Statement of Paul A. Thomsen
Vice President, Business Development - Americas
Submitted to the U.S. Senate Committee on Energy and Natural Resources
June 20, 2019

Chairman and members of the committee, it is my honor to testify today on behalf of not only ORMAT Technologies, but also on behalf of the Geothermal Resource Council.

By way of introduction, ORMAT Technologies is a New York Stock Exchange registered company (symbol "ORA"). Ormat Technologies, Inc. is a leading geothermal company and the only vertically integrated company engaged in geothermal and recovered energy generation ("REG"). The Company owns, operates, designs, manufactures, and sells geothermal and REG power plants primarily based on the Ormat Energy Converter—a power generation unit that converts low-, medium-, and high-temperature heat into electricity. With 77 U.S. patents, Ormat's power solutions have been refined and perfected under the most grueling environmental conditions. Ormat has 584 employees in the United States and 762 overseas. Ormat's flexible, modular solutions for geothermal power and REG are ideal for a vast range of resource characteristics. The Company has engineered, manufactured, and constructed power plants, which it currently owns or has installed, to utilities and developers worldwide, totaling over 2,900 MW of gross capacity. Ormat's current 910 MW generating portfolio is spread globally in the U.S., Kenya, Guatemala, Indonesia, Honduras, and Guadeloupe. Ormat expanded its operations to provide energy storage and energy management solutions by leveraging its core capabilities and global presence, as well as through its Viridity Energy Solutions Inc. subsidiary. I have the pleasure of serving as Vice President of Business Development for the Americas.

The Geothermal Resource Council (GRC) is a non-profit professional association for the geothermal industry and community in the USA and abroad. Founded in 1972 and headquartered in Davis, California, the GRC has over 1,300 members from around the world working to advance our industry by supporting the development of geothermal energy resources through the communication of robust research, knowledge, and guidance. The GRC Policy Committee is a separate part of the GRC, independently funded by interested organizations, to advocate on behalf of the geothermal community. I have the pleasure of serving as Chair of the Policy Committee.

We applaud the U.S. Department of Energy and the Geothermal Technologies Office for initiating the GeoVision analysis and presenting the comprehensive roadmap that calls for broad Stakeholder action across the geothermal community. We can—and we must—move toward realizing the GeoVision deployment levels of 60 GW by 2050 for our nation.

1. Today's Geothermal Market

In 2017, for the first time, the combined energy and capacity values of geothermal energy significantly exceeded the value of solar photovoltaic (PV) resources in California. When you account for geothermal's ancillary services and operational flexibility, combined values climb to more than $40/MWh higher than solar PV. These calculations demonstrate that geothermal can compete with solar PV on a net cost basis, even as PV costs continue to decline.[1]

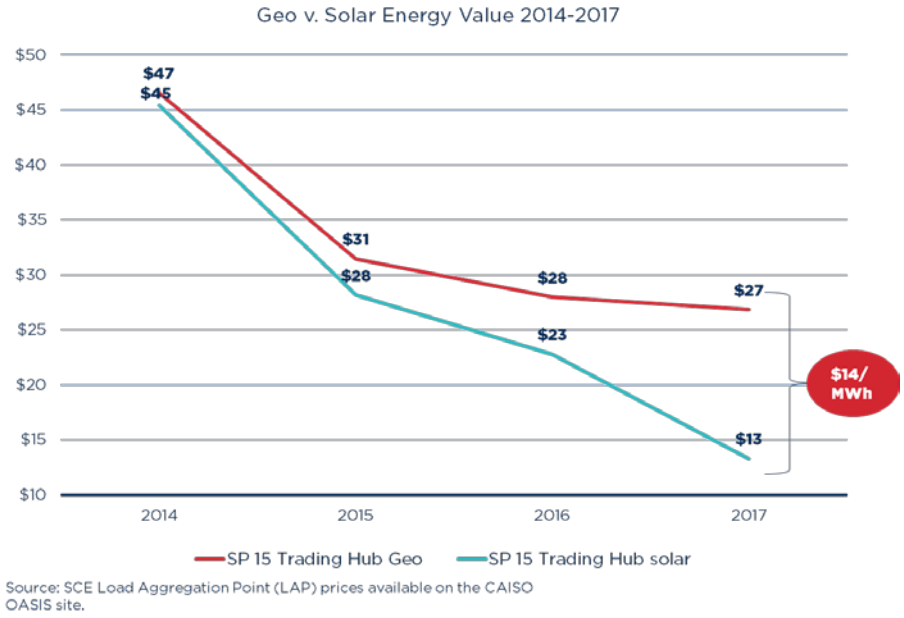
[1] Orenstein, R., Thomsen, P., The Increasing Comparative Value of Geothermal – New Market Findings and Research Needs, GRC Transactions, Vol. 41, 2017.
Thomsen, P., The Increasing Comparative Value of Geothermal in California-2018 Edition GRC Transactions, Vol. 42, 2018
Thomsen, P., Geothermal Selection in California Resource Planning: Preliminary results from CPUC's IRP Tools and Recommendations for future Development and Analysis, GRC Transactions Vol 42, 2018

