Photo by Dennis Schroeder, NREL

Initial Results from the *2020 U.S. Geothermal Power Production and District Heating Market Report*

The ***2020 U.S. Geothermal Power Production and District Heating Market Report*** is being developed by the National Renewable Energy Laboratory and Geothermal Rising, previously Geothermal Resources Council (GRC), with support from the Geothermal Technologies Office of the U.S. Department of Energy. The report is intended to provide geothermal policymakers, regulators, developers, researchers, engineers, financiers, and other stakeholders with up-to-date information and data reflecting the 2019 geothermal power production and district heating markets, technologies, and trends in the United States. Analysis of the current state of the U.S. geothermal market and industry for both the power production and district heating sectors will be presented, with consideration of developing power projects. In addition, the report will evaluate the impact of state and federal policy, present current research on geothermal development, and offer a future outlook for the U.S. geothermal market and industry.

Between 2009 and 2016, the Geothermal Energy Association (GEA) published an annual ***U.S. Geothermal Power Production and Development Report.***[1] These reports presented a yearly snapshot of the state of the geothermal power industry and tracked the status of geothermal power deployment, developing projects, and emerging geothermal technologies in the United States. The National Renewable Energy Laboratory/ Geothermal Rising report is an effort to reevaluate the state of the industry since the final GEA report in 2016 and recommence this publication. Data for the 2020 report are compiled from previous GEA reports, the U.S. Energy Information Association (EIA), and from a Geothermal Rising industry survey conducted in 2020 via a questionnaire sent to all known companies operating U.S. geothermal power plants or with projects in development.

Following is a summary of the updated U.S. power production and developing project data collected for the 2020 report.

[1] For more information and links to each year's report, visit: https://www.geothermal.org/Policy_Committee/Policy_Committee_Documents.html

Geothermal Power Generation Capacity

Geothermal capacity and generation in the United States have grown little since the 2016 GEA report. As seen in Figure 1, the current nameplate capacity of 3,673 MW is marginally higher than the 3,627 MW that the GEA reported for 2015. When pushing the comparison back to 2013, there has been a small nameplate capacity increase of 119 MW. However, winter net capacity has remained relatively static during this time, while summer net capacity has steadily declined.

Actual utility-scale geothermal power generation exhibits a similar trend. For the purposes of this comparison, actual generation has been divided by total hours in a year to create a "mean net generation" capacity (Pettitt et al. 2020). The mean net generation capacity calculated from the actual generation that the EIA reported for 2018 (the most recent data available at the time of publication) is 1,823 MW, which is slightly more than the 1,817 MW calculated for 2015. Moreover, the 2018 power production is less than the 1,917 MW calculated for 1990, the first year the EIA published this data. Pettitt et al. (2020) examine the capacity versus production metrics in greater detail using EIA data back to 2007.

