U.S. Geothermal Electric Power Sector:
Good for America's Energy System and Economy

The Geothermal Energy Association represents over 100 companies in the American geothermal power industry. That industry supports a workforce of almost 12,000 full-time jobs in the United States. Our nation's leading developers and energy producers run 104 operating plants in nine (9) states with a capacity of 3,700 Megawatts at a replacement value of over $20 billion[1]. There are over 80 new projects in development.

Geothermal delivers a triple bottom line to our energy system: It is an abundant domestic energy source, it brings economic benefits in the form of taxes and long term high-paying jobs, and it has one of the lowest Levelized Costs of Energy (LCOE)[2] of all power sources in the United States[3].

Geothermal assets typically have 30-50 year lifecycles and the sector employs more workers during drilling, exploration, construction and power operations than any clean energy source, with workforces comparable to coal, gas and nuclear power.

Hundreds of small and large American businesses in the geothermal supply chain, together with large crews operating 24/7, help deliver this valuable power into the electric grid.

In 2015, U.S. geothermal plants made enough electricity to power 30 million homes[4], at 15.9 billion kilowatt-hours (kWh) that is 0.4 percent of total U.S. electricity generation.

In the U.S., geothermal plants often serve utilities, but we've also built them to directly power refineries, milk pasteurization and agricultural processing plants, and gold and silver mining facilities. Direct-use geothermal uses could be expanded to the benefit of the economy and industry.

Geothermal energy is a near zero-emission electricity resource.
It runs 24/7 or can be scheduled for system flexibility and peak energy needs.

Geothermal Provides Energy the Grid Needs
Baseload, Load-Following, Spinning and Non-Spinning Reserve Energy

Geothermal provides numerous values to the grid that intermittent power sources cannot. Known to be a baseload generation technology, advancements in geothermal production make it possible to provide ancillary and on-demand services, such as load-following or energy imbalance services, spinning reserves, non-spinning reserves, and replacement or supplemental reserves. This helps load serving entities avoid additional costs from purchasing and then balancing intermittent resources with storage or new transmission. Flexible projects are operating in three states with several more planned, based on demand.

The Puna Geothermal Venture (PGV) is a flexible geothermal plant built and operated by Ormat Technologies, Inc.
The 38 Megawatt capacity project can provide 16 MW of on-demand energy on an almost immediate basis to its purchasing utility.

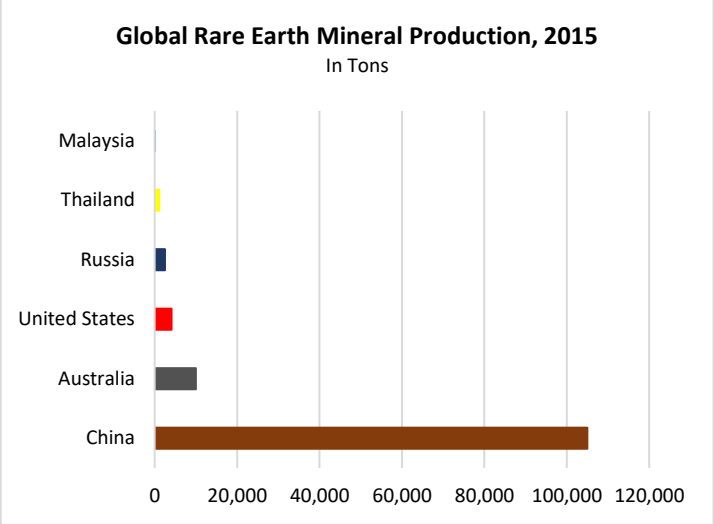
[1] 2015 Annual U.S. and Global Geothermal Power Production Report, Nov. 2015, http://geo-energy.org/reports/2015/2015%20Annual%20US%20%20Global%20Geothermal%20Power%20Production%20Report%20Draft%20final.pdf
[2] Levelized Cost of Energy (LCOE) is one of the primary metrics used by the electric power, utility and finance industries to estimate the cost of electricity produced by a given electric resource or generator. In the Lazard 10.0 analysis referenced in this document, LCOE is performed on a $/Megawatt-hour basis. It includes capital construction and operating costs, and sensitivities to factors such as, fuel prices, tax subsidies, geography, and cost of capital.
[3] Lazard's Levelized Cost of Energy Analysis—Version 10.0, Dec. 2016, https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf
[4] U.S. Energy Administration, Electric Power Annual 2015, Nov. 2016, Independent Statistics & Analysis, https://www.eia.gov/electricity/annual/pdf/epa.pdf

New Secondary-Uses for Geothermal Can Induce Industrial Growth in America and Help Our National Security Issues

Exciting opportunities in extracting minerals from geothermal brines could bring the U.S. new sources of lithium, zinc, manganese, potash and rare earth minerals, now dominated by China[5]. (In 2015 the only U.S. rare earth production facility closed as part of a bankruptcy proceeding.) Minerals can be extracted from the brine at geothermal facilities prior to reinjection.

