Response to Borenstein's Critique

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Summary

Severin Borenstein at the Energy Institute at the Haas Business School posted a reply[1] to our analysis[2] of the Public Advocates Office's claim[3] of a large "cost shift" created by rooftop solar customers to other customers.

- **Issues of agreement:** Borenstein acknowledges that the PAO used an ***incorrect capacity factor*** to calculate the total amount of rooftop solar generation. He also acknowledged that the **monthly bill payments** from rooftop solar customers ***should be included*** in the calculation, an error that both PAO and he has previously committed. Further, he agreed, with caveats, that the rate reductions and subsidy savings for ***low-income CARE customers should be included***. Those elements alone add up to ***reducing PAO's claimed cost shift approaching $2 billion*** or 25%
- **Self generation**: Borenstein and the PAO ignore the fact that **self generation is *not* included in any utility resource planning**. Rooftop solar generation is counted in load forecasts as a load reduction just like energy efficiency. Grid investments, generation capacity and operational decisions such as reserve margins all focus solely on metered load that excludes all self generation. Borenstein mistakenly asserts that grid and self-provided power mingles, obviating the right to self generation. If there is generation and consumption onsite at the same time, those electrons do not touch the grid. Along with the fact that the energy does not mix, **legal precedents and analysis by leading regulators contradict Borenstein's** (and PAO's) position. Further, **the NEM tariffs explicitly recognize the right to self generate for the term of the tariff.**
- **Historic utility savings:** Borenstein, like PAO, ***creates a confusing "apples-to-oranges" comparison*** of historic costs vs. projected future savings. The Avoided Cost Calculator does not include information about historic costs and therefore cannot be used to calculate historic savings from previously installed rooftop solar systems. Using this tool to estimate how much utilities *would have spent* were it not for previous solar installations is highly inaccurate. The ACC does not have this data. Rates do not reflect future value. In addition, Borenstein ***ignores* suppression of peak load growth *since 2006 by the addition of rooftop solar***. He confuses the total customer peak served by all resources including rooftop solar with the CAISO metered peak served only by utility resources, asserting that rooftop solar provides little value to meeting today's metered peak. Only by recreating the

[1] See https://energyathaas.wordpress.com/2025/01/27/guess-what-didnt-kill-rooftop-solar/

[2] See https://mcubedecon.com/2024/11/14/how-californias-rooftop-solar-customers-benefit-other-ratepayers-financially-to-the-tune-of-1-5-billion/

[3] See https://www.publicadvocates.cpuc.ca.gov/-/media/cal-advocates-website/files/press-room/reports-and-analyses/240822-public-advocates-office-2024-nem-cost-shift-fact-sheet.pdf

costs that would have been borne by ratepayers over the last two decades can the actual savings and reduction in rates be calculated.

- **Customer Bill Payment**: While he agrees bill payments should be included in the PAO's analysis, but he focuses only on the cost-shift burden and fails to acknowledge the contribution to utility fixed costs made by these customers. The appropriate comparison is customer bill payments compared to utility fixed costs per customer. My analysis shows solar customers more than cover utility fixed costs.
- **Overall savings provided to all ratepayers from rooftop solar conservatively is $1.5 billion in 2024.**

Preface

To start, the focus of our analysis is on the Public Advocates Office (PAO) report issued in August 2024. We used PAO's own spreadsheet as the base of the analysis and supplemented that with other sources. The critique of Borenstein's analysis is collateral and, compared to that of the PAO analysis, is limited to the questions of self generation and how to calculate the cost savings created by rooftop solar. His capacity factor, inclusion of CARE customers and applicable retail rates are much closer to those that I used. I pointed out in my blog post that Borenstein had not made the mistakes that PAO had made on technical issues.

Yet on the other hand, Borenstein's own spreadsheet was entirely undocumented,[4] and the final calculation of the "cost shift" was a set of raw values with no internal calculations. When I recreated those calculations, I could not exactly duplicate what Borenstein presented. Similarly, the PAO's spreadsheet was sparse on documentation. Most of what is shown in my workpapers are my own additions, not PAO's.

Finally, many of the sources that Borenstein refers to are in fact himself. The NRDC citation relies on his own Next10 report. The LAO report cites back to his own blog post. He refers to his own critique of NEM from four years ago to criticize the NEM 3.0/NBT framework that was finalized two years later. That analysis is likely now obsolete.