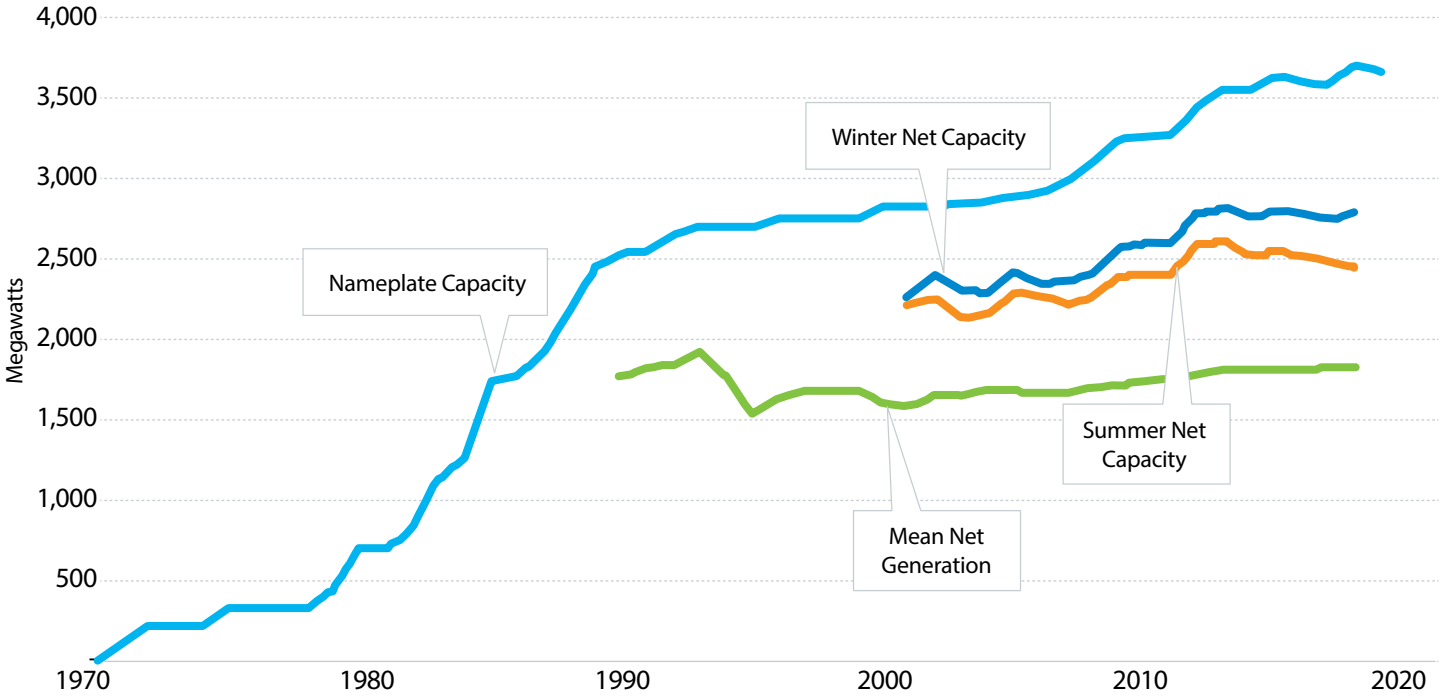

Figure 1. U.S. industry geothermal nameplate and net capacity, as well as mean net generation (an effective capacity value calculated by dividing actual geothermal generation by the total hours in a year).

Sources: EIA 2019a, EIA 2019b, and Matek 2016

Geothermal Power Production Fleet Age

One consequence of the lack of geothermal capacity growth is that with relatively few new plants being built, the U.S. geothermal power production fleet has aged. Currently, 44% of U.S. geothermal plants (Figure 2) are more than 30 years old, which represents 64% of the total geothermal nameplate capacity (Figure 3). This can be compared to the 4% of plants (representing 11% of the geothermal capacity) that were more than 30 years old at the time of the first GEA report in 2009. As older geothermal plants and fields tend to experience a reduction in capacity, the relatively advanced age of the geothermal fleet likely accounts for the previously noted capacity stagnation and decrease in power generation from 1990 to 2018.

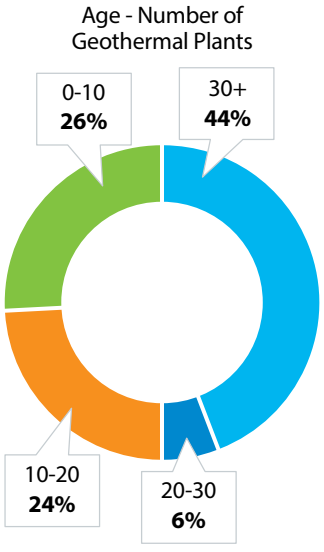

Figure 2. Age of U.S. geothermal plants by % of total number

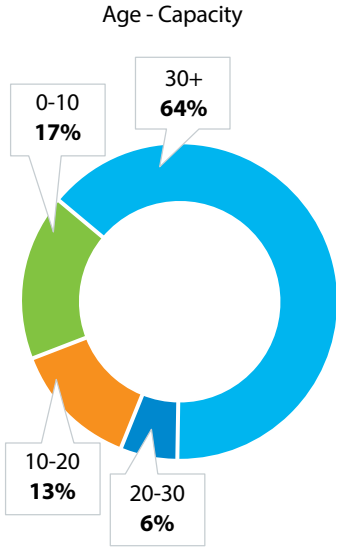

Figure 3. Age of U.S. geothermal plants by % of capacity

Geothermal Capacity by Plant Technology Type

Figure 4 shows that dry steam and flash technology formed the foundation of the U.S. geothermal power production capacity. However, other than one triple-flash plant in 2011, all geothermal capacity additions from 2000 through 2020 have been binary plants. Binary technology allows lower-temperature resources to be used, but the capacity of a binary plant is inherently smaller than a plant using the older technologies. These smaller binary plant capacities, along with the previously noted advanced age of the geothermal fleet, contribute to the stagnation of geothermal capacity growth. Thus, beginning in 2013, essentially all capacity gains from new binary plants have been offset by decreases in the capacity of the older steam and flash plants.

