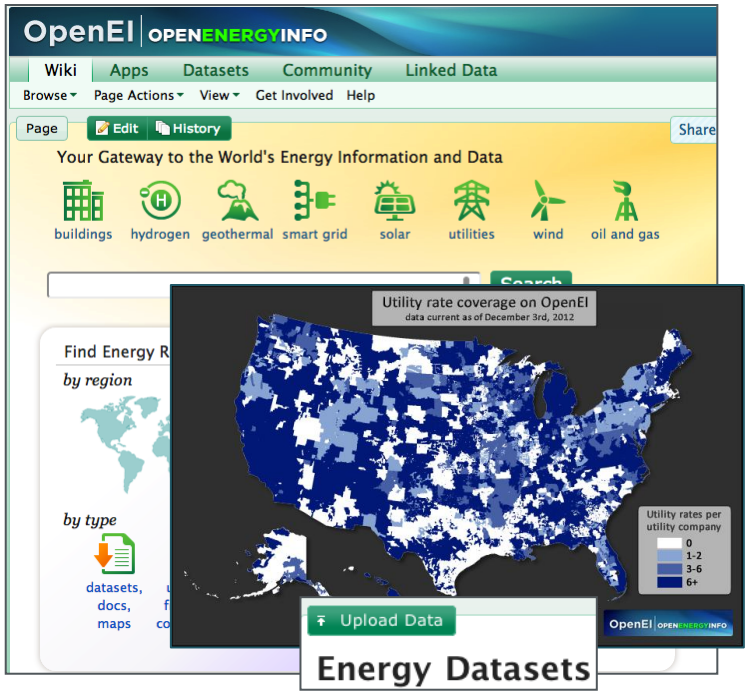
+ LOD: Linked Open Data

Kate Young
Jon Weers

April 25, 2013

IMPACT AND OVERVIEW

http://en.openei.org



OPEN GOV

Open Government Initiative

OpenEI supports the U.S. Department of Energy's fulfillment of open government standards: transparency, public participation, and collaboration.

Data Analysis and Visualization Group
Project Lead:
Debbie Brodt-Giles, NREL
Debbie.brodt.giles@nrel.gov

Project Description

OpenEI is a free and open knowledge sharing platform created to facilitate access to energy-related data, models, tools, and information.

Sponsored by the Department of Energy, and developed by the National Renewable Energy Lab, in support of the **Open Government Initiative**, OpenEI strives to make energy-related data and information searchable, accessible, useful to both people and machines.

Built utilizing the standards and practices of the **Linked Open Data** community, the OpenEI platform is much more robust and powerful than typical web sites and databases. All users can search, edit, contribute, and access data in OpenEI; all for free.

OpenEI Statistics *

- 1,239,000+ visitors from 200+ countries
- **Over 840 datasets**
- Creation of **over 56,000 content pages**
- Upload of over 7,500 images and files
- More than 620,000 contributor actions
- Over 939,000 unique visitors
- More than 5,000 registered users
- Over 8,000 Twitter followers
- More than 600 Facebook likes
- **Over 19 million RDF triples**

per Google Analytics as of March 5, 2013

Project History and Timeline

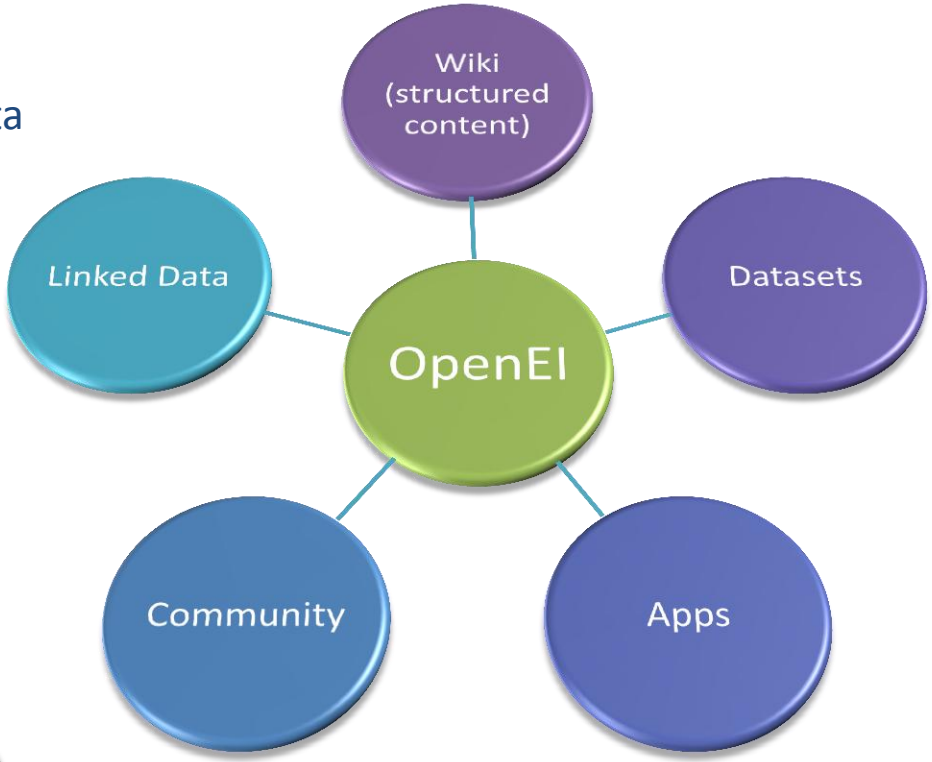
Sep. 2009	Launched OpenEI: Wiki
Dec. 2009	OpenEI confirmed as DOE's Open Government Initiative (OGI)
Apr. 2010	Recognized by White House as a Flagship Open Government Initiative
Oct. 2010	Launched OpenEI: Datasets
Jan. 2011	Featured on White House Innovations Gallery
Jan. 2012	Launched OpenEI: Apps
Jun. 2012	Launched OpenEI: Community

A PLATFORM OF PLATFORMS

http://en.openei.org

OpenEI consists of several open source platforms which have been custom-integrated for optimal collaboration and to allow a seamless user experience.

- **Wiki** – Built upon the same underlying technology as Wikipedia
- **Datasets** – Utilizes Drupal and Amazon data storage services
- **Linked Open Data** – Semantic wiki extensions and a Virtuoso triple store
- **Apps** – Simile Exhibit used to display extracted wiki data
- **Community** – Built on Drupal Commons