Mining our own minerals would reduce our reliance on foreign sources of these important and expensive elements, and enhance our competitive advantage.

Reliable access to affordable minerals is crucial to America's defense and technology sectors.



Geothermal Mitigates Water and Drought Impacts

Wastewater recycling

Calpine, America's largest natural gas and geothermal electricity generator, injects over 15.5 million gallons per day (MGD) of wastewater from two counties at their Geysers power plant complex, one of the largest geothermal operations in the world. The Geysers converts the water into steam and supplements the production of original reservoir steam to the Geysers power plants. Wastewater recycling saves the counties millions in expenses and could be replicated at other geothermal sites.

Creative solution at Lake Mead, on the Colorado River and at the Salton Sea

The multi-state problem of water flows on the Colorado River and dangerously low levels at Lake Mead could be relieved using geothermal energy to desalinate the dying Salton Sea. If geothermal powered a water desalination plant, the Sea's water intake from the Colorado River could be reduced substantially. The saved water could be redirected to other Colorado River users and help restore the water levels at Lake Mead. The cost of the plant could be covered by the sale of the new fresh water.

Conveying water around the West

Moving water requires large amounts of electricity. In some Western states, water conveyance accounts for 20 percent of the state's total energy consumption. Geothermal could be used to move water in a cost-effective way, helping rural water co-ops, the Western Area Power Administration, private water conveyors and other users.

[5] Rare Earth Investing News, Top Rare Earth Producing Countries, November 1, 2016, http://investingnews.com/daily/resource-investing/critical-metals-investing/rare-earth-investing/top-rare-earth-producing-countries-2013-U.S.gs-2/ .

Geothermal Electric Power Boosts Local and Regional Economies in a Big Way

The local and regional economic benefits of geothermal power plants cannot be overstated. In some counties, geothermal energy is the largest employer and often the largest taxpayer. Geothermal energy developments also pay more taxes than any other clean energy resource. Geothermal resources, generally developed in rural areas, can transform some of America's most economically disadvantaged areas into technology hubs, keeping communities healthy and families whole.

The economic benefits of a typical 30 MW geothermal plant during its 30-year lifecycle:

- $150-225 million inbound capital investment to build the plant (cost dependent on technology)
- Up to 50 long-term jobs to run it
- Many supply chain companies each year to assist and supply plant operators
- $9.5-16.5 million paid in property taxes to the state and county
- $18-33 million paid in annual royalties to the land owner(s)
- Average construction period 2-4 years with a construction team of 100+ full-time jobs (FTE)
- Average geothermal worker operating the plant will earn about $70,000 per year
- Millions in employee, employer, sales and other taxes paid to Federal and state governments
- Social, environmental and economic justice in rural and disadvantaged areas.

Market and development barriers have limited the U.S. geothermal potential.

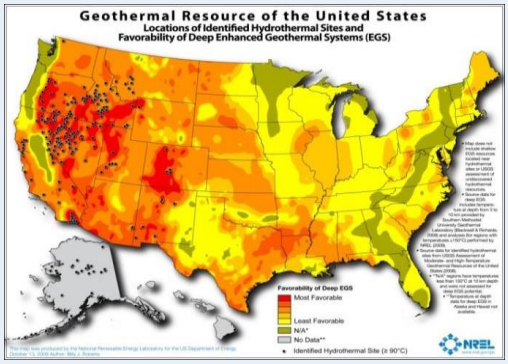
There are over 30 Gigawatts of geothermal capacity in the U.S. with 83 active projects (over 1,250 MW) stuck in development limbo[6].

The US is the world leader in utility-scale geothermal production. Unfortunately, that lead has been slipping as asymmetrical market-subsidies undercut new US geothermal development, federal regulation created duplicative hurdles to development, and investment in new technology development by the US has lagged.

