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## Improving Metrics for Equitable Energy and Community Resilience

Dear Commissioners,

I am an energy and community resilience researcher at PSE Healthy Energy with a particular interest in equitable and affordable resilience. My recent published work includes estimates of electricity outage costs and impacts that incorporate equity considerations, and the potential for community resilience hubs to mitigate some of these costs and impacts.

Incorporating metrics that capture how households, especially vulnerable and disadvantaged households, struggle from a lack of electricity and the household energy services it provides will improve the Commission's Energy Equity Indicators. Additionally, understanding how energy and electricity resilience are just a part (although a key part) of household and community resilience will start to demonstrate how the combined impacts of a just energy transition, including improved air quality and health, reduced health care costs, reduced energy burdens,increased community cohesion, and reduced harms from climate disasters all reinforce each other to help households grow and maintain their resilience reserve.

Beyond just energy resilience, the concept of a resilience reserve has gained traction as a framework for understanding how resilience resources (money, time, effort, physical health, mental health) that are needed in response to disasters are often drained by constant use in addressing day-to-day challenges. This is especially true for those households and communities that bear the burdens of legacy pollution and poverty.

As the CEC continues this work, I respectfully recommend the following priorities for incorporating concepts of community resilience and resilience reserves. Towards this I offer the following recommendations:
Draft resilience metrics in the Justice Access Equity Diversity Inclusion (JAEDI) Framework are inadequate, as they focus only on resilience hubs, and even then do not address whether the investments in hubs meet community needs nor total statewide needs. In addition, they do not capture or compare the benefits and cost differences between resilience in the home and resilience in a hub, and the different benefit and cost differences between resilience hubs and hub services in different regions, where climate, utility costs, and outage frequency and duration impact the value. Most importantly from an equity perspective, many vulnerable populations will face mobility, language, health, and other difficulties in accessing resilience hubs, even if they exist.
Avoid grid reliability metrics like SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency Index), and CAIDI (Customer Average Interruption Duration Index) as they are grid-focused averages that fail to capture actual customer impacts, because (1) averages hide the most impactful, long duration

outages, and (2) the grid perspective does not capture actual customer experiences. These metrics do not help policy makers focus on the specific geographies that experience longer, more impactful outages, nor on the vulnerable households that face greater hardship from outages.

Develop equitable resilience metrics that are comprehensive and defensible to support policy decisions and tradeoffs. Where possible, to simplify benefit-cost comparisons, monetized metrics can be extremely valuable, including metrics like a â€œresilient energy affordability gapâ€□ that adds the cost of outages to traditional energy affordability gap calculations, and can be used to identify household and regional energy burdens that include electricity resilience. Using net income after essential expenses (food, shelter, medical, transportation) rather than gross income improves the affordability gap calculations, as that begins to take into account cost of living impacts on affordability and resilience reserves.Other metrics may be harder to monetize, but are still quantifiable, like the increase in quality-of- life-years gained by reduced by extreme heat exposure from access to affordable and resilient energy for air conditioning. Some metrics may remain qualitative, but no less important, like feelings of stress from the fear of power outages or utility shut offs. Importantly, all metrics should be developed with community participation.

Expand the categories socio-economic, demographic, and geographic data to categorize and prioritize resilience interventions, while also supporting the development of more detailed monetized and quantifiable metrics. The Self-Generation Incentive Program (SGIP) already targets additional support with quantitative and qualitative thresholds that identify households experiencing more outages and with vulnerable occupants based on both income and medical needs. Additional characteristics to focus interventions beyond SGIP categories should include not just the existence of outages from Public Safety Power Shutoffs (PSPS) or Enhanced Powerline Safety Setting (EPPS), but also identification of where these outages are longest. Additionally, outages experienced due to utility shut-offs can serve as an additional indicator of depleted resilience reserve. Finally, an additional metric important to the consideration of resilient pathways is a better understanding of the overall need for improved electricity resilience: knowing how many households would be eligible by SGIP and improved SGIP criteria, and how many or what fraction of these are budgeted in programs, or have received support are important considerations for resource allocation and budgeting.