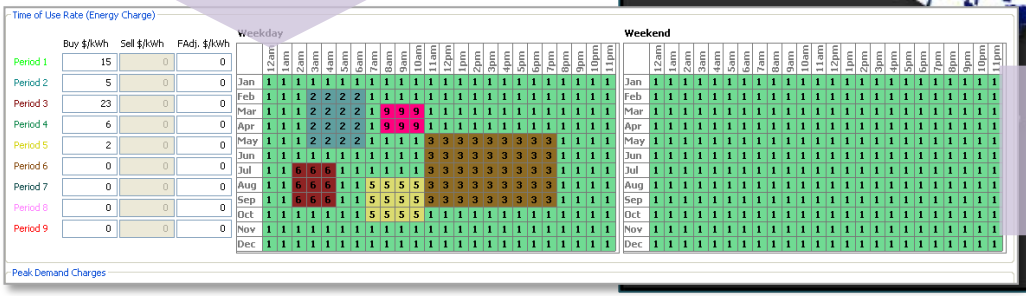
CROWD SOURCING DATA ON OPENEI

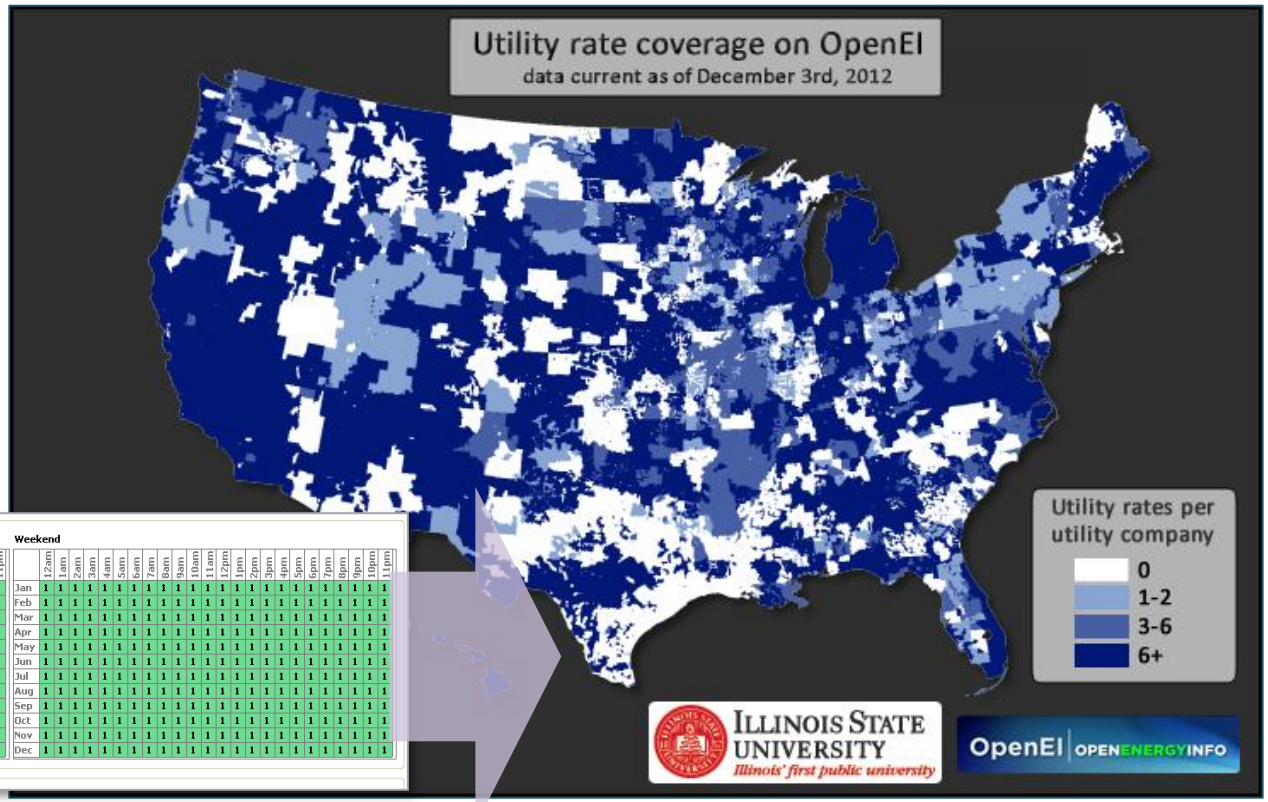
http://en.openei.org

The ability to crowd source data is another one of OpenEI's key features.

"**Does EIA publish electric utility rate, tariff, and demand charge data?**
No, EIA does not collect or publish data on electricity rates, or tariffs, for the sale or purchase of electricity, or on demand charges for electricity service, nor does EIA publish retail electricity rates or prices for peak or off-peak periods (sometimes referred to as time-of-use-rates)."

EIA Frequently Asked Questions
http://www.eia.doe.gov/tools/faqs/faq.cfm?id=20&t=3





LINKED OPEN DATA (LOD)

Linked open data is one of the more exciting ways OpenEI keeps energy information open, available and relevant.

Typical Websites

Linked Open Data Community

LOD is about connecting information to enrich content, reduce duplication of effort, and provide a more universalized data structure. It is an essential strategy in competitive information dissemination.

LINKED OPEN DATA: OVERVIEW

Without Linked Open Data

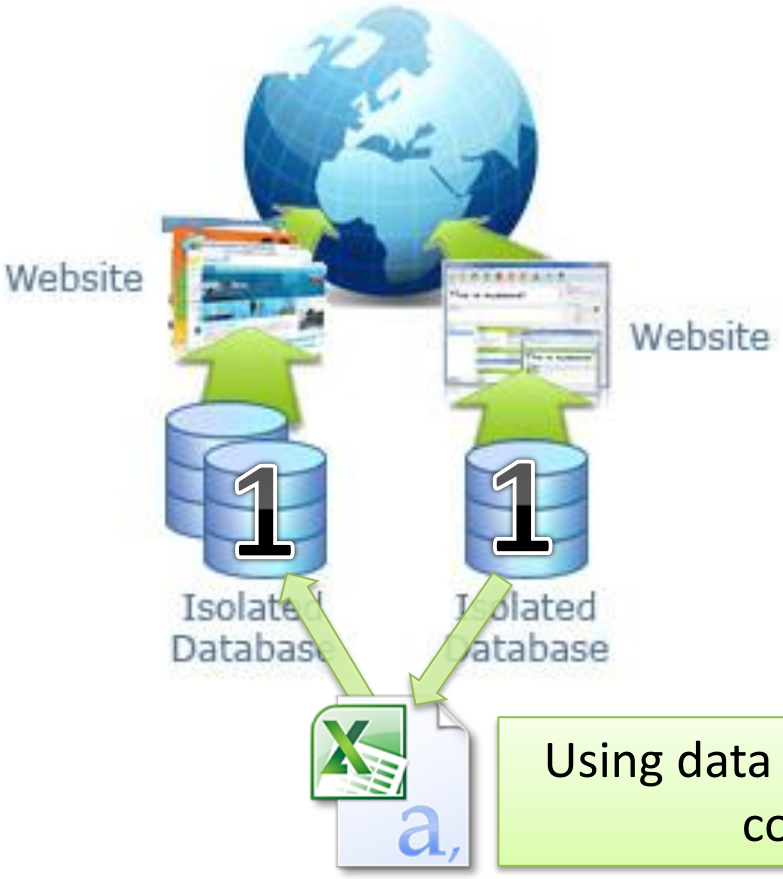
(a typical website)

- **Stores all information in its own database**
- Other sites have similar design pattern
  => Duplication of effort and information
- **Both sites responsible for updating information**
  => Potential for online community to be presented with conflicting information

LINKED OPEN DATA: OVERVIEW

Without Linked Open Data

(a typical website)



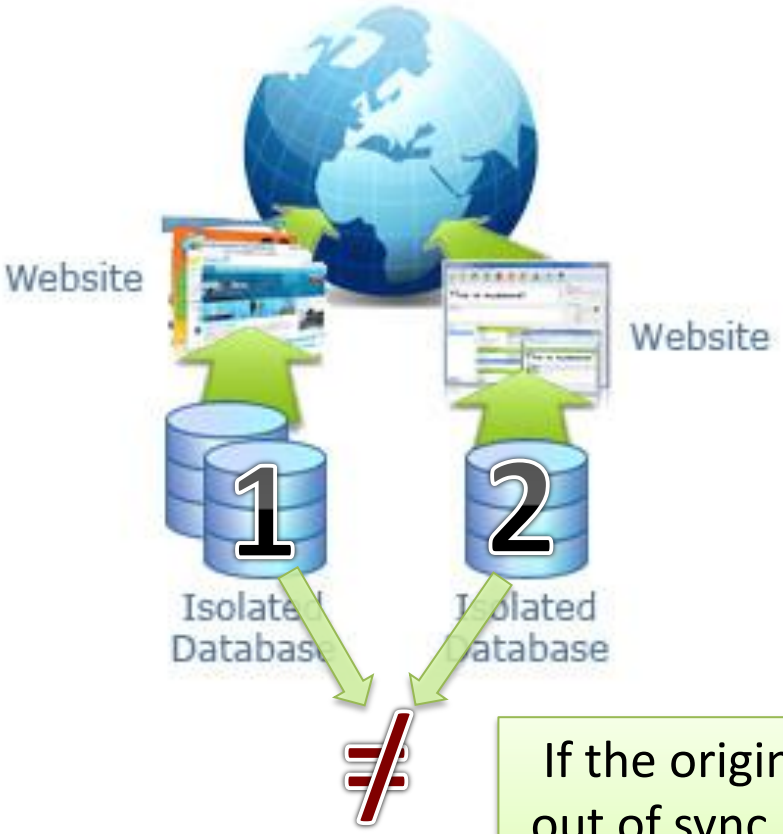
- **Stores all information in its own database**
- Other sites have similar design pattern
  => Duplication of effort and information
- **Both sites responsible for updating information**
  => Potential for online community to be presented with conflicting information

Using data from another site requires you to download a copy of it to install into your database.

LINKED OPEN DATA: OVERVIEW

Without Linked Open Data

(a typical website)



- **Stores all information in its own database**
- Other sites have similar design pattern
  => Duplication of effort and information
- **Both sites responsible for updating information**

=> Potential for online community to be presented with conflicting information

If the original site updates its data, the two sites become out of sync. How does the online community know which site is more accurate?

LINKED OPEN DATA: OVERVIEW

With Linked Open Data

(a typical website)

- **Datasets are shared behind the scenes**
  => Each site can focus on key data and import supplemental data
- **Imported data updates automatically**
  => Provides users with consistent information across multiple sites
- **Other Websites can consume** LOD resources to present new content in exciting and unanticipated ways

LINKED OPEN DATA: OVERVIEW

With Linked Open Data

(a typical website)

- **Datasets are shared behind the scenes**
  => Each site can focus on key data and import supplemental data
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- **Other Websites can consume** LOD resources to present new content in exciting and unanticipated ways

Data is shared at the database level. Updates to a linked database appear instantly on partner sites.

