UNITED STATES GEOTHERMAL ENERGY MARKET REPORT

GLITNIR GEOTHERMAL RESEARCH

September 2007

GLITNIR

GLITNIR

INDEX

FOREWORD & MAIN FINDINGS 4
- FOREWORD 4
- KEY FINDINGS 5

GEOTHERMAL ENERGY 6
- GEOTHERMAL ENERGY COMPARED TO OTHER RENEWABLES 6
- COST COMPETITIVENESS OF GEOTHERMAL 7
- LAND USE & TECHNOLOGY MATURITY 7
- SUMMARY OF KEY ADVANTAGES OF GEOTHERMAL ENERGY 8

GLOBAL GEOTHERMAL ENERGY OVERVIEW 9
- GEOTHERMAL ENERGY PRODUCTION – THE TOP 10 COUNTRIES 9
- GLOBAL GEOTHERMAL ENERGY POTENTIAL 10

U.S. GEOTHERMAL ENERGY OVERVIEW 11
- U.S. OVERALL ANNUAL ENERGY CONSUMPTION 11
- GEOTHERMAL DEVELOPMENT IN THE U.S. 12
- GEOTHERMAL DEVELOPMENT VS. OTHER RENEWABLES 12
- UNITED STATES – GEOTHERMAL REGIONS 13
- RENEWABLE ENERGY/ PORTFOLIO STANDARDS WESTERN STATES 13
- U.S. GEOTHERMAL POWER CAPACITY IN PERSPECTIVE 14
- ALASKA 14
- CALIFORNIA 15
- HAWAII 16
- NEVADA 16
- UTAH 16
- GEOTHERMAL DIRECT USE IN THE U.S. 17

U.S. GEOTHERMAL ENERGY POTENTIAL 18
- POTENTIAL OF GEOTHERMAL ENERGY FOR THE U.S. 18
- U.S. GEOTHERMAL DEVELOPMENT & RESOURCE ESTIMATES FOR ELECTRICITY GENERATION 19
- U.S. GEOTHERMAL OVERALL RESOURCE ASSESSMENT 20
- GEOTHERMAL ENERGY – CURRENT, PROJECTS & POTENTIAL 20
- ALASKA 21
- ARIZONA 22
- CALIFORNIA 22
- HAWAII 23
- IDAHO 24
- NEVADA 25
- NEW MEXICO 25
- OREGON 26

UTAH 27
WASHINGTON 28
POTENTIAL ESTIMATED IN OTHER PUBLICATIONS 28
U.S. INVESTMENT NEEDS FOR CURRENT PROJECTS 29
U.S. INVESTMENT NEEDS FOR THE NEXT 10-20 YEARS 30
U.S. GEOTHERMAL DEVELOPMENT NEEDS 31
GEOTHERMAL ENERGY – MARKET & PLAYER, PROJECT TIMELINE 32
GEOTHERMAL INDUSTRY/ PLAYER OVERVIEW 32
U.S. GEOTHERMAL ENERGY OPPORTUNITIES & CHALLENGES 33
OPPORTUNITIES 33
CHALLENGES 33
GEOTHERMAL ENERGY ASSOCIATIONS 34
GLITNIR GEOTHERMAL ENERGY OVERVIEW 35
DISCLAIMER 36
CONTACT INFORMATION 37

FOREWORD & MAIN FINDINGS

FOREWORD

Dear Reader

It is our pleasure to present the first Geothermal Market Report by Glitnir's Global Sustainable Energy team. Given the proud history and strong development of geothermal energy in the United States, it follows that our first report should highlight the U.S. geothermal market.

The U.S. is a global leader in geothermal energy, with total installed capacity of some 2,800 MW and annual electricity generation of approximately 16,000 GWh. It will continue to be at the forefront of the world's geothermal development and currently has projects underway that, when completed, will boost U.S. installed capacity by a further 2,500 MW. Given an overall estimated resource base of up to 30,000 MW for hydrothermal, and an even greater potential for direct use of geothermal energy, the opportunities for the industry are tremendous. The industry also has a strong advocate in the Geothermal Energy Association (www.geo-energy.org), and we base a lot of our findings on the excellent work provided by this organisation.

Glitnir sees a number of challenges facing the industry. These include securing the necessary equipment for further development, together with the promotion of geothermal energy itself and the education of the future leaders of the industry. But those obstacles are nothing compared to the huge opportunities that geothermal energy provides. Total electricity sales revenues alone could increase nearly 6-fold over the coming 15-20 years.

We hope you will find this report useful and informative. We at Glitnir are proud of our strong team of sustainable energy industry experts and look forward to working with you in our quest to maximise the potential and opportunities that geothermal energy offers. The Sustainable Energy team can be contacted at energy@glitnirusa.com and www.glitnirusa.com/energy.

Best regards,

Lárus Welding
CEO Glitnir Bank

KEY FINDINGS

Tremendous opportunities in the utilization of geothermal energy in the U.S.

- The biggest potential for geothermal energy applications in electricity production is in the Western States, primarily in California, Nevada, Idaho and Oregon. In California, geothermal could provide about 20 percent of today's electricity needs. In Nevada this could be even 60 percent and 17 percent of the electricity in Idaho could come from geothermal. In Hawaii, the potential of geothermal power is particularly interesting, as it could provide around 30% of the islands' electricity needs, decreasing the state's dependence on fossil fuels. Most of the current development is taking place in Nevada and California.
- Glitnir estimates the investment requirement to service current projects to be some USD 9.5 billion. A total Investment of USD 16.9 billion will be required to develop available resources over the next 8 years with a further USD 22.5 billion during the following 10 years. We forecast that the total investment needed to develop the resources available is in the region of USD 39.4 billion until 2025.
- Sales of geothermal powered electricity could increase from currently USD 1.8 billion to USD 11.0 billion, without taking into consideration the vast opportunities for the development of geothermal direct use applications, e.g. geothermal heat pumps.
- The geothermal industry in the U.S. is still very fragmented, consisting of relatively few big companies and many small ones. Some of the smaller companies lack the financial strength to fully develop projects that in many cases could be profitable. Therefore Glitnir believes there will be considerable consolidation in the industry in the next few years.
- For successful development of the geothermal industry it will be necessary to increase the capacity of drilling equipment and related human resources. As the industry is recovering from a decline that took place in the late 1980s and is to some degree competing with the oil industry for human resources, it is crucial to train and educate people to work within the sector.

GEOTHERMAL ENERGY

'Geothermal' literally means 'Earth's heat'. The temperature at the Earth's core is estimated to be 5,500 degrees centigrade – about as hot as the surface of the sun. Geothermal energy is a clean, renewable resource that can be tapped by many countries around the world located in geologically favourable areas. Geothermal energy can be harnessed from underground reservoirs, containing hot rocks saturated with water and/or steam. Wells of typically two kilometres in depth or more are drilled into the reservoirs.

The hot water and steam are then piped up to a geothermal power plant, where they are used to drive electric generators to create power for businesses and homes. Geothermal energy is considered a renewable resource because it exploits the abundant Earth's interior heat, and the water, once used and cooled, is then piped back to the reservoir. It can be utilized for electricity production and for direct use, e.g. for heating and industrial purposes.

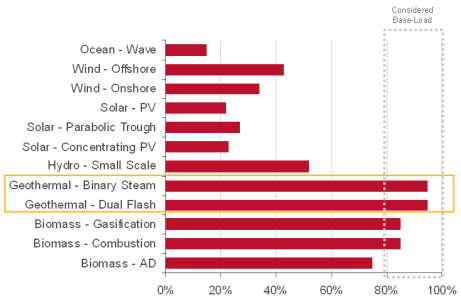
Electricity Production Hydrothermal	• Wells drilled into a geothermal reservoir produce hot water and steam from depths of up to 3 km • Hot water and steam are the carriers of the geothermal energy • The geothermal energy is converted at a power plant into electric energy, or electricity
• Hot Dry Rock • Deep Geothermal. / EGS (both not commercial yet)	• Extracts heat by creating a subsurface fracture system to which water can be added through injection wells • Water is heated by contact with the rock and returns to the surface through production wells • Energy is then converted at a power plant into electric energy as in a hydrothermal geothermal system
Direct Use	• Applications that use hot water from geothermal resources directly • Examples: space heating, crop & lumber drying, food preparation, aquaculture, industrial processes etc. • Historical traces back to ancient Roman times, e.g. for baths
Geothermal Heat Pumps	• Taking advantage of relatively constant earth temperature as the source and sink of heat for both heating and cooling, as well as hot water provision • One of the most efficient heating and cooling systems available.

GEOTHERMAL ENERGY COMPARED TO OTHER RENEWABLES

- Geothermal energy can be utilized for electricity production and for using geothermal heat directly, e.g. for heating purposes, food processing, fish farming, bathing and other applications that require heat. In this, geothermal is unique compared to other renewables. It not only provides a real base-load capacity for electricity generation, but also presents a real and cleaner alternative to fossil fuels for heat production.
- The overall prospects for geothermal energy utilization, either for electricity generation or direct use are excellent. While depending heavily on political and financial support, geothermal energy represents the only real base-load capacity alternative to fossil fuels, such as coal or oil. The biggest potential and prospects for the short(er) term are in the direct use of geothermal energy, particularly for heating and other applications that use heat directly. With technological developments, e.g. in binary systems and engineered geothermal systems, geothermal could provide all the electricity of this world.

Capacity Factors selected Renewables[1]

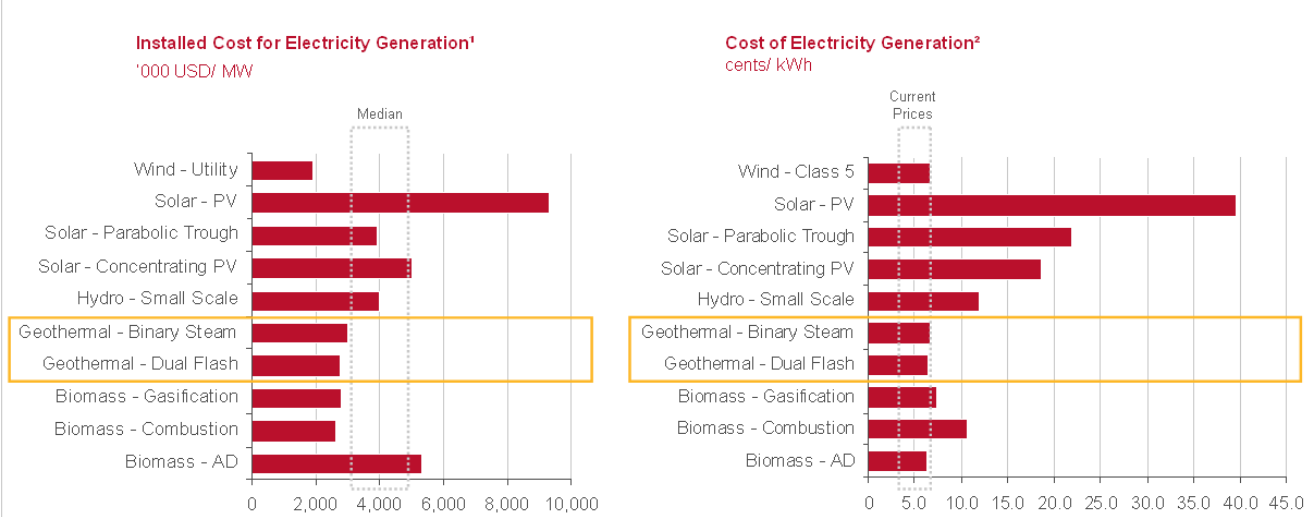
Average Net Capacity (%)



Net Capacity Factor (%) averages for selected renewables Source: Glitnir Research