As for being an "industry consultant," a sample of our recent clients shows their diversity where we have worked for environmental organizations, water districts and utilities, agricultural and business associations intervening at the CPUC, CCAs, county governments, tribes, regional energy networks, state agencies, and lately solar advocates. We must present analyses that are sufficiently balanced so as to be credible with all of these different stakeholders. Further, our work is carefully documented and our data and assumptions completely transparent, unlike the work of Borenstein or the PAO.

Introduction

The analyses presented by both Borenstein and PAO reflect an obsession with "mark-to-market" as the only valid means to evaluating the worth of electricity investments (although this standard apparently doesn't apply to utility investments.) This is why they use the ACC that relies on this premise. Mark-to-market is a common method of valuing a commodity portfolio by market traders

[4] Published with his April 2024 blog post.

by using today's short-term posted price. It is the standard in the oil and natural gas industries. And the CAISO and Power Exchange (now defunct) was set up on this premise. But that obsession by academic economists who advised on the market formation was a leading factor in causing the 2000-2001 energy crisis that we are still responding to. State law required that 100% of all electricity transactions be valued as mark-to-market for up to three years and merchant generators (including Enron) exploited that vulnerability to manipulate prices. UCEI researcher Catherine Wolfram identified this problem in 1997, yet nothing was done until 2001 after the market collapsed.

The most critical problem with mark-to-market valuation for electricity is that the commodity is not truly fungible (i.e., easily transported and substituted among different sources and uses) and there are several barriers to entry for suppliers. Oil can be purchased from either Saudi Arabia or Texas with little difficulty, and even natural gas can be moved around North America easily. Not so for electricity—California can't purchase power from Texas or vice versa. Further, a supplier must be interconnected at great expense to enter the market through the transmission network, and then once connected, many suppliers must pay substantial costs to be up and running (known as commitment costs) to bid into and supply the market. Numerous other external factors depress the market price including the reserve margins imposed to maintain reliability, prescheduling of nuclear and renewables because they are not dispatchable on an hourly basis and bid adjustments for renewables to ensure that they scheduled for generation. Add that almost all new resource acquisitions occur outside of the CAISO market through power purchase agreements for renewables and resource adequacy bid markets, and that market becomes even more irrelevant. The focus on the momentary mark-to-market valuation is highly misleading.

Instead, the true value of an electric resource needs to reflect the importance of location, both for generators and customers, and incorporation of risk mitigation to avoid market price volatility. A house is not valued at the daily hotel room rate for this reason, nor even at the rental rate for a house. We generally don't check our house value on a daily basis to determine if we're going to sell it today and move. The value of an asset in this position must include the cost of replacing the infrastructure that allows the asset to participate in the market and of mitigating market price volatility. The Avoided Cost Calculator does not even do this for future resources and does not even attempt to value what resources were displaced by past resource additions.

For this reason, Borenstein and the PAO miss the essential reason why customers have invested their own money into a resource from which they can self-supply. It provides generation on-site and mitigates market price volatility expressed in utility rates. The NEM 1.0 and 2.0 tariffs confirmed this perspective by restricting utilities from billing usage beyond the meter, which is self generation.

They ignore the substantial adverse impact that abrogating agreements that customers have made to finance their own private investments will have on California's future ability to achieve its ambitious climate change mitigation goals. Why would a customer invest in an electric vehicle or a heat pump if they fear that they too will lose a benefit that they counted on to the whim of state policy makers? The siloed views exhibited by Borenstein and the PAO threaten more than just current customers who they want to punish for doing the good deed that the state asked of them.

PAO's calculation errors

Capacity factor too high: First, Borenstein acknowledges that the PAO was wrong and that my value is consistent with his own. But then he makes an error in calculating the magnitude of the error.

The effect of the difference in the rooftop solar capacity factor is multiplicative, not additive as Borenstein implies. Going from 20% to 17.5% is a reduction of 12.5%, not 1.8%.[5] That makes a $1.1 billion reduction in the PAO's answer.[6]

Missing CARE customers: By excluding the 15% of customers with rooftop solar who are on the CARE low income rate and received a 32% discount, the PAO's calculation is overestimated by 5% or $320 million. Borenstein asserts that this error could be reduced by CARE customers having smaller panel installations, but he's speculating with no evidence. Even if it were true, failing to acknowledge CARE participation among NEM customers skews the results.