LINKED OPEN DATA: OVERVIEW

With Linked Open Data

(a typical website)

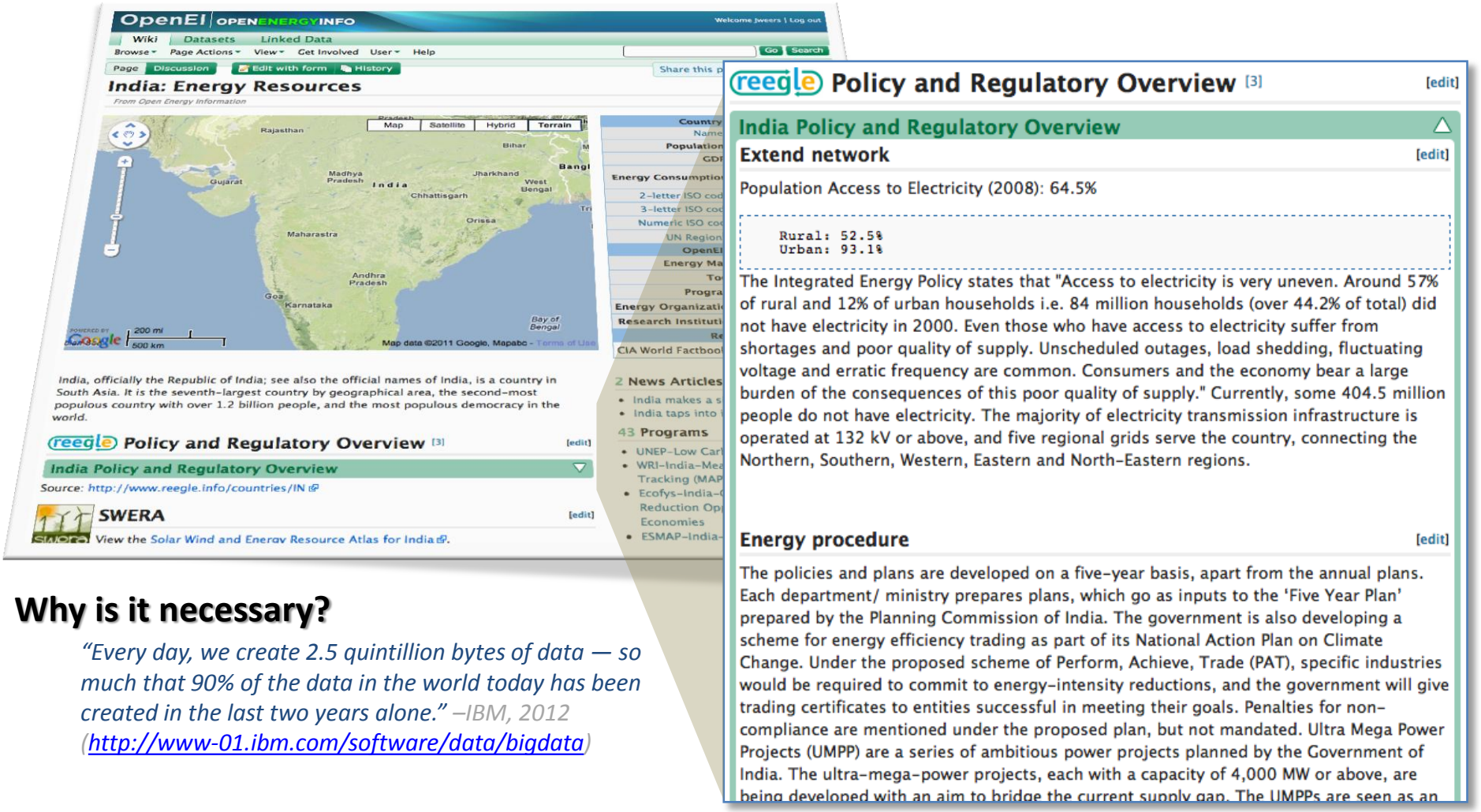
- **Datasets are shared behind the scenes**
  => Each site can focus on key data and import supplemental data
- **Imported data updates automatically**
  => Provides users with consistent information across multiple sites
- **Other Websites can consume** LOD resources to present new content in exciting and unanticipated ways

Third party websites can combine (or "mashup") linked open data to form innovative content, or new data.

LINKED OPEN DATA ON OPENEI

http://en.openei.org

One of the featured pieces of content on OpenEI's country pages is the Reegle Policy and Regulatory Overview:

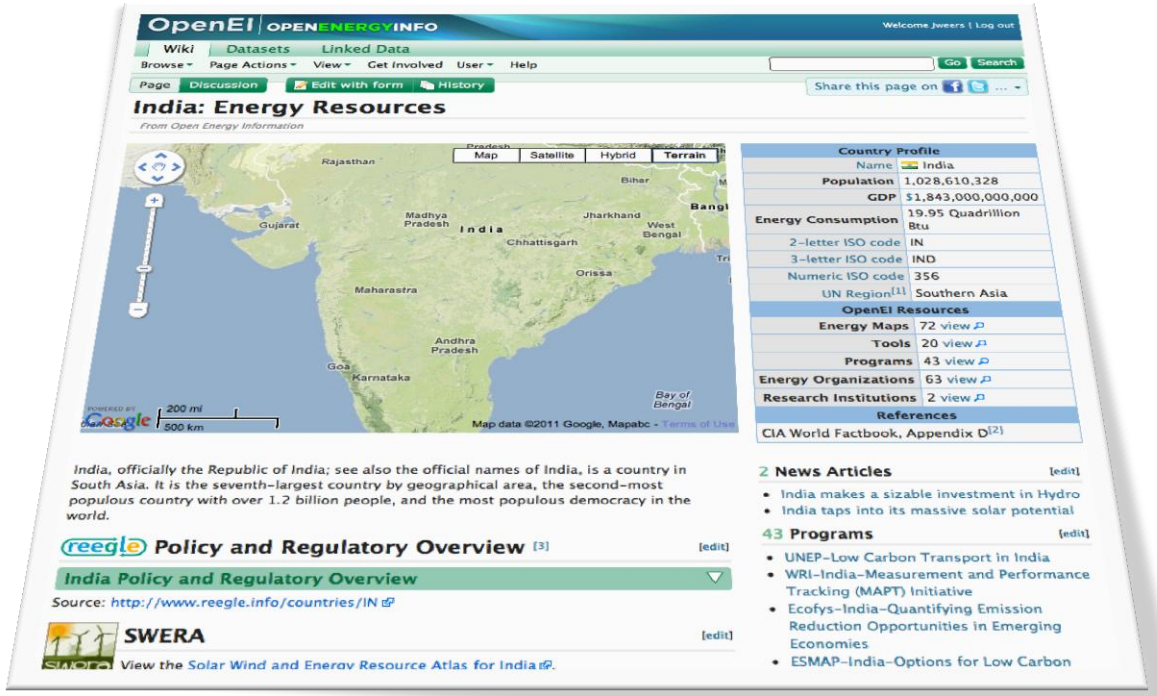


Why is it necessary?

"Every day, we create 2.5 quintillion bytes of data — so much that 90% of the data in the world today has been created in the last two years alone." –IBM, 2012 (http://www-01.ibm.com/software/data/bigdata)

LINKED OPEN DATA AT WORK

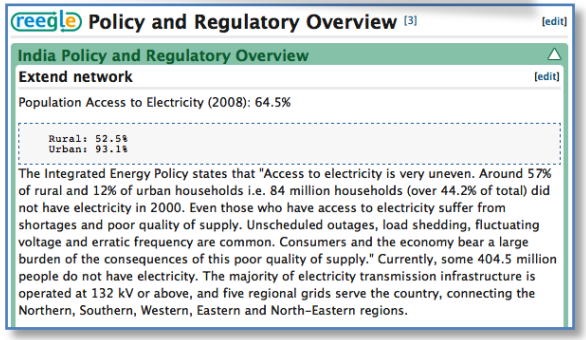
Behind The Scenes, Linked Open Data at Work:



reegle profiles are consumed in real time using SPARQL

use of semantic concepts allows the correct profile to be pulled

SPARQL



reegle DATA

SPARQL Endpoint
Print page
Contact reegle

Open Energy Information

OpenEI | OPENENERGYINFO

Wiki | Apps | Datasets | Community | Linked Data

Browse | Page Actions | View | Get Involved | User | Help

Page | View source | History

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Since 2009, 5,478 users and bots have contributed 632,414 edits on 154,896 pages. See the impact we're having.

Follow OpenEI on:

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Find Energy Resources

by region

by type

datasets, docs, maps | updates from the community | developer resources

Recent Community Activity

Blog | Groups | Discussions | Twitter | Videos

SDG&E Customers Can Connect Home Area Network Devices With Smart Meters

Swinerton Renewable Energy Awarded Contract to Construct and Operate 250 MWac K Road Moapa Solar Plant

Happy New Year!

Get Widget

Featured on OpenEI

Launch of Water Power Gateway on OpenEI new!

Discover the world's first Global Renewable Energy Atlas.

