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DOCKET
12-IEP-1D
DATE MAY 17 2012
RECD. MAY 17 2012

Date: **May 17, 2012**

To: **CEC – docket@energy.ca.gov, Heather.Raitt@energy.ca.gov**

From: **Phillip Muller for Ormat Technologies, Inc.**

Subject: **CAISO TPP Portfolio Comments**

Ormat is pleased to have this opportunity to comment and offer some suggestions related to identifying and prioritizing geographic areas in California for potential renewable resource development. Ormat is a world leader in Organic Rankine Cycle technology with a focus on geothermal and Recovered Energy Generation power applications. Ormat has supplied over 1,400 MW of geothermal and recovered energy power plants in 24 countries, owns and operates 556 MW worldwide, and employs over 500 people in the US. Ormat has long been committed to the development and growth of geothermal energy in California and Nevada. We currently own and operate 208 MW of geothermal generation in the Imperial Valley and Mammoth Lakes areas in California and 141 MW in Nevada.

Ormat is actively pursuing development of promising geothermal resources in California as well as northern Nevada and southeastern Oregon that could all support California's RPS program under Portfolio Content Category 1.

Geothermal energy is a very high quality renewable resource. Compared to solar or wind, geothermal plants tend to have a much smaller footprint and have the advantage of generating predictable, schedulable baseload power – requiring less transmission capacity to deliver the same amount of energy and not requiring other generating resources to be available to respond to the intermittency of other renewable resources. Unfortunately, the value of predictable, schedulable baseload geothermal generation is not yet accounted for in RPS procurement. Additionally, these resources must be located adjacent to available resource areas which are limited in size and located in remote areas not generally near electric transmission facilities. As a result, the cost of facilities needed to interconnect to the grid and meet RA deliverability requirements can be sufficiently high to render some areas and potential projects uneconomic. This has proven to be the case for several of Ormat's planned expansions and new projects that have been delayed due to the high cost and long lead times for interconnection.

While much attention and investment has focused on accessing resource areas such as the Tehachapis, Mojave Desert and the Imperial Valley, other potential geothermal

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resource areas have not received the same level of attention. Mono County may not have thousands of megawatts of potential resources, but the baseload geothermal resources in the area can deliver two to three times the energy per each megawatt of capacity. Unfortunately, the RETI studies and other forecasted renewable portfolios have given short shrift to areas with significant geothermal potential. As a result, there is no comprehensive plan in place that considers the overall geothermal potential in various resource areas. Instead, individual projects are allocated the entire cost of transmission upgrades that could interconnect entire resource areas. Ormat encourages the Commission to recommend assessment of the overall potential of geothermal resource areas in and adjacent to California.

Ormat believes that it is very important to include an accurate representation of all projects that have a reasonable prospect of success in any analysis of geographical areas. Potential commercial interest may not be sufficient to justify a potential transmission expansion, but having an accurate inventory of what may be out there – based on actual development plans not second or third order guesses – will provide more useful information about actual potential. Ormat requests that the following list of geothermal projects it is in the process of developing in California, Nevada and eastern Oregon be considered as viable geographical locations for renewable development:

Name	Location or CREZ	MW	COD
Mammoth Optimization	Mono County, CA – near Mammoth Lakes	3 MW	2013
Mammoth CD4	Mono County, CA – near Mammoth Lakes	30	TBD
Wild Rose	Mineral County, NV	15-20 MW	2013
Carson Lake	Churchill County, NV	20 MW	TBD
Dixie Meadows	Churchill County, NV	30 MW	TBD
Tungsten Mountain	Churchill County, NV	TBD	TBD
Crump Geyser*	Lake County, OR near CA/NV/OR tri-state border	20	TBD
Goose Lake	Lake County, OR near CA border	TBD	TBD
Midnight Point	Lake County, OR	TBD	TBD
Twilight	Deschutes County, OR near Bend	TBD	TBD

**Joint Venture with Nevada Geothermal Power*

These are only our more advanced projects and not all of them have yet been assigned MW or CODs. Attached Appendices A and B provide greater details on resource potential in these areas.

Of particular concern at this time is the need for a focused stakeholder initiative to assess potential interconnection/ delivery options to deliver identified renewable resources in Mono County and western Nevada to California load. Whether directly, or via the Oxbow line, many of these projects have proposed to deliver to the CAISO at

SCE's Control Substation near Bishop. Unfortunately, it appears that even minor increases in deliveries to Control trigger massively expensive upgrades on the SCE system. Considering the confluence of transmission facilities in the general vicinity, by gathering together the relevant parties (geothermal resource developers, SCE, LADWP, NV Energy, Valley Electric Association, Terra Gen/Oxbow, and CAISO) it may be possible to identify a creative alternative that might make these potential RPS resources accessible to California while avoiding massive transmission expansion.