Source: California ISO OASIS

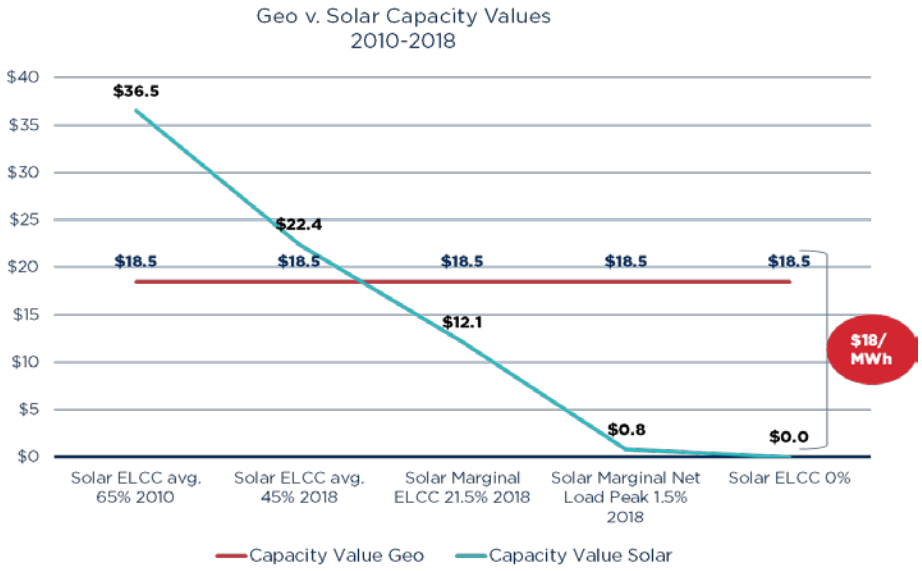
The California electric power system, like many in the nation, is undergoing many operational, reliability, and market changes due to the rapid penetration of solar PV. Solar penetration in California has increased from 500MW in 2010 to over 14GW today.[2] At low penetration levels (e.g., under 5 percent of annual energy), solar in California had high energy and capacity values because it generated during what were then the peak load hours.

As a result of increased solar penetration—and because now solar provides energy and capacity during times of low or even negative pricing—energy and capacity values for solar have plummeted. Geothermal can obtain higher energy and capacity values because it can produce outside the solar PV production hours during the new peak load hours, illustrated by the famous CAISO "duck curve."

[2] http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf



Source: Orenstein, R., Thomsen, P., The Increasing Comparative Value of Geothermal – New Market Findings and Research Needs, GRC Transactions, Vol. 41, 2017.