Historical XML feed of U.S. incentive and policy data

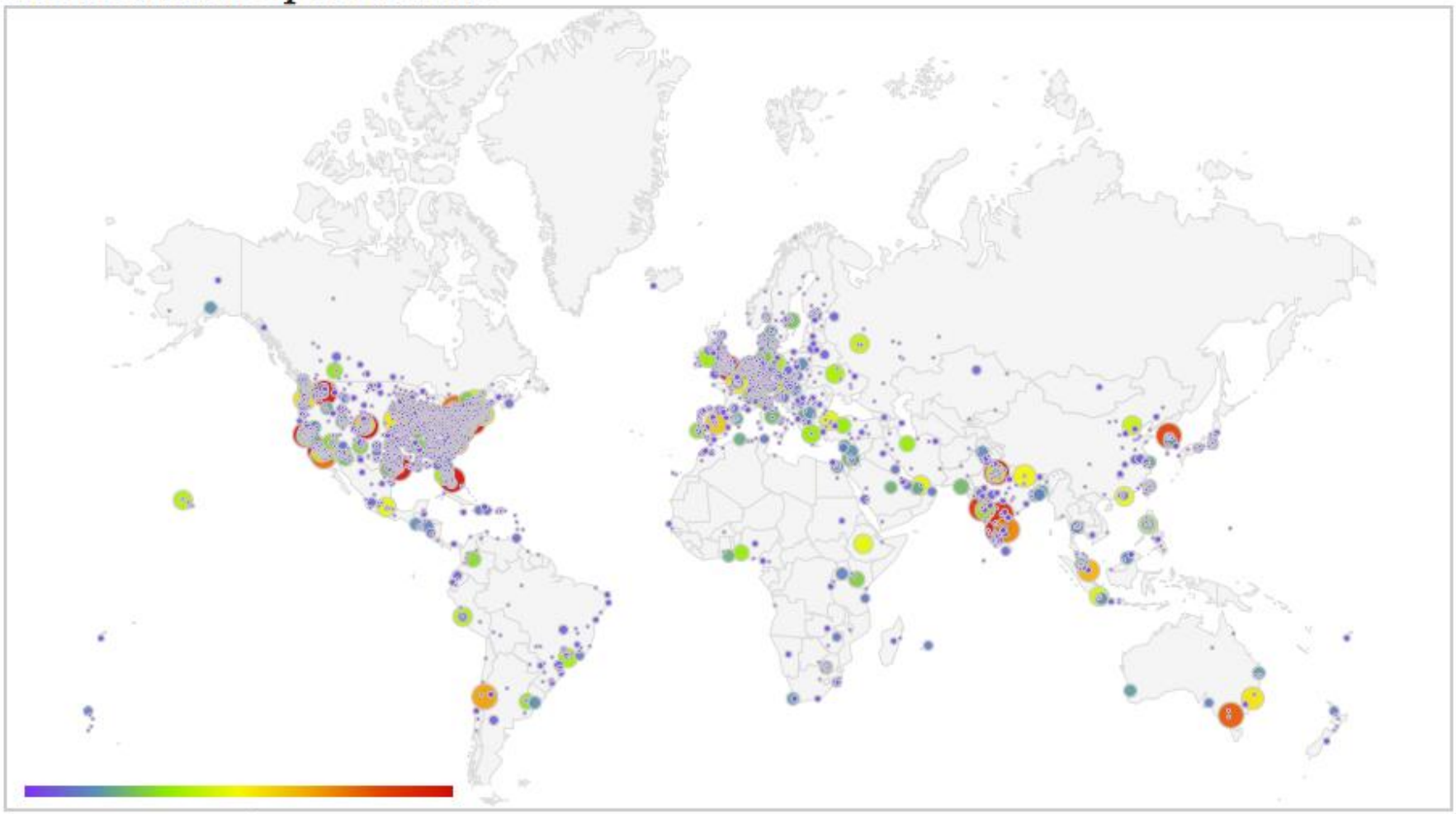
transparent cost database

GREEN BUTTON APPS

View, Access, and Share Green Button Apps

http://en.openei.org

International OpenEI users

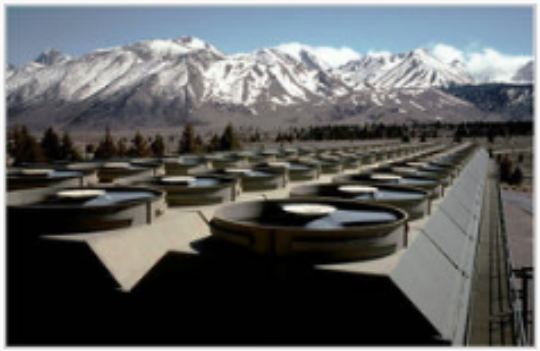


Change timeframe to...

Zoom to...

Map shows last 7 days of data by default. Hover over a city for more statistics. Click on a country to zoom in, or select a geographical region from the dropdown list.

Geothermal Energy



The Sierra Nevada Mountains provide a spectacular backdrop for a cooling tower array at the ORMAT Mammoth Geothermal Power Plant in Central California.

Geothermal energy is heat extracted from the Earth. A wide range of temperatures can be suitable for using geothermal energy, from room temperature to above 300° F.[1] This heat can be drawn from various depths, ranging from the shallow ground (the upper 10 feet beneath the surface of the Earth) that maintains a relatively constant temperature of approximately 50° to 60° F, to reservoirs of extremely hot water and steam located several miles deep into the Earth.[2][3]

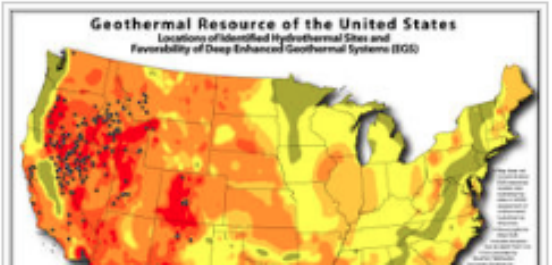
Geothermal reservoirs are generally classified as either low temperature (<302°F) or high temperature (>302°F). Commercial electricity production normally requires a high-temperature reservoir capable of providing hydrothermal (hot water and steam) resources, called hydrothermal reservoirs.[1]

Geothermal is distinct from other renewables such as solar or wind because it is a considered a "baseload" technology, providing electricity 24 hours a day, 365 days a year.[4]

Geothermal Resources

In 2008, scientists with the U.S. Geological Survey (USGS) completed an assessment of the geothermal resources in the U.S., which indicated:

- 9,057 MWe of *identified geothermal resource*
- 30,033 MWe of *undiscovered potential*



Geothermal Topics

Find technical details on field operations, permits, and best practices

- Land Use
- Leasing
- Exploration
- Well Field
- Power Plant
- Transmission
- Environment
- Water Use

Geothermal Data

Find data, upload data, visualize data

- NGDS National Geothermal Data System
- GDR Geothermal Data Repository
- State Geothermal Data
- Geothermal Prospector
- OSTI Geothermal Technologies Legacy Collection

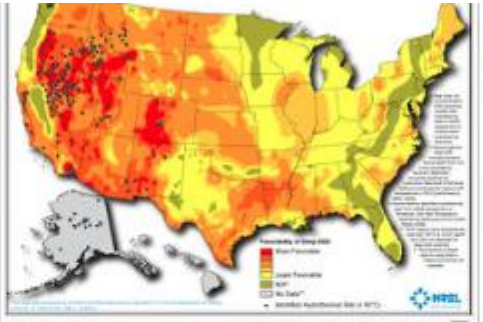
Permitting and Policy

Regulatory roadmaps, policymaker's guidebooks, incentive data

the geothermal resources in the U.S., which indicated:

- 9,057 MWe of *identified geothermal resource*
- 30,033 MWe of *undiscovered potential*
- 517,800 MWe of *EGS potential*

Visit the Geothermal Resources page to view other resource assessments that have been conducted.



NREL Geothermal Favorability Map

Geothermal Market Data

An engineer inspects the blades of a backup turbine at a Northern California Power Agency (NCPA) geothermal power plant at The Geysers.

In 2012, the Geothermal Energy Association reported a global installed geothermal capacity of 11,224 MW, and a U.S. installed geothermal capacity of 3,187.[5] Geothermal energy accounts for approximately 3% of renewable energy-based electricity consumption in the United States.[6]

Find more information on Installed Geothermal Capacity, Geothermal Generation, and Planned Geothermal Capacity.

Geothermal Technologies

Hydrothermal Systems

Hydrothermal Systems use coincident heat, water, and permeable rock at shallow depths (typically <5 km) to

Permitting and Policy

Regulatory roadmaps, policymaker's guidebooks, incentive data

- GRR Geothermal Regulatory Roadmap
- Geothermal Policymakers' Guidebooks
- State Geothermal Incentives
- State Geothermal Electricity Incentives
- DSIRE Database for State Incentives and Renewables and Efficiency

Geothermal Financing

Guidebooks, finance tacking, news and tools to aid in geothermal project financing

- Geothermal Developers' Financing Handbook
- RE Project Finance Website
- REFTI RE Finance Tracking Initiative
- CREST Cost of Renewable Energy Spreadsheet Tool
- GETEM Geothermal Electricity Technology Evaluation Model
- SAM System Advisor Model

Useful Links

Geothermal pages and links

Geothermal Exploration

[edit]

General | Techniques Tree | Techniques Table | Regulatory Roadmap

[edit]

Geothermal Exploration searches the earth's subsurface for geothermal resources that can be extracted for the purpose of electricity generation. A geothermal resource is as commonly a volume of hot rock and water, but in the case of EGS, is simply hot rock. Geothermal exploration programs utilize a variety of techniques to identify geothermal reservoirs as well as information that can point to areas of low density, high porosity, high permeability, and subsurface fault lines that can help define well field development.

Geothermal springs along Yellowstone National Park's Firehole River in the cool air of autumn. The world's most environmentally sensitive geothermal features are protected by law.

Groups of Exploration Techniques

[edit]

There are many different techniques that are utilized in geothermal exploration depending on the region's geology, economic considerations, project maturity, and other considerations such as land access and permitting requirements. Geothermal techniques can be broken into the following categories:

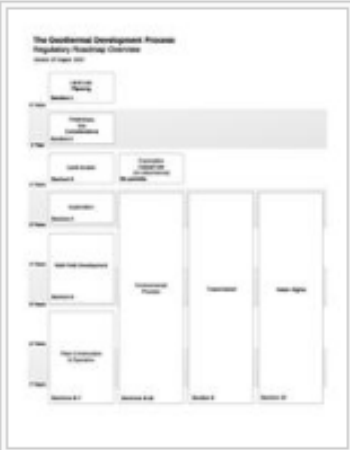
- Data and Modeling Techniques
- Downhole Techniques
- Drilling Techniques
- Field Techniques
- Geochemical Techniques
- Geophysical Techniques
- Lab Analysis Techniques
- Remote Sensing Techniques

Full List of Exploration Techniques →

Geothermal Exploration [edit]

Geothermal Regulatory Roadmap for Exploration [edit]

The flowcharts listed below were developed as part of the Geothermal Regulatory Roadmap project. The roadmap covers the major regulatory requirements for developing geothermal energy, including, land access, exploration and drilling, plant construction and operation, transmission siting, water resource acquisition, and relevant environmental considerations.