Miscalculated applicable NEM rates: My workpapers include a summary of the calculation done in separate workpapers.[7] I will post those workpapers separately.[8] PAO got their NEM rates for PG&E and SCE from the utilities with no supporting workpapers and the commercial rates from SDG&E. PAO only calculated the SDG&E residential NEM rates, and those rates (excluding CARE) are quite close to the rates we calculated. That appears to confirm that Borenstein also fails to understand that (1) baseline allowances are allocated by TOU period and (2) that NEM customers import more energy during peak price hours and export during off-period periods. The result is that NEM customers receive less credit than they pay out for the same amount of energy.[9] Further, NEM customers are now self generating during off peak periods which means the impact on baseline usage is much smaller.

Self Generation

Borenstein appears to be unaware of a legal analysis refuting his position by a former FERC Chair and a retired CPUC ALJ now teaching law at UC Berkeley. He also overlooked important court decisions that confirm the right to self provision. The first states that utilities are not protected from "economic forces," implying that consumer sovereignty is paramount. The second states that being interconnected to a utility does not mean that the energy created by a customer's system is dedicated to the public purpose and therefore subject to a utility charge. Rather, that resource

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[5] Unless Borenstein is comparing this to overall IOU revenue requirements—his basis is unclear.

[6] Borenstein refers to a critique of my method posted on Bluesky by Xiao Wang. I rebutted those calculations on that post. In addition, because I used the PAO's spreadsheet as the base file, the capacity factor error that Wang cites must also exist in the PAO's worksheet. Even so, I found most of Wang's discussion incoherent. There a number of other erroneous assertions made by that commentator who has no experience whatsoever in California utility analysis. Notably, Borenstein does not refer to or incorporate any of those critiques in his response.

[7] Borenstein does not document where he got his rates either, but they looked approximately correct are close to what we computed which is why we did not include that in the critique of his analysis.

[8] See https://mcubedecon.com/wp-content/uploads/2025/01/crossborder-blended-retail-rates.xlsx

[9] NEM 2.0 customers were put on TOU rates before other customers, starting in late 2016. Due to the transition to TOU rates for all customers, the vast majority of NEM 1.0 customers are on those TOU rates as well.

stands alone for internal use exclusive of any utility charge. Both PURPA and FERC rulings on generators' station use allows those generators to self consume without paying a retail rate. Even the NEM 1.0 and NEM 2.0 tariffs clearly acknowledge that difference by stating use beyond the meter cannot be billed by the utility.

An article coauthored by a former FERC Chair Jon Wellinghoff and a former California Public Utilities Commission administrative law judge Steve Weissman confirms this analytic perspective, stating,

> *Property owners in the United States have the right to generate electricity onsite, for their own use. This understanding is so fundamental that legislatures have not bothered to spell it out. But the right does exist in the law, and it derives both from common law principles concerning the beneficial use of property and from federal and state laws that imply that property owners can self-generate through encouragement, protection, or facilitation of such activity.*[10]

The right to self-generation is readily apparent in statutory and legal precedents. Are we to accept the sole word of an academic economist over two highly experienced regulators?

Borenstein asserts there is no real difference between self consumption and grid supply when a customer is interconnected. He appears to be confusing the flows of imported and exported power with what is used internally for self consumption. The fact is that the power generated on site and used on site does not leave the site. A water utility does not charge a customer who has a well and self supplies the portion of their use from the well water. Yet if that well fails, the water utility will serve that customer for a larger amount. Other examples abound.

Using Borenstein's reasoning, energy efficiency also creates a cost shift because customers also are still connected to the grid. Based on that logic, energy efficiency is creating a $17 billion cost shift from 64,000 GWH of savings according to PAO's equations (calculation in my workpapers.) Yet the state's loading order places energy efficiency as the first resource to tap.

Borenstein also makes the mistaken assumption that a utility invests a set amount of transmission and distribution capacity explicitly for each individual customer.[11] In fact, a utility invests in transmission to convey generation to a substation and energy between substations, and only looks at the total system or area load. For distribution, the utility again invests in capacity to cover total metered loads at the feeder and circuit level, not individual customers. Only at the service line does the utility invest in a single identified customer and then residential customers share the final line transformer with an average of a half-dozen other customers.