COST COMPETITIVENESS OF GEOTHERMAL

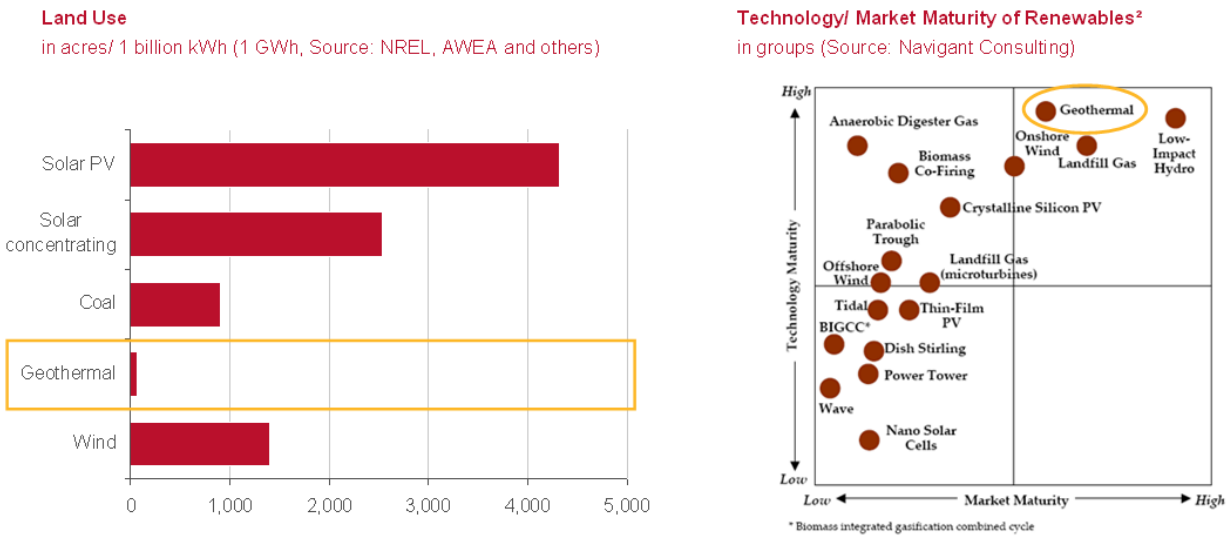
Geothermal is average in installed cost, but very competitive on cost per produced kWh of electricity



Sources: (1) California Energy Commission (Draft Staff Report) June 2007; (2) Selected renewables; averages for Biomass, Solar & Fuel Cells; In-Service Year = 2007 (Nominal 2007$), California Energy Commission (Draft Staff Report) June 2007; Navigant Consulting "Levelized Cost of Generation Model...", at: http://westcarb.org/2007_energypolicy/documents/2007-06-12_workshop/presentations/2007-06-12_NAVIGANT_CONSULTING.PDF

LAND USE & TECHNOLOGY MATURITY

High market and technology maturity with development potential and very little use of land



Sources: (1) NREL, AWEA and Glitnir Research. For biomass, the land use is tremendous and particular critical as it can be of influence to the food sector. It also has to be mentioned, that Solar PV could use space on roofs and walls and therefore not be a huge limitation. (2) Navigant Consulting, Presentation, at: http://www1.eere.energy.gov/femp/pdfs/rewg_navigant.pdf

SUMMARY OF KEY ADVANTAGES OF GEOTHERMAL ENERGY

- Base-load power (capacity factor)[1]
  - 24 hours a day (e.g. wind powered energy requires more than double the installed capacity of geothermal power to supply electricity to the same number of households)
  - Availability of electricity throughout peak hours
  - Flexibility in being shut-down/ turned on if needed
- Pollution prevention
  - Geothermal power plant emits 35 times less carbon dioxide (CO2) than the average U.S. coal power plant per kilowatt of electricity produced (NREL)
- Land use
  - Geothermal uses by far the least land for electricity production per billion kWh compared to all other renewables.
- Social Economics[2]
  - National security advantage of having a resource on one's own soil
  - No dependence on outside factors, such as oil prices, weather etc.
  - Potential for rural development around power plants
  - There is far greater job creation potential within the geothermal industry than within other renewable energy sectors
- Electricity costs
  - USD 0.05-0.08/ kWh - way below solar and other renewables
  - Direct use/ Energy & Fuel Cost Savings
  - Extensive savings on fuel costs through geothermal (up to 5-8 percent of operating cost, DOE)

Sources: (1) See also: NREL, at: http://www.nrel.gov/analysis/power_databook/docs/pdf/db_chapter12_2.pdf, (2) See also a detailed analysis by GEA, "Kagel, A. – Socioeconomics and Geothermal Energy", at: http://www.geo-energy.org/publications/power%20points/SocioeconomicsKagel.ppt

GLOBAL GEOTHERMAL ENERGY OVERVIEW

Today, geothermal energy generates about 57,000 GWh in electricity, with an installed capacity of 8,900 MW. The main producing countries are the United States, the Philippines, Mexico, Indonesia, Italy, which alone produce about 80% of the world's total geothermal electricity generation. The top 10 countries produce around 97%. Geothermal direct-use applications generate around 75,900 GWh (thermal), with China, Sweden, the United States, Turkey and Iceland producing around 60% of the world direct use in GWh thermal. The top 10 countries account for around 70%.

The largest potential for geothermal electricity generation lies along the hot regions of this earth, along the tectonic plates of the Earth, e.g. along the Pacific ring of fire. The regions with the largest potential are Asia where particularly Indonesia has the largest potential of around 27,000 MW, followed by the Americas, primarily Latin America and the Caribbean, and the United States. There is also great potential in regions like North-Eastern Africa (the Horn of Africa) and Oceania.

GEOTHERMAL ENERGY PRODUCTION – THE TOP 10 COUNTRIES

Electricity Production (2005)

	In GWh electric
United States	17,917.00
Philippines	9,253.00
Mexico	6,282.00
Indonesia	6,085.00
Italy	5,340.00
Japan	3,467.00
New Zealand	2,774.00
Iceland*	1,483.00
Costa Rica	1,145.00
Kenya	1,088.00
Sum of Top 10	**54,834.00**
All Other	**1,952.00**
World Total	**56,786.00**

Direct Use (2005)

	in GWh thermal
China	12,604.6
Sweden	10,000.8
United States	8,678.2
Turkey	6,900.5
Iceland*	6,806.1
Japan	2,861.6
Hungary	2,205.7
Italy	2,098.5
New Zealand	1,968.5
Brazil	1,839.7
Sum of Top 10	**54,124.5**
All Other	**19,978.7**
World Total	**75,942.9**

Data for Iceland as of 2006
Source: Electricity – Bertani, Direct Use – Lund, Freeston, Boyd (all Geothermics 34 (2005), with data of 2005)

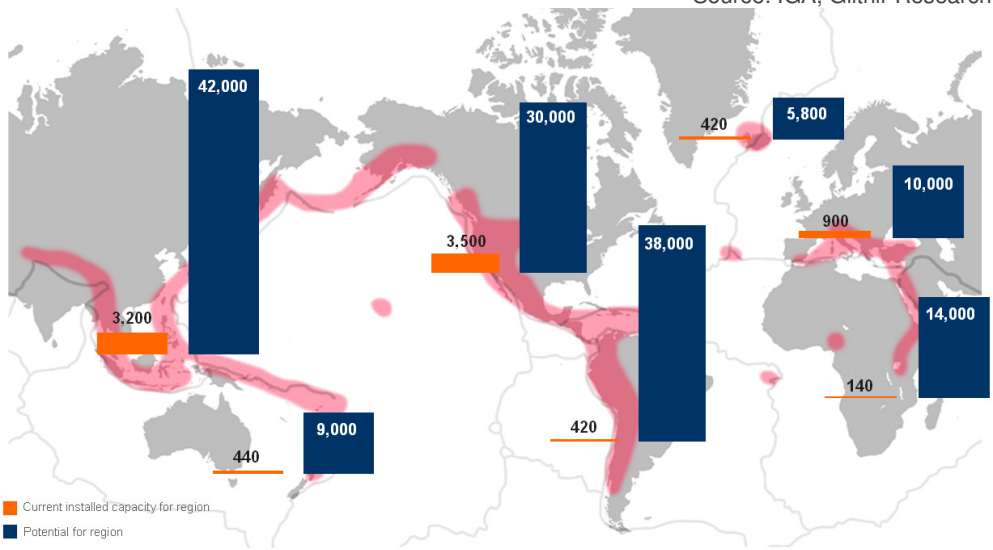
GLOBAL GEOTHERMAL ENERGY POTENTIAL

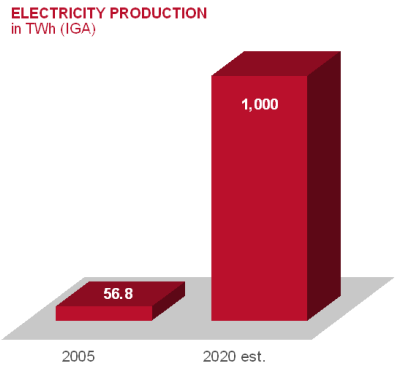
- The International Geothermal Energy Association has looked at different estimates for geothermal energy potential. The estimates referred to here look at the "accessible resource base", which includes the "identified economic resource (the Reserve) – that part of the resources of a given area that can be extracted legally at a cost competitive with other commercial energy sources and that are known and characterized by drilling or by geochemical, geophysical and geological evidence." This compiles all existing data to provide a "minimum-maximum expected potential for geothermal exploitation", individually for electricity generation and direct use.
- The direct use potential draws an even more promising picture, with an extrapolation of 140/700 TWh/year until 2020, a minimum of 30,000 GWth (100,000 TWh/year) and a maximum of 50,000,000 GWth (170,000,000 TWh/ year).
- For electricity generation the potential is given with an extrapolation to the year 2020 of 40 GW installed capacity (or 300 TWh/ year), a minimum potential of 140 GW (1,000 TWh/ year) and a maximum potential of 6,000 GW (40,000 TWh/ year). To put this into perspective, today's total electricity generation is 17,530 TWh, so geothermal could provide from 10 percent to up to 100 percent of the electricity needs of today's electricity demand.

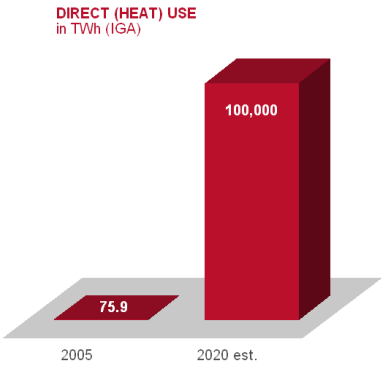
Global Geothermal Capacity & Potential
In Installed Capacity in MW (IGA, Glitnir Research)

	Installed Capacity (MWe 2005)	Potential (MWe)
North America	3,517.00	30,000
Asia	3,290.30	42,000
Europe	1,124.40	15,800
Oceania	441.20	9,000
Central & South America, Carribean	424.00	38,000
Africa	136.30	14,000
World Total	**8,933.20**	**148,800**

Source: IGA, Glitnir Research







Sources:

Lund, J.W., Freeston, D.H. and Boyd, T.I. (2005). Direct application of geothermal energy: 2005 worldwide review. Geothermics, Vol. 34, 690-727; Bertani, R. "What is Geothermal Potential", International Geothermal Association Quarterly No.53 (July-September 2003) retrieved on December 28, 2007, at: http://iga.igg.cnr.it/documenti/IGA/potential.pdf

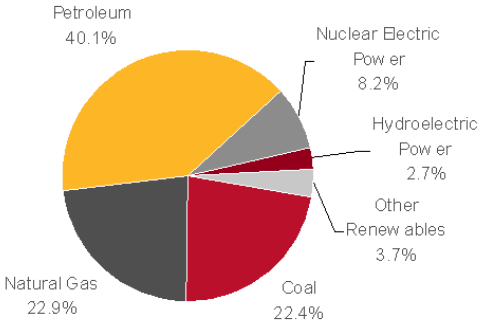
U.S. GEOTHERMAL ENERGY OVERVIEW

With its level of geothermal development throughout the 1970s, the United States are at the forefront of the utilization of geothermal energy and will continue to lead with the number of current projects under way. Today, the U.S. have an installed capacity of 2,850 MW and produce around 16,000 TWh of electricity per year, representing around 28% of the world's electricity generation through geothermal energy.

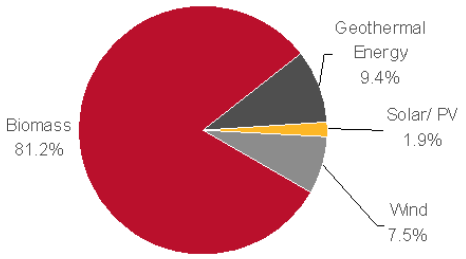
U.S. OVERALL ANNUAL ENERGY CONSUMPTION

Highly dependent on fossil fuels. Hydro is the largest sustainable energy resource, followed by Biomass (wood & waste.

