



Market Outlook

Geothermal electricity and heat are produced from hydrothermal (hot water) resources in the western United States, where such resources exist naturally. Researchers are currently determining the feasibility of utilizing nonhydrothermal resources via emerging technologies. Geothermal energy is beneficial for electric grids because it is always available and can produce baseload and/or flexible power generation throughout the day. Geothermal energy also provides more long-term jobs and more local operation and maintenance spending than most other energy sources and has a relatively small land use requirement.

Key BLM Geothermal Statistics

- 32 producing geothermal units³
• 2,471-MW nameplate capacity (512-MW post-2000)
• 2018 capacity factor⁴: 77.3%
• 79 producing leases³
• 98,704 acres in producing status³
• 565 geothermal wells\*³

U.S. direct-use and district heating systems (2016):

- 21 district heating installations⁵
• 100 MWth installed capacity of district heating systems⁵
• 386 other direct-use installations⁵
• 401 MWth installed capacity of other direct-use systems⁵

\*Total geothermal well count includes Federal wells in injecting or producing status based on Geothermal Resources Automated Support System (GRASS) records. Note that GRASS is a dynamic system that is frequently updated.

Geothermal Energy

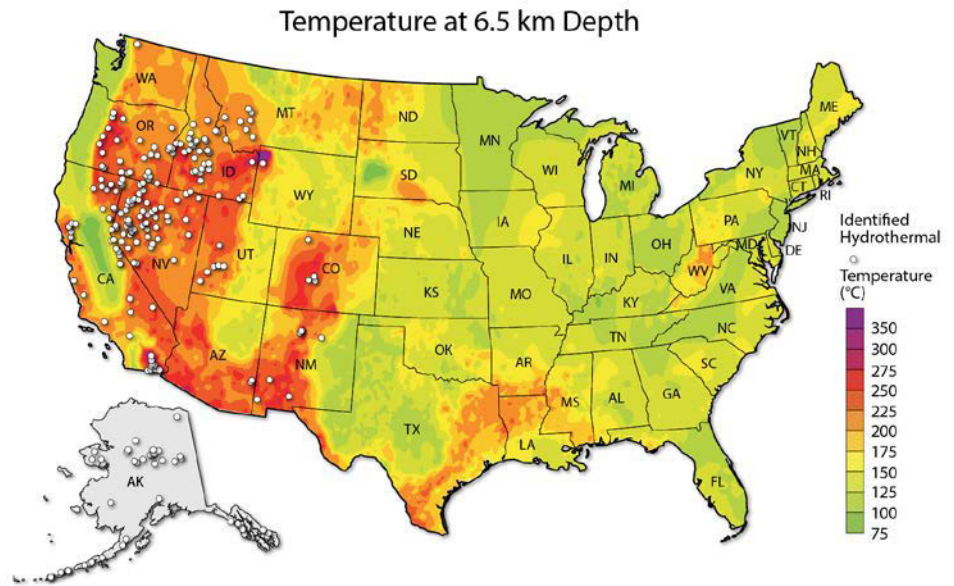


Image by Billy J. Roberts, NREL. See the References section of this fact sheet for source data for the identified hydrothermal systems¹ and for temperature at depth.²

Geothermal Energy Technology Basics:

Geothermal power plants come in several varieties. The type of plant deployed depends on resource temperature, permeability, and the state of the fluid.⁶

- Dry steam plants draw primarily steam from underground reservoirs directly into the turbine/generator unit.⁶
• Flash steam plants also utilize steam, but not directly from the reservoir. High temperature fluids are pumped to the surface where pressure is much lower, causing a portion of the fluids to vaporize or flash. The steam is separated from the water and passed through a turbine/generator unit.⁶
• Binary cycle plants extract low- to moderate-temperature fluids that are passed through a heat exchanger where a secondary fluid with a much lower boiling point is heated. Heat from the geothermal fluid causes the secondary fluid to vaporize, and the steam drives a turbine/generator unit.⁶
• Direct-use and district heating systems use lower-temperature geothermal fluids pumped from springs or reservoirs near the surface through heat exchangers or directly into buildings for heating applications and hot water demands.⁵

In addition to conventional hydrothermal geothermal resources which require a hot, permeable, fluid-filled reservoir, the following emerging technologies have potential to expand geothermal utilization in the United States:

- An Enhanced Geothermal System (EGS) is an emerging technology in which man-made geothermal systems are created in hot rock with insufficient natural permeability and fluid circulation.⁷
• Deep Direct-Use (DDU) utilizes lower-temperature geothermal resources for large-scale heating and cooling applications. DDU research includes subsurface thermal energy storage, which carries potential for primary and contingent energy sourcing for areas underlain by certain types of aquifers.⁸

## Leasing and Permitting Basics

The Bureau of Land Management (BLM) has delegated authority for issuing leases and approving development of geothermal resources on Federal public lands, including National Forest System lands administered by the U.S. Forest Service, under the Geothermal Steam Act of 1970 (GSA), as amended by the Energy Policy Act of 2005 (30 U.S.C. 1001 et seq.). The BLM's geothermal regulations can be found at 43 CFR Part 3200 and contain information on BLM's geothermal leasing (subpart 3200), exploration (subpart 3250), drilling (subpart 3260), and utilization (subpart 3270) regulations. BLM geothermal regulations for geothermal resource unit agreements are located at 43 CFR Part 3280. In addition to the GSA, all activities on geothermal leases on BLM-managed mineral estates must be in compliance with other applicable Federal, state, and local permitting and regulatory requirements.