This concept of utility investment is important because rooftop solar units are a highly diversified resource. While a single customer may have an outage, 99 other customers are still generating and the loss of that resource is almost imperceptible at the utility's operational level. This concept is why the CAISO treats rooftop solar as a load reduction rather than as an interconnected generation

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[10] Jon Wellinghoff and Steven Weissman, "The Right to Self-Generate as a Grid-Connected Customer," Energy Law Journal, 36:305, https://escholarship.org/content/qt3643z0qx/qt3643z0qx.pdf?t=pgnfj3, 2015, p. 305.

[11] Large industrial customers at transmission and subtransmission voltages do get specific attention.

unit. The CAISO does not plan for rooftop solar capacity and does not make day ahead or momentary operational changes other than to adjust its load forecast. A utility does not hold a separate portion of its T&D capacity to serve rooftop solar customers in case of an outage. That's simply because doing so is unnecessary.

Historic Utility Savings

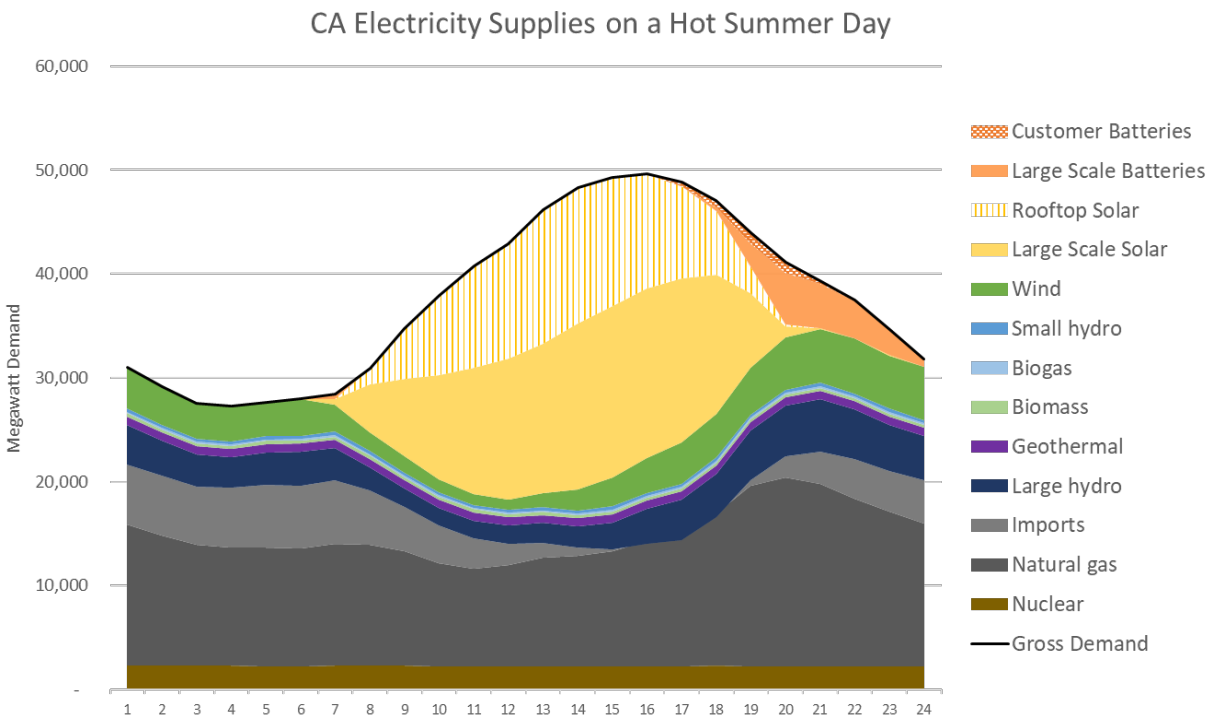
The Avoided Cost Calculator is constructed solely for forward looking investment decisions (and not necessarily done well for that purpose). It is not appropriate for evaluating past investment decisions because it does not include the conditions under which those decisions were made. Any results from the ACC applied to past decisions must be disregarded. It might include a projected mix of *future* resources, but it cannot account for the mix of *past* resources. We can't use the same analytic tools to measure what future benefits might be (which is the purpose of the ACC) and what historic benefits have accrued (which requires reviewing past forecasts and data.) That's an important distinction that has been lost on those claiming a cost-shift. Sometimes those who have a hammer think everything is a nail.