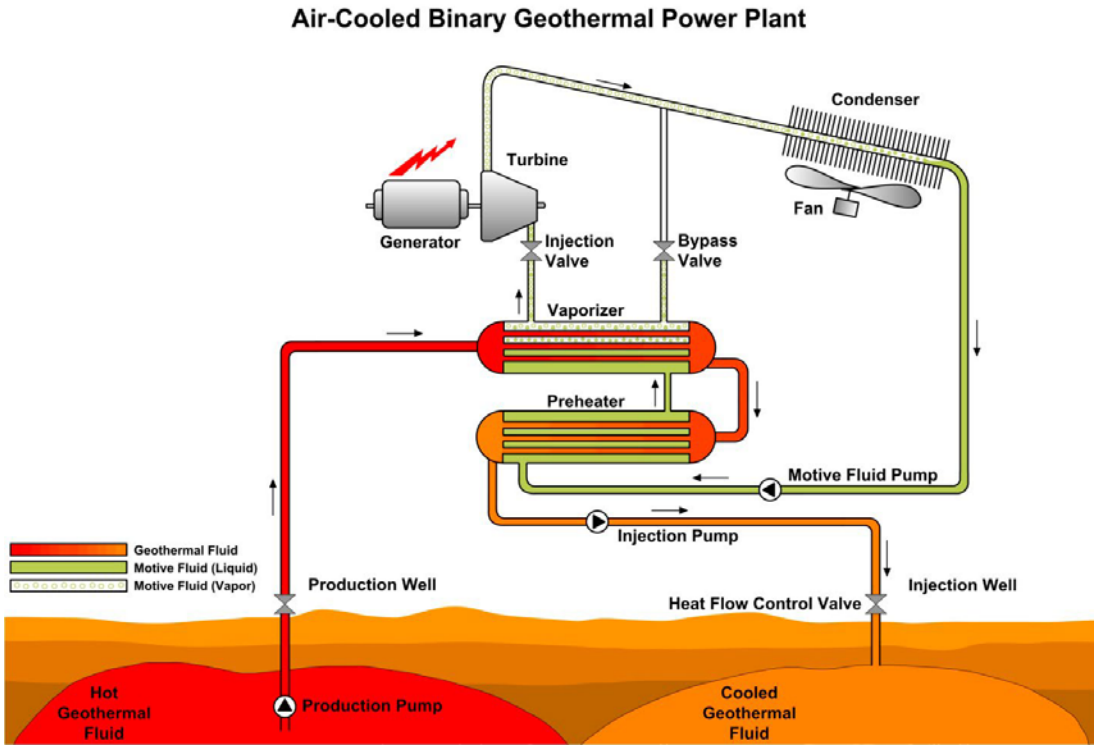


Source: Orenstein, R., Thomsen, P., The Increasing Comparative Value of Geothermal – New Market Findings and Research Needs, GRC Transactions, Vol. 41, 2017.

Geothermal's operational flexibility further enhances geothermal's value. For over 50 years, geothermal facilities have performed diligently to provide power 24 hours a day, seven days a week. So effective was the industry in marketing this attribute that many believe geothermal is solely a baseload resource. That is no longer the case. Since 2010, 96

percent of all installed geothermal facilities in the U.S. utilize a binary geothermal technology that can ramp up and down as fast, if not faster than, many "flexible" gas turbines such as the LM2500 or GELMS1003.

A binary geothermal facility cycles geothermal fluid through a set of heat exchangers, where the heat is transferred to a motive fluid that vaporizes and spins the turbo-generator, while the geothermal fluid is returned to the underground reservoir. Decoupling the geothermal reservoir and well field from the power generating equipment through the use of a working fluid allows binary geothermal facilities to operate in both a baseload or an operationally flexible mode that provides 100 percent dispatchability at unparalleled ramp rates—up to 30 percent of generator nameplate per minute—and can even be controlled by the system operator using Automatic Generation Control (AGC). Geothermal power plants offer additional benefits to grid stability like voltage support and inertia. Ormat's Puna geothermal facility in Hawaii has provided these services since 2011.[4]



