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October 25, 2023
via electronic filing

Public Utility Commission
Attn: Filing Center
PO Box 1088
Salem, OR 97308-1088

RE: LC 82 – Fervo Round 1 Comments on PacifiCorp's 2023 Integrated Resource Plan and Clean Energy Plan.

Fervo Energy Company ("Fervo") appreciates the opportunity to provide feedback on PacifiCorp's 2023 Integrated Resource Plan ("IRP") and the Oregon 2023 Clean Energy Plan ("CEP"). Fervo is a next-generation geothermal developer with projects in development throughout PacifiCorp's service territory, and the following comments are focused on the consideration of geothermal in the IRP and the CEP.

PacifiCorp's six state territory contains some of the best geothermal resources in the country. Furthermore, PacifiCorp has been a successful owner and operator of geothermal resources, including the 34MW Blundell Geothermal Plant in Beaver County, Utah. However, the 2023 IRP took an inadequate approach to modeling geothermal resources, and as a result fails to identify new geothermal capacity in any scenario. Nor does the IRP provide further insight into pathways for geothermal procurement, despite the rapid pace of innovation happening in geothermal technology. These results represent a significant missed opportunity to consider a valuable clean, firm and renewable resource that is set to play a critical role in supporting grid reliability and consumer affordability while meeting the emissions reductions enacted by HB 2021.

The 2023 IRP correctly reflects the importance of clean firm power for PacifiCorp's future reliability and affordability but fails to consider the full range of viable clean firm technologies. Geothermal is excluded from the preferred portfolio and all sensitivity portfolios, depriving ratepayers from accessing potentially lower-cost resources with faster deliverability timelines. Geothermal, and especially next-generation geothermal technologies like Enhanced Geothermal Systems (EGS), are able to meet the same grid capabilities as resources considered in the IRP like advanced nuclear, and have a track record of rapid innovation, commercial readiness and widespread available resources. PacifiCorp should reappraise its assessment of geothermal energy, reflect the trajectory of technological innovation and capabilities of next-generation

resources, and consider the full suite of clean firm options that can provide consumer benefits by 2030 and beyond.

Geothermal represents a valuable opportunity for PacifiCorp.

According to studies using the RESOLVE model – which is used in California Public Utility Commission (CPUC) integrated resource planning – geothermal has the potential to provide 3-5 times the generation output as the equivalent capacity of variable renewables.[1] This high-capacity factor capability will become increasingly valuable for grid reliability and cost-efficient decarbonized grid portfolios.[2] Increased investment in geothermal resources would allow PacifiCorp to comply with HB2021 more affordably, by avoiding an overbuild of capacity for the purpose of ensuring reliability when dealing with long-duration weather variability.

The western U.S. contains massive untapped geothermal resources. Table 1 below shows conservative resource estimates for the states in PacifiCorp's service region.[3] A more recent analysis by the National Renewable Energy Laboratory estimated even more significant regional potential, which can be found in Figure 1 below.[4] Considering regional transmission constraints, local resource adequacy needs and land use and permitting timeline, the scale and distribution of geothermal resources position it as a key opportunity to meet PacifiCorp's growing demand.

Table 1. F95 Geothermal resource estimates for selected western states (MWe).

State	Identified Resources	Undiscovered Resources	Enhanced Geothermal Systems (EGS)
Idaho	81	427	47,500
Oregon	163	432	43,600
Utah	82	334	32,600
California	2,422	3,256	32,300
Washington	7	68	3,900
Wyoming	5	40	1,700
Total	**2,840**	**5,562**	**273,300**