APPENDIX A

SUMMARY OF GEOTHERMAL RESOURCES THAT COULD INTERCONNECT IN THE EASTERN SIERRA, CALIFORNIA

The Eastern Sierra has several areas with geothermal potential. The two most well-known are Coso Junction, with 270 MW of installed geothermal capacity 30 miles north of Ridgecrest and the Long Valley Caldera area near Mammoth Lakes, where Ormat owns and operates 29 MW (net, on a yearly average), and has proposed up to 70 MW (net, on a yearly average) through expansion, with potential for additional capacity from undeveloped areas in the existing leases. Eastern Sierra geothermal resources are located in Inyo and Mono Counties. A list of some of these resources is provided by the Geo Heat Center of the Oregon Institute of Technology: http://geoheat.oit.edu/califor.htm

They reference geothermal resources near Benton, Bishop, Bridgeport, and Lee Vining.

Geothermal Resources in the Oxbow corridor – Northern and Western Nevada
The Oxbow Line is a *214-mile*, 230 kV radial transmission *line that begins in northern Dixie Valley in Churchill County, Nevada, and terminates at the 115 kV SCE Control substation in Inyo County, California.*

The line passes within the immediate vicinity of at least 10 identified geothermal resources areas and double that when considering prospects within 10-20 miles of the line.
Source (Nevada Bureau of Mines and Geology – Nevada Geothermal Resources Map - 2010):
http://www.nbmg.unr.edu/dox/m161.pdf

The only generating unit currently sending power through the line is the 60 MW Dixie Valley Geothermal Power Plant, operated by Terra-Gen Power. The line is capable of transmitting at least 5 or 6 times what is currently transmitted through the line. We contend that geothermal prospects in the vicinity of the line could make up that capacity if there was a market opportunity to develop the projects.

Ormat has identified at least four or five geothermal prospects we are currently developing in Nevada that could potentially make use of the line. While these projects have not been assigned MW, utility-scale geothermal projects in Nevada typically range from 15-30 MW. The problem remains congestion at SCE Control and the Eastern Sierra where the line terminates. Combined with geothermal resources in the Eastern Sierra of California, described above, mitigating issues in the Eastern Sierra could unlock hundreds of MW of geothermal resources to serve the California market with baseload renewable resources.**APPENDIX B**

SUMMARY OF OTHER GEOTHERMAL RESOURCES IN NEVADA

Besides just the resources in proximity to the Oxbow line, Nevada remains an untapped market for geothermal projects. Resources are abundant, with potential sites within an area encompassing almost 2/3rds of the state (see map: http://www.nbmg.unr.edu/dox/m161.pdf)

While NV Energy has signed up several new geothermal projects, the market for new renewable energy projects in Nevada has slowed, due in part to stagnant load growth, and the fact that Nevada is a small market overall. However, when projects were in high demand in Nevada, there was significant investment in leasing and exploration drilling, where there are hundreds of potential geothermal sites. In fact, from 2005 through 2012, over 200 MW of new geothermal capacity has been placed in service in Nevada.

A generally accepted figure for potential MW in Nevada is about 1,500 MW of near-term potential with current technology.

MW estimates for Nevada

Estimates for geothermal potential in Nevada range from about 1,500 MW to 2,500 MW. Even conservative estimates show high confidence that Nevada has at least 1511 MW of resource potential at high confidence (USGS 2008). This fits well with the reports discussed below, as well as projects under development in Nevada, as reported by the Geothermal Energy Association (GEA) in April 2012.

In 1978, the U.S. Geological Survey (USGS) released USGS Circular 790. The document estimated the recoverable geothermal power potential from identified resource areas in Nevada at 2,559 MW, and the total recoverable identified/unidentified resource at roughly 12,800 MW.

In 2008, USGS updated this, considering 30 years of exploration data and actual development results, while considering resource areas with temperatures below 302°F (150°C).

USGS suggests Nevada has 95% chance of at least 515 MW of identified resource potential and 95% of 996 MW of unidentified resource potential. This is the most conservative estimate. While they suggest 50% confidence of at least 1216 MW of identified resource potential and 3243 MW of unidentified resource potential.