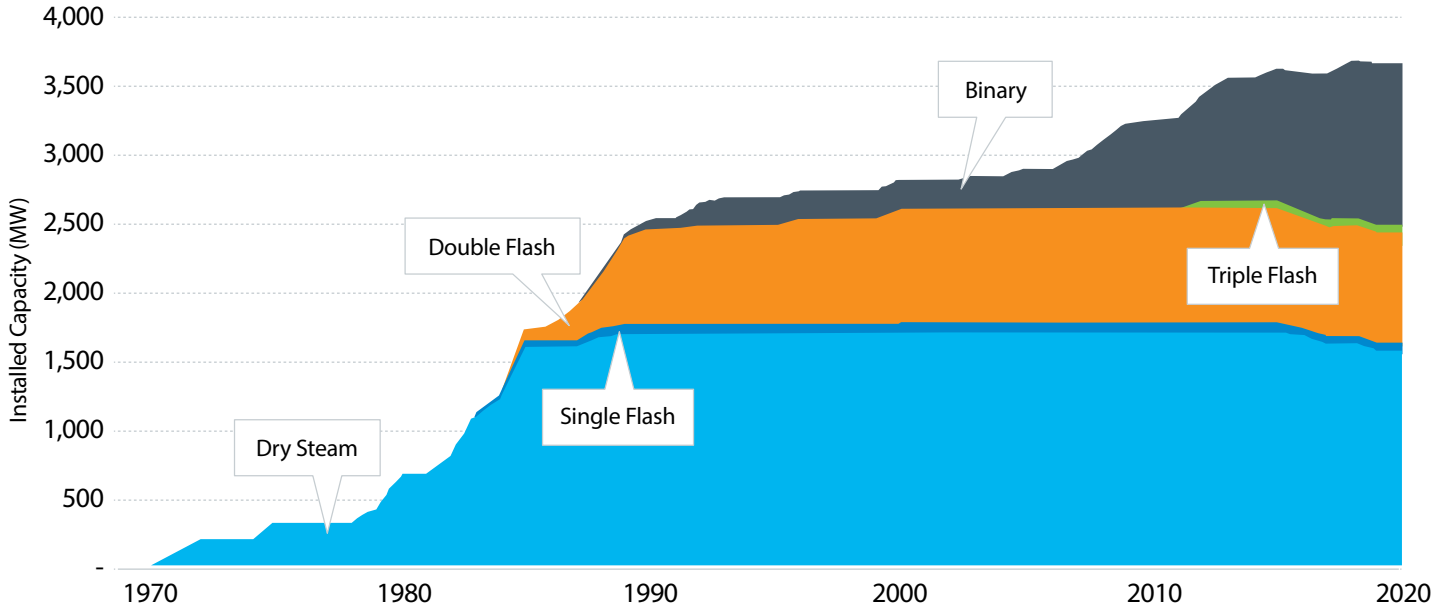

Figure 4. U.S. geothermal capacity by plant technology

Projects in Development

Information on geothermal projects in development was collected from Geothermal Rising's 2020 industry survey. Survey participants were asked to classify their projects as "prospects" or in Phases 1 through 4. Projects categorized as "prospects" are early in development, and projects in Phase 4 are nearing completion. Geothermal companies operating in the United States have a combined 58 active projects and prospects across nine states. Of these projects, five are in Phase 4. As seen in Figure 5, this represents a large decrease in developing projects. In addition, of the 77 projects that were listed in various stages in the 2016 GEA report, 2 have been completed, 25 are still active, and 50 are no longer in development.