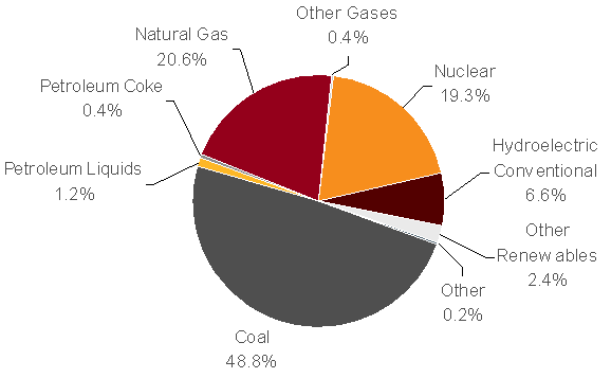
U.S. Energy Consumption (100.7 Quadrillion Btu)
By Sources, rolling 12 months – May '07



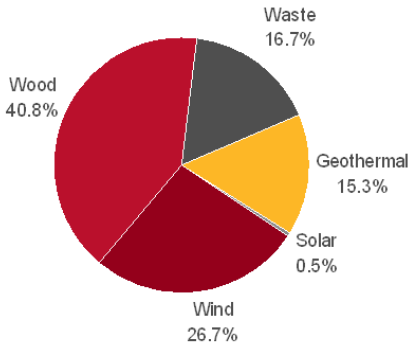
U.S. Energy Consumption (3.7 Quadrillion Btu)
By Sources 'Other Renewable' (excl. Hydro) rolling 12 months – May '07



U.S. Electricity Production (4,103 TWh)
Rolling 12 months – May '07



U.S. Electricity Production (99 TWh)
'Other Renewables' (excl. conv. Hydro) rolling 12m – May '07

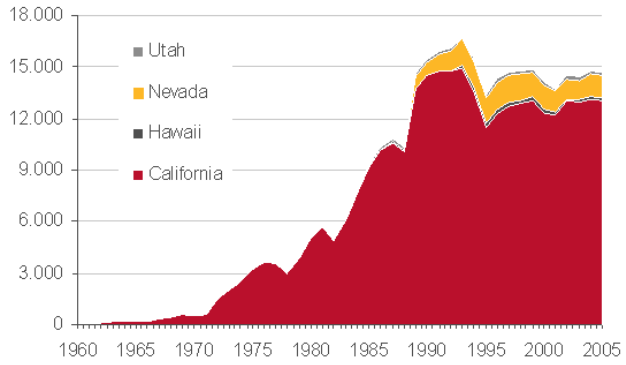


EIA, Energy Information Administration, "Electric Power Monthly, August 2007 edition", at:
http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html

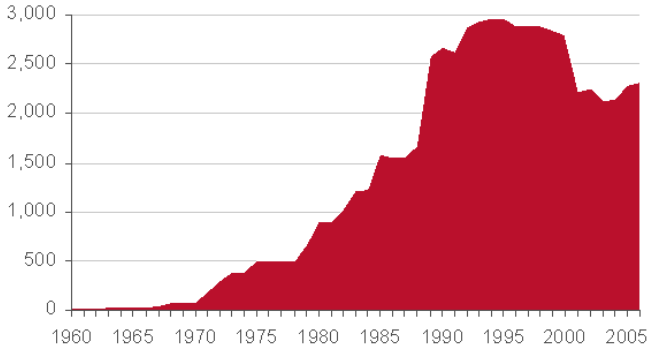
GEOTHERMAL DEVELOPMENT IN THE U.S.

Tremendous growth from 1970 until the mid-1990s with current electricity sales of around USD 1.8 billion.

U.S. Geothermal Electricity Production
In GWh/year (1960-2005, Source: EIA)



U.S. Geothermal Power Generation Capacity
In MW Net Summer Capacity (1960-2005, Source: EIA)

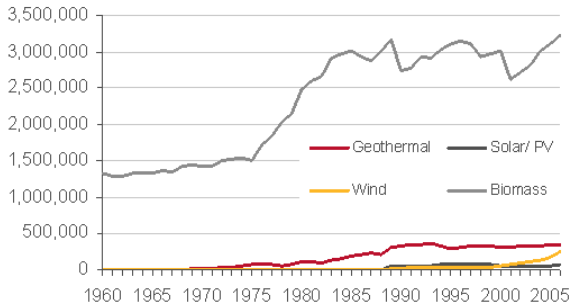


EIA, Electricity Net Generation 1949-2006, at http://www.eia.doe.gov/emeu/aer/txt/ptb0802a.html, EIA, Electric Net Summer Capacity 1949-2006, at: http://www.eia.doe.gov/emeu/aer/txt/ptb0811a.html

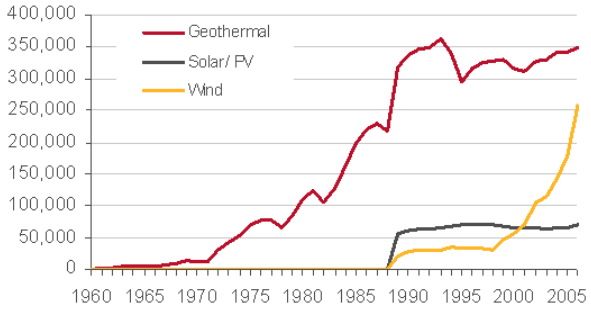
GEOTHERMAL DEVELOPMENT VS. OTHER RENEWABLES

Including direct use, showing the great importance of geothermal for overall energy consumption in the U.S.

U.S. Renewable Energy Prod. (excl. Hydro)
In billion Btu (1949-2006, Source: EIA)



U.S. Renewable Energy Prod. (excl. Hydro & Biomass)
In billion Btu (1949-2006, Source: EIA)

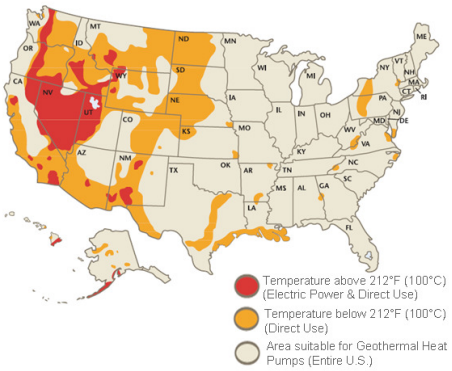


EIA, Electricity Net Generation 1949-2006, at http://www.eia.doe.gov/emeu/aer/txt/ptb0802a.html

UNITED STATES – GEOTHERMAL REGIONS

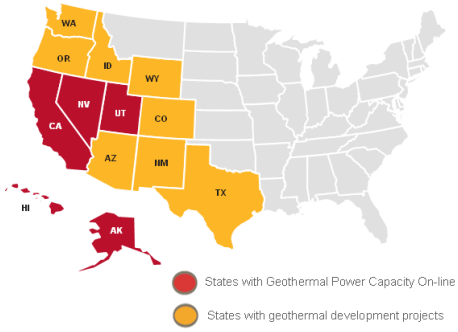
Overview Geothermal Regions

- Main geothermal resources located in the Western States of the U.S.
- Main states: California (CA), Nevada (NV), Utah (UT), Washington (WA), Oregon (OR), Alaska (AK)



States with current Geothermal Installations & Projects

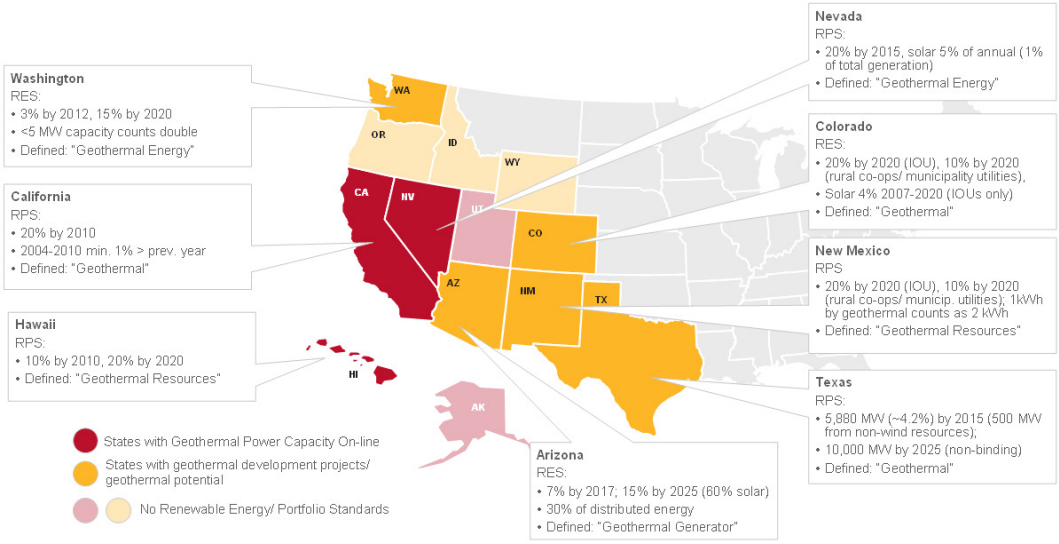
- States currently with Geothermal Installed Capacity
  - Alaska, California, Hawaii (HI), Nevada and Utah
- States with development projects:
  - All of the above and Arizona (AZ), Colorado (CO), Idaho (ID), New Mexico (NM), Oregon, Texas (TX), Washington and Wyoming (WY)



Source: "Geothermal – The Energy Under Our Feet - Geothermal Resource Estimates for the United States", National Renewable Energy Laboratory, Technical Report November 2006, at: http://www1.eere.energy.gov/geothermal/pdfs/40665.pdf and Geothermal Energy Association.

RENEWABLE ENERGY/ PORTFOLIO STANDARDS WESTERN STATES

Not all states provide favorable incentives to Geothermal.



"Defined" = as it is defined in the Renewable Energy / Portfolio Standards of the individual state. Source: UCS, "Renewable Electricity Standards Toolkit", at: http://go.ucsusa.org/cgi-bin/RES/state_standards_search.pl?template=main

U.S. GEOTHERMAL POWER CAPACITY IN PERSPECTIVE

The United States are the largest individual player when it comes to Geothermal.

	Installed Capacity (MWe)	Running Capacity (MWe)	Annual Energy Produced (GWh)	# of Units
United States[1]				
Alaska	0.45	0.40		2
California	2,492.10	2,030.47	14,379.00	67
Hawaii	35.00	27.50		1
Nevada	297.40*		1,268.70	40
Utah	26.00		177.00	4
United States Total*	2,850.90		16,010.00	
North America	3,517.00	1,935.00	24,199.00	245
Asia	3,290.30	3,225.30	18,902.80	105
Europe	1,124.40	948.30	7,209.70	73
Oceania	441.20	409.10	2,791.50	35
Central America & Carribean	424.00	349.00	2,595.00	21
Africa	136.30	136.30	1,088.00	11
South America	0.00	0.00	0.00	0
Middle East	0.00	0.00	0.00	0
World Total	**8,933.20**	**7,003.00**	**56,786.00**	**490**

Data of 2007, all other data as of/ for 2005, Numbers might not add up due to different reporting from sources
Source: (1) Geothermal Energy Association, May 2007, at: http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf, (2) R. Bertani, Geothermics, 34 (2005) p. 651-690, at: http://www.geothermal.org/articles/worldpower05.pdf

ALASKA

Alaska is the newest entrant into the states with geothermal energy production with the Chena Hot Springs installation.

Alaska Geothermal Power Plants/ Capacity Online

Plant Name	Location	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
CHENA	Near Fairbanks, Alaska	2006	Binary	2	450 kW		0.4 MW

Source: Geothermal Energy Association, May 2007

CALIFORNIA

California is the state with most of the geothermal installations with a total installed power capacity of today 2,492.1 MW.