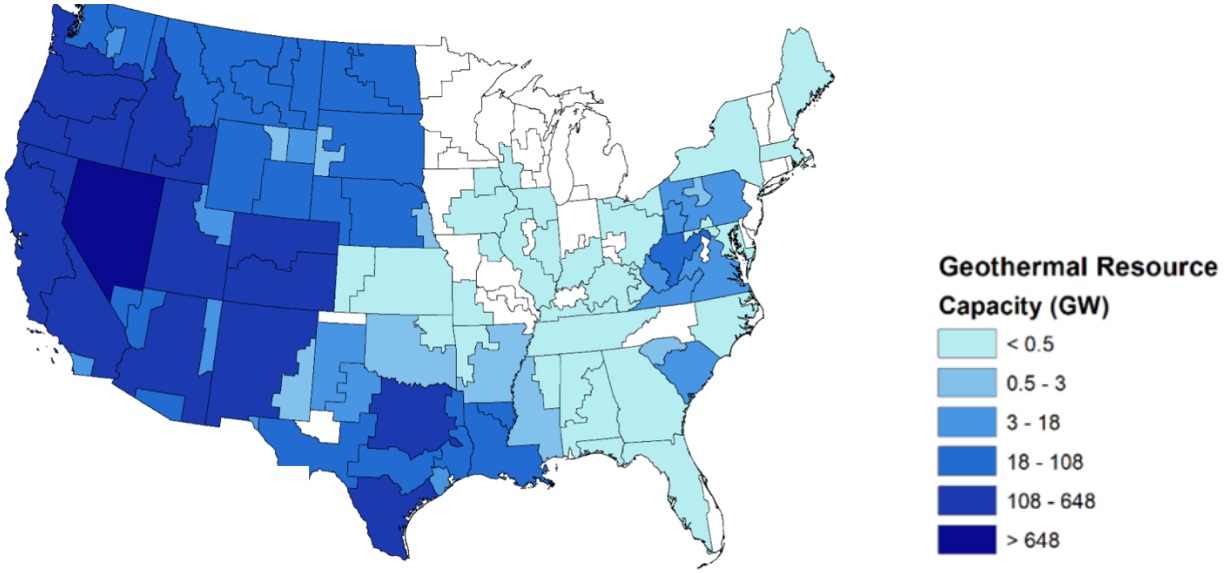
[1] Thomsen, Paul. *Geothermal in Western U.S. Resource Planning.* GRC Transactions. 2021. https://publications.mygeoenergynow.org/grc/1034485.pdf

[2] Sundar, S., Craig, M.T., Payne, A.E. *et al.* Meteorological drivers of resource adequacy failures in current and high renewable Western U.S. power systems. *Nat Commun* **14**, 6379 (2023). https://doi.org/10.1038/s41467-023-41875-6

[3] Williams, Colin F. et al. *Assessment of moderate- and high-temperature geothermal resources of the United States*. U.S. Geological Survey. Fact Sheet 2008-3082. https://pubs.usgs.gov/fs/2008/3082/

[4] Augustine, Chad et al. *Enhanced Geothermal Shot Analysis for the Geothermal Technologies Office.* National Renewable Energy Laboratory. January 2023. https://www.nrel.gov/docs/fy23osti/84822.pdf

Figure 1. Geothermal resource estimates for the US.



Operating assumptions in the IRP do not represent the modern geothermal industry.

The *2023 Renewables IRP report*[5] ("Renewables Report") prepared by WSP includes a review of geothermal costs and operational characteristics. The Renewables Report, and subsequently the 2023 IRP, explores two technology options for geothermal electricity generation: a dual flash expansion of the Blundell Power Plant, and a greenfield binary cycle plant. Neither of these resources represent modern conventional hydrothermal technology, let alone the next-generation advancements in Enhanced Geothermal Systems, that are being developed in PacfiCorp's territory today.

The Renewables Report relies on dated assumptions and inputs and should be updated to reflect the state of the market. As stated in the report, "all data provided and reviewed from the New Zealand team fits with current industry standards"[6]. However, one of the three reports cited by the analysis, *Assessment of Current Costs of Geothermal Power Generation in New Zealand (2007 Basis)*[7] ("Assessment"), is nearly 15 years old, even older than PacifiCorp's own previous analysis of geothermal.[8] There have been significant developments in the geothermal industry, in both subsurface resource development as well as power plant construction, since either of these reports were published.

Firstly, the Renewables Report relies on flash technology which is a poor representation of modern geothermal development. Flash systems are outdated and rely on specific subsurface

[5] WSP USA. *2023 Renewables IRP. PacifiCorp.* September 2022. PacifiCorp 2023 IRP, Appendix M. https://pscdocs.utah.gov/electric/23docs/2303510/3281822023IRPFnlVlmII5-31-2023.pdf
[6] Ibid.
[7] Quinlivan, Paul. *Assessment of Current Costs of Geothermal Power Generation in New Zealand (2007 Basis)*. Australian Geothermal Energy Conference 2009. https://www.geothermal-energy.org/pdf/IGAstandard/AGEC/2009/Quinlivan_2009.pdf
[8] Black & Veatch Corporation. *Power Generation, Geothermal Resource Study*. August 2010. https://pscdocs.utah.gov/electric/09docs/09203501/68052FinalRep8-4-2010.pdf

conditions which make them difficult to scale. The current industry standard is to use binary plants. Binary operations are more flexible, utilize lower temperature resources, and are completely emission-free. Aside from one triple-flash plant constructed in 2011, all geothermal plants constructed since 2000 have been binary plants.[9]

The Renewable Report also extrapolates analysis focused on geothermal resources in New Zealand and applies it to development in the western United States. These are two completely different geologic areas with different geothermal resources, and do not provide a reasonable comparison. For example, because of its volcanic setting, geothermal resources in New Zealand are extremely hot, shallow, and permeable. On the other hand, the geothermal resources which are targeted by next-generation EGS projects in PacifiCorp's territory are economic at lower temperature, located deeper under the earth in less permeable strata, and utilize completely different techniques to drill and complete wells. Furthermore, these new modern techniques can utilize different power generation facilities. In fact, the Assessment warns of generalization of its results to other geologies, in this case, Australia: "Although we consider the method to be robust and suitable for Australian projects, there are very real differences between the two countries which make the specific results inapplicable"[10]. PacifiCorp should look to resources being developed in their own service territory rather than relying on dated erroneous reports from the other side of the world.