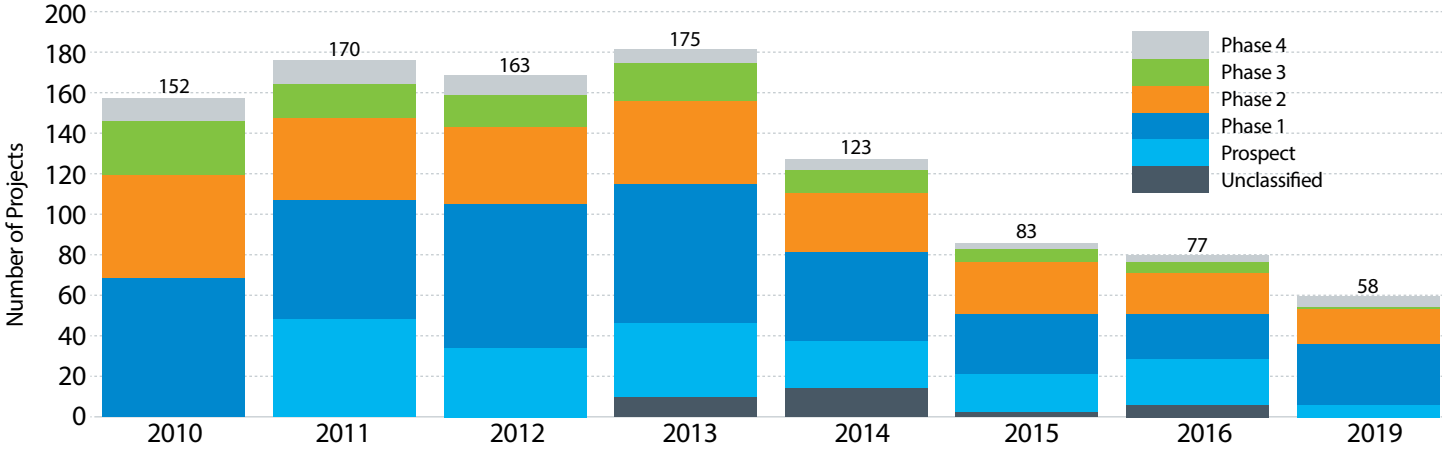

Figure 5. Developing projects by year and phase

Future Outlook

Although the geothermal industry power generation numbers were relatively stagnant from 2016 to 2019, there is reason to expect capacity growth in the near future. Nine new geothermal Power Purchase Agreements have already been signed since late 2019, including one each in Utah, Hawaii, and Alaska, and six in California (Howard 2020). Contained in these agreements are plans for the first two geothermal power plants to be built in California in a decade (Roth 2020). In addition, after the data for this report were collected, Ormat brought the Steamboat Hills expansion online, increasing its generating capacity by 19 MW.

Figure 6. Geothermal power purchase agreements signed from November 2019 through September 2020.

References

Energy Information Administration. 2019a. Annual Electric Generator data. https://www.eia.gov/electricity/data/eia860/.

Energy Information Administration. 2019b. Table 3.1.B. Net Generation from Renewable Sources: Total (All Sectors), 2004–2018. Electricity. http://www.eia.gov/electricity/annual/html/epa_03_01_b.html.

Howard, K. 2020. *Geothermal Power Purchase Agreements on the Rise*. Geothermal Resources Council Bulletin, Vol. 49, No. 3. June 2020. https://geothermal.org/pdfs/Power-Purchase-Agreements-on-the-Rise-FINAL.pdf?utm_source=grcbulletin&utm_medium=grcblog&utm_campaign=june2020.

Matek, B. 2016. Geothermal Energy Association. 2016 Annual U.S. & Geothermal Power Production Report. https://www.geothermal.org/Policy_Committee/Documents/2016_Annual_US_Global_Geothermal_Power_Production.pdf.

Pettitt, W., B. Schmidt, and J. Robins. 2020. *Baseline Geothermal Power Capacity in the USA and California*. Geothermal Resources Council Transactions, Vol. 44, 2020.

Roth, S. 2020. *California needs clean energy after sundown. Is the Answer under our feet?* Los Angeles Times. https://www.latimes.com/environment/story/2020-01-22/california-needs-clean-energy-after-sundown-geothermal-could-be-the-answer.

NREL Transforming ENERGY

National Renewable Energy Laboratory
15013 Denver West Parkway, Golden, CO 80401
303-275-3000 • www.nrel.gov

NREL prints on paper that contains recycled content.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

NREL/FS-5500-77774 • October 2020