California Geothermal Power Plants/ Capacity Online

Plant Name	Location (County)	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
AIDLIN	Sonoma	1989	Dry Steam	2	20	17	16
AMEDEE	Amedee	1988	Binary	2	1.6	0.5	0.5
BEAR CANYON	Lake	1988	Dry Steam	2	20	18	16
BIG GEYSERS	Lake	1980	Dry Steam	1	97	75	60
BLM	Coso	1989	Double Flash	3	90	90	85
BOTTLE ROCK*	Lake	2007	Dry Steam	1	10		
CALISTOGA	Lake	1984	Dry Steam	1	80	72	70
CE TURBO	Calipatria Country, Imperial Valley	2000	Single Flash	1	10	10	10
COBB CREEK	Sonoma	1979	Dry Steam	1	110	54	53
EAGLE ROCK	Sonoma	1975	Dry Steam	1	110	61	60
ELMORE	Calipatria	1989	Dual Flash	1		42	41
FUMAROLE	Sonoma	1973	Dry Steam	2	106	106	
GEM RESOURCES I	Holtville	1989	Single Flash	1	20	22.5	20
GEM RESOURCES II	Imperial	1986	Binary		18	20	18
GRANT	Sonoma	1985	Dry Steam	1	113	47	40
HEBER PLANT	Imperial Valley	1985	Dual Flash	2	52	47	47
HL POWER	Wendel	1989	Hybrid-Biomass/ Geothermal	1	35.5	17	16
HOCH	Calipatria	1989	Dual Flash	1	38	42	0.5
LAKE VIEW	Sonoma	1985	Dry Steam	1	113	58	50
LEATHER	Calipatria	1990	Dual Flash	1	38	42	41

Plant Name	Location (County)	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
MAMMOTH PACIFIC I	Sierra Nevada Mtns.-Mono	1984	Binary	4	10	10	10
MAMMOTH PACIFIC II	Sierra Nevada Mtns-Mono	1990	Binary	1	15	15	15
McCABE	Sonoma	1971	Dry Steam	2	106	82	75
NAVY I	Coso	1987	Double Flash	3	110	90	85
NAVY II	Coso	1988	Double Flash	3	110	90	85
NCPA I	Lake	1983	Dry Steam, Low Press. React.	2	110	67	63
NCPA II	Lake	1983	Dry Steam, Low Press. React.	2	110	69	64
ORMESA I, IE, IH	Imperial	1989	Binary	3	44	38	38
ORMESA II	Imperial	1986	Binary	1	18	20	18
QUICKSILVER	Lake	1985	Dry Steam	1	113	71	61
RIDGELINE	Sonoma	1972	Dry Steam	2	106	53	72
SALTON SEA I	Calipatria	1982	Dual Flash	1	10	10	16
SALTON SEA II	Calipatria	1990	Dual Flash	3	20	17	0.5
SALTON SEA III	Calipatria	1989	Dual Flash	1	50	50	50
SALTON SEA IV	Calipatria	1996	Dual Flash	1	40	40	41
SALTON SEA V	Calipatria	2000	Dual Flash	1	49	49	10
SIGC BINARY	Imperial Valley	1992	Binary	7	42	15	33
SOCRATES	Sonoma	1983	Dry Steam	1	113	63	53
SONOMA	Sonoma	1983	Dry Steam	1	72	39	58
SULFUR SPRINGS	Sonoma	1980	Dry Steam	1	109	57	55
VULCAN	Calipatria	1986	Dual Flash	1	34	38	63

Source: Geothermal Energy Association, May 2007

HAWAII

Hawaii as the volcanic hot spot of the U.S. currently has only one geothermal power plant.

Hawaii Geothermal Power Plants/ Capacity Online

Plant Name	Location	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
PUNA	Pahoa	1993	Hybrid-Single Flash/Binary	10	NA	35	20

Source: Geothermal Energy Association, May 2007

NEVADA

Nevada's installed capacity is 297.4 MW, ranking no. 2 in the U.S.

Nevada Geothermal Power Plants/ Capacity Online

Plant Name	Location (County)	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
BEOWAWE	Beowawe	1985	Double Flash	1	16.6	14.5	12.5
BRADY HOT SPRINGS	Churchill	1992	Double Flash & Binary	3	27	27	22
DESERT PEAK	Churchill	1985	Double Flash	1	10	9	7
DIXIE VALLEY	Dixie Valley	1988	Double Flash	1	62.5	60.5	54.5
SAN EMIDIO	San Emidio	1987	Binary	4	4.8	N/A	N/A
SODA LAKE I	Fallon	1987	Binary	4	5.1	2.8	2.2
SODA LAKE II	Fallon	1990	Binary	6	18	12	8
STEAMBOAT I	Washoe	1986	Binary	7	8.4	5.6	3.5
STEAMBOAT IA	Washoe	1988	Binary	2	2.95	2.5	2
STEAMBOAT II	Washoe	1992	Binary	2	24	19.3	14.3
STEAMBOAT III	Washoe	1992	Binary	2	24	19.5	14.5
WABUSKA	Wabuska	1984	Binary	3	2.2	1.2	0.8
YANKEE	Reno	1988	Single Flash	1	14.41	14.5	12.5
RICHARD BURDETT (form. GALENA)	Reno	2005	Binary	2	30	26	20

Source: Geothermal Energy Association, May 2007

UTAH

Utah Geothermal Power Plants/ Capacity Online

Plant Name	Location (County)	Start Year	Type of Plant	# of Units	Name Plate Capacity	Annual Avg. Gross Capacity	Annual Avg. Net Capacity
BLUNDELL	Rooselvelt Hot Springs, Milford	1984	Single Flash	1	29	26.1	27
COVE FORT 1	Cove Fort	1990	Dry Steam	1	8.5	6.5	4
COVE FORT 2	Cove Fort	1990	Binary	3	2.25	6.5	4
BLUNDELL	Rooselvelt Hot Springs, Milford	1984	Single Flash	1	29	26.1	27
COVE FORT 1	Cove Fort	1990	Dry Steam	1	8.5	6.5	4
COVE FORT 2	Cove Fort	1990	Binary	3	2.25	6.5	4
BLUNDELL	Rooselvelt Hot Springs, Milford	1984	Single Flash	1	29	26.1	27
COVE FORT 1	Cove Fort	1990	Dry Steam	1	8.5	6.5	4
COVE FORT 2	Cove Fort	1990	Binary	3	2.25	6.5	4
BLUNDELL	Rooselvelt Hot Springs, Milford	1984	Single Flash	1	29	26.1	27
COVE FORT 1	Cove Fort	1990	Dry Steam	1	8.5	6.5	4

Source: Geothermal Energy Association, May 2007

GEOTHERMAL DIRECT USE IN THE U.S.

… tremendous and untapped potential.

Overview

- Direct utilization of geothermal energy includes the heating of pools and spas, greenhouses and aquaculture facilities, space and district heating, snow melting, agricultural drying, industrial applications and ground-source heat pumps.[1]

U.S. Direct Use

Total thermal installed capacity in MWt:	7,817.4
Direct use in TJ/year	31,239.0
Direct use in GWh/year	8,678.2
Capacity factor	0.13

While traditional direct use accounts for 617 MWt/ 9,024 TJ/ year, the remainder, around 7,200 MWt (22,214 TJ/ year) comes from geothermal heat pumps. Direct Use has seen a continuing increase over the years, but by far the largest annual growth has been in geothermal heat pumps.

Growth Rates (2000-2005):

Space heating	9.3%
Agricultural drying	10.4%
Overall direct use average growth	2.6%
Heat Pumps	11.0%
Combined overall annual growth rate (2000-2005)	8.0%

Individual Direct Use

- Heat Pumps: installed units for heat pumps are estimated at 600,000 12-kWt units, most of which are located in the mid-west, mid-Atlantic and southern states (from North Dakota to Florida).
- Traditional direct-use categories (installed capacity/ annual use):
  - individual space heating (146 MWt/ 1,335 TJ/yr), district heating (84 MWt and 788 TJ/yr), cooling (<1 MWt/ 15 TJ/yr),
  - greenhouse heating (97 MWt/ 766 TJ/yr), fish farming (138 MWt/ 3012 TJ/yr), agricultural drying (36 MWt/ 500 TJ/yr),
  - industrial process heat (2 MWt/ 48 TJ/yr), snow melting (2 MWt/ 18 TJ/yr), bathing & swimming (112 MWt/ 2,543 TJ/yr)
- Traditional direct use combined capacity factor of 0.46.
- Some factors influencing the direct use market for geothermal applications and its slowed growth have been:
  - competition from cheap natural gas, import of roses from South America and dried garlic from China
- Examples of direct use applications in the U.S.:
  - Small district heating system in northern California, a greenhouse operation to raise tree seedlings added to the district heating system in Klamath Falls, Oregon.
- Growth in space heating and greenhouse projects is expected, along with increased countrywide interest in geothermal heat pumps.

Source: (1) John W. Lund, Derek H. Freeston, and Tonya L. Boyd: "World-Wide Direct Uses of Geothermal Energy 2005", published in Proceedings of the World Geothermal Congress 2005, Turkey, 24-29 April 2005.

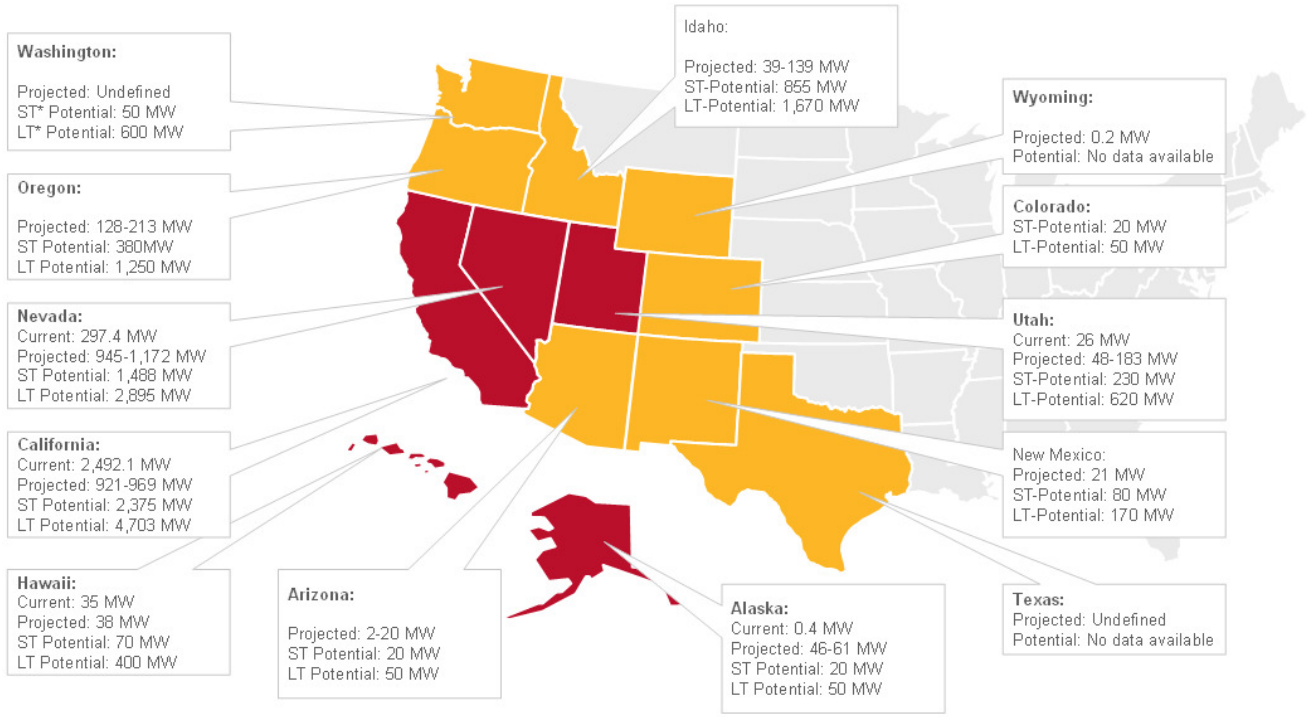
U.S. GEOTHERMAL ENERGY POTENTIAL

Glitnir estimates a potential six-fold increase in the annual sales of electricity from geothermal sources in the US, from USD 1.8 billion today to USD 11.0 billion. Potentially, geothermal energy could fill up to 20% of California's, 60% of Nevada's and 30% of Hawaii's electricity needs. Glitnir expects the investments required to service current geothermal projects at USD9.6 billion, while the total investments required to develop the resources available through 2025 are estimated at approximately USD39.4 billion.

POTENTIAL OF GEOTHERMAL ENERGY FOR THE U.S.

The potential of geothermal energy for the U.S. is huge, particularly for California, Nevada, Idaho and Oregon.

United States has a large untapped potential for the utilization of geothermal energy resources. While development for electricity production is limited to the Western States, direct use potential exists for all of the U.S., in particular for the application of geothermal heat pumps. The picture below gives an overview of the potential for individual states.



*ST = Short Term; LT = Long Term
Source: (1) Geothermal Energy Association, "Update on US Geothermal Power Production and Development, May 10, 2007", at: www.geo-energy.org; (2) WGA, Geothermal Task Force Report January 2006, at: http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf

U.S. GEOTHERMAL DEVELOPMENT & RESOURCE ESTIMATES FOR ELECTRICITY GENERATION

Development projects of up to 2,916 MW, Resource Estimate of 12,558 MW.