Borenstein does not understand how utility revenue requirements are developed, and apparently does not understand that the PAO's cost shift analysis is based on using revenue requirements for retail rates, not an annual market valuation. At the core of PAO's error is using rates reflecting revenue requirements on one hand and a market valuation tool that does not reflect direct impacts on rates on the other hand. Revenue requirements are based on total investment accumulated over time, i.e., since 2006 in the case of my analysis, that are then allocated to annual cost recovery increments. This is how a house mortgage works and the PAO used the equivalent of a mortgage payment as its starting point.

Savings in revenue requirements and mortgage payments reflect what the alternative costs *would* have been over the period that the resource or the house has been owned. A homeowner does not measure the value of their house against the value of today's hotel room or even the current rental market. Yet that is precisely what both the PAO and Borenstein are doing. They ignore the fact that a homeowner weighed the purchase of a house against owning another house or an expectation of what would happen in the rental market including volatility in the rental rate. And similarly, we can see what the historic costs were avoided by the utilities that would have been rolled up into the annual revenue requirements. So in order to make the cost and valuation comparison's "apples-to-apples" we must create an equivalent reduction in the annual revenue requirements from avoided cumulative historic costs.

Borenstein also confuses total plug or site load with metered load. This chart shows how they have diverged due to the addition of rooftop solar (and illustrates how self-generation now functions.) We still have a site or plug load peak at 2-4 pm. But the CAISO peak load that measures only load served and billed directly by the utilities, which Borenstein focuses on, has shifted to about 6 pm. (He also confused metered peak load with net peak load which peaks at 8 pm. The net peak subtracts grid-scale solar and wind from the load stack and is significantly below the metered

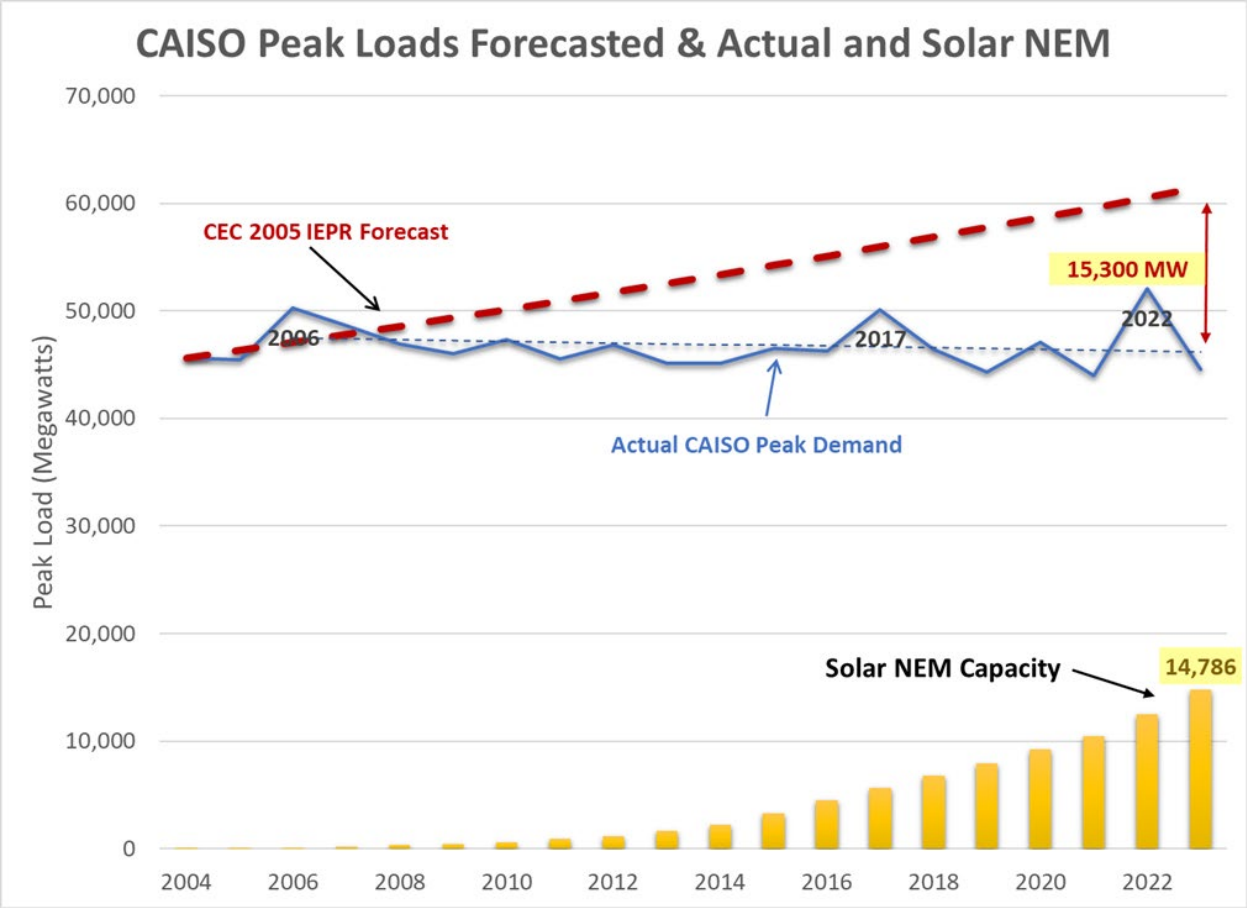
peak.) The latter is the peak Borenstein wants to ignore--the unmetered load because that falls outside of the CAISO's hourly bulk power market (of which he is on the Board of Governors).[12]



He also fails to understand how the CEC's peak load forecast has been created since well before 2005. That peak load forecast was for one-in-ten year conditions, and it included all expected enhancements in energy efficiency standards and expected new resources, contrary to Borenstein's uninformed assertion. However, in 2005 the CEC could not anticipate the rapid growth in rooftop solar. That is the salient factor that can explain the large divergence.

The 2022 peak load was driven in one-in-35 year weather conditions—well outside of the CEC's planning parameters. The 2022 peak is not useful for measuring peak load growth. The 2006 peak is still the second highest ever peak, and the 2023 and 2024 peaks have been well below the 2022 level despite record temperatures. Even the 2020 peak when the CAISO implemented rolling blackouts was 3,000 MW below the 2006 peak. The trend line for peak loads through 2023 shows an equivalent peak of 47,000 MW or 15,000 MW less than the CEC's forecast for that year.

[12] Borenstein clearly has not read my rebuttals to Xiao Wang's critique on Bluesky to my posting. Notably, Borenstein does not adopt any of Xiao's criticisms.



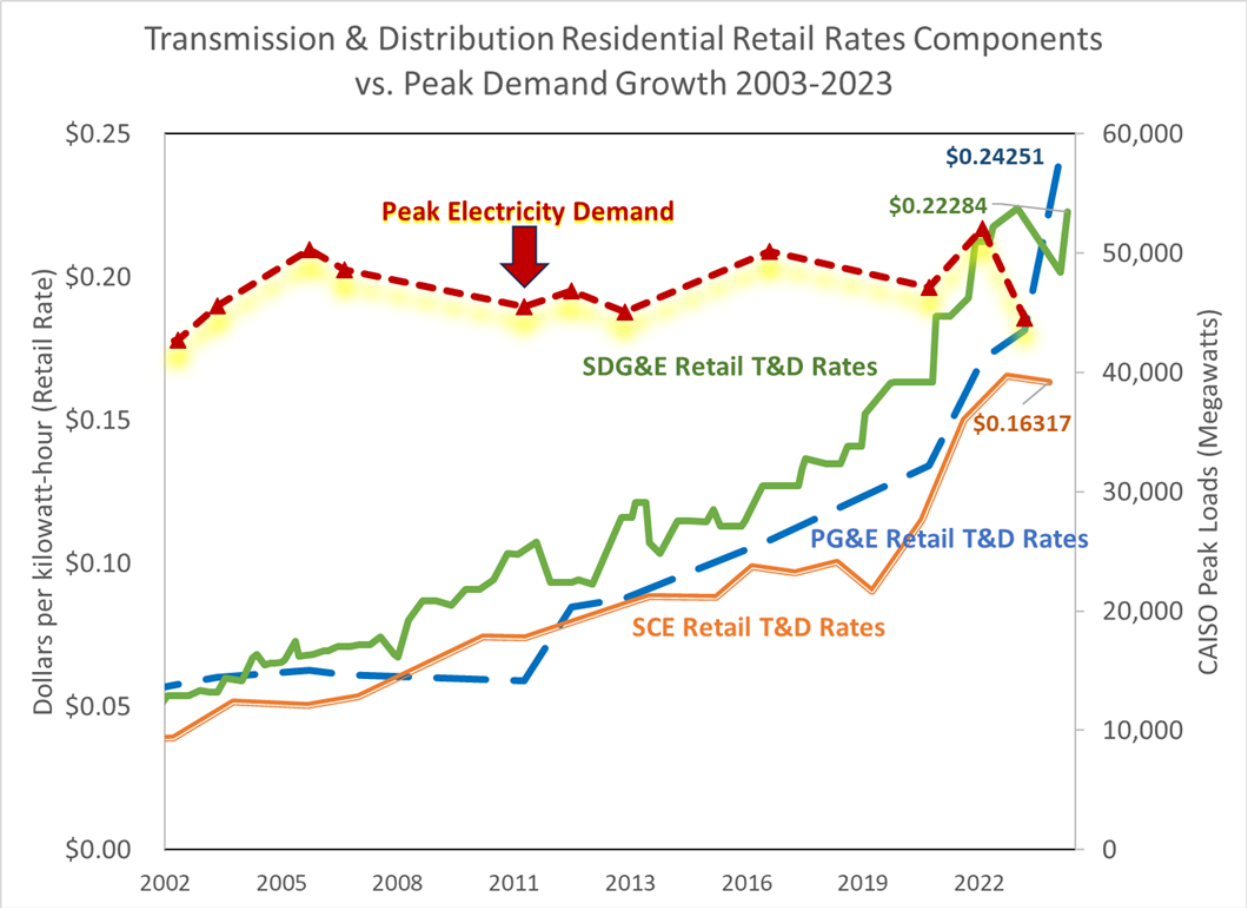
I also conservatively excluded three important peak capacity enhancements from using rooftop solar instead of a combustion turbine. The first is that rooftop solar does not require a 15% planning reserve margin or 7% operating reserve margin. The CAISO has made no operational changes since 2005 to adapt to increased rooftop solar with no apparent ill effects. The second is that rooftop solar avoids line losses, especially during peak loads at the hottest time of the year. The average line loss over the year is about 7%, but during peak loads reaches 14% or more.[13] And third, solar output is correlated with variations in air conditioning load—higher temperatures are when solar output is highest. The first two effects add 32% to a megawatt of rooftop solar compared to a grid-scale resource. That means that 15,000 MW of rooftop solar is equivalent to 19,840 MW of grid-scale generation (and combustion turbines are further derated 5% for thermal inefficiency at peak and unexpected outages.)

Borenstein appears not to understand how utility marginal costs are calculated. The chart I created for my blog post measures a change in cost against a change in quantity. *We can only see that average costs are rising by examining the time steps of those costs.* Generally, a time-series of costs are calculated against a change in the quantity over time. The red flag here is that average costs have been rising rapidly for transmission and distribution for more than two decades since restructuring (when the utilities' profit center was narrowed to T&D). Unless explained well by explicitly incorporating other factors, we should rely on basic economic principles as a likely

[13] Don Kondoleon, CEC, "average and peak T&D losses," To Bill Powers, January 30, 2008.

explanatory factor. Hand waving which Borenstein has long relied on is not sufficient. Saying what he believes is *not* an explanatory factor.

The chart below illustrates the rise in the T&D component of rates (excluding non bypassable charges and program costs). Why transmission costs have been rising so fast is clear—the utilities have added substantial amounts of remote renewable generation that requires both direct interconnection and rewiring of the load center networks to maintain reliability.[14] Why distribution costs have gone up so much is not so apparent, but it is not driven yet by either wildfire risk or electrification because the utilities have not yet invested substantially in those. That the CPUC has not investigated this trend more deeply is concerning about the lack of oversight.