Source: Ormat Technologies

After years of solar dominating new renewable energy contracts in California, utilities, the CAISO and CCA's are starting to appropriately value renewable resources that provide energy and capacity value while also being operationally flexible. On June 1, 2017, the Los Angeles Department of Water and Power (LADWP) announced it had entered into a new, 26-year power sales agreement for approximately 150MW of power to be generated by a portfolio of new and existing binary geothermal power plants. LADWP explained in its press release: "In addition to producing fossil-free power, geothermal energy offers many desirable benefits. Because it can provide continuous energy generation, a geothermal plant is expected to produce power at 95 percent or more of its capacity year-round—a higher capacity

[3] http://www.ge.com/mining/docs/2981884_1346772682_GE_Aeroderivative_Product_and_Services_Solutions.pdf
[4] Nordquist, J., T. Buchanan, and M. Kaleikini, Automatic Generation Control and Ancillary Services, GRC Transactions, Vol. 37, 2013.

than the wind or solar renewable energy resources. With its baseload predictability, geothermal energy also saves on transmission and other integration costs, as compared to variable renewables like wind and solar power."[5]

Independent System Operators are now looking for flexible resources that can perform the following functions:[6]
• sustain upward or downward ramp;
• respond for a defined period of time;
• change ramp directions quickly;
• store energy or modify use;
• react quickly and meet expected operating levels;
• start with short notice from a zero or low-electricity operating level;
• start and stop multiple times per day; and
• accurately forecast operating capability.

Geothermal stands alone in providing all of those operating capabilities while assisting in absorbing more variable renewable energy resources and reducing greenhouse gas emissions. Higher renewable penetration and greenhouse gas reductions are absolutely possible when utilities, regulators, and system operators appropriately evaluate, procure, and develop cost-effective, flexible renewable resources such as geothermal to meet goals.

2. "Increasing Access to Geothermal Resources" *(GeoVision 2019)*

Ormat and the Geothermal Resources Council Policy Committee have identified the following regulatory reform initiatives that enable the geothermal industry to deploy more megawatts on public lands, creating new jobs and royalty revenues for our local states and counties. The following recommendations are the result of extensive consultation within the industry, whitepapers, and a review of geothermal permitting conducted in 2013 and 2014 conducted by the National Renewable Energy Laboratory (NREL). NREL's researchers noted:

"Reducing the overall project time directly attributable to NEPA, whether by reducing the time of individual NEPA processes or reducing the frequency of NEPA analysis for a particular project, can alleviate some of the major barriers to geothermal development. Reducing NEPA timelines directly decreases overall project timelines which indirectly decreases the perceived risk profile—lowering three of the four barriers to geothermal development identified by industry. Lowering these barriers is in line with one of NEPA's stated goals: to "enhance the quality of renewable resources."

Therefore, we outline four targeted concepts below that will significantly relieve the permitting burden for the geothermal industry without undermining environmental stewardship. They are:

I. Strengthen the administrative categorical exclusion for geothermal resource confirmation drilling
II. The Public Land Renewable Energy Development Act (PLREDA)
III. Eliminate Casual Use permits for select geothermal exploration activities
IV. Transmission and Interconnection

Executing these suggested changes, many of which can be found in the geothermal title in S. 2012 (114th Congress, 2015-16), would help unlock new projects and their associated economic impacts.

I. In order for the geothermal industry to grow rapidly, Ormat and the GRC Policy Committee have requested that DOI or Congress issue a new rulemaking or memorandum to expand, clarify, and strengthen the administrative categorical exclusion (CX) from NEPA, to reduce the permitting burden for geothermal resource confirmation and

[5] http://www.ladwpnews.com/new-geothermal-project-helps-create-clean-energy-future-for-los-angeles/
[6] https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

observation. This action would immediately unlock new projects and their associated economic impacts, while allowing the hardworking BLM field staff to focus on appropriate permitting priorities.