In January of 2006, the Geothermal Taskforce of the Western Governor's Association (WGA) estimated that Nevada could install an additional 1,488 MW of geothermal power economically by 2015 and estimated potential by 2025 as high as 2,895 MW from identified resource areas. The WGA report complemented the April 2004 Public Interest Energy Research Program (PIER) report on *New Geothermal Site Identification and Qualification*, prepared for the California Energy Commission (CEC) by GeothermEx, Inc. 42 geothermal prospects are estimated in the WGA report (63 total are mentioned) and 60 prospects are identified in the PIER report (although the report did not estimate the # of MW).

In April 2012, the GEA released a report on projects under development which estimated that in the State of Nevada, there were 59 projects with between 631.5 MW and 641.5 MW under active development and over 2,000 MW of potential resources from those projects over the long-term.

Federal geothermal leases in Nevada, mostly from the Bureau of Land Management (BLM), now total approximately ~1.4 million acres (combined with private leases, the total number in the state is likely ~1.5 million acres of geothermal leases). Even if we ascribe 1 MW for every 1,000 acres, we get about 1500 MW.

		Identified Resources (MWe)				Undiscovered Resources (MWe)				Enhanced Geothermal Systems (MWe)			
State	N	F95	F50	Mean	F5	F95	F50	Mean	F5	F95	F50	Mean	F5
Alaska	53	236	606	677	1,359	537	1,428	1,788	4,256	NA	NA	NA	NA
Arizona	2	4	20	26	70	238	775	1,043	2,751	33,000	52,900	54,700	82,200
California	45	2,422	5,140	5,404	9,282	3,256	9,532	11,340	25,439	32,300	47,100	48,100	67,600
Colorado	4	8	11	30	67	252	821	1,105	2,913	34,100	51,300	52,600	75,300
Hawaii	1	84	169	181	320	822	2,027	2,435	5,438	NA	NA	NA	NA
Idaho	36	81	283	333	760	427	1,391	1,872	4,937	47,500	66,700	67,900	92,300
Montana	7	15	51	59	130	176	573	771	2,033	9,000	16,100	16,900	27,500
Nevada	56	515	1,216	1,391	2,551	996	3,243	4,364	11,507	71,800	101,300	102,800	139,500
New Mexico	7	53	153	170	343	339	1,103	1,484	3,913	35,600	54,400	55,700	80,100
Oregon	29	163	485	540	1107	432	1,406	1,893	4,991	43,600	61,500	62,400	84,500
Utah	6	82	171	184	321	334	1,088	1,464	3,860	32,600	46,500	47,200	64,300
Washington	1	7	20	23	47	68	223	300	790	3,900	6,300	6,500	9,800
Wyoming	1	5	31	39	100	40	129	174	458	1,700	2,900	3,000	4,800
Total	248	3,675	8,356	9,057	16,457	7,917	23,739	30,033	73,286	345,100	507,000	517,800	727,900

Table : USGS estimates for geothermal projects in the western US (2008)

While these reports assess many different geothermal resource areas in Nevada, geothermal developers have actually leased several prospects not included in either of these reports because some discoveries have been held in propriety. For this reason, an effort to evaluate the full quantity of the work performed on Nevada's (and other states) geothermal resources was funded by USDOE and released in 2005 by Geo Hills Associates. In their final report, they cited 2,737 thermal gradient boreholes and 377 slim holes or exploration and/or commercial production wells in Nevada -- most drilled in the 1970s and early 1980s. They cited 122 separate geothermal prospects (including those that now have power generation projects). This is well above the 63 total in the WGA and PIER reports. According to the report, of these 122 prospects, only 39 have been considered "identified prospects", leaving 83 prospects that need further assessment and exploration data.

Primary published reports on the subject of geothermal resource potential in Nevada agree that this volume of geothermal exploration is accurate. Oil and gas exploration companies came to Nevada in the 1970s and performed much of the initial exploration drilling for geothermal resources. At the time, however, these companies were generally looking for big hits, similar to The Geysers in California. Because few prospects indicated temperatures or conditions of a similar magnitude, companies did not move ahead on many of these prospects at the time.