Overview Flowchart

Reading the Roadmap [edit]

The flowcharts are divided into General, Federal, and State sections to allow for ease of use. To use the flowcharts, start with General Flowchart for Exploration. The General Flowcharts will lead you to the federal and state flowcharts you will need. The overview flowchart on the right shows additional sections in the roadmap.

- For more information on reading these flowcharts, Visit the "Getting Started" Section → .
- If you'd like to see regulations in other sections of the roadmap, see the entire listing of flowcharts
- The GRR is continually being updated and added to. Some flowcharts have not yet been developed, but placeholders have been created. If you have input on any of these processes, please feel free to login to make updates, or contact us .

Disclaimer [edit]

The flowcharts have been reviewed by relevant agency, developer and legal personnel, and are meant to serve as a guide to obtaining the permits needed for geothermal power plant development and a way to communicate the process among interested parties. This website is not intended to constitute legal advice or the provision of legal services. None of the individuals or agencies involved in developing this document warrant or certify that the information on this page is accurate. The services of a competent professional should be sought if legal or other specific expert assistance is required.

Geothermal Exploration

[edit]

Overview Flowcharts

Section 4 – Exploration Overview

Federal Flowcharts

Section 4-FD-a – Exploration Application Process BLM
Section 4-FD-b – Exploration Pre-Application Process (NV only)
Section 4-FD-c – Exploration Application Process USFS

State Flowcharts

Section 4-AK-a – State Exploration Process
Section 4-AK-b – Geophysical Exploration Permit
Section 4-AK-c – Geothermal Exploration Permit
Section 4-CA-a – State Exploration Process
Section 4-CO-a – State Exploration Process
Section 4-FD-a – Exploration Application Process BLM
Section 4-FD-b – Exploration Pre-Application Process (NV only)
Section 4-FD-c – Exploration Application Process USFS
Section 4-HI-a – State Exploration Process
Section 4-ID-a – State Exploration Process
Section 4-MT-a – State Exploration Process
Section 4-NV-a – State Exploration Process
Section 4-NV-b – Temporary Use of Ground Water for Exploration
Section 4-NV-c – Monitoring Well Waiver
Section 4-OR-a – State Exploration Process
Section 4-OR-c – Geothermal Prospect Well Process
Section 4-OR-d – Exploration Injection Permit
Section 4-UT-a – State Exploration Process

Geothermal Regulatory Roadmap

Since April 2012, the Geothermal Regulatory Roadmap (GRR) Team has been working with federal, state and local agencies to develop a working guide for agency, industry and policymaker use in an effort to understand processes and timelines and identify potential areas of concern. The project is sponsored by the DOE Geothermal Technologies Office (GTO).

The roadmapping initiative covers the eight western states, including California, Nevada, Hawai'i, Alaska, Idaho, Utah, Oregon, and Montana (shown in green on the map). The roadmap is being developed at the federal and state levels, allowing for future expansion to the local (county) level. Development of the roadmap for two additional states (Colorado and Texas) is underway for Fiscal Year 2013.

GRR 2-page Flyer

GRR Introduction and Project Overview

OpenEI and Linked Open Data (Video)
or view the Original PowerPoint

The Challenge

Geothermal industry stakeholders have identified the permitting process as one of the most significant barriers to geothermal power project development. Drilling exploration and development wells is expensive. A protracted time line has a critical impact on the

What People Are Saying

Read more comments →

"GRR is a much needed tool for navigating the geothermal regulatory environment. It will go a long way towards facilitating more geothermal energy development."

"Please get this website out to as many agencies as possible for them to link directly to your websites – it's a great tool!"

Getting Started

New to the Geothermal Regulatory Roadmap? Check out our "Getting Started" page for information on how to read and use the GRR, including a YouTube video presentation overview.

Roadmap Sections

Browse or filter sections of the roadmap to view flowcharts, narratives, and lists of links and supporting documents. Note that the roadmap is currently under development and is being modified regularly.

GRR Project Blog

GEOTHERMAL ENERGY

Geothermal Exploration

[edit]

General | Techniques Tree | Techniques Table | Regulatory Roadmap

[edit]

- Data and Modeling Techniques
  - Data Techniques
    - Data Acquisition-Manipulation
    - Geographic Information System
    - Geothermal Literature Review
  - Modeling Techniques
    - Analytical Modeling
    - Conceptual Model
    - Modeling-Computer Simulations
    - Numerical Modeling
- Downhole Techniques
  - Well Log Techniques
    - Acoustic Logs
      - Cement Bond Log
      - Cross-Dipole Acoustic Log
      - Single-Well And Cross-Well Seismic
    - Caliper Log
    - Density Log
    - Gamma Log
    - Image Logs
      - Electric Micro Imager Log
      - FMI Log
      - Optical Televiewer
    - Neutron Log
    - Pressure Temperature Log

GEOTHERMAL ENERGY
Geothermal Home

Exploration Technique: Acoustic Logs

[edit]

Details | Activities (7) | Areas (6) | Regions (0)

[edit]

Acoustic Logs: A display of traveltime of acoustic waves versus depth in a well. The term is commonly used as a synonym for a sonic log. Some acoustic logs display velocity.

Other definitions: *Wikipedia Reegle*

Introduction

The acoustic log exploration technique includes those techniques that use a transducer to transmit an acoustic wave through the fluid in the well and surrounding elastic materials. Several different types of acoustic logs are used, based on the frequencies used, the way the signal is recorded, and the purpose of the log. All these logs require fluid in the well to couple the signal to the surrounding rocks. There are four main types: acoustic velocity, acoustic waveform, cement bond, and acoustic televiewer.

Use in Geothermal Exploration

Acoustic logs are used to determine the lithology and porosity of the rocks surrounding the well. This information can be helpful for determining future well locations and potential areas for well bore stimulation. The log when combined with other logs run provides the gbasis for a detailed analysis pr lithologies, alteration, stratigraphy, etc.

Related Techniques

- Cement Bond Log
- Cross-Dipole Acoustic Log
- Single-Well And Cross-Well Seismic

Exploration Technique Information	
Exploration Group:	Downhole Techniques
Exploration Sub Group:	Well Log Techniques
Parent Exploration Technique:	Well Log Techniques
Information Provided by Technique	
Lithology:	
Stratigraphic/Structural:	map discontinuities to determine their orientation.
Hydrological:	
Thermal:	
Cost Information	
Low-End Estimate (USD):	1.00 / foot
Median Estimate (USD):	4.62 / foot
High-End Estimate (USD):	16.00 / foot
Time Required	
Low-End Estimate:	8.39 days / job
Median Estimate:	16.08 days / job
High-End Estimate:	32.17 days / job
Additional Info	
Cost/Time Dependency:	Depth, Temp, Resolution

Exploration Technique: Acoustic Logs

[edit]

Details | Activities (7) | Areas (6) | Regions (0) [edit]

Field Procedures

The geophysical/well logging service company conducts the down hole logging operation and produces both digital and hard copy logs. The Drilling contractor trips the drill pipe and bit and conditions the well bore for logging.

Data Access and Acquisition

Most acoustic-velocity probes employ magnetorestrictive or piezoelectric transducers that convert electrical energy to acoustic energy. Most of the transducers are pulsed from 2 to 10 or more times per second, and the acoustic energy emitted has a frequency in the range of 20 to 35 kHz. Acoustic probes are centralized with bow springs or rubber fingers so the travel path to and from the rock will be of consistent length. Some of the energy moving through the rock is refracted back to the receivers. The receivers reconvert the acoustic energy to an electrical signal, which is transmitted up the cable. At the surface, the entire signal may be recorded digitally for acoustic waveform logging, or the transit time between two receivers may be recorded for velocity logging. Amplitude of portions of the acoustic wave also may be recorded; that technique is described later under waveform logging.

Best Practices

Probes are constructed of low-velocity materials, producing the shortest travel path for the acoustic pulse through the borehole fluid and the adjacent rocks, which have a velocity faster than that of the fluid.

Potential Pitfalls

An unstable well bore (sluffing, wash outs, etc) can be of concern in any well logging operation. In extreme condition, the loss of the logging tool down hole could possibly result in the loss of the hole and would require premature abandonment or the necessity to side track to complete the well drilling operation.