Many geothermal resources that are commercially viable for energy production using today's technologies are located on public lands. BLM manages all subsurface geothermal resource on federal lands, regardless of the federal agency that manages the surface estate (such as the Forest Service). Therefore, almost all geothermal development must conduct a National Environmental Policy Act (EPA) review. While geothermal is inexpensive to operate and maintain once a project is complete, during the resource discovery, phase developers must drill resource confirmation holes to determine the true quality and quantity of the underground resource. This means the industry has a disproportionate permitting burden at the "front end" of a project, before a revenue payback is guaranteed. A heavy permitting burden means a slow development cycle, and a slow development cycle means developers pay a lot for financing.

Geothermal resource confirmation wells are distinct from geothermal production wells, which are permitted and constructed differently from resource confirmation wells. Resource confirmation wells are needed for geothermal developers to assess the underground resource for project viability. While developers do what they can to determine the quality of the underground resource through mapping and surface observations, it simply is not possible for developers to characterize the resource without making physical contact with the geothermal fluid deep in the earth. At this time, most geothermal resource confirmation wells must be permitted with BLM via a detailed Environmental Assessment (EA), even though resource confirmation wells are very limited in scope, are reclaimed quickly after confirmation, and result in tiny surface disturbance. These resource confirmation wells also cannot be "repurposed" as production wells under the same permit. This means developers can't access the heat resource they need to evaluate whether a commercial project would even be viable without undertaking significant, time-consuming environmental review. A Categorical Exclusion from NEPA for select types of geothermal resource confirmation wells and other low-impact activities would help the industry tremendously, without undermining environmental stewardship. When developers are able to utilize a CX, they can avoid conducting a full Environmental Assessment and instead perform a CX review, which is far quicker and less costly. A more useable geothermal CX that allows developers to evaluate their energy resource for viability before undertaking extended environmental review could drastically improve timelines and cost profiles for project development. This step would also provide greater parity between geothermal and oil and gas, which is afforded a broad CX for exploration activities, including resource confirmation wells, under Section 390 of the Energy Policy Act of 2005.

II. Ormat also supports passage of the Public Land Renewable Energy Development Act (H.R.825 and S.282)[7]. The Public Land Renewable Energy Development Act (PLREDA) makes a commitment to improving and expanding renewable energy projects on public lands. If passed, this legislation would promote the development of wind, solar, and geothermal resources on public lands by identifying priority areas and encouraging smart siting and efficient permitting of project in places with high energy potential and low impact on wildlife and habitat.

This bill provides economic benefits to states and counties in the West, supports community conservation efforts, and improves access to public lands. Specifically, this legislation would distribute the revenue collected from renewable energy development on public lands in the following way:

- 25 percent would go to the state where the project is built,
- 25 percent would go to the county where the project is built,
- 25 percent of the revenue would be deposited in a fund for wildlife and land conservation and securing recreational access to public lands,
- and 25 percent of the revenue collected would go to the Bureau of Land Management to facilitate permitting of renewable energy projects.

[7] Status this Congress- Senate – The Public Land Renewable Energy Development Act of 2017 was introduced in the Senate by Sen. Heller [R-NV] on February 2, 2017. House – The Public Land Renewable Energy Development Act of 2017 was introduced in the House by Rep. Gosar (R-AZ) and Rep. Polis (D-CO) on February 2, 2017. The bill was reported out of committee to the House of Repredssentatives by unanimous consent on July 26, 2017.

PLERDA would also direct the Department of Interior to identify priority areas for wind, solar, and geothermal projects on public lands, using the 2012 Western Solar Plan as a model. Priority areas must meet certain criteria, including having access to transmission lines and being likely to avoid or minimize conflict with wildlife habitat.

III. Declare that Casual Use Permit notifications to DOI are not needed for specified noninvasive geothermal exploration activities.

Under NEPA, Casual Use (CU) is an action on Federal Lands that causes no disturbance, i.e. no drilling or digging or major construction. Geothermal developers need to notify BLM in advance of Casual Use activities, which are listed below. In general, a company will send a letter to BLM with their proposed activities as a Notice of Intent (NOI). BLM reviews the NOI, responds to the applicant in a letter verifying that the exploration activity are casual use, and may request that the applicant notify BLM when the activity commences and when it has been completed. This process takes about one month.