GEA – GEOTHERMAL PROJECTS IN DEVELOPMENT (MAY 2007)[1]

	Phase 1-4*		Total (with unconfirmed)		Projects
	low	high	low	high	(with unconfirmed)
ALASKA	45.6	45.6	60.6	60.6	4
ARIZONA	2	20	2	20	1
CALIFORNIA	921.3	969.3	921.3	969.3	16
COLORADO					
HAWAII	38	38	38	38	2
IDAHO	39	39	239	239	4
NEVADA	945	1172	945	1172	31
NEW MEXICO	21	21	21	21	2
OREGON	128.2	213.2	128.2	213.2	7
TEXAS	undefined	undefined	undefined	undefined	1
UTAH	47.6	47.6	182.6	182.6	4
WASHINGTON	undefined	undefined	undefined	undefined	1
WYOMING	0.2	0.2	0.2	0.2	1
TOTAL	**2,140.3**	**2,565.9**	**2,537.9**	**2,915.9**	**74**

WGA GEOTHERMAL TASK FORCE – RESOURCE ESTIMATES[2]

	Resource Capacity Values (MW)**	
	Near-Market/ 2015	Longer-Term/ 2025
ALASKA	20.0	150.0
ARIZONA	20.0	50.0
CALIFORNIA	2,375.0	4,703.0
COLORADO	20.0	50.0
HAWAII	70.0	400.0
IDAHO	855.0	1,670.0
NEVADA	1,488.0	2,895.0
NEW MEXICO	80.0	170.0
OREGON	380.0	1,250.0
TEXAS		
UTAH	230.0	620.0
WASHINGTON	50.0	600.0
WYOMING		
TOTAL CAPACITIES: Western States	**5,588.0**	**12,558.0**

*Phases: Status of the project, e.g. phase 1 (identifying site, secured rights, initial exploration), phase 2 (exploratory drilling), phase 3 (securing PPA & final permits), phase 4 (production drilling and under construction. **The WGA Geothermal Task Force looked at the potential at known sites and potential capacity that could be added to the current capacity as of 2005 (date of issuance of the report). Source: (1) Geothermal Energy Association, "Update on US Geothermal Power Production and Development, May 10, 2007", at: www.geo-energy.org; (2) WGA, Geothermal Task Force Report January 2006, at: http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf

U.S. GEOTHERMAL OVERALL RESOURCE ASSESSMENT

Estimated Developable Resource (NREL) November 2006

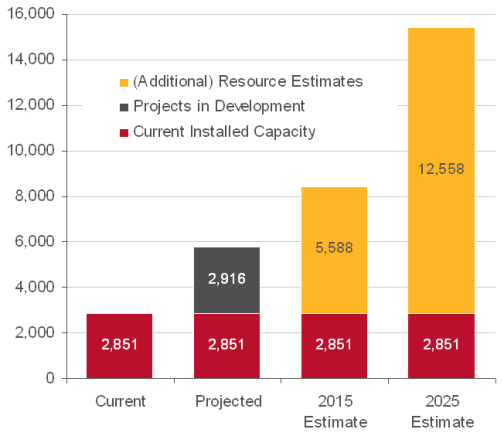
	Estimated Accessible Resource (MWe)	2006 (Actual MWe)	2015 (MWe)	2025 (MWe)	2050 (MWe)
Geothermal* (Identified) >90-150°C/ >194°F	30,000	2,800	10,000	20,000	30,000
Geothermal* (Unidentified) >150°C/ 302°F	120,000		TBD	TBD	TBD
Co-Produced & Geopressured	>100,000	2	10,000 to 15,000	70,000	>100,000
Deep Geothermal (EGS/ Hot-Dry-Rock)	1,300,000 to 13,000,000	0	1,000	10,000	130,000

Thermal Uses	(MWt)	(MWt)	(MWt)	(MWt)	(MWt)
Direct Uses	>60,000	620	1600	4,200	45,000
Geothermal Heat Pumps	>1,000,000	7,385	18,400	66,400	>1,000,000
GHP Avoided Power	120,000	880	2,100	8,000	120,000

* Here NREL talks about shallow hydrothermal (traditional geothermal) energy, which normally is referred to for depths of up to 6,500 ft (~2,000 m), in the context of the resource assessment here, it is more the average depth for a hydrothermal well for electricity generation of 6,500-13,000 ft (2,000-4,000 m). **Deep Geothermal is then referred to for depths of 13,000 ft and beyond (>4,000m). Source: Geothermal – The Energy Under Our Feet - Geothermal Resource Estimates for the United States", National Renewable Energy Laboratory, Technical Report November 2006, at: http://www1.eere.energy.gov/geothermal/pdfs/40665.pdf

GEOTHERMAL ENERGY – CURRENT, PROJECTS & POTENTIAL

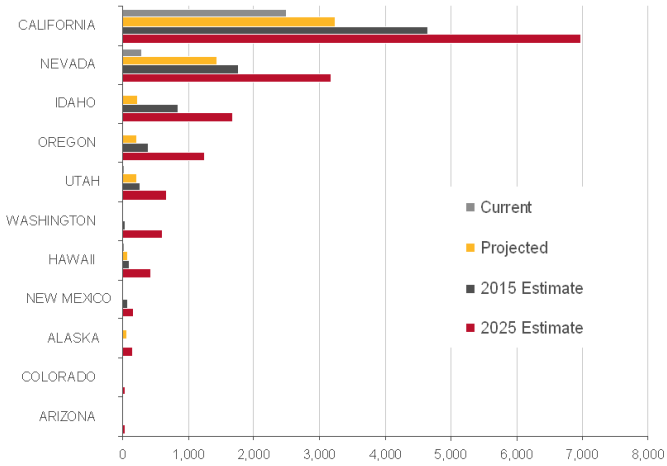
U.S. Geothermal Installed Capacity Estimates of 15,400 MW by 2025 In (total) MW installed capacity



*Estimates for resources that could be added to current capacity.

Sources: Geothermal Energy Association, WGA Geothermal Task Force, see above.

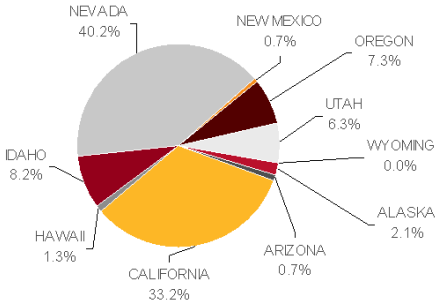
Most of the development (by MW) will happen in California, Nevada, Idaho and Oregon. In (total) MW installed capacity.



*Estimates for resources that could be added to current capacity. Figures for "Projected", as well as Estimates for 2015 and 2025 exclude current installed capacity.
Sources: Geothermal Energy Association, WGA Geothermal Task Force, see above.

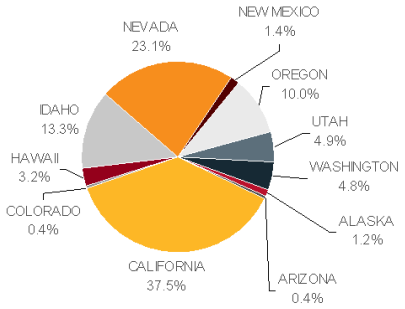
U.S. Geothermal Projects as of May 2007

In Percent, by State (Source GEA)



U.S. Geothermal Developable Resource Estimate (WGA)*

In Percent, by State, long-term 2025 (Source: WGA)



*All are estimates for resources that are either projected or are developable resources in addition to currently installed capacity.

Sources: Geothermal Energy Association, WGA Geothermal Task Force, see above.

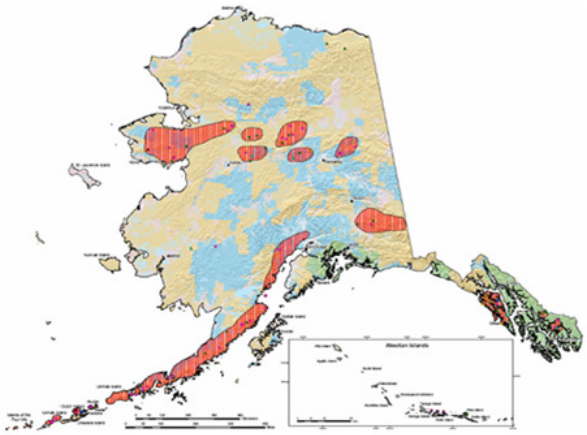
ALASKA

Largest potential for the direct use of geothermal energy

Current[1]

- A power plant at the Chena Hot Springs Resort 60 miles north of Fairbanks provides 0.4 MW of electricity. More small power units are expected to be installed at the site that will provide power and heat for the entire resort that serves 70,000 visitors each year. A larger 20 MW project is under development that could supply power needs for the population in Fairbanks.
- Projects with an installed capacity of 46-61 MW are planned
- With the coldest climate of all U.S. states, Alaska also could benefit tremendously from utilising geothermal energy directly, e.g. for greenhouses, space heating etc.

Alaska Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 20 MW
- Long-term (2025): 50 MW

Renewable Energy Standards

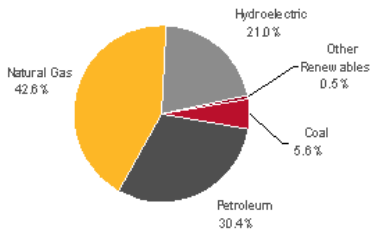
- There are currently no Renewable Energy or Portfolio Standards in place for Alaska

Renewable Energy Incentives

- There are no state incentives available to geothermal electricity production and geothermal heat pumps
- Federal incentives are available

Electricity Production (2005)[3]

- Total Installed Capacity (Net Summer Capacity) 1,890 MW
- Net Electricity Gen.: 6,577 GWh; Other Renewables ~ 0.5%



Source: (1) GEA Developing Projects Update at: http://www.geo-energy.org/information/developing/Alaska/AK.asp (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/ak.pdf, (3) EIA, Annual Data for Alaska, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/alaska.html

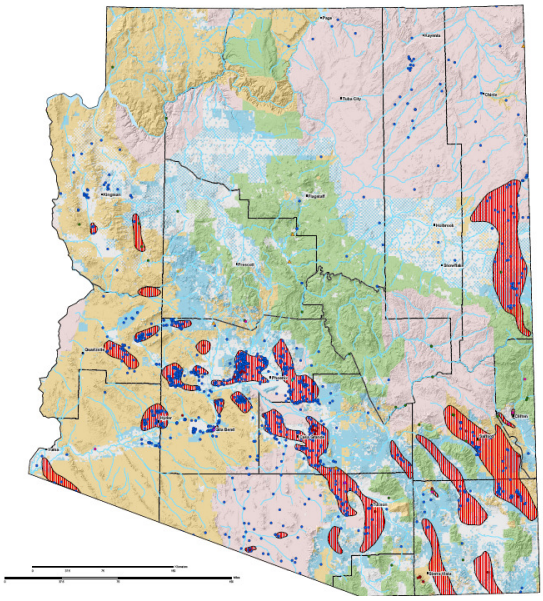
ARIZONA

Current projects are covering nearly half of the resource estimate for the state.

Current[1]

- There is currently no geothermal capacity installed in the state.
- There are 2 projects under development in Arizona, in Clifton and at Northern Arizona University with a total of 20 MW installed capacity.

Arizona Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 20 MW
- Long-term (2025): 50 MW

Renewable Energy Standards

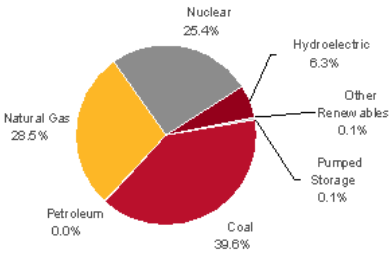
- Renewable Portfolio Standard for Geothermal Electric and Geothermal Heat Pumps; 15% by 2025; allows for credit trading

Renewable Energy Incentives

- Interconnection Standards (different classes removing barriers to competition)

Electricity Production (2005)[3]:

- Total Installed Capacity (Net Summer Capacity) 24,904 MW
- Net Electricity Generation: 101,479 GWh; Other Renewables ~ 0.07%



Source: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Arizona/AZ.asp, (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/az.pdf, (3) EIA, Annual Data for Arizona, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/arizona.html

CALIFORNIA

Geothermal could provide ~ 20% of the state's electricity generation.

Current[1]

- California has 49 power plants with a total installed capacity of 2492.1 MW
- There are 15 projects under development. When finished they will increase the installed capacity for the state by ~970 MW.

Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 2,375 MW
- Long-term (2025): 4,703 MW

Renewable Energy Standards

- Renewable Portfolio Standard for Geothermal Electric, growth of at least 1% by year, at least 20% by 2010, longer term state goal of 33% by 2020

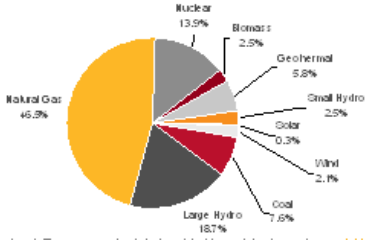
California Geothermal Resource Areas[2]

Renewable Energy Incentives

- Interconnection Standards (up to 10 MW)
- Power Source Disclosure Program (utilities)
- Public Benefit Funds for Renewables & Efficiency ("public goods surcharge"), R&D funds for renewable energy programs (until 2011)
- Supplemental Energy Payments (production based incentive)

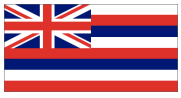
Electricity Production (2006)[3]

- Total Installed Capacity 61,707 MW
- Net Total Electricity Generation: 294,865 GWh; Other Renewables ~ 11%



Source: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/CA/CA.asp , (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/ca.pdf, and R. Bertani, "World Geothermal Power Generation in the period 2001-2005" (Geothermics 34(2005) 651-690), (3) California Energy Commission, at: http://www.energy.ca.gov/electricity/gross_system_power.html

HAWAII

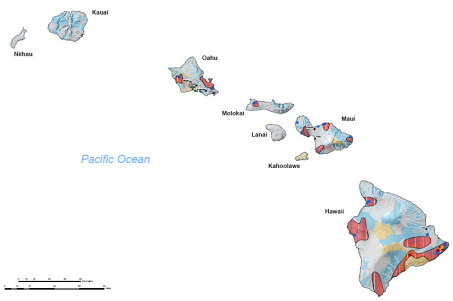


Geothermal could supply around 30% of today's electricity generation in the state.

Current[1]

- There is one power plant on the big island of Hawaii. The Puna Geothermal Venture has an average installed capacity of 25-35 MW, supplying around 20% of the total electricity needs of the Big Island.
- It is planned to extend the existing capacity at Puna by another 38 MW.Arizona Geothermal Resource Areas[2]

Hawaii Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

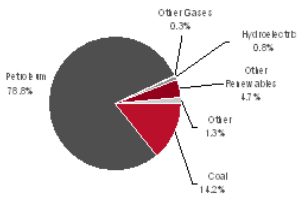
- Short term, near market (2015): 70 MW
- Long-term (2025): 400 MW

Renewable Energy Standards

- Renewable Portfolio Standard for Geothermal Electric & Heat Pumps, 10% by 2010, 15% by 2015 and 20% by 2020 (incl. existing renewables)

Renewable Energy Incentives

- High Technology Business Investment Tax Credit for Geothermal Electric & Geothermal Heat Pumps (max. limit USD 2.0 million tax credit on equity investment, different percentages/ year)
- Interconnection Standards (up to 50 kW capacity)



Hawaii Electricity Production (2005)[3]

- Total Installed Capacity 2,358 MW
- Net Total Electricity Generation: 11,523 GWh; Other Renewables ~ 4.7%

Source: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Hawaii/Hawaii.asp; (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/hi.pdf; (3) EIA, Annual Data for Hawaii, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/hawaii.html

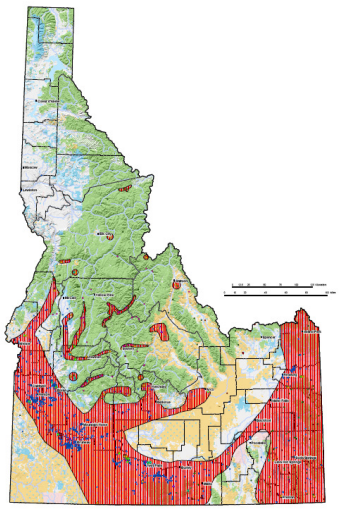
IDAHO

Geothermal could provide 17% of the state's electricity by current projects only.

Current[1]

- There are currently no geothermal power plants in Idaho.
- One project at Raft River is currently under construction and would supply 10 MW of electricity, all other confirmed and unconfirmed projects could provide another 239 MW

Idaho Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 855 MW
- Long-term (2025): 1,670 MW

Renewable Energy Standards

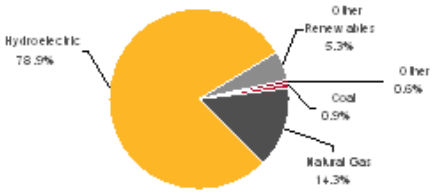
- There are no renewable energy standards in place for Idaho.

Renewable Energy Incentives

- BEF Renewable Energy Grant (non-profit, local & tribal gov't up to 33% of total capital cost), geothermal electric.
- Renewable Energy Equipment Sales Tax Refund (Sales Tax Exemption), geothermal electric, until 2011.
- Renewable Energy Project Bond Program (state bond program) , geothermal electric (independent power producer, non-utility only)

Electricity Production (2005)[3]

- Total Installed Capacity 3,160 MW
- Net Total Electricity Generation: 10,825 GWh; Other Renewables ~ 5.3%



Source: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Idaho/ID.asp, (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/id.pdf; (3) EIA, Annual Data for Idaho, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/idaho.html

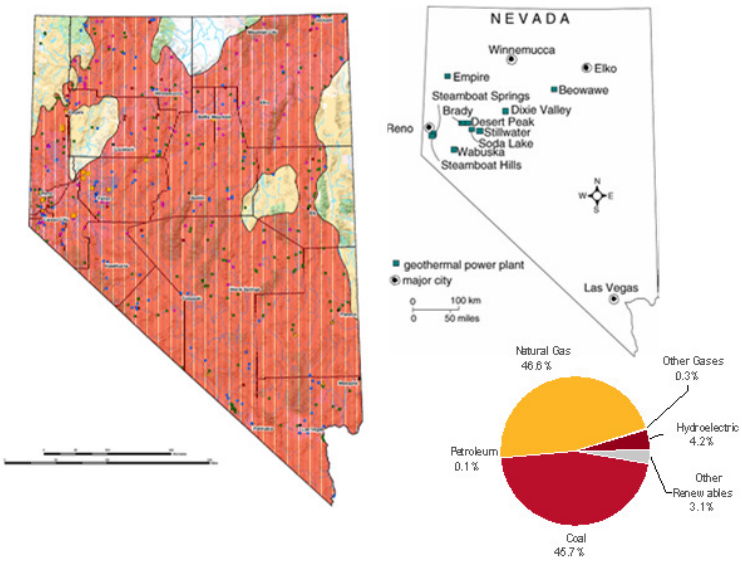
NEVADA

Second largest geothermal potential, which could provide 60% of the state's electricity.

Current[1]

- Nevada has 15 geothermal power plants, with a total capacity of 297.4 MW.
- There are 19 projects in development, which could supply 945-1,172 MW in installed capacity.

Nevada Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015):1,488 MW
- Long-term (2025): 2,895 MW

Renewable Energy Standards

- Renewable Portfolio Standard, geothermal electric & hot water district heating system (IOU), up to 20% by 2015, 5% of portfolio from solar (technology minimum), credit trading.

Renewable Energy Incentives

- Fuel mix and Emissions Disclosure, geothermal electric
- Interconnection Standards (up to 20 MW capacity)
- Nevada – Net Metering (up to 1 MW), geothermal electric (IOUs)
- Portfolio Energy Credits (production incentive), geothermal electric, tradable.
- Property Tax Abatement for Green Buildings (property tax assessment), geothermal electric
- Renewable Energy Systems Property Tax Exemption, geothermal electric

Electricity Production (2005)[3]

- Total Installed Capacity 8,670 MW
- Net Total Electricity Generation: 40,214 GWh; Other Renewables ~ 3.1%

Sources: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Nevada/nevada.asp (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/nv.pdf; and R. Bertani, "World Geothermal Power Generation in the period 2001-2005" (Geothermics 34 (2005) 651-690), (3) EIA, Annual Data for Nevada, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/nevada.html

NEW MEXICO

Geothermal could add 3-4% to electricity generation from renewables in the state

Current[1]

- There are no geothermal power plants in New Mexico today.
- 2 projects are currently under development, one with at least 20 MW installed capacity and the other with 1 MW.

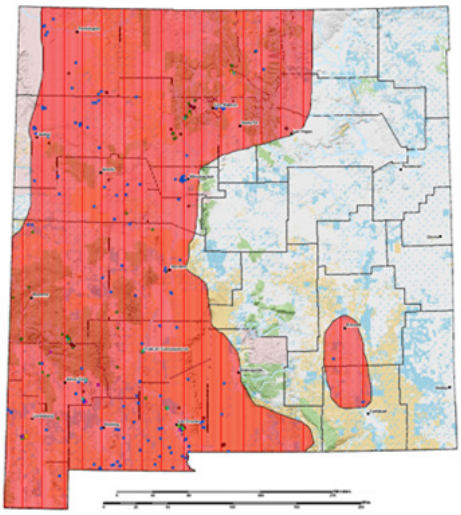
Potential (WGA Geothermal Task Force Estimates)

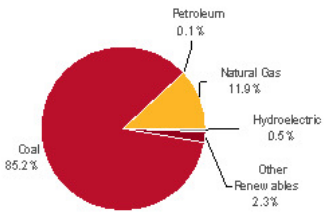
- Short term, near market (2015): 80 MW
- Long-term (2025): 170 MW

Renewable Energy Standards

- Renewable Portfolio Standard, geothermal electric
- IOUs: 10% by 2011, 15% by 2015, 20% by 2020;
- Rural co-ops: 5% by 2015, 10% by 2020

New Mexico Geothermal Resource Areas[2]





Renewable Energy Incentives

- Alternative Energy Product Manufacturers Tax Credit (Industry recruitment), geothermal electric (5% of taxpayer's qualified expenditures, 5 yr tax credit forward)
- Interconnection Standards (up to 80 MW capacity)
- Line Extension (analysis), geothermal electric (<25 kW)
- Mandatory Utility Green Power Option, geothermal electric (utility)
- New Mexico Net Metering, geothermal electric (IOUs, co-ops; <80 MW)

Electricity Production (2005)[3]

- Total Installed Capacity . 6,480 MW
- Net Total Electricity Generation: 35,136 GWh; Other Renewables ~ 2.3%

Sources: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/New%20Mexico/NM.asp, (2) Department of Energy, via Idaho National Lab.: http://geothermal.id.doe.gov/maps/nm.pdf, (3) EIA, Annual Data for New Mexico, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/new_mexico.html

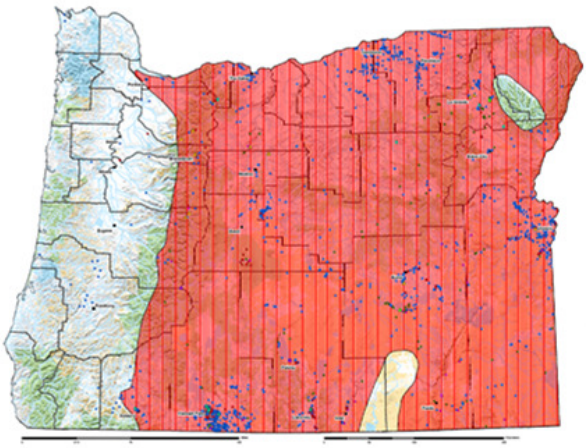
OREGON

Geothermal could add around 10-15% to the state's total electricity generation

Current[1]

- There are no geothermal power plants in Oregon today.
- 4 projects are currently under development, together with unconfirmed projects the total installed capacity would supply up to 213 MW.

Oregon Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

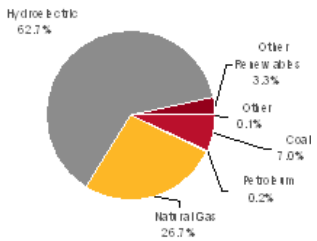
- Short term, near market (2015): 380 MW
- Long-term (2025): 1,250 MW

Renewable Energy Standards

- Renewable Portfolio Standard, geothermal electric
- Large utilities 25% by 2025, small utilities 10% by 2025, smallest utilities 5%.

Renewable Energy Incentives

- BEF- Renewable Energy Grant (non-profit, local & tribal gov't)
- Business Energy Tax Credit (Corp. Tax Credit), geoth. electric & heat pumps, 50% of eligible project cost, distributed over 5 years (10%/ year), max $10m.
- Energy Trust – Open Solicitation Program (state grant program)
- Renewable Energy Systems Exemption (property tax exemption, 100%), geothermal electric & heat pumps



Electricity Production (2005)[3]

- Total Installed Capacity . 12,198 MW
- Net Total Electricity Generation: 49,325 GWh; Other Renewables ~ 3.3%Net Total Electricity Generation: 40,214 GWh; Other Renewables ~ 3.1%

Sources: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Nevada/nevada.asp (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/nv.pdf; and R. Bertani, "World Geothermal Power Generation in the period 2001-2005" (Geothermics 34 (2005) 651-690), (3) EIA, Annual Data for Nevada, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/nevada.html

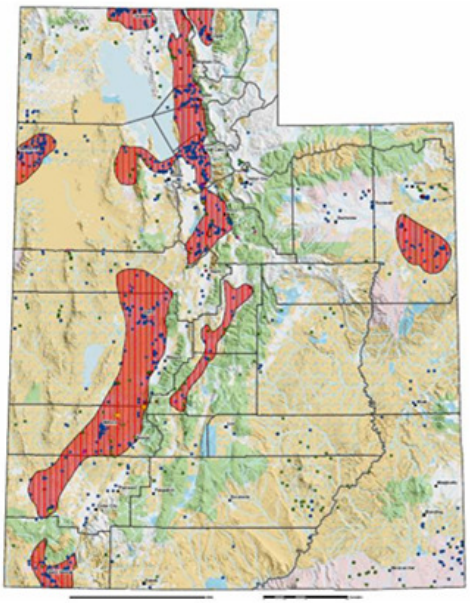
UTAH

Geothermal could provide ~13% of the state's electricity

Current[1]

- There have been 3 geothermal power plants in Utah, while two have been decommissioned (both are planned to be reconstructed), one is up and running with an annual average net capacity of 27 MW.
- 2 plants are under development (50 MW) and one is unconfirmed (183 MW).