## Geothermal Power Sector Jobs

The geothermal power sector employed 8,526 people in 2018. The majority of geothermal jobs were construction related (5,016), followed by the professional services industry (1,727), and employment by electric utilities (1,116).<sup>10</sup>

## References

1. U.S. Department of the Interior. U.S. Geological Survey. 2008. "Assessment of Moderate- and High-Temperature Geothermal Resources of the United States." <https://pubs.usgs.gov/fs/2008/3082/>
2. Blackwell, David, et al. 2011. "Temperature-At-Depth Maps For the Conterminous US and Geothermal Resource Estimates." Southern Methodist University Geothermal Laboratory. <https://www.osti.gov/biblio/1137036>
3. U.S. Department of the Interior. Bureau of Land Management. 2018. Public Land Statistics. <https://www.blm.gov/sites/blm.gov/files/PublicLandStatistics2018.pdf>
4. U.S. Energy Information Administration. 2019. Electric Power Monthly. "Table 6.07.B Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels," January 2013–April 2019. [https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_b](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)
5. U.S. Department of Energy. 2019. Geovision: Harnessing the Heat Beneath Our Feet. <https://www.energy.gov/sites/prod/files/2019/06/f63/GeoVision-full-report-opt.pdf>
6. U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. "Geothermal Electricity Generation." <https://www.energy.gov/eere/geothermal/electricity-generation>
7. U.S. Department of Energy. 2016. Geothermal Technologies Office. Enhanced Geothermal System Factsheet. <https://www.energy.gov/sites/prod/files/2016/05/f31/EGS%20Fact%20Sheet%20May%202016.pdf>
8. U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. "Energy Department Explores Deep Direct-Use." <https://www.energy.gov/eere/geothermal/downloads/energy-department-explores-deep-direct-use>
9. Electric Power Research Institute. 2012. "Land Use for Wind, Solar, and Geothermal Electricity Generation Facilities in the United States." Technical Report. <https://www.epri.com/#/pages/product/1023819/>
10. National Association of State Energy Officials and Energy Futures Initiative. 2019. "The 2019 U.S. Energy & Employment Report." <https://www.usenergyjobs.org/s/USEER-2019-US-Energy-Employment-Report.pdf>
11. U.S. Department of the Interior. Natural Resources Revenue Data. 2018. "Federal Revenue Data." <https://revenue.data.doi.gov/explore/revenue/>

## Land Disturbance

Capacity-weighted land disturbance is based on analysis of annual megawatt-hours (MWh) of generation and direct land disturbance caused by well pads, pipelines, power plants, and roads. This value has decreased over time as power plants have become more efficient. A previous study found geothermal power to have the lowest direct land disturbance by MWh/acre among non-hydropower renewable energy sources.<sup>9</sup>

Direct Land Disturbance	
Number of Projects Analyzed	22
Direct Land Disturbance (acres)	2,430.6
Capacity-Weighted Generation (MWh/acre)	206

## Competitive Leasing Data

	Competitive Geothermal Leases Prior to Energy Policy Act of 2005 <sup>3</sup>		Competitive Geothermal Leases Under the Energy Policy Act of 2005 <sup>3</sup>	
	Leases as of 9/30/2018		Leases as of 9/30/2018	
	Number	Acres	Number	Acres
California	60	79,360	9	14,975
Colorado	0	0	3	9,152
Idaho	0	0	10	20,525
Nevada	31	26,558	111	216,765
New Mexico	1	280	2	8,249
Oregon	7	5,009	6	14,854
Utah	7	6,059	14	29,520
<b>Total</b>	<b>106</b>	<b>117,266</b>	<b>155</b>	<b>314,040</b>

## Noncompetitive Leasing Data

Noncompetitive Geothermal Leases <sup>3</sup>		
	Leases as of 9/30/2018	
	Number	Acres
Alaska	3	7,680
California	14	12,158
Nevada	64	89,233
New Mexico	1	640
Oregon	14	17,347
Washington	4	8,436
<b>Total</b>	<b>100</b>	<b>135,494</b>

## Federal, State, and Local Revenue<sup>†</sup>

Federal Revenue from Geothermal Energy—FY18 <sup>11</sup>	
Royalties	\$12,995,371
Rents	\$1,367,993
Bonuses	\$38,422
Other Revenues	\$278,622
<b>Total</b>	<b>\$14,680,408</b>

<sup>†</sup> Except with respect to lands in the State of Alaska, all monies received by the United States from sales, bonuses, rentals, and royalties must be paid into the Treasury of the United States. Of these funds, 50 percent are paid to the State within the boundaries of which the leased lands or geothermal resources are located, 25 percent must be paid to the county within the boundaries of which the leased lands or geothermal resources are located, and the remaining 25 percent are retained by the Treasury of the United States. 30 U.S.C. § 1019(a).



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The data, results, and interpretations presented in this document are based on prior published products. The data, results, and interpretations presented in this document have not been reviewed by technical National Renewable Energy Laboratory experts outside NREL or BLM.