Energy resilience metrics should include regional and demographic distributional impacts considering (1) distributions of outages, (2) distributions of hazards, (3) distributions of vulnerabilities.

Incorporate outage probability distributions into resilience metrics, as long duration outages have disproportionate impact that is lost when using data averaged across large geographies and populations. Measures of outage resilience and lack of resilience at the household level are more useful than grid reliability metrics toward effective, equity supporting policies. Outage impact has been shown to increase non-linearly with outage duration, such that the impact is proportional to the square of the duration (a two day outage is four times as impactful as a one day outage). Metrics that use average frequency and duration will not capture non-linear costs, nor will metrics that simply sum total outage minutes per year. Calculations of the harm from outages and value of

mitigations (like grid hardening and distributed energy resources (DER)) should take into account the potential for long duration outages that far exceed the average. I recommend using a localized distribution of outage potential. For example, a certain location might have an annual probability of 100% to experience an outage of at least 2 hours, of 50% for an outage of at least 8 hours, and a 1% chance of an outage of at least 48 hours. While the lower probability of the longer outage might appear less impactful, the increasing harm with increasing duration means that if it occurs, it will be 576 times more harmful than the 2 hour outage, resulting in a the probability-weighted expected harm that is still 5.76 times that of the 100% likely 2-hour outage. In addition, utility shutoffs can also be considered a long duration outage whose frequency and duration is more a function of household energy burden than grid reliability.

Use localized data to incorporate different regional hazard risks into resilience metrics. Localized exposure to hazardsâ€“ like extreme heat, poor air quality from cooking, from pollution, and from wildfire smoke, flooding, sea level rise, and moreâ€“should be included in outage cost, outage mitigation, and resilience reserve calculations. The Vulnerable Communities Platform serves as a great resource for understanding regional hazards now, and in the future.

Incorporate additional vulnerabilities into resilience priorities now, and continue to work towards more detailed quantification of community and household resilience metrics that incorporate vulnerabilities. Considering (and especially monetizing) specific potential impacts from socioeconomic and health vulnerabilities has the potential to become very complicated, given that different impacts from various hazards, and different energy services needed to mitigate them. SGIP vulnerability criteria (Medical Baseline Program, income eligibility, and electric well pump reliance) illustrate how household characteristics are vital for understanding resilience needs. In addition to these specific, high priority filters, metrics should also consider the additional needs that households with children and elderly members face. Research shows that outage impacts (measured by willingness to pay for them to end) are 20% higher for households with children compared to those without children, and we can expect other non-medical baseline vulnerabilities to generate similar increased impacts.

Mitigations and resilience reserve. Household and community mitigations, include reducing grid outages, increasing investments in household and community energy resilience, improving health outcomes, and reducing healthcare costs all helping households and communities increase and maintain their resilience reserves for actual disasters. Capturing the individual and interacting impacts across these metrics will better estimate the value of an equitable energy transition. A key component of these metrics will be estimating the value of incomplete interventions toward undoing the harms.

Resilient energy. How much of the impact of outages, utility shut-offs and self-curtailed energy use can be mitigated by solar and storage at different scales for different types of households? It is quite straightforward to design and build solar, storage, and fuel based DER to mitigate 100% of outage impacts, but the high cost of these systems makes them rare, especially for disadvantaged households. It is much more complicated to estimate the value of partial backup, but this should be studied, especially the potential for balcony scale systems to extend solar plus storage resilience to renters and apartment dwellers.

Resilience reserves. How much do chronic health outcomes and healthcare costs, energy affordability challenges, housing affordability challenges, and other day-to-day stressors eat away at community resilience reserves? And what is the value of improved indoor and outdoor air quality, energy affordability, and household and community investment in resilient energy toward undoing these chronic harms?

Energy justice and equitable climate resilience will require affordable, resilient, renewable energy for all, but economic and systemic barriers often prevent the most vulnerable households from accessing affordable and affordable resilient energy. Solutions that reduce energy bills, reduce the impacts of outages, improve household habitability and comfort, reduce exposure to indoor pollutants and other environmental hazards, mitigate climate catastrophe, and serve the most vulnerable all help households and communities to grow and maintain their resilience reserves. The IEPR should include and improve metrics that help quantify the harