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Date: March 13, 2026

Witnesses: Anirudh Krishna

PREPARED TESTIMONY OF ANIRUDH KRISHNA

ON BEHALF OF SIERRA CLUB ON THE APPLICATION OF PACIFIC GAS AND ELECTRIC COMPANY (U39E) FOR APPROVAL OF ELECTRIC RULE NO. 30 FOR TRANSMISSION-LEVEL RETAIL ELECTRIC SERVICE

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I. INTRODUCTION

This testimony is submitted on behalf of Sierra Club in response to the questions provided in the January 9, 2026 Administrative Law Judge's Ruling Establishing Proceeding Schedule ("ALJ Ruling").[1] This testimony only addresses Question 1 in the ALJ Ruling, which seeks information about how the costs of a Type 4 upgrade should be allocated, when a preliminary engineering study determines that a customer seeking transmission-level energization has triggered the need for such an upgrade. Sierra Club reserves the right to address the issues raised in the ALJ Ruling's other questions in rebuttal testimony.

The witness sponsoring this testimony is Anirudh Krishna. Dr. Krishna's qualifications and resume are included as Attachment 1 at the end of this testimony.

II. SUMMARY OF RECOMMENDATIONS

Sierra Club makes the following recommendations, the support for which is set forth in subsequent sections of this testimony.

- Cost allocation for Type 4 upgrades should be based on benefits-commensurate cost-causation principles.
- Cost allocation for Type 4 upgrades caused by large load customers such as data centers should avoid cross-subsidization by ratepayers at-large.
- Type 4 upgrade planning and study costs, including engineering studies, such as route and site evaluation, environmental studies, and testing and commissioning studies, should be allocated to the data center customers that necessitate the upgrade.
- The Commission should treat data centers, rather than large loads in general, as a unique rate class when allocating costs because of their distinct electricity requirements and the risks they pose to the grid.
- Costs for Type 4 upgrades necessitated by multiple data center customers as part of a cluster should be allocated proportionally based on the requested load.
- The economic value of benefits from a Type 4 upgrade that are uniquely enjoyed by data center customers, such as capacity savings and avoided transmission investments, should be fully allocated to those data center customers.
- The Commission should adopt a benefits-commensurate cost allocation policy for Type 4 upgrades, such as an adapted version of CAISO's TEAM methodology that is geographically granular.

[1] Administrative Law Judge's Ruling Establishing Proceeding Schedule, at 4–7 (Jan. 9, 2026), available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M593/K231/593231120.PDF.

III. ALLOCATING THE COSTS OF A TYPE 4 UPGRADE

The ALJ Ruling poses the following questions in Question 1:

> *If a preliminary engineering study determines that a customer seeking transmission-level energization has triggered the need for a Type 4 upgrade, how should the costs for that upgrade be allocated? Specifically, should such costs be allocated to that customer, or among a defined class of large load or data center customers? If multiple customers involved in a cluster study collectively require a Type 4 upgrade, how should the costs of that upgrade be allocated among participants in that cluster study, and what allocation methodology would be appropriate (e.g., by MW ratio of total MW of the cluster study)?*

The California Public Utilities Commission ("Commission") should allocate the costs of these Type 4 upgrades in a manner that is consistent with its policy principles and informed by existing cost allocation methodologies at the federal, regional, and state levels.

A. The Commission's Policy Principles

Cost allocation is an integral component of the electric rate design process.[2] At the California Public Utilities Commission ("Commission"), rate design must follow ten principles outlined in a 2023 Commission decision.[3] Following these principles of rate design at the Commission, cost allocation for transmission upgrades in California should generally be based on a cost-benefits-balancing methodology that incorporates cost-causation tempered with the equity concerns of the benefits received.[4] Two of these rate design principles are most pertinent to the allocation of network upgrade costs necessitated by transmission-level customers.

First, Principle 3 states that "[r]ates should be based on cost causation."[5] Cost-causation implies that utility rates should mirror the costs a customer imposes on the electric system, ensuring that those responsible for expenses, including upgrades to the system,

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[2] Jim Lazar, *The Regulatory Assistance Project*, Dividing the Pie: Cost Allocation, the First Step in the Rate Design Process, available at https://www.raponline.org/wp-content/uploads/2023/09/appendix-a-smart-rate-design-2015-aug-31.pdf (last accessed Mar. 10, 2026).

[3] D.23-04-040, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M507/K837/507837776.PDF, at 6 (last accessed Mar. 11, 2026).

[4] Energy Strategies for the Western Interstate Energy Board and the Committee on Regional Power Cooperation Transmission Collaborative, *State Exploration of Western Transmission Cost Allocation Frameworks*, available at https://www.westernenergyboard.org/wp-content/uploads/CREPC-TC-Cost-Allocation-Frameworks-White-Paper-FINAL-11-26-24.pdf, at 7 (last accessed Feb. 14, 2026).

[5] *See supra* D.23-04-040, at 6, 12-13.

pay for the expenses they are responsible for.[6] Thus, when the set of customers that cause a Type 4 upgrade is not identical to the set of customers that benefit from that upgrade, the Commission should generally strive to assign costs based on cost causation.

Second, Principle 8 states that "[r]ates should avoid cross-subsidies that do not transparently and appropriately support explicit state policy goals."[7] Two of the Commission's (and thereby the state's) policy goals by enacting these principles of rate design are to "make electric bills more affordable and equitable," and to "enable widespread electrification of buildings and transportation to meet the state's climate goals."[8] Broad allocation of the costs caused by large transmission-level customers would frustrate these policies by driving up electricity costs for all customers. Meanwhile, there are no goals that explicitly support the ratepayers at large cross-subsidizing all classes of transmission-level customers. To the contrary, state law authorizes the Commission to prevent cost-shifts from large-load customers such as data centers to other utility customers.[9]

The overarching aim of the Commission's principles of rate design is to avoid inequitable cost allocation for grid upgrades and thereby ensure that electricity rates remain affordable to ratepayers at-large. This aim must guide cost allocation for transmission network upgrades.

Principle 9 does not call the Commission's overall equity and affordability goals into question. Principle 9 states that "[r]ate design should not be technology-specific and should avoid creating unintended cost-shifts."[10] The technology neutrality of Principle 9 is intended to avoid creating competitive advantages to specific technologies, at the expense of unintentionally shifting the costs that shoulder these technologies to non-participants.[11] Under this principle, the Commission should give all technologies an equal

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[6] R.12-06-013, *Order Instituting Rulemaking on the Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations*, https://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/169782-02.htm at 3 available at https://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/169782-02.htm#TopOfPage (last accessed Feb. 14, 2026).

[7] *See supra* D.23-04-040, at 6, 19-20.

[8] *See* supra D.23-04-040, at 4.

[9] S.B. 57, 2025-2026 Reg. Sess., Ch. 647, Cal. Stat. 2025; Cal. Pub. Util. Code §913.22.

[10] *See* supra D.23-04-040, at 6, 20-21.

[11] *See* supra D.23-04-040, at 20-21. Pacific Gas and Electric also supported this stated intent and spirit of the Commission adopting Principle 9 in avoiding unintended cost-shifts. See also R.22-07-005, Comments of Pacific Gas and Electric Company (U-39), San Diego Gas & Electric Company (U-902E), and Southern California Edison Company (U-338E) on Proposed Decision Adopting Electric Rate Design Principles and Demand Flexibility Design Principles, at 1-2 available at

opportunity to participate in the tariffs that incentivize grid and societal benefits because giving special opportunities to one technology could unnecessarily increase cross-subsidies from the programs that deliver those benefits. In this proceeding, the Commission should continue its work to avoid cost-shifts and protect ratepayers at-large from bearing the costs associated with transmission upgrades caused by transmission-level or large-load customers.

B. Models from Other States

Data centers would impose costs on the transmission grid that need to be properly accounted in cost allocation, to avoid ratepayers cross-subsidizing them. Once a transmission-level customer has necessitated a transmission network upgrade, there are at least four stages in the upgrade and customer-utilization process: the planning or study, building, utilization, and customer decommissioning. The costs attached to each stage need to properly be allocated to the customer that necessitates the upgrade. In doing so, California would not chart novel tariff pathways for large load customers such as data centers. Rather, the Commission can follow similar steps taken by other states that have seen a recent influx of data centers, such as Indiana and Ohio, and states within the Western Interconnection, such as Oregon.

1. Costs Imposed by Large Load Customers on the Transmission Grid

The interconnection of large load customers such as data centers to the transmission grid requires certain interconnection applications, studies, and agreements. These studies would, at the very least, include engineering studies, such as route and site evaluation, environmental studies, and testing and commissioning studies as part of project planning. The costs for these studies are generally estimated to be around 3% of the total project cost for transmission upgrades.[12] With transmission project costs exceeding $8 million/mile as of 2023, these study costs could add up to over $250,000/mile.[13] If a preliminary engineering study indicates that a new large load will trigger a Type 4 upgrade, the costs of planning for that upgrade are necessary and inherent costs of the upgrade project. Even beyond a preliminary study, these costs could also include

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https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M505/K070/505070481.PDF) (last accessed Feb. 14, 2026).

[12] Midcontinent Independent System Operator, 2024 Transmission Cost Estimation Guide, at 6, available at https://cdn.misoenergy.org/20240131%20PSC%20Item%2005%20Transmission%20Cost%20Estimation%20Guide%20for%20MTEP24%20-%20Redline631529.pdf (last accessed Mar. 4, 2026).

[13] Center for Strategic and International Studies, Assessing Electric Transmission's Cost Allocation Dilemma, available at https://www.csis.org/analysis/assessing-electric-transmissions-cost-allocation-dilemma#:~:text=For%20example%2C%20a%20single%20roughly%2060%2Dmile%20high%2Dvoltage,Operator%20(MISO)%2C%20will%20cost%20nearly%20$500%20million (last accessed Mar. 4, 2026).

additional pre-construction engineering and planning studies following the initial study phase that indicated the need for the upgrade. Without these studies, it would be impossible to begin physical work on the transmission upgrade. As such, these costs should be borne by the large load-customer that necessitates the upgrade.

These significant costs require clear transparency and cost responsibility mechanisms for transmission grid upgrades that protect existing ratepayers from bearing costs that they have not caused. As an example, in Indiana, Indiana Michigan Power Company's tariff-related settlement agreement requires large load customers to fully pay for all studies they necessitate, including various aspects of engineering and project-planning studies.[14] Pennsylvania, which conducts cluster studies similar to those in California, also plans to allocate study costs to large load customers whose interconnection triggers the studies.[15] Following the other states' examples in assigning study costs to the large load/data center customers that necessitate them would help avoid placing undue burdens on ratepayers at-large.

2. Data Centers as a Distinct and Unique Subset of Large Load Customers

A developing trend is for utilities in other states to allocate transmission upgrade costs for data centers—including transmission network costs—to a unique rate class for data center customers. Even among large load customers, other states are increasingly acknowledging the unique costs data centers impose on the grid.

For instance, when the Public Utilities Commission reviewed competing proposed settlements for establishing a large-load tariff in AEP Ohio territory—one that would apply to new data centers larger than 25 MW and one that would apply to all new loads greater than 50 MW—the Ohio Commission found that the data center tariff better serves the public interest. [16] The Commission rejected the argument that a data center tariff was unduly discriminatory partly because of "the volume and highly intensive pattern of electric usage that distinguishes data center customers from other high intensive energy customers, like large manufacturers."[17] The Commission also found that data centers

[14] Indiana Utility Regulatory Commission, Cause No. 46097, February 19, 2025 Order at 41, available at https://www.in.gov/iurc/files/ord_46097_021925.pdf, (last accessed Mar. 10, 2026).
[15] Pennsylvania Public Utility Commission, Docket No. M-2025-3054271, Tentative Order at 26, available at https://www.puc.pa.gov/pcdocs/1901687.pdf, (last accessed Mar. 10, 2026).
[16] Public Utilities Commission of Ohio, Case No. 24-508-EL-ATA, Opinion and Order at 72, available at https://dis.puc.state.oh.us/ViewImage.aspx?CMID=A1001001A25G09B43531I00509(last accessed Mar. 10, 2026).
[17] *Id.* at 77. The utility had presented evidence that data centers are distinguished from commercial or industrial businesses because they require a high level of demand, operating throughout the day with no natural cycling, and often have load factors that exceed 95%. *Id.* at 13. Its stated goal was to "create two new customer classifications that appropriately reflect the unique load requirements of the data centers

create "systematic, data center industry-wide risks that are not present with other types of customers," such as breakthroughs in efficiency, market changes, and capacity underestimation.[18] The Commission relied on the utility's testimony that "unlike non-data center load, which comprises a diverse group of customer end uses, data center load cannot be naturally hedged by other industries in AEP Ohio's service territory."[19]

A tailored tariff helped the Ohio Commission adhere to cost-causation principles. The data center-specific tariff included several features that would ensure data centers actually contribute the costs they cause the utility to incur, despite the unique uncertainties related to their future loads. A data center-specific tariff can include appropriate mechanisms such as long-term contracts, exit fees, higher minimum demand charges, and minimum load ramps that prevent data centers from avoiding responsibility for paying for transmission facilities for which they are the main cost-causers.[20] This approach helps ensure the Commission's cost allocation decisions are enforceable and that data centers cannot avoid cost responsibility if their predicted load fails to materialize.

The unique characteristics and uncertainties of data center loads are an increasing subject of attention in jurisdictions across the country. In Washington, another western state, Chelan County Public Utility District's Electric Rate Schedule 36 differentiates data centers from other commercial or industrial large load customers for a litany of reasons. The District applied this tailored rate schedule to data centers based on the following characteristics:

> [H]igh energy use density, high load factor, need for more than routine alterations to the District's Electric Service Facilities in order to maintain safety, load that is portable and distributable, highly variable load growth or load reduction as an individual customer and/or in aggregate with similar customers in the District's service area, able to relocate quickly in response to short-term economic signals, high sensitivity to volatile commodity or asset prices, or part of an industry with potential to quickly become a large concentration of power demand in the District's service area.[21]

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and mobile data centers," because of the immediacy of the unprecedented data center-led load growth. *Id.* at 12.

[18] *Id.* at 78.

[19] *Id.*

[20] *Id.* at 90.

[21] Chelan County Public Utility District, Electric Rate Schedule 36 at 14, available at https://www.chelanpud.org/docs/default-source/default-document-library/rate-schedule-36-data-centers-and-similar-loads.pdf (last accessed Mar. 10, 2026).

Similarly, in Virginia, Dominion Energy has proposed creating a separate new rate class for data centers, due to their higher load factor and energy density.[22] These states have accordingly structured their large load tariffs or rate schedules to account for the unique costs and risks associated with data centers as opposed to large loads in general. CAISO has also recognized unique electricity use requirements and risks of data centers compared to other large load customers.[23]

To mitigate the risks posed by the distinct and complex electricity use patterns of data centers on California's transmission grid, the Commission should consider cost allocation mechanisms that distinguish data centers from other large loads. Doing so would avoid negatively impacting the state's policy goals of promoting beneficial electrification, while adequately allocating data center-driven grid upgrade costs to the cost-causer data centers.[24] Thereby, the Commission could protect ratepayers at-large from shouldering inordinate rate increases while allowing them access to beneficial end-uses.[25]

3. Allocating Transmission Network Upgrade Costs to Multiple Cost-causers

The Commission can also look to other states for examples of transmission grid upgrade cost allocation among multiple data center customers, where those customers are not necessarily subject to a special rate structure for data centers. Some states, such as our neighbor Oregon, have designed specific large load tariff provisions to allocate for network upgrade costs among multiple large load customers that necessitate the upgrade. Being careful to exclude capturing other residential or commercial customers, the

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[22] Zachary Skidmore, *Dominion proposes new rate class for data centers in Virginia*, https://www.datacenterdynamics.com/en/news/dominion-proposes-new-rate-class-for-data-centers-in-virginia/ (last accessed Mar. 10, 2026).

[23] RTO Insider, CAISO Examines 'Pulsating' Data Center Loads, available at https://www.rtoinsider.com/124778-caiso-examines-pulsating-data-center-loads/ (last accessed Mar. 10, 2026); CAISO, Large Loads, available at https://www.caiso.com/generation-transmission/load/large-load#:~:text=California%20faces%20a%20surge%20in,and%204.9%20GW%20by%202040.1 (last accessed Mar. 10, 2026); *see also* Idaho National Laboratory, Characterizing Large Loads, at 9, available at https://inl.gov/content/uploads/2023/07/Characterizing-Large-Loads-A-Taxonomy-to-Support-Large-Load-Integration.pdf#:~:text=Over%20the%20past%2020%20years,%20data%20centers,grid.%20Balancing%20authorities,%20utilities,%20regulators%20and%20other (last accessed Mar. 10, 2026).

[24] The Commission recognizes the following policy objectives in rate design (and thereby, cost allocation, which is an essential component of rate design): "(a) enhance the reliability of California's electric system; (b) make electric bills more affordable and equitable; (c) reduce the curtailment of renewable energy and greenhouse gas (GHG) emissions associated with meeting the state's future system load; (d) **enable widespread electrification of buildings and transportation to meet the state's climate goals**; (e) reduce long-term system costs through more efficient pricing of electricity; and (f) enable participation in demand flexibility by both bundled and unbundled customers." D.23-04-040, at 4 (emphasis added).

[25] This would also align with proposed state legislation. *See* S.B. 57, 2025-2026 Reg. Sess., Ch. 647, Cal. Stat. 2025.

provision states that "Consumers with total loads in excess of 1000 kVA will share in the Network Upgrade cost."[26] Each qualifying consumer's share is proportional to the new requested load divided by the total capacity of the network upgrade minus the existing load on the network facility.[27] Similarly, the Commission should follow a similar load-based proportional cost allocation if multiple customers in a cluster study require a Type 4 upgrade. This proportional sharing of network upgrades among the large load customers such as data centers ensures compliance with cost-causation principles.

C. Regional Cost Allocation Methodology

Cost-causation-based allocation is comparatively straightforward where there are clear cost-causers. In situations with multiple or unclear cost-causers, a sound cost-allocation methodology for Type 4 network upgrades should assign costs based on the multiple benefits the upgrade provides, as illustrated by practices already in place in CAISO and elsewhere in the western region. For instance, FERC Order 1000 states that "[t]he cost of transmission facilities must be allocated to those within the transmission planning region that benefit from those facilities in a manner that is at least roughly commensurate with estimated benefits."[28] Although FERC rules do not govern the cost allocation for Type 4 network upgrades, this approach is sound and worthy of the Commission's consideration as a model practice. This benefits-commensurate cost allocation guides the cost-causation principle by assigning to cost-causers economic costs based on unique benefits that they enjoy from a transmission upgrade.

The Committee on Regional Power Cooperation Transmission Collaborative's ("CREPC TC") exploration of the western states' transmission allocation framework offers several categories of quantifiable benefits for transmission network upgrades.[29] CREPC TC is a joint committee composed of energy and regulatory officials from all the western states. As its cost allocation framework illustrates, a well-planned benefits-commensurate cost allocation needs to consider multiple benefits, including but not limited to:[30]

- Operational benefits – these benefits include any reduction to the levelized cost of electricity or adjusted production cost because of congestion benefits received from a transmission network upgrade.

[26] Public Utilities Commission of Oregon, Electric Rule 13, at 4, available at https://www.pacificpower.net/content/dam/pcorp/documents/en/pacificpower/rates-regulation/oregon/tariffs/rules/13_Line_Extensions.pdf (last accessed Mar. 12, 2026).
[27] *Id*.
[28] FERC Order 1000, Docket No. RM10-23-000, https://www.ferc.gov/sites/default/files/2020-04/OrderNo.1000.pdf at 421 available at https://www.ferc.gov/sites/default/files/2020-04/OrderNo.1000.pdf (last accessed Feb. 14, 2026).
[29] *See supra* n.4, at 12-13.
[30] *Id*.

- Capacity savings – an analysis of these benefits would quantify the resource adequacy benefits that a transmission network upgrade would enable by allowing capacity sharing during peak demand events.
- Avoided transmission investments – these benefits include the savings benefits associated with avoiding or deferring alternative system upgrades that would otherwise be needed had it not been for the addition of a larger transmission upgrade project.
- Resilience benefits – these benefits include the economic harm avoided from extreme weather and other system reliability issues, mitigated or remedied by the transmission upgrade.

An analysis of these various benefits is important because it is not reasonable to assume that they are shared broadly and equally across all ratepayers.

It is important to separately examine how the multiple benefits of a Type 4 upgrade flow to each of the various categories of customers. Otherwise, the Commission may inadvertently confuse benefits to transmission-level customers as if they were system-wide benefits. At least two of the quantifiable benefits could be unique to, or substantially beneficial to, transmission-level customers as compared to other customers at-large: capacity savings and avoided transmission investments. Capacity savings refers to the overall regional or zonal benefits from sharing unused capacity created by a transmission upgrade during peak capacity needs. Avoided transmission investments benefits are more localized savings realized by avoiding alternative patchwork system upgrades in favor of a larger transmission upgrade to serve local demand. These two types of benefits capture the entire geographic scope of a common problem: increased demand for electricity.

In California, the growth in demand that drives the value of capacity savings and the avoided transmission investments is largely projected to come from transmission-level customers such as data centers for the near future.[31] Large-load customers are ushering in an era of load growth after years of stable electric demand in the state. From 2010 to 2020, electricity consumption in California has remained nearly steady year-on-year at

[31] PG&E estimates data centers to contribute close to half of all the forecast load growth in their territory for 2023–2040. Dan Swinhoe, *PG&E: 3.5GW of data center capacity in California's connection pipeline over next five years, Data Center Dynamics,* available at https://www.datacenterdynamics.com/en/news/pge-35gw-of-data-center-capacity-in-connection-pipeline-over-next-five-years/ (last accessed Mar. 10, 2026); New Project Media*, California data center demand forecasted to reach 10% of total load by 2036*, available at https://newprojectmedia.com/california-data-center-demand-forecasted-to-reach-10-of-total-load-by-2036/ (last accessed Mar. 10, 2026); Noah Baustin, *California boosts estimate of data centers' power demand, E&E News*, available at https://www.eenews.net/articles/california-boosts-estimate-of-data-centers-power-demand/ (last accessed Mar. 10, 2026).

around 31 GW per year.[32] In comparison, one recent forecast found that data center load alone is projected to increase by 1.8 GW by 2030 (equivalent to roughly 5.8% of the state's total demand during the period 2010-2020).[33] By 2040, these projections are even higher, at 4.9 GW (equivalent to about 15.8% of the state's total electric demand over the period 2010-2020).[34] Transmission upgrades, including transmission network upgrades, are necessary even for a grid with steady demand and load conditions. However, unprecedented data center-driven load growth is likely to drive additional transmission network upgrades, including those necessitated by generation and storage.[35] The distinct benefits that flow to transmission-level customers from these network upgrades are not vague, but economically quantifiable. These benefits must directly influence the benefits-driven cost-allocation for transmission-level customers that necessitate transmission network upgrades.

Moreover, CAISO has long acknowledged that transmission network upgrades do not provide uniform benefits to all consumers. Cost allocation for Type 4 upgrades should reflect the varying benefits received by customers and avoid ratepayers at-large cross-subsidizing substantial beneficiaries from a transmission upgrade. To do so, the Commission should consider benefits assessment methodologies with the greatest possible geographical granularity, to avoid inadvertently assessing Type 4 upgrade benefits that may be unique to specific customers or load zones to all ratepayers, thereby creating a socialized cost allocation for these upgrades.

As an example of a benefits analysis capable of geographical differentiation, CAISO models grid transmission upgrades using a cost-benefits methodology called the Transmission Economic Assessment Methodology ("TEAM") to support economic transmission planning.[36] The TEAM cost-benefits analysis has been used in high-voltage

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[32] California Energy Commission, Electricity Consumption Dashboard, available at https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-consumption-dashboards-0 (last accessed Feb. 14, 2026).

[33] CAISO, Large Load Considerations – January 2026, at 3, available at https://www.caiso.com/documents/issue-paper-large-load-consideration-jan-20-2026.pdf (last accessed Feb. 14, 2026).

[34] *Id*.

[35] CAISO, The California ISO's role in Large Loads, available at https://www.caiso.com/generation-transmission/load/large-load#:~:text=California%20faces%20a%20surge%20in%20electricity%20demand,by%202030%20and%204.9%20GW%20by%202040.1 (last accessed Mar. 10, 2026); *see also* John D. Wilson, Sophie Meyer, Zach Zimmerman, Rob Gramlich, *Power Demand Forecasts Revised Up for Third Year Running, Led by Data Centers,* available at https://gridstrategiesllc.com/wp-content/uploads/Grid-Strategies-National-Load-Growth-Report-2025.pdf (last accessed Mar. 10, 2026).

[36] CAISO, *Transmission Economic Assessment Methodology (2017)*, available at https://www.caiso.com/documents/drafttransmissioneconomicassessmentmethodology.pdf)(last accessed

transmission projects in California for over 21 years, including in the Path 26 expansion,[37] and in projects necessitated by load growth, such as in the Devers-Palo Verde 2 project, where CAISO used TEAM to evaluate the transmission line economics.[38] TEAM provides a standard for measuring transmission expansion benefits for consumers, producers, and transmission owners.[39] The TEAM framework provides a means of analyzing the economics of transmission upgrades in general, and the model is capable of analyzing the economic value of distinct benefits reaped by consumers in different zones, recognizing that a grid expansion could benefit consumers in one zone and harm consumers in another zone by increasing prices.[40] Thus, the TEAM framework

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Feb. 14, 2026); this methodology is used by the CAISO in its transmission plan, and has been used in prior high-voltage transmission upgrade projects in California, including those necessitated by load growth. *See* CAISO, 2024–2025 Transmission Plan, Appendix G (available at https://www.caiso.com/documents/appendix-g-economic-assessment.pdf)(last accessed Mar. 10, 2026); M. Awad *et al*., 2006 IEEE Power Engineering Society General Meeting, The California ISO transmission economic assessment methodology (TEAM): principles and application to Path 26; M. Awad *et al*., Economic Assessment of Transmission Upgrades: Application of the California ISO Approach, https://web.stanford.edu/group/fwolak/cgi-bin/sites/default/files/files/Economic%20Assessment%20of%20Transmission%20Upgrades_Application%20of%20the%20California%20ISO%20Approach_Awad,%20Casey,%20Geevarghese,%20Miller,%20Rahimi,%20Sheffrin,%20Zhang,%20Toolson,%20Drayton,%20Hobbs,%20Wolak.pdf (last accessed Mar. 10, 2026); CAISO, *Transmission Economic Assessment Methodology (2004)*, https://www.caiso.com/documents/transmissioneconomicassessmentmethodology.pdf (last accessed Mar. 10, 2026); Restructured Electric Power Systems: Analysis of Electricity Markets with Equilibrium Models, Ch. 7: Using Market Simulations for Economic Assessment of Transmission Upgrades: Application of the California ISO Approach, Ed. Xiao-Ping Zhang (2010); CAISO, News Release: California ISO Board Approves Major New Transmission Line, https://www.caiso.com/documents/californiaisoboardapprovesmajornewtransmissionline-paloverde-devers2targetonlinedate-2009.pdf (last accessed Mar. 10, 2026).

[37] M. Awad *et al*., The California ISO transmission economic assessment methodology (TEAM): principles and application to Path 26, 2006 IEEE Power Engineering Society General Meeting. for examples of how the TEAM model has been used in practical applications, *see* Mohamed Awad *et al.*, *Economic Assessment of Transmission Upgrades: Application of the California ISO Approach*, available at https://web.stanford.edu/group/fwolak/cgi-bin/sites/default/files/files/Economic%20Assessment%20of%20Transmission%20Upgrades_Application%20of%20the%20California%20ISO%20Approach_Awad,%20Casey,%20Geevarghese,%20Miller,%20Rahimi,%20Sheffrin,%20Zhang,%20Toolson,%20Drayton,%20Hobbs,%20Wolak.pdf (last accessed Feb. 14, 2026).

[38] A.05-04-015, Attachments 1-7, available at https://docs.cpuc.ca.gov/Published/Graphics/49931.pdf (last accessed Mar. 10, 2026).

[39] CAISO, *Transmission Economic Assessment Methodology (2017)*, at 13, available at https://www.caiso.com/documents/drafttransmissioneconomicassessmentmethodology.pdf (last accessed Feb. 14, 2026).

[40] CAISO, *Transmission Economic Assessment Methodology (2017)*, at 19-22, available at https://www.caiso.com/documents/drafttransmissioneconomicassessmentmethodology.pdf (last accessed Feb. 14, 2026).

demonstrates that a broad allocation of the costs of all transmission network upgrades will not lead to benefits-commensurate cost allocation. The Commission should explore whether the TEAM model can isolate the benefits of a planned transmission network upgrade to a single entity or cluster of large-load customers that necessitate that upgrade, making it a practical tool for benefits-commensurate cost allocation.

Other regional transmission cost allocation analyses also use similar practices to assess benefits-commensurate costs to various loads. For instance, the PJM interconnection recognizes that load growth creates reliability violations that could necessitate transmission upgrades, the benefits from which could be specific to certain loads or load zones.[41] PJM uses a "Solutions-based DFAX" methodology to determine the transmission upgrade benefit derived by one load zone relative to other load zones.[42] The quantifiable benefit is then used for cost allocation to the load zones.[43] The Solutions-based DFAX takes a geographically differentiated approach to benefits-based cost allocation, and the Commission could evaluate whether an approach like this can isolate single loads within load zones to allocate costs in a more detailed manner.

As one possible means to better granularity, recent research contemplates analyzing transmission upgrade benefits to isolated loads.[44] In such a benefits-commensurate cost allocation methodology, benefits to each load follow the consumer surplus at the bus and node level at which they connect to the grid.[45] The theoretical model states that while transmission cost allocation is primarily interested in zonal analysis, it is possible to account for a "more detailed representation of price-responsive load for individual customers" to "enable a more granular calculation of benefits."[46] The researchers' numerical benefits analysis on the Texas grid showed that allocating costs to only those loads with positive benefit values as opposed to all loads at large was more consistent with the beneficiaries-pay principle.[47]

Thus, Type 4 upgrade cost allocation can and should take geographically differentiated benefits into account. I recommend that the Commission adopt a benefits-commensurate cost allocation policy for Type 4 upgrades, such as an adapted version of CAISO's

[41] PJM Interconnection, PJM Manual 14B: PJM Region Transmission Planning Process, Attachment A: PJM Baseline Reliability Upgrade Cost Allocation Procedures, at 61, available at https://www.pjm.com/-/media/DotCom/documents/manuals/archive/m14b/m14bv53-pjm-regional-transmission-planning-process-07-26-2023.pdf (last accessed Mar. 13, 2026).
[42] *Id*.
[43] *Id*.
[44] Han Shu and Jacob Mays, "Transmission Benefits and Cost Allocation under Ambiguity," available at https://arxiv.org/pdf/2403.14803 (last accessed Mar. 13, 2026).
[45] *Id*. at 15.
[46] *Id*.
[47] *Id*. at 21.

TEAM methodology that is geographically granular, to quantify the benefits of Type 4 upgrades to the data center customer and allocate the costs to the same customer. The TEAM analysis used by CAISO acknowledges zonal variation in benefits, and examples from other regions depict the possibility of evaluating these transmission upgrade benefits with better specificity and granularity than what PG&E has proposed. The Commission should strive to apply benefits-commensurate cost allocation with the greatest feasible geographical granularity. Doing so would prevent ratepayers at-large from shouldering the costs for Type 4 upgrades that uniquely benefit large load customers such as data centers.

IV. CONCLUSION

Ultimately, cost allocation for transmission network upgrades should follow a benefits-commensurate cost-causation methodology, consistent with the best practices already implemented in CAISO. By adequately accounting for the unique benefits data center customers would receive from transmission upgrades, the unique costs data center customers would impose on the transmission grid, and the distinct data-center-led load growth that necessitate the grid upgrades, and by placing data centers in their own rate class, the Commission could avoid unintentional cost-shifts to other ratepayers in contravention of its principles of rate design and the Commission's duty to ensure rates for all customers are just and reasonable.

ATTACHMENT LIST

Attachment #

1 Witness Qualifications

A.24-11-007

Attachment to Prepared Testimony of Anirudh Krishna on Behalf of Sierra Club

Attachment 1

Witness Qualifications

Anirudh Krishna graduated from the University of California, Los Angeles School of Law and holds a Ph.D. in Mechanical and Aerospace Engineering from the University of California, Irvine. Dr. Krishna has previously worked as a Climate Mitigation Fellow specializing in large loads and data centers at the Georgetown Climate Center in Washington, D.C., as a judicial clerk at the Administrative Law Judge Division of the California Public Utilities Commission, and as a legal clerk at the Chief Counsel's Office of the California Energy Commission. Dr. Krishna's doctoral research has focused on renewable energy solutions, and he has previously taught Heat Transfer at the University of California, Irvine. His resume is attached below.

Anirudh Krishna, J.D., Ph.D. *(he/him)*
Associate Attorney, Earthjustice
Phone: (415) 217-2063
E-Mail: akrishna@earthjustice.org

Education

University of California, Los Angeles [a] 2022 – 2025
Juris Doctor, Environmental Law, David J. Epstein Program in Public Interest Law and Policy

University of California, Irvine
Doctor of Philosophy in Mechanical and Aerospace Engineering 2017 – 2020
Master of Science in Mechanical and Aerospace Engineering 2014 – 2016

National Institute of Technology, Tiruchirappalli, India 2010 – 2014
Bachelor of Technology in Mechanical Engineering

Experience and Professional Appointments

Earthjustice, Los Angeles 2026 – present
Associate Attorney, Clean Energy
- Represent public interest environmental groups in energy related matters before California agencies.

Georgetown Climate Center, Washington, District of Columbia 2025 – 2026
Climate Fellow, Mitigation Program
- Developed federal, state, and local clean energy and climate mitigation law and policy.

UCLA Emmett Institute on Climate Change and the Environment, Los Angeles [a] 2023 – 2025
Student Attorney, California Environmental Legislation and Policy Clinic
- Drafted legislation, in coordination with EJ groups, on safety requirements for carbon capture.

UCLA Journal of Environmental Law and Policy, Los Angeles 2023 – 2025
Managing Editor (previously Staff Editor)
- Managed, reviewed, and edited legal journal article submissions.

California Energy Commission, Sacramento 2024
Summer Law Clerk, Chief Counsel's Office
- Developed strategies advancing the state's net-zero emissions goals and clean energy future.

The School of Law at the University of California, Los Angeles 2023
Research Assistant, Administrative Law
- Analyzed upcoming constitutional separation-of-powers cases in federal court dockets.

California Public Utilities Commission, San Francisco 2023
Summer Law Clerk, Administrative Law Judge Division
- Drafted decisions on minority upliftment in the state's utilities and renewable energy programs.

Intel Corporation, Hillsboro, Oregon 2021 – 2022
Process Technology Development Engineer
- Led projects for sustainable resource use in the Portland Technology Development division.

University of California, Irvine
Professor/Instructor of Record (previously Teaching Assistant), Heat Transfer 2016 – 2021
- Developed a curriculum and taught classes of 25+ students on thermal energy and heat transfer.

Selected Honors and Awards

1. School of Law Dean's Merit Scholarship, 2022 – 2025
2. California Lawyers Association Environmental Law Diversity and Inclusion Finalist, 2022 – 2023
3. Graduate Dean's Dissertation Fellowship, 2020 – 2021 [b]
4. Outstanding Paper Award, IEEE Intersociety Conference, 2019 [c]
5. Samueli School of Engineering Graduate Student Research and Travel Grant, 2019
6. Best Oral Presentation Award, Materials Research Society Spring Meeting, 2018
7. Samueli School of Engineering Ph.D. Bridge Fellowship, 2017

Publications, Peer-Reviewed

1. **A. Krishna**, *Power to the People: Nationalizing the United States' Electricity*, in preparation (2025).

Related press mentions: [a] *New Bill Targets Carbon Dioxide Pipeline Leaks*, Legal Planet, Feb. 20, 2024.
[b] *Graduate Students Win Engineering Dissertation Fellowships*, U.C. Irvine News, June 12, 2020
[c] *MAE Students Win Best Paper Awards*, U.C. Irvine News, June 27, 2019

2. **A. Krishna** et al., *Air Temperature Drives the Evolution of Mid-Infrared Optical Properties of Butterfly Wings*, 11(1) Sci. Reps. 1–10 (2021).
3. X. Nie, … **A. Krishna** et al., *Cool White Polymer Coatings based on Glass Bubbles for Buildings*, 10 Sci. Reps. 6661 (2020).
4. **A. Krishna** et al., *Infrared Optical and Thermal Properties of Microstructures in Butterfly Wings*, 117(3) Proc. of the Nat'l Acad. of Sci. 1566 (2020). [d, e, f, g]
5. **A. Krishna** et al., *Ultraviolet to Mid-Infrared Emissivity Control by Mechanically Reconfigurable Graphene*, 19(8) Nano Letters 5086 (2019).
6. M. Sala-Casanovas[†], **A. Krishna**[†] et al., *Bio-inspired Stretchable Selective Emitters based on Corrugated Nickel for Personal Thermal Management*, 23(3) Nanoscale and Microscale Thermophysical Eng'g 173 (2019).
7. **A. Krishna** & J. Lee, *Morphology-Driven Emissivity of Microscale Tree-like Structures for Radiative Thermal Management*, 22(2) Nanoscale and Microscale Thermophysical Eng'g 124 (2018).

Conference Proceedings, Peer-Reviewed

1. **A. Krishna** et al., *Dynamic Radiative Thermal Management by Crumpled Graphene*, IEEE Intersociety Conf. 2019.
2. X. Nie, **A. Krishna** et al., *Stretchable Selective Emitters based on Carbon Nanotube Films for Adaptive Thermal Control*, IEEE Intersociety Conf. 2019.
3. G. Liang, … **A. Krishna** et al., *Modeling and Analysis of a Shape Memory Alloy-based Adaptive Regulator for Thermal Management*, ASME Int'l Tech. Conf. 2019.
4. **A. Krishna** & J. Lee, *Morpho Butterfly-Inspired Spectral Emissivity of Metallic Microstructures for Radiative Cooling*, IEEE Intersociety Conf. 2018.
5. J. Sullivan, **A. Krishna**, and J. Lee, *Porous Nickel as a Selective Emitter for Surface Cooling in Various Environments*, IEEE Intersociety Conf. 2018.

Invited Talks and Featured Speeches

1. **A. Krishna**, *How Butterflies Adapt to Climate and What We Can Learn from Them*, Joint Ann. Meeting of the Entomological Soc'ies of Am., Can., and Brit. Columbia 2022.

Patents

1. Adaptive Optical Thermal Device based on Shape Memory Alloy Wires (*Patent pending*).

Community Involvement

Law Students for Climate Accountability, University of California, Los Angeles — 2024 – 2025
Founding Signatory Officer; Chair, Business and Finance

Anteaters in Service, University of California, Irvine — 2021 – present
Community Upliftment Volunteer, Hunger, Poverty, and Housing Insecurity

Sierra Club, Orange County, California — 2021 – 2022
Committee Member, Political/Conservation Committee

Henry Samueli School of Engineering, University of California, Irvine — 2018 – 2020
Mentor, High School and Undergraduate Underrepresented Student Outreach Program

Associated Graduate Students, University of California, Irvine — 2016 – 2017
Senator from the School of Engineering; Chair, Subcommittee on International Education
- Introduced legislation for recycling and leftover food donation in on-campus events.

National Service Scheme, Tiruchirappalli, India — 2010 – 2011
Volunteer, Rural Education
- Pioneered weekly classes on sustainability and environmental studies in rural community schools.

Skills

Languages
Tamil (native), English, Hindi, Malayalam (fluent), Sanskrit, Swedish, Urdu (intermediate), Arabic, French, German, Japanese, Latin, Norwegian, Russian, Spanish (beginner)

Programming languages
C++, CSS, HTML, Java, JavaScript, MATLAB, Python, SQL

Related press mentions: [d] *These Infrared Images Show Just How Alive Butterflies' Wings Are*, Popular Science, Nov. 19, 2021
[e] *Les Ailes, Système de Climatisation du Papillon*, Le Monde, Feb. 5, 2020
[f] *Researchers Discover How Butterflies Keep Their Cool*, U.C. Irvine News, Jan. 10, 2020
[g] *Butterflies' Secret to Keeping Cool Hidden in Wings*, Fla. Museum of Nat. Hist. News, Jan. 5, 2020