For generation, I used values used by the utilities built from different filings documents in my workpapers. For transmission, the marginal costs are driven directly and indirectly by generation additions—transmission takes that output and delivers it to substations where it is sent out through the distribution system. I conservatively used the current retail rate as a proxy of the cumulative spending on transmission.[15] Given the large increase in RPS generation, this correction likely will triple the estimate of the transmission marginal cost. For distribution marginal costs, I

[14] For example, SCE has invested substantially in the ring surrounding the LA Basin.

[15] The preferred approach is to calculate the total transmission spending and divide by the total added generation, most of which has been renewables since 2005

conservatively used the values that the utilities filed in their general rate case applications. These are the basis of the same cost category in the ACC. However, the PAO misused the ACC by failing to include the full amount of these distribution marginal costs, instead relying only on the immediate single year value.

Most importantly, Borenstein does not even broach the question of *why* transmission and distribution costs have been rising so rapidly for more than two decades, long before wildfire risk came on the scene. Instead, he chooses to assert that rising average costs are not driven by ever higher marginal costs without any evidence on his part. He understands that if we acknowledge that we can save more than average rates by installing distributed energy resources, the cost-shift claim disappears. Until we see a full accounting of why rates have been rising, we have to assume that fundamental economic principles apply and that marginal costs are above average costs.

Displaced CARE Subsidy

Again, Borenstein doesn't seem to understand the distinction between revenue requirements and annual avoided costs. The CARE subsidy is entirely an internal shift in revenue requirement responsibility among all ratepayers. It has nothing to do with avoided costs for other customers.

Borenstein makes the same mistake as PAO, conflating contributions to "fixed" costs by CARE customers with subsidies flowing to CARE customers from other customers. Both aspects are included separately in our analysis, contrary to PAO's assertion. Meanwhile, they treat CARE customers as though they are paying full retail rates and are responsible for the same amount of "fixed" costs as all other customers. The fact is today that non-CARE customers are paying a share of "fixed" costs that are attributable to CARE customers before the latter group receives a subsidy. The non-CARE customers are relieved of a portion of that subsidy when CARE customers instead self generate and pay for their own power source.

Customer Bill Payments

Borenstein acknowledges that these payments should have been included in both his and PAO's analyses. Yet he tries to diminish this effect. Even so, the 8% he acknowledges is worth $500 million, compared to the $1.2 billion I calculated.

He ignores the fact that the assertion of a cost shift is based on the utilities' claim that there are "fixed costs" to be covered by customers. Those costs are on a per customer basis and do not vary with usage. PG&E calculated the fixed cost per customer per month is $53 in its filing in the income-graduated fixed charge (IGFC) proceeding,[16] and the CPUC issued a decision finding the evidence shows a fixed cost of $24 per customer. Yet NEM customers are contributing an average of $70 per customer per month, well above what anyone else is claiming.

[16] The average fixed charge in the utilities' original proposals were $49 for SCE, $53 for PGE, and $74 for SDGE.

Borenstein with his coauthors proposed an income-based fixed charge specifically to as a payment from rooftop solar customers to address the cost shift.[17] The average fixed charge that they proposed was in the range of $70 per month. Yet when presented with evidence that those customers are already paying that amount, he fails to acknowledge that they are already contributing the amount that he proposed. In other words, his complaint is moot—rooftop customers are paying their fair share by his own calculations.

Conclusion

Our correction of the PAO's analysis reverses their purported $8.5 billion cost estimate to a $1.5 billion savings instead. Borenstein's own version of the calculation, acknowledging PAO's errors, would also lower the PAO's estimate by nearly $2 billion. Commonsense and legal and regulatory precedents and practices require regulators to ignore self consumption in setting rates, lowering the PAO's estimate another $4 billion. The remaining $2 billion differential between our correction and the PAO's original figure comes down to errors in using the Avoided Cost Calculator instead of measuring actual historic savings to all ratepayers of lowering the growth of peak electricity demand over the past twenty years with privately-financed rooftop solar systems. While we might quarrel over certain details, the result is that any potential "cost shift" is lost in the noise and uncertainty of utility rate making.

[17] Severin Borenstein, Meredith Fowlie, and James Sallee "Designing Electricity Rates for An Equitable Energy Transition," Energy Institute at Haas, WP-314, https://haas.berkeley.edu/energy-institute/research/abstracts/wp-314/ (February 2021).