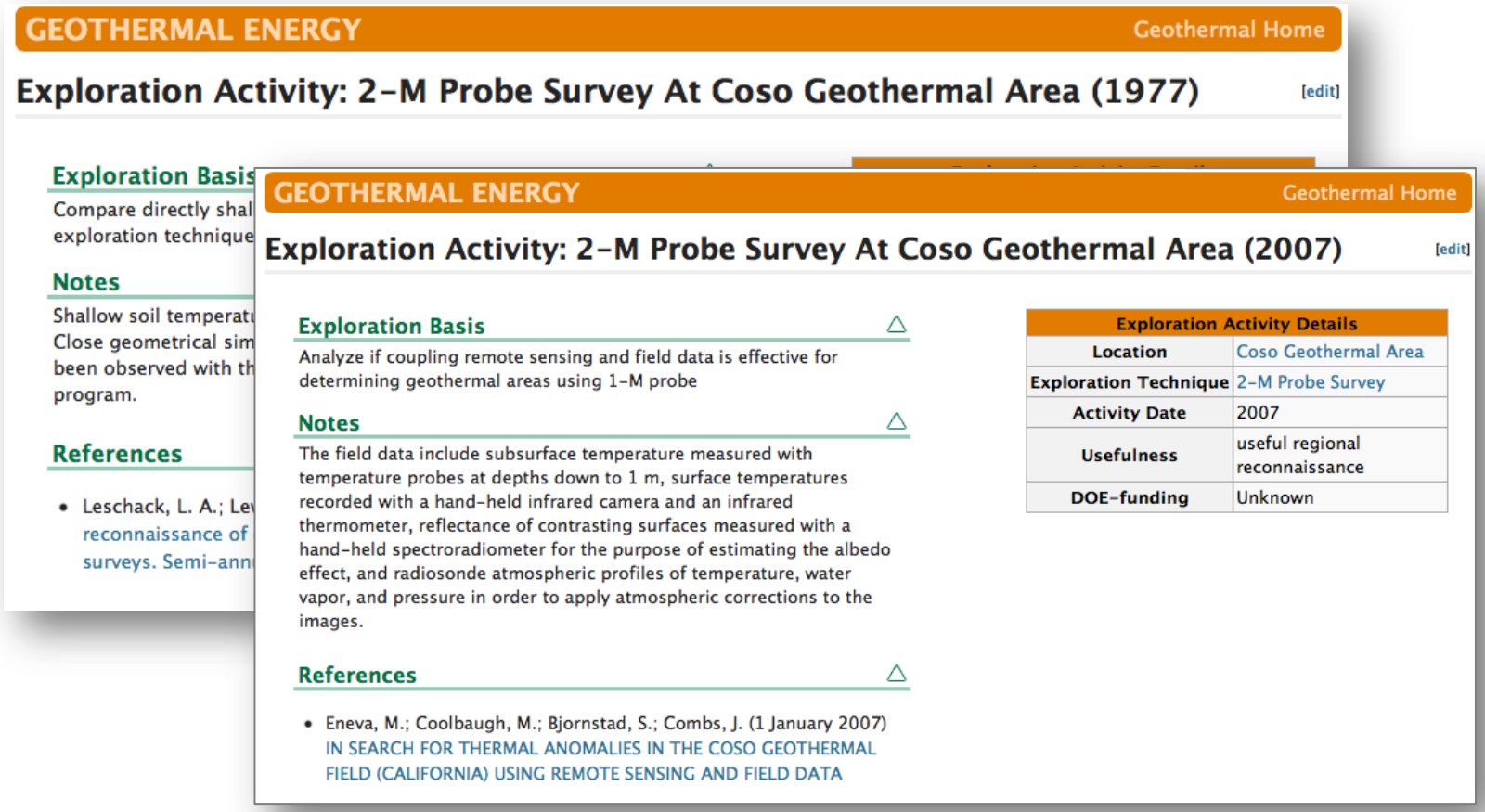
NEPA Analysis

Well logging is a standard operation associated with the drilling permit approval and is included in the downhole analysis of the drilling program.

References

EPA-Environmental Geophysics-Geophysical Methods-Acoustic Logging

Technique + Geothermal Area + Date = Activity



GEOTHERMAL ENERGY
Geothermal Home

Exploration Technique: Acoustic Logs

[edit]

Details | Activities (7) | Areas (6) | Regions (0)

[edit]

Page	Area	Activity Start Date	Activity End Date	Reference Material
Acoustic Logs At Alum Area (Moos & Ronne, 2010)	Alum Geothermal Area			• Selecting The Optimal Logging Suite For Geothermal Reservoir Evaluation- Results From The Alum 25-29 Well, Nevada
Acoustic Logs At Coso Geothermal Area (1977)	Coso Geothermal Area	1977	1977	• Geological and geophysical analysis of Coso Geothermal Exploration Hole No. 1 (CGEH-1), Coso Hot Springs KGRA, California • Static downhole characteristics of well CGEH-1 at Coso Hot Springs, China Lake, California
Acoustic Logs At Coso Geothermal Area (2005)	Coso Geothermal Area	2005	2005	• COMPARISON OF ACOUSTIC AND ELECTRICAL IMAGE LOGS FROM THE COSO GEOTHERMAL FIELD, CA
Acoustic Logs At Newberry Caldera Area (Combs, Et Al., 1999)	Newberry Caldera Geothermal Area			• Slimhole Handbook- Procedures And Recommendations For Slimhole Drilling And Testing In Geothermal Exploration
Acoustic Logs At Raft River Geothermal Area (1979)	Raft River Geothermal Area	1979	1979	• Role of borehole geophysics in defining the physical characteristics of the Raft River geothermal reservoir, Idaho

GEOTHERMAL ENERGY
Geothermal Home

Resource Area: Coso Geothermal Area

[edit]

Details | Technical Info | Geology | Power Plants (3) | Projects (0) | Activities (132) [edit]

Geothermal Area Profile	
Location	California
Exploration Region	Walker-Lane Transition Zone
GEA Development Phase	Operational
Coordinates	36.04701°, -117.76854° Display map
2008 USGS Resource Estimate	
Mean Reservoir Temp	285°C
Estimated Reservoir Volume	30 km^3
Mean Capacity	518 MW
Power Production Profile	
Gross Production Capacity	
Net Production Capacity	
Number of Operating Plants	3
Owners	• Coso Operating Co.
Power Purchasers	
Other Uses	
References	foo1[1]

Area Overview

History and Infrastructure

Regulatory and Environmental Issues

Future Plans

Terra-Gen, LLC, the current owner of the Coso Geothermal Facility, has many plans to increase production from the field. Since the field is liquid-limited, one idea is to inject more water into the reservoir. In 2009, Terra-Gen obtained the critical permits from the Bureau of Land Management (BLM) to begin construction of a 9-mile pipeline for recharging the existing reservoir. The intent of the project, referred to as the Hay Ranch Water Project, is to inject supplemental water into the reservoir to stabilize and enhance the field, increasing electricity production to serve an estimated 50,000 more homes, or about 50 MW. The BLM completed an extensive environmental review and

Resource Area: Coso Geothermal Area

[edit]

Exploration History

Well Field Description

Technical Problems and Solutions

The Coso geothermal fluid contains a high concentration of non-condensable gases (NCG), consisting of mostly carbon dioxide, as well as dissolved solids, such as silica . If not properly separated and disposed of, these can limit power generation, as well as cause environmental, health and safety problems. The Coso plants have developed technical strategies to overcome these problems, meeting strict California emissions regulations and even creating an alternative source of profit. At first the geofluid condensate, with NCG, was reinjected back into the reservoir after power generation. This practice began to affect the performance of the reservoir and was stopped . It was decided to build treatment facilities to remove the hydrogen sulfide and mercury from the NCG and exhaust the remaining gas, carbon dioxide and water vapor into the atmosphere. Investigation into various hydrogen sulfide and mercury removal systems in 1993 led to the selection of LO-CAT® process for hydrogen sulfide removal and a sulfided, activated carbon media upstream for mercury removaliv. After using this treatment process for more than 15 years, Terra-Gen Power LLC considers it the "Best Available Control Technology" (BACT) for geothermal power plants. More detailed information on the LO-CAT® process at Coso is available here: [1].

The other difficulty obstructing power production was the dissolved solids, mostly silica, in the geofluid. The problem was addressed by a private and governmental collaboration between Caithness Operating Company (who owned Coso at the time, as well as Dixie Valley and Steamboat Springs in Nevada all three of which served as test centers for the new technology) and Brookhaven National Laboratory (BNL). In order to develop a method for extraction silica, BNL tested reaction parameters such as temperature, pressure, pH, concentration of reagents, and aging to see their impacts on the properties of silica products. After it was shown that the silica could be extracted, they also

Well Field Information	
Number of Production Wells	
Number of Injection Wells	
Number of Replacement Wells	
Average Temperature of Geofluid (°C)	
Sanyal Classification (Wellhead)	
Reservoir Temp (Geothermometry)	
Sanyal Classification (Reservoir)	
Depth to Top of Reservoir	
Depth to Bottom of Reservoir	
Average Depth to Reservoir	
Development Area	
First Discovery Well	
Completion Date	
Well Name	
Location	
Depth	
Initial Flow Rate (kg/s)	
Flow Test Comment	30 MW
Initial Temperature	
Well Log	

Resource Area: Coso Geothermal Area

[edit]

Geology of the Area

Hydrothermal System

Heat Source

The heat source for the Coso hydrothermal system is interpreted to be a silicic-magma chamber, possibly still partially molten, at a depth of about 5-8 km. Data suggest that there is an ongoing process of mafic magma intruding to relatively shallow depths. Temperature gradients in the geothermal field, determined from down-hole measurements, range between about 85-120°C/km (Monastero and Unruh, 2002). It is estimated that the temperature at the top of the inferred magma chamber range from 425-600°C. Figure 5 shows the temperature at 5 m and 10 m below the surface measured from shallow boreholes. The areas with high temperatures are near the Devil's Kitchen area and Sugarloaf Mountain.