Utah Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 230 MW
- Long-term (2025): 620 MW

Renewable Energy Standards

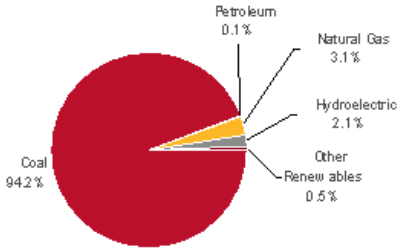
- There are no renewable energy/ portfolio standards in place for the state.

Renewable Energy Incentives

- Renewable Energy Sales Tax Exemption (<20 kW, as well as for extensions of 1 MW or more)
- Renewable Energy System Tax Credit – Corporate, geothermal electric & heat pumps (max $ 50,000, 0.35 cents/ kWh)

Electricity Production (2005)[3]

- Total Installed Capacity 6,528 MW
- Net Total Electricity Generation: 38,165 GWh; Other Renewables ~ 0.5%



Sources: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Utah/utah.asp, (2)Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/ut.pdf, (3) EIA, Annual Data for Utah, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/utah.html

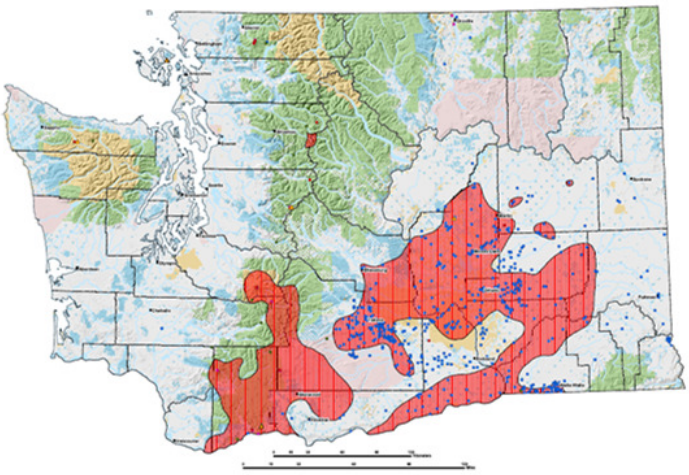
WASHINGTON

Geothermal could add 4% to renewable electricity generation, strong direct use potential

Current[1]

- There are no geothermal power plants running in Washington state.
- One project is in development at Mt. Baker, with a resource capacity estimate of 50-100 MW (WGA Geothermal Task Force)

Washington Geothermal Resource Areas[2]



Potential (WGA Geothermal Task Force Estimates)

- Short term, near market (2015): 50 MW
- Long-term (2025): 600 MW

Renewable Energy Standards

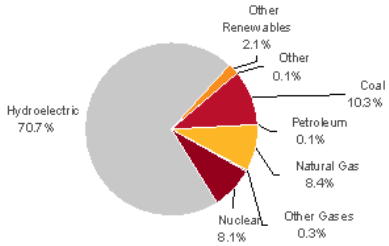
- Renewable Portfolio Standard, geothermal energy, 3% by 2012, 9% by 2016, 15% by 2020 and cost-effective conservation

Renewable Energy Incentives

- BEF – Renewable Energy Grant (private grant of up to 33% of capital cost, smaller scale), non-profit and local/ tribal governments
- Interconnection Standards (up to 25 kWh)
- Mandatory Utility Green Power Option (voluntary option for customers)

Electricity Production (2005)[3]

- Total Installed Capacity 27,791 MW
- Net Total Electricity Generation: 101,966 GWh; Other Renewables 2%



Sources: (1) GEA Developing Projects Update, at: http://www.geo-energy.org/information/developing/Washington/Washington.asp (2) Department of Energy, via Idaho National Laboratory: http://geothermal.id.doe.gov/maps/wa.pdf, (3) EIA, Annual Data for Washington, at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/washington.html

POTENTIAL ESTIMATED IN OTHER PUBLICATIONS

… all estimates* are coming to the same conclusion, the potential is HUGE

Massachusetts Institute of Technology (MIT) [view on the U.S.]

"The Future of Geothermal Energy – Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century" at: http://www1.eere.energy.gov/geothermal/future_geothermal.html

In its study MIT looks at geothermal energy utilization technology that is currently not technically and economically feasible. It would be an addition to conventional hydrothermal applications. MIT, in its vision for 2050, believes that EGS could "become a major supplier of primary energy for U.S. base-load generation capacity by 2050", providing up to 100 GWe (100,000 MW) or more of cost-competitive generating capacity. The fact that geothermal is a base-load option makes it particularly competitive compared to other renewables.

U.S. Geological Survey (USGS) [view on the U.S.][1]

USGS Circular 790 - Assessment of Geothermal Resources in the United States

at: http://pubs.er.usgs.gov/usgspubs/cir/cir790#viewdoc

USGS estimates a "hydrothermal resource base of 95,000-150,000 MWe", defined in "identified resource base of 23,000 MWe" and an "undiscovered resource base" of 72,000-127,000 MWe. A new resource assessment by USGS is expected for 2008.

National Renewable Energy Laboratory [view on the U.S.]

"Updated U.S. Geothermal Supply Characterization" Petty S., Porro G., Presented at the 32nd Workshop on Geothermal Reservoir Engineering, January , 2007 at: http://www.nrel.gov/docs/fy07osti/41073.pdf

The article refers to a base case scenario of co-produced potential of 71,600 MWe (71.6 GWe) and an overall potential of 126,300 MWe (126.3 GWe, including EGS).

World Wide Fund for Nature (WWF) [more global view]

"Climate Solutions – WWF's Vision for 2050" at: http://www.wwfindia.org/about_wwf/what_we_do/cc_e/pub/index.cfm

Under the premise of the need for the reduction of carbon emissions as well as increased energy demand, the WWF looked only at technologies that are in place today. It identified two "technologies" at the forefront of covering both angles on the climate/ energy solutions. These are "industrial energy efficiency & conservation" and "Geothermal". Other renewable energy technologies are lower in the WWF ranking. In the overall "supply mix" combining energy savings (reducing the demand) and "low-carbon" energy sources, Geothermal (heat and electricity) could provide 77 Exajoules or 6% of the overall "supply mix".

* There are a large number of further estimates in various publications, e.g. USGS, Bonneville (1985), Wright (1991), Petty (1992, 1993), Wright (2000) and PERI (2000) which assess identified and undiscovered hydrothermal potential with a total potential ranging from 4,800 MWe to 153,000 (318,000) MWe for the next 30 years. (see: Entingh, D. "U.S. Geothermal Resources Review & Needs Assessment (EGS Report 2001-01), at: http://www.osti.gov/geothermal/servlets/purl/896527-VgPcxA/896527.pdf

Source: (1) GEA, Potential Use of Geothermal Energy, at: http://www.geo-energy.org/aboutGE/potentialUse.asp

U.S. INVESTMENT NEEDS FOR CURRENT PROJECTS

USD 9.5 billion for the currently planned projects in the U.S.

Glitnir's view on the investment required for the U.S. Geothermal Industry

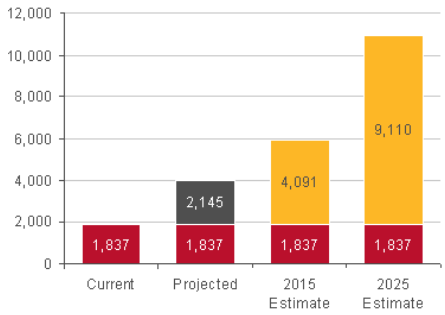
- Investment in geothermal power plants will be of a significant size for the years to come.
- For the currently planned projects (based on GEA's), Glitnir estimates investment needs of USD 9.5 billion.

Assumptions on a conservative basis:

- Drilling:
  - Average days per well, wells per year.
  - With current rig availability around 175 MW/ year could/ can be developed
- **Investment Cost[2]:**
  - Investment cost for each MW = USD 3.5 million (Current average numbers for geothermal development are giving an overall average cost figure of USD 3.5 million/ MW)

U.S. Annual Geothermal Electricity Sales

In mio. USD (Average 2005 $/kWh by individual State)



- **GEA assumptions for developing projects[1]:**
  - 74 projects with a total of confirmed and unconfirmed power capacity of 2,537.9-2,915.9 MW
  - Overall investment needs of USD 8.8-10.2 billion
  - With current availability of rigs, this can only be accomplished within or by 15 years from now.
  - Doubling the rigs available to projects can be done in 7-8 years

Source: (1) GEA, "May 2007 GEA Update on U.S. Geothermal Power Production & Development", at: http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf ; (2) Based on Sanyal, S.K., Morrow, J.M., Butler, S.T. (2007), Proceedings, Thirty-Second Workshop on Geothermal Reservoir Engineering; (2) Glitnir Research based on EIA Electricity Sales figures.

U.S. INVESTMENT NEEDS FOR THE NEXT 10-20 YEARS

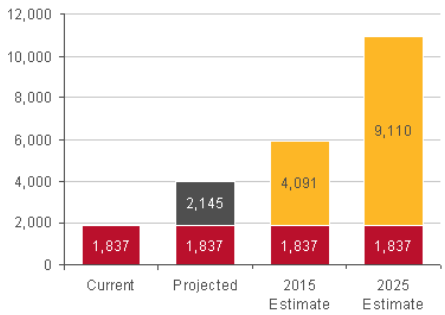
USD 16.9 billion for short term and USD 39.4 billion for long term

Glitnir's view on investment needs for potential in the Western United States.

- Short and long term potential, as defined by the WGA report, includes current projected installations of geothermal power plant (GEA, see above).
- The investment need for developing the estimated resource (until 2015) is USD 16.9 billion.
- For the longer term development of the available resources (until 2025) is USD 39.4 billion.

U.S. Annual Geothermal Electricity Sales

In mio. USD (Average 2005 $/kWh by individual State)



Assumptions based on findings of the WGA Geothermal Task Force[1]:

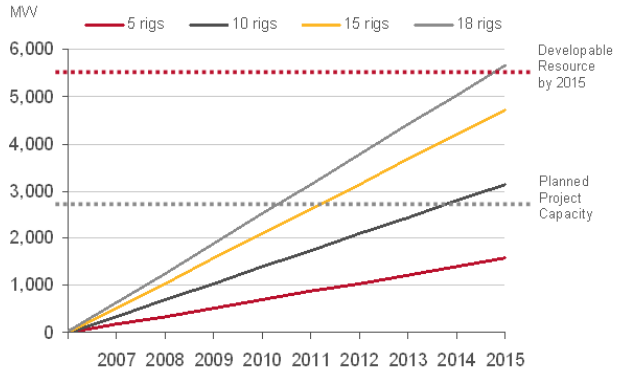
- Western Governor's Association, Clean and Diversified Energy Initiative, Geothermal Task Force Report 2005
- Detailed Geothermal Resource Capacity Estimates and individual site cost allocations
- Short Term 2015; defined as "near-market cost up to 8 cents/ kWh online within 10 years"
- Long Term 2025; defined as "longer term cost up to 20 cents/ kWh online within 20 years"
- Cost allocation range from USD 3,000 to 4,000/ kW
- Operation & Maintenance estimates of 1.8-2.6 cents/ kWh
  -

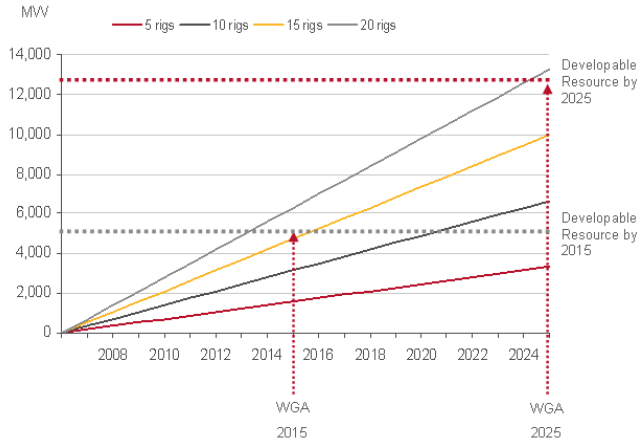
- Individual Site estimates by state (short term/ long term):
  - California: 25 areas, 2,375/ 4,703 MW
  - Nevada 43+ areas, 1,488/ 2,895 MW
  - Oregon 11 areas, 380/ 1,250 MW
  - Washington 5 areas, 50/ 600 MW
  - Alaska 4 areas, 20/ 150 MW
  - Arizona: 2 areas, 20/ 50 MW
  - Colorado: 9 areas, 20/ 50 MW
  - Hawaii: 3/ 4 areas, 70/ 400 MW
  - Idaho: 6+ areas, 855/ 1,670 MW
  - New Mexico: 6 areas, 80/ 170 MW
  - Utah: 5 areas, 230/ 620 MW

Source: (1) WGA, Geothermal Task Force Report January 2006, at: http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf (2) Glitnir Research based on EIA Electricity Sales figures.