Geothermal does not enjoy the subsidies and tax credits other energy resources do, yet its unsubsidized Levelized Cost of Energy is still lower or comparable to most energy sources, including natural gas, nuclear and other renewable resources[7]. America's geothermal fleet also provides a natural hedge against fuel price volatility, making it an ideal long-term energy source for ratepayers on the U.S. grid[8]

Nevertheless, U.S. utilities have flocked to wind and solar. Even battery storage, whose LCOE is many times greater than geothermal, has gotten more procurement in the last few years than geothermal electricity.

Over the last several years, new technology demonstration and exploration projects in the field of Enhanced Geothermal Systems (EGS) have occurred in Texas, Idaho, North Dakota, Louisiana, Montana, Mississippi, and Wyoming. In 2013, the Churchill County geothermal project increased production by 38 percent with the installation of the Desert Peak 2 EGS system. With continued development of EGS technologies, nearly every state could have cost-effective geothermal within the next 10-15 years. The Massachusetts Institute of Technology estimates the U.S. has 100 GWe (energy) in cost-competitive EGS capacity that could be developed in the next 50 years[9].



[6] 2016 Annual U.S. & Global Geothermal Power Production Report, Geothermal Energy Association, http://geo-energy.org/reports/2016/2016%20Annual%20U.S.%20Global%20Geothermal%20Power%20Production.pdf
[7] Lazard's Levelized Cost of Energy Analysis—Version 10.0, Dec. 2016, page 3 https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf
[8] Lazard's Levelized Cost of Energy Analysis—Version 10.0, Dec. 2016, page 6. https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf
[9] The Future of Geothermal Energy, Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century, MIT, Nov. 2006, https://energy.mit.edu/wp-content/uploads/2006/11/MITEI-The-Future-of-Geothermal-Energy.pdf

Risk Reduction in Drilling and Exploration, Tax Code Certainty and Permit Streamlining on Public Lands Needed to Expand Geothermal Development.

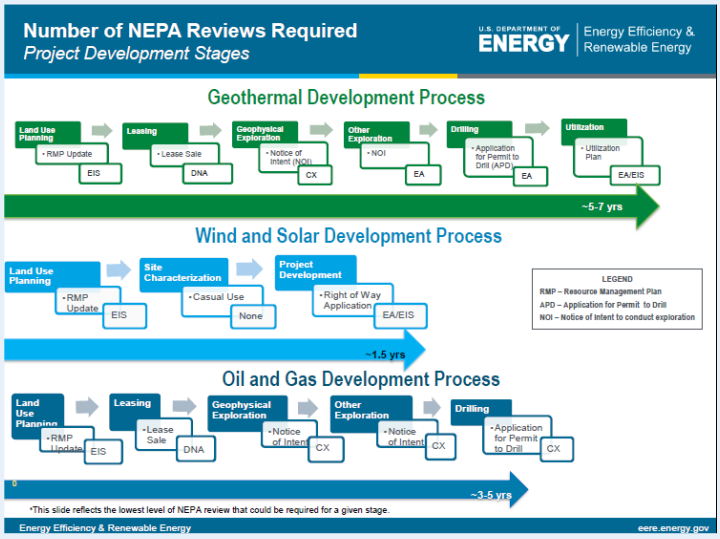
Risk mitigation: Risk mitigation is a critical component to expand geothermal production and reduce project costs. A sustained effort to address the risks in geothermal exploration would pay scientific, technological and financial benefits to the U.S. energy system, ratepayers and American workers.

Public-Private partnership for exploration: Most of the geothermal resource in the U.S. has yet to be discovered. DOE and USGS should establish a risk-reduction effort that rewards early drilling and exploration by supporting grants for cost-shared exploratory drilling and by funding collaborative research to improve drilling advancements.

Expeditious permitting: Time is money. Geothermal needs timely decision-making from Federal agencies to accelerate leasing of public lands and permitting for drilling and exploration, development and construction.

- **Fast-Track Processing:** Lengthy permitting periods routinely bar geothermal projects from getting off the ground, and increase costs. Fixed response timelines and accountability in Federal agency performance will help speed project development and unlock investment. Geothermal should not take longer to permit than wind or solar.

- **Expedited NEPA Processing:** As with gas and oil, geothermal should have expedited permitting under the National Environmental Protection Act (NEPA) to allow exploration on public lands to proceed quickly and cost-effectively.



Tax parity: A level playing field is needed in U.S. tax code for geothermal to be able to compete fairly in the market. A long-term incentive for new geothermal power development would value geothermal's baseload and flexible attributes, its system reliability factor, and its ability to deliver affordable clean power to American homes and businesses. Geothermal should have parity with wind and solar, which are eligible for a 30% Investment Tax Credit through the end of 2021.

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