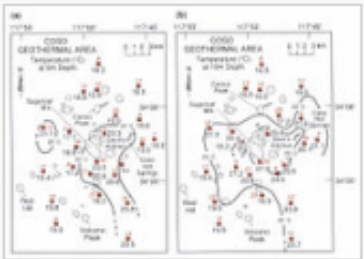
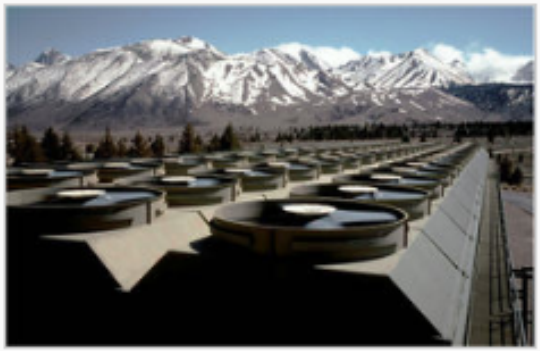


Figure 5. Temperatures at depths of 5 m (a) and 10 m (b) from shallow heat flow boreholes in the Coso geothermal area (Wohletz and Heiken, 1992)

Geologic Setting	
Exploration Region	Walker-Lane Transition Zone
Tectonic Setting	
Controlling Structure	
Topographic_Features	
Brophy Model	
Geologic Features	
Modern Geothermal Features	
Relict Geothermal Features	
Volcanic Age	
Host Rock Age	
Host Rock Lithology	
Cap Rock Age	
Cap Rock Lithology	
Geochemistry	
Salinity (low)	
Salinity (high)	
Salinity (average)	
Brine Constituents	
Water Resistivity	

List of existing Geothermal Resource Areas: Category:Geothermal Resource Areas

Geothermal Energy



The Sierra Nevada Mountains provide a spectacular backdrop for a cooling tower array at the ORMAT Mammoth Geothermal Power Plant in Central California.

Geothermal energy is heat extracted from the Earth. A wide range of temperatures can be suitable for using geothermal energy, from room temperature to above 300° F.[1] This heat can be drawn from various depths, ranging from the shallow ground (the upper 10 feet beneath the surface of the Earth) that maintains a relatively constant temperature of approximately 50° to 60° F, to reservoirs of extremely hot water and steam located several miles deep into the Earth.[2][3]

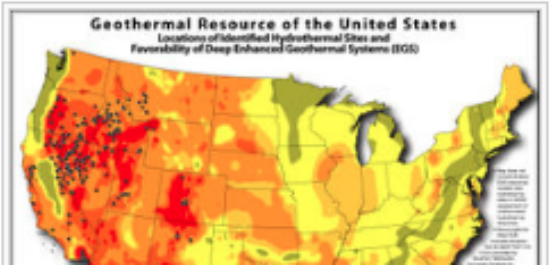
Geothermal reservoirs are generally classified as either low temperature (<302°F) or high temperature (>302°F). Commercial electricity production normally requires a high-temperature reservoir capable of providing hydrothermal (hot water and steam) resources, called hydrothermal reservoirs.[1]

Geothermal is distinct from other renewables such as solar or wind because it is a considered a "baseload" technology, providing electricity 24 hours a day, 365 days a year.[4]

Geothermal Resources

In 2008, scientists with the U.S. Geological Survey (USGS) completed an assessment of the geothermal resources in the U.S., which indicated:

- 9,057 MWe of *identified geothermal resource*
- 30,033 MWe of *undiscovered potential*



Geothermal Topics

Find technical details on field operations, permits, and best practices

- Land Use
- Leasing
- Exploration
- Well Field
- Power Plant
- Transmission
- Environment
- Water Use

Geothermal Data

Find data, upload data, visualize data

- NGDS National Geothermal Data System
- GDR Geothermal Data Repository
- State Geothermal Data
- Geothermal Prospector
- OSTI Geothermal Technologies Legacy Collection

Permitting and Policy

Regulatory roadmaps, policymaker's guidebooks, incentive data

Geothermal Power Plants [edit]

General | Regulatory Roadmap [edit]

Geothermal Power Plants discussion

Binary power system equipment and cooling towers at the ORMAT Ormesa Geothermal Power Complex in Southern California.

Electricity Generation [edit]

Converting the energy from a geothermal resource into electricity is achieved by producing steam from the heat underground to spin a turbine which is connected to a generator to produce electricity. The type of energy conversion technology that is used depends on whether the resource is predominantly water or steam, the temperature of the resource, and the chemical composition of the fluid.

The 3 conventional methods that are used are Dry Steam, Flash Steam, and Binary Cycle power plants.

- **Dry Steam Power Plants**

  Steam from hydrothermal reservoirs is withdrawn from below the Earth's surface via a production well and goes directly to a turbine; the turbine drives a generator that produces electricity. This is the oldest type of geothermal power plant, and in use at the largest single source of geothermal power: The Geysers (in northern California)[1].

- **Flash Steam Power Plants**

  Flash steam power plants are the most common type geothermal power plants. They generally require the use of hydrothermal fluids above in the range of 300 - 700°F[2]. The fluid is vaporized, and the vapor drives the turbine, which then drives the generator[1]."

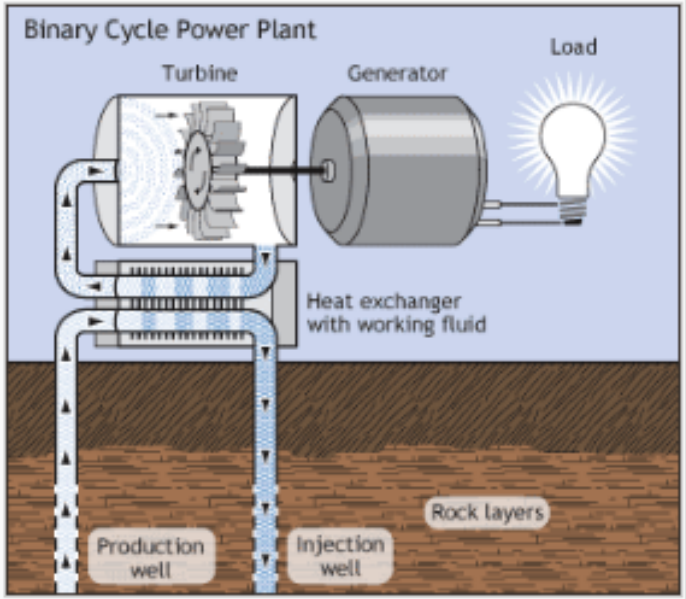
- **Binary Cycle Power Plants**

  Both moderate-temperature (below 400°F) water and a secondary, or "binary", fluid with a much lower boiling point than water are used in

GEOTHERMAL ENERGY
Geothermal Home

Binary Cycle Power Plant [edit]

General | List of Binary Plants [edit]



Binary power plant process diagram – DOE EERE 2012

Binary cycle geothermal power generation plants differ from Dry Steam and Flash Steam systems in that the water or steam from the geothermal reservoir never comes in contact with the turbine/generator units. Low to moderately heated (below 400°F) geothermal fluid and a secondary (hence, "binary") fluid with a much lower boiling point that water pass through a heat exchanger. Heat from the geothermal fluid causes the secondary fluid to flash to vapor, which then drives the turbines and subsequently, the generators.

Binary cycle power plants are closed-loop systems and virtually nothing (except water vapor) is emitted to the atmosphere. Resources below 400°F are the most common geothermal resource, suggesting binary-cycle power plants in the future will be binary-cycle plants[1]

References [edit]

1. ↑ "US DOE EERE Geothermal Technologies Program, *Hydrothermal Power Systems*"

Binary Cycle Power Plant

[edit]

[edit]

Sort descending

List of Binary Plants

Facility Name	Owner	Capacity (MW)	Commercial Online Date	Geothermal Area	Geothermal Region
Amedee Geothermal Facility	Amedee Geothermal Venture	1.6 MW	1988	Amedee Geothermal Area	Walker-Lane Transition Zone Geothermal Region
Blundell 2 Geothermal Facility	PacificCorp	11 MW	2007	Roosevelt Hot Springs Geothermal Area	Northern Basin and Range Geothermal Region
Chena Hot Springs Geothermal Facility	Chena Hot Springs	0.45 MW	2006	Chena Geothermal Area	Alaska Geothermal Region
Desert Peak II Geothermal Facility	Ormat Technologies	11 MW	2006	Desert Peak Geothermal Area	Northwest Basin and Range Geothermal Region
ENEL Salt Wells Geothermal Facility	Enel North America	23.6 MW	2009	Salt Wells Geothermal Area	Northwest Basin and Range Geothermal Region
Galena 2 Geothermal Facility	Ormat Technologies	15 MW	2007	Steamboat Springs Geothermal Area	Walker-Lane Transition Zone Geothermal Region
Galena 3 Geothermal Facility	Ormat Technologies	20 MW	2008	Steamboat Springs Geothermal Area	Walker-Lane Transition Zone Geothermal Region
Gould Geothermal Facility	Ormat Technologies	10 MW	2006	Heber Geothermal Area	Gulf of California Rift Zone Geothermal Region
Heber II Geothermal Facility	Ormat Technologies	48 MW	1993	Heber Geothermal Area	Gulf of California Rift Zone Geothermal Region
Heber South Geothermal Facility	Ormat Technologies	10 MW	2008	Heber Geothermal Area	Gulf of California Rift Zone Geothermal Region
Lightning Dock Geothermal Facility	Raser Technologies Inc	10 MW	2009		