Under the current program, Geothermal CU Activities are:

- Aerial surveys—This includes both manned flights of small aircraft (helicopters and airplanes) down to Unmanned Aerial Vehicles (drones) less than 2 kg that are equipped with thermal infrared cameras. The manned aerial surveys, because of aircraft noise, are the most likely of the CU activities to incur any disturbance of federal lands.
- Sampling existing streams and water wells
- The use of all-terrain vehicles (ATVs) in off-road vehicle areas
- Two meter probe surveys—A 2-meter long, thin (<1/2 in) hollow steel tube with a tungsten-carbide alloy tip is driven into the ground. Then a high-precision resistive-temperature device is inserted into the tube. The probe is then left in place for at least one hour.
- Magneto-Telluric (MT) surveys—Typically 3-10 small observational instruments are placed 2-3 inches deep in the ground over a span of just a few yards to record observations of microseismicity, etc. The total instrument combined is about 20 lbs. The small holes dug for the electrodes are refilled when the equipment is removed.
- Gravity surveys—A relative gravimeter is transportable by one person with a backpack and weighs roughly 17 lbs. The instrument is carried to the measurement station, placed on the ground surface, and leveled. The gravity measurement takes a few minutes, and then the gravimeter is picked up and transported to the next station.
- Geochemical surveys—Very small samples of soils and surface fluids are collected at the site and removed. The review of these materials is conducted in a laboratory.
- Archaeological surveys—The field work component of geothermal archaeological surveys involves simple visual observations and photographs.

It is clear that most of the activities above cause zero or near-zero disturbance, so we believe that the CU process is unnecessary in many cases. All federal lands are open to most Casual Use by the public with no prior notification, permitting, or approval from the BLM or USFS. For example, if a tourist wants to sample a stream and test it, they don't need prior permission. Geothermal should be no different. We seek to exempt the use of public lands for several Casual Use-style geothermal exploration activities from any notice requirement and approval by the federal agency. We acknowledge some CU actions likely still merit a notice to BLM, namely manned aerial surveys, and do not seek to eliminate CU requirements for cases like these where they are warranted. While CU permits are not especially difficult to get, they take one month on average. If developers can limit their CU burden, that would represent a real savings in time and money.

IV. Due to the aging infrastructure of the electric grid, interconnection and transmission are now major hurdles to the development of renewable energy. This affects geothermal in a unique way when compared to other renewables because geothermal resources are stationary and can't be moved around depending on interconnection costs and transmission availability. System upgrades that are required to interconnect projects can take between five and

seven years to complete and can cost developers millions of dollars, which puts project development at risk. Once interconnected, transmission service is costly, and system congestion and transmission line losses can also be significant factors in project development. Ormat would encourage this committee to evaluate what can be done to interconnect these vital projects more efficiently.

3. **"Reduced costs and improved economics for geothermal projects"** ***(GeoVision 2019)***

In order to reduce costs and improve the economics of geothermal projects, Ormat and the Geothermal Resources Council (GRC) urge Congress to pass the Tax Extender and Disaster Relief Act of 2019 introduced on February 28 by Senate Finance Committee Chairman Chuck Grassley and Ranking Member Ron Wyden.

Quick action on this issue is critical for the geothermal industry, which saw its tax credits lapse at the end of 2017, creating confusion for the numerous industry sectors that utilize these incentives to support deployment of clean energy solutions. The continued uncertainty also undermines the effectiveness of these incentives and stands as a needless barrier to additional job creation and economic growth. Our industry needs an extension of the expired tax credit — two years retroactive (2018-19) and at least two years forward (2020-21) to level the playing field with other technologies and provide predictable market signals for project development, which in turn leverages private investment and promotes job creation and local economic benefits across the country. Geothermal should be restored to an ITC schedule identical to what was provided to solar under the 2015 PATH Act.