Sources:

1) Geothermal Energy Association. Annual U.S. Geothermal Power Production and Development Report April 2012: http://www.geo-energy.org/reports/2012AnnualUSGeothermalPowerProductionandDevelopmentReport_Final.pdf
2) Geothermal Energy Association: *Geothermal Development Needs in Nevada*. December 2006: http://www.geo-energy.org/reports/Geothermal%20Resource%20Development%20in%20Nevada%202006.pdf
3) USGS Assessment of Moderate- and High-Temperature Geothermal Resources of the United States. 2008: http://pubs.usgs.gov/fs/2008/3082/pdf/fs2008-3082.pdf
4) GeothermEx, Inc. *New Geothermal Site Identification and Qualification*. Prepared For the California Energy Commission (CEC) Public Interest Energy Research Program (PIER). April 2004: http://www.energy.ca.gov/reports/500-04-051.PDF
5) Western Governors Association (WGA) Geothermal Taskforce Report (January 2006): http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf (pages 62-64)
6) Combs, Jim. "Historical Exploration and Drilling Data from Geothermal Prospects and Power Generation Projects in the Western United States." Geo Hills Associates, Reno NV. GRC Transactions, Vol. 30, 2006: Pgs. 387-392
7) USGS Circular 790 (1978): Table 8 on page 33 of USGS Circular 790 broke down the identified and undiscovered accessible geothermal resource by geologic province (shown on the map on page 32). The identified/undiscovered ratio in the northwestern Basin and Range Province (which covers a small part of northeastern California and southern Oregon and nearly all of northern Nevada) is 280/1400 or 5:1. This would be

the ratio to use to give a rough estimate of the undiscovered resource in Nevada. In USGS Circular 790, the estimated total identified electrical energy potential from geothermal resources in Nevada is 2559 MW (Table 5, pages 51 to 55). Using the same assumptions as were used in USGS Circular 790 and the ratio of 5:1, you get the estimated undiscovered electrical energy of 10,236 MW, which adds to a total of 12,795 MW or roughly 12,800. The southern part of Nevada is still considered part of the Basin and Range province, and although it is expected to have less potential than the northwestern section, the ratio is still 5:1, and is part of the 12,800 MW estimate.

APPENDIX C

SUMMARY OF OTHER GEOTHERMAL RESOURCES IN OREGON

In regards to the transmission planning process, deliveries from geothermal resources in the Pacific Northwest, particularly sites in Oregon east of the Cascade Mountains, need consideration. Geologically, eastern Oregon is partly in the Basin and Range province, similar to Northern Nevada, and partly in transition zones, like the Brothers Fault Zone in northern Lake County, where volcanic features dominate the landscape, and geothermal systems have been discovered in multiple locations.

Ormat believes there are at least several hundred megawatts of potential in this region. However, while promising from a resource development standpoint; geothermal resources in eastern Oregon are constrained by access to market. Most of these geothermal prospects are located in the service territory of Bonneville Power Administration (BPA) or PacifiCorp. Energy from these facilities can be sold into the California/Oregon Border (COB) trading hub and scheduled into CAISO. Further, these generators can qualify for the CPUC Portfolio Content Category 1 since they will have a first point of interconnection with a WECC Balancing Authority and should be able to be scheduled without substitution into California.

Unlike geothermal resources in California, where significant development has occurred in known fields like the Salton Sea, The Geysers, Coso and the Mono-Long Valley area, Oregon geothermal resources are completely untapped. Not a single utility-scale power plant exists in the state. Several projects in eastern Oregon are in advanced development, but efforts to market the power are constrained.

Oregon geothermal resources were initially assessed in the Renewable Energy Transmission Initiative (RETI) begun in 2008.

In its first major report, a map of regional geothermal resources and an estimate of potential MW was provided. The report identified 392 MW of geothermal potential from Oregon, with 324 MW east of the Cascade Mountains (See the attached map).

The 392 MW is noted on page 17 of the Phase 1B report:
http://www.energy.ca.gov/2008publications/RETI-1000-2008-003/RETI-1000-2008-003-D.PDF

Ormat believes that this number is fairly accurate, if not a conservative estimate of potential resources in eastern Oregon.

In the first week of April 2012, the Geothermal Energy Association released its “Annual US Geothermal Power Production and Development Report – April 2012”:
http://www.geo-

energy.org/reports/2012AnnualUSGeothermalPowerProductionandDevelopmentReport_Final.pdf. In the report, the State of Oregon is estimated to have approximately 285-330 MW of Resource Capacity under development (see page 28 of the report); similar to the numbers identified in the RETI report. These numbers are based on the 8 potential projects where geothermal development companies actually reported estimated MW. The number is likely much higher since 16 potential projects were actually identified. Ormat noted 8 potential geothermal projects in the report that range from initial exploration to advanced development.
It is interesting to note that almost every project identified is located east of the Cascade Mountains. Only one utility scale project has a signed PPA (Neal Hot Springs) and that project is selling to Idaho Power, since it is located within their service territory on the Idaho/Oregon border. No other projects identified appear able to market their power into the CAISO at this time.

Consideration of these resources is warranted in transmission planning, in order to account for this untapped potential, and the exploration efforts already underway by a number of geothermal development companies.