While Fervo appreciates the attempt to update 2023 IRP's consideration of geothermal, this analysis does not accurately characterize modern geothermal technology and the benefits it could provide to PacifiCorp customers.

Geothermal is excluded from the preferred portfolio despite lower modeled costs and more advanced commercial progress.

Modeled costs of geothermal as depicted in the Supply Side Resources table[11] are lower than those of advanced nuclear technology (see Table 2 below), with higher capacity factors and lower EFOR. However, the Preferred Portfolio selects 1,500MW of nuclear and no geothermal, nor is geothermal selected in any of the portfolio variants.

Table 2. Comparison of geothermal and nuclear costs and operational assumptions, from 2023 IRP Supply-Side Resource Table.

Resource	Total Resource Cost ($/MW)	Capacity Factor	EFOR
Geothermal (Blundell expansion)	$45.33	90%	0%
Geothermal (Greenfield Binary)	$58.82	90%	0%
Nuclear (Small Modular Reactor)	$68.03	86%	5%

[9] Robbins, Jody C. et al. *2021 U.S. Geothermal Power Production and District Heating Market Report.* National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy21osti/78291.pdf
[10] Quinlivan, Paul. *Assessment of Current Costs of Geothermal Power Generation in New Zealand (2007 Basis)*. Australian Geothermal Energy Conference 2009. https://www.geothermal-energy.org/pdf/IGAstandard/AGEC/2009/Quinlivan_2009.pdf
[11] PacifiCorp. *2023 Integrated Resource Plan (Amended Final). Volume I.* May 31, 2023. Page 181-188.

In addition to lower modeled costs, EGS projects are successfully being developed today. Fervo's recent commercial demonstration in Nevada confirms that EGS is commercially viable and ready for scale now.[12] Fervo's 400 MW Cape Station project, currently being drilled in Beaver County, UT, is the first greenfield EGS project in the world. We expect the project to come online in two phases, with the first power production on the grid in 2026.[13] The Cape Station project is demonstrating powerful learning curves in drilling speed, a critical indicator of cost reduction and evidence of the modular approach enabled by EGS.[14] Incorporating these real-life learning curves into PacifiCorp's cost modeling, along with demonstrated commercial progress, would indicate that geothermal is well positioned amongst all technology options to deliver real projects, on time and on budget, to meet PacifiCorp's clean firm energy needs.

Concluding Comments.

As noted above, Fervo appreciates PacifiCorp's effort and planned progress towards emissions reductions and HB2021 compliance. However, by failing to adequately consider geothermal, and overlooking the significant opportunity for next-generation geothermal in its service territory, PacifiCorp risks burdening its customers with higher-cost resources and a less reliable grid. PacifiCorp notes in the CEP that "absent new technologies or access to an emissions-free market, utilities may not be able to meet the requirements of HB 2021 in 2040 without overbuilding resources to ensure zero emissions at all hours of every day."[15] Geothermal energy can provide capacity and generation to reliably meet growing load in the PacifiCorp region and is ready to do so today.

Fervo appreciates the opportunity to provide comments on PacifiCorp's 2023 IRP and CEP.

Dated: October 10, 2023

Respectfully submitted,

/s/ Laura Singer
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Fervo Energy Company

[12] Howland, Ethan. *Fervo Energy sees 'breakthrough' in enhanced geothermal technology, opening path for firm, clean power.* Utility Dive. July 21, 2023. https://www.utilitydive.com/news/fervo-energy-enhanced-geothermal-system-google/688620/
[13] Galluci, Maria. *Fervo Energy breaks ground on next-generation geothermal plant.* Canary Media. September 26, 2023. https://www.canarymedia.com/articles/geothermal/fervo-energy-breaks-ground-on-next-generation-geothermal-plant
[14] Fervo Energy. *Fervo Energy Technology Day.* [Video]. https://fervoenergy.com/technology/
[15] Pacific Power. *Oregon 2023 Clean Energy Plan*. May 31, 2023. Page 4. https://www.pacificpower.net/content/dam/pcorp/documents/en/pacificpower/about/2023_Oregon_Clean_Energy_Plan.pdf