GEOTHERMAL ENERGY

Geothermal Home

Development Project: Akutan Geothermal Project

[edit]

Project Location Information	
Coordinates	54.1325°, -164.92194444444° Display map
Location	Akutan, AK
County	Aleutians East Borough, AK
Geothermal Area	Akutan Fumaroles Geothermal Area
Geothermal Region	Alaska Geothermal Region
Geothermal Project Profile	
Developer	City Of Akutan
Project Type	Hydrothermal Systems
GEA Development Phase	Phase II – Resource Exploration and Confirmation
Capacity Estimate (MW)	10

References

[edit]

Category: Geothermal Projects

GEOTHERMAL ENERGY
Geothermal Home

GEA Development Phase II: Resource Exploration and Confirmation [edit]

The information for this page was taken directly from Geothermal Reporting Terms and Definitions: A Guide to Reporting Resource Development Progress and Results to the Geothermal Energy Association (GEA, November 2010)

Contents [hide]

Phase II Criteria [edit]

In reporting a Phase II geothermal project to the GEA the developer must ascertain whether or not the project being reported meets the following specified criteria. The development criteria are divided into three different subsections of Phase II geothermal development (Resource, Transmission, and External Development). It is not necessary that a geothermal project meet all of the criteria listed. The number of criteria that a project must meet in each subsection of geothermal Phase II development is specified below.

1. Resource Development Criteria [edit]

For a project to be considered a Phase II project *at least one* of the following Resource Development criteria must be met:

- **Temperature Gradient Holes (TGH) Drilled**

  A sufficient number of TGH holes have been drilled which measure temperature gradients that indicate a potential geothermal resource over a large enough thermal anomaly to justify further drilling.

- **Slim Hole Drilled**

GEA Development Phases

The Geothermal Energy Association's (GEA) Geothermal Reporting Terms and Definitions are a guideline for geothermal developers to use when submitting geothermal resource development information to GEA for public dissemination in its annual US Geothermal Power Production and Development Update. GEA's Geothermal Reporting Terms and Definitions serve to increase the consistency, accuracy, and reliability of industry information presented in the development updates.

- Phase I – Resource Procurement and Identification
- **Phase II – Resource Exploration and Confirmation**
- Phase III – Permitting and Initial Development
- Phase IV – Resource Production and Power Plant Construction

Phase II – Projects

[edit]

Technique	Developer	Project Type	Capacity Estimate (MW)	Location	Geothermal Area	Geothermal Region	GEA Report Date
Akutan Geothermal Project	City Of Akutan	Hydrothermal System	10	Akutan, Alaska	Akutan Fumaroles Geothermal Area	Alaska Geothermal Region	
Alum Geothermal Project	Ram Power	Hydrothermal System	64	Silver Peak, Nevada	Alum Geothermal Area	Walker-Lane Transition Zone Geothermal Region	
Bald Mountain Geothermal Project	Oski Energy LLC	Hydrothermal System	20	Susanville, California			
Canby Cascaded Project Geothermal Project	Canby Geothermal	Hydrothermal System	5	Canby, NV	Canby Geothermal Area	Transition Zone Geothermal Region	
Clayton Valley Geothermal Project	Ram Power	Hydrothermal System	80	Silver Peak, Nevada	Silver Peak Geothermal Area	Walker-Lane Transition Zone Geothermal Region	
Cove Fort Geothermal Project	Oski Energy LLC	Hydrothermal System			Cove Fort Geothermal Area	Northern Basin and Range Geothermal Region	
Crump Geyser Geothermal Project	Nevada Geo Power Ormat Technologies	Hydrothermal System	80	Utah	Crump's Hot Springs Geothermal Area	Northwest Basin and Range Geothermal Region	
Desert Queen Geothermal Project	Alterra Power	Hydrothermal System	36	Fernley, Nevada	Desert Queen Geothermal Area	Northwest Basin and Range Geothermal Region	
Dixie Valley Geothermal Project	Alterra Power	Hydrothermal System		Nevada	Dixie Valley Geothermal Area	Central Nevada Seismic Zone Geothermal Region	
El Centro/Superstition Hills Geothermal Project (2)	Navy Geothermal Program	Hydrothermal System		El Centro, NV			
Fallon Geothermal Project	Gradient Resources	Hydrothermal System	70	Fallon, Nevada	Fallon Geothermal Area	Northwest Basin and Range Geothermal Region	
Fallon-Main Geothermal Project	Navy Geothermal Program	Hydrothermal System	30	Fallon, Nevada	Fallon Geothermal Area	Northwest Basin and Range Geothermal Region	
Fireball Geothermal Project	Earth Power Resources Inc	Hydrothermal System	32	Nixon, Nevada	Fireball Ridge Geothermal Area	Northwest Basin and Range Geothermal Region	
Granite Springs Geothermal Project	Alterra Power	Hydrothermal System		Jessup, NV			
Hawthorne Army Depot	Navy Geothermal Program	Hydrothermal System		Hawthorne, Nevada	Hawthorne Geothermal Area	Walker-Lane Transition Zone Geothermal Region	

GEOTHERMAL POWER

NEPA Document: EA for Well Field Development at Brady Hot Springs - DOI-BLM-NV-W010-2012-0057-EA

Proposed Action

Ormat's well 15-12, located north of the Hot Springs Mountains, approximately 50 miles northeast of Reno, in Churchill County, Nevada; T. 22 N., R. 26 E., sec. 12 (Figure 1), was installed in April 2007 to serve as a production well; however, further testing revealed that the well does not have sufficient hydraulic connections with the geothermal reservoir and it has since remained inactive. Ormat proposes to implement a hydro-stimulation program (EGS) to increase energy production by enhancing natural hydraulic connections within the existing hydrothermal system. Hydro-stimulation involves creating better hydraulic connections by injecting cool geothermal water (temperatures ranging from 90-140°F) to further open the existing network of minute cracks in the rocks deep underground, where natural fractures already occur. During the process, geothermal water produced from the geothermal production wells and processed at the geothermal plant would be injected at wellhead pressures less than 1,400 pounds per square inch at depths ranging from approximately 4,245 to 5,096 feet below ground surface. The stimulation plan outlines the injection of cool geothermal water into three vertical intervals at varying pressures over a period of approximately three weeks. The increase in pressure would also accompany a pulsing of the rate of injection. Tracer compounds would be injected at specific times during the stimulation to identify movement of geothermal fluid in real time. Additional details are provided in the Tracer Testing section of the report.

Applicant-Proposed Environmental Protection Measures

Impacts

Mitigation

Conditions of Approval

Link to Document: https://www.blm.gov/epl-front-office/projects/nepa/34003/42110/44613/2013-1-11_Brady_Hydro-Stimulation_EA.pdf

General NEPA Document Info	
Document Type	Environmental Assessment (EA)
Applicant	Brady Power Partners
Consultant	Agency
Geothermal Area	Brady Hot Springs Geothermal Area
State	NV
Project Phase	Well Field Development
Techniques	Hydro-Shearing
Comments	DOE/BLM Staff
Time Frames (days)	
Lease to Application	
Application Time	
Process Time	
Total Time	
Participating Agencies	
Lead Agency	Bureau of Land Management
Managing Field Office	BLM Winnemucca Field Office
Funding Agencies	DOE
Surface Manager	Bureau of Land Management
Mineral Manager	Bureau of Land Management
Selected Dates	
Lease Date	
Pre-Application Meeting Date	
Application Date	
Preliminary EA/EIS	
Final EA/EIS	
Decision Document	
Relevant Numbers	
Lead Agency Document Number	DOI-BLM-NV-W010-2012-0057-EA
Funding Agency Document Number	DOE/EA-1944
Funding Number	DE-PS36-08GO98008
Serial Number/Case File Number	N-65561
Lease Numbers	NVN 065558

GEOTHERMAL POWER

Area: Brady Hot Springs Geothermal Area

General | Technical Info | Power Plants (2) | Projects (0) | Activities (9) | NEPA (2)

Document #	Document Type	Project Phase	Project Activities	Applicant	Decision Date	Total Time (days)
DOI-BLM-NV-W010-2012-0057-EA	EA	Well Field Development	Hydro-Shearing	Brady Power Partners	11/20/2012	320

GEOTHERMAL ENERGY

Geothermal Technique: Hydro-Shearing

Details | Activities (9) | Are]as(2) | Regions(0) | NEPA (2)

Document #	Document Type	Project Phase	Project Activities	Applicant	Decision Date	Total Time (days)
DOI-BLM-NV-W010-2012-0057-EA	EA	Well Field Development	Hydro-Shearing	Brady Power Partners	11/20/2012	320

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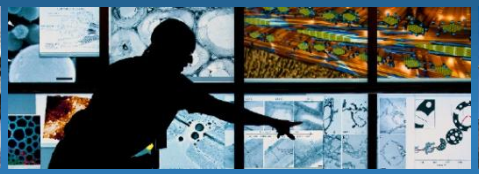
Thank You!

This work was funded by the US Department of Energy

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