U.S. GEOTHERMAL DEVELOPMENT NEEDS

To develop available resources the drilling capacity* needs to be heavily increased



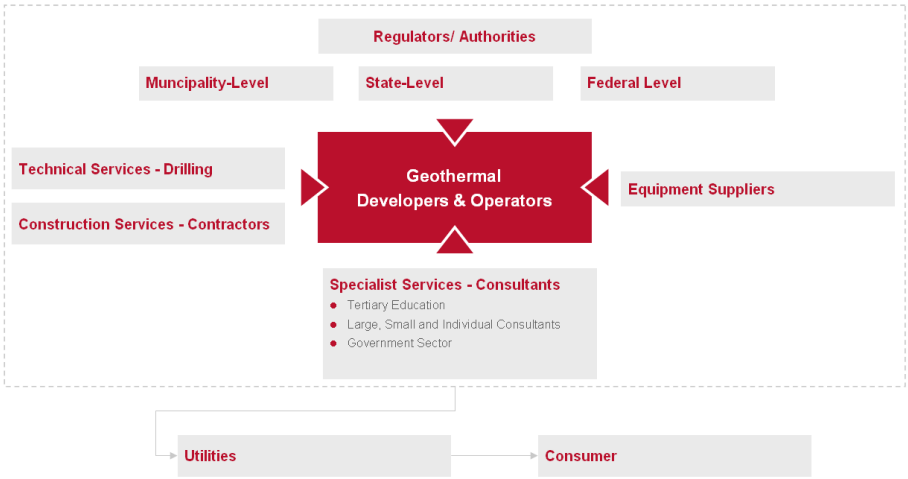


* Glitnir Research estimates based on conservative assumptions.

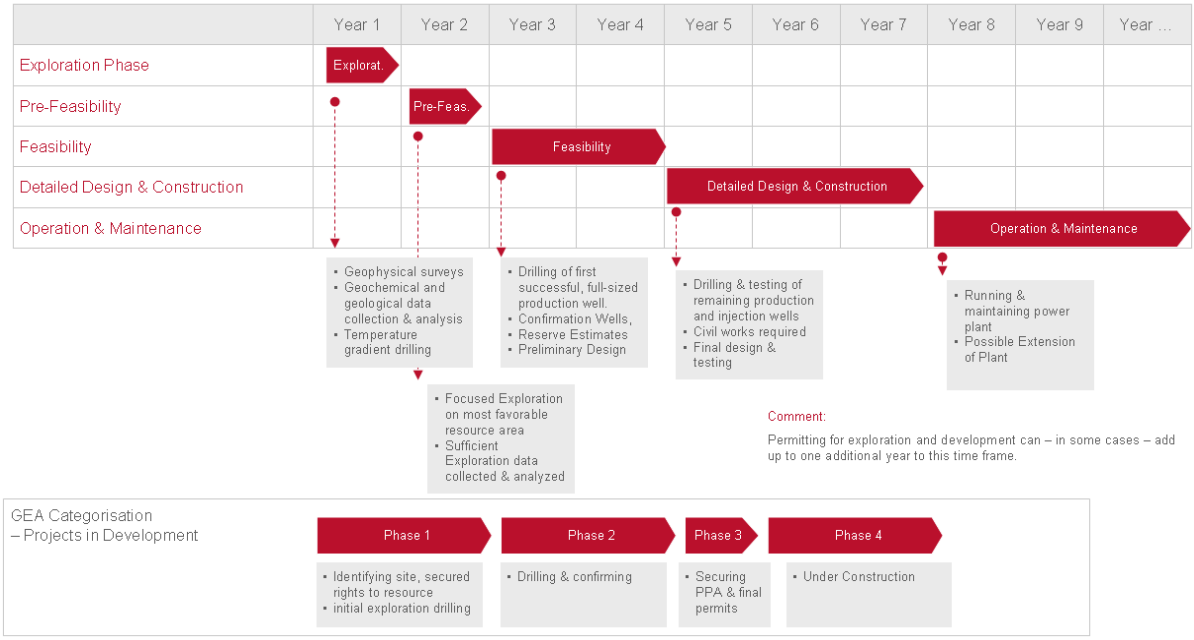
GEOTHERMAL ENERGY – MARKET & PLAYER, PROJECT TIMELINE

It is not uncommon for geothermal power projects to take around 7 years until the actual operation of the installation. This can also be 1-2 years more or less depending on permitting and other licensing issues. Projects for direct use of geothermal heat need less time. Both applications depend greatly on the success of drilling and the resources available. Clearly, like in any other industry depending on a drilling success raising capital can be difficult. Here the drilling success is the proven resource – in volume, temperature and pressure of the fluids. Generally a geothermal project can be divided into 5 different phases.

GEOTHERMAL INDUSTRY/ PLAYER OVERVIEW



GEOTHERMAL PROJECT TIMELINE ... generally a time intensive process



U.S. GEOTHERMAL ENERGY OPPORTUNITIES & CHALLENGES

OPPORTUNITIES

- Clear demand for renewable energy will go unabated for the foreseeable future – this is not only a fashionable, but a structural change.
- Political and social support for geothermal energy is just now being recognized as an important part of the renewable energy mix.
- There is a clear need for dependable, base-load electricity and geothermal is best positioned to deliver.
- While the first generation in the geothermal energy space was ahead of its time in many ways, the new generation has a group of sophisticated, well capitalized players who see the value creation opportunities and are more disciplined about moving forward.
- The resource base, as it is estimated today, has yet to be fully understood or analyzed – but the overall resource landscape looks strong.
- New technology, like Enhanced Geothermal Systems (EGS), will add further efficiencies and competitiveness to the industry in the years to come.
- The industry is very fragmented but has many opportunities for developing strong companies.
- Resource estimates for EGS show huge geothermal energy opportunities all over the U.S., meaning that in the future development can take place all over the US, rather than like today, where all of the development happens in the Western States.

CHALLENGES

- With the rapid development of the industry, there is an immediate need for additional expertise (from resource development to business management), support services (drilling capacity, data/information, technology, power generation equipment, etc.) and focused capital.
- There is still some fragmentation in the sector - to appropriately fund and develop the resource, consolidation will be required.
- Additional 'patient capital' is required from multiple sources.
- Partnerships between project developers, sponsors, utilities and end users should be strengthened to ensure the industry is built on a strong and stable foundation.
- Pressure will remain to ramp up projects at a rapid pace, requiring commitments from multiple players including the public sector.
- The geothermal industry competes with the oil industry for highly skilled staff. Current geothermal experts are coming of age.
- Further education is necessary to increase the industry talent pool, but more importantly incentives for people to join the industry are required. Overall project risks are higher with inexperienced scientists leading projects.
- Availability of rigs: the industry needs to be more competitive in securing access to the drilling equipment required to develop potential resources in the U.S.. For current projects alone the number of rigs needs to double. To exploit the overall potential even more rigs are needed to maintain the speed.
- Polical support needs to increase. Geothermal is the only real renewable base-load electricity option, yet does not get enough political support, e.g. through favorable incentives, to help in moving this sector forward. The short time frame of the Federal Production Tax Credit is one example of an incentive that is not taking into consideration factors of great influence on geothermal energy. Furthermore incentives for geothermal exploration are needed, which could help to cover at least parts of the drilling risk for geothermal.

GEOTHERMAL ENERGY ASSOCIATIONS

- U.S. Geothermal Energy Association (GEA)
  - Website: www.geo-energy.org

- Geothermal Resources Council (GRC)
  - Website: www.geothermal.org

- International Geothermal Association (IGA):
  - Website: iga.igg.cnr.it

GLITNIR GEOTHERMAL ENERGY OVERVIEW

Glitnir is a growing financial services group with strong foundations in its Nordic home markets, Iceland and Norway, offering universal banking and financial services. Services include retail, corporate and investment banking, stock trade/brokerage and capital management.

The Bank's drives its international expansion, based on two specialized industry sectors: Seafood and Geothermal Energy, where the bank has developed significant industry expertise built on its Icelandic and Norwegian heritage. Glitnir has served the energy industry in Iceland for decades and today works with companies in this sector all over the world.

Activities in these industry sectors require strong commitment, experience, knowledge and expertise, which Glitnir has accumulated through its dedicated industry teams. Operating on a global level those industry teams have been essential in building the leading position of the bank in those industry sectors. Glitnir focuses on all applications utilizing Geothermal Energy. The Bank's Global Geothermal Energy team is based in Reykjavik, Iceland, and works globally with the support of the Bank's offices and subsidiaries abroad.

UNIQUE BASIS FOR SUSTAINABLE ENERGY SERVICES

- Home markets, Iceland & Norway with more than 99% of electricity production from renewables (~9% in the United States).
- Iceland, one of the leaders of geothermal energy utilization for electricity production & direct use.
- Currently installed capacity (geothermal) in Iceland 422 MWe.
- Strategic partners with leading positions in the sector.

GLITNIR GEOTHERMAL BUSINESS ORIGINATION

- Extensive geographical and industry research.
- Industry player mapping & networks.
- Advisory for players in the geothermal sector, across the whole "value chain".
- Glitnir Geothermal Team members are located in:
  - Iceland and the U.S., but act globally

HOW CAN WE AS A GLOBAL LEADER IN GEOTHERMAL ENERGY HELP YOU TO GROW?

With our unique background and experience, we have a strong foundation for our activities in this industry. Our dedicated industry team, including geothermal reservoir specialists, provides us with unparalleled market knowledge in combination with strong banking skills. This enables us to fulfill the needs of companies across the value chain of the geothermal industry sectors providing opportunities for growth. Our expertise and understanding of the industry, as well as our ongoing efforts to promote geothermal energy makes us a valuable partner for our clients and companies in the industry.

SELECTED CUSTOMERS/ DEALS

ThermaSource L.L.C.

ARCLIGHT

CAITHNESS ENERGY

NGP Nevada Geothermal Power

CHAR LLC

Western GeoPower Corp.

GEYSIR Green Energy

JARÐBORANIR HF Iceland Drilling Company Ltd At Your Resources

HITAVEITA SUÐURNESJA HF

enex

CGC Overseas Construction Co Ltd.

陕西绿源地热能源开发有限公司 Shaanxi Green Energy Geothermal Development Co.,ltd

SINOPEC

DISCLAIMER

All opinions and analyses represent the views of Glitnir at the time of writing and are subject to change without notice.
Glitnir and its employees cannot be held responsible for any trading conducted on the basis of the information and views presented here.
Glitnir may at any time have vested interests in individual companies, for example as an investor, creditor or service provider, but its opinions and analyses are produced independently by the Glitnir Research division, based on publicly available information on the company in question.

This U.S. Geothermal Market Report was written by:
Alexander Richter
Director I Global Geothermal Energy – Glitnir International Banking:
alexander.richter@glitnir.is

CONTACT INFORMATION

GLOBAL GEOTHERMAL TEAM

Árni Magnússon	Managing Director, Head Global Geothermal Energy Team	+354 440 4688	Arni.magnusson@glitnir.is
Jóhannes Hauksson	Director	+354 440 4514	Johannes.hauksson@glitnir.is
Alexander Richter	Director, Research & Communication	+354 440 4766	Alexander.richter@glitnir.is
Arnar Hjartarson	Analyst, Geothermal Reservoir Specialist	+354 440 4561	Arnar.hjartarson@glitnir.is
Berglind Sigmarsdóttir	Analyst	+354 440 4533	Berglind.sigmarsdottir@glitnir.is

GEOTHERMAL TEAM – GLITNIR CAPITAL CORP.

Jonathan Logan	Managing Director, Bus. Development, U.S. & Canada	+1 (212) 716 0101	Jonathan.logan@glitnirusa.com
Ignacio Kleiman	Managing Director, Corporate Finance	+1 (212) 716 0111	Ignacio.kleiman@glitnirusa.com
Michael Richard	Director, Business Management	+1 (212) 716 0104	Michael.richard@glitnirusa.com
Charles J. Arrigo II	Director, Corporate Credit	+1 (212) 716 0120	Charles.arrigo@glitnirusa.com
Julien Rosso	Senior Associate, Corporate Credit	+1 (212) 716 0112	Julien.rosso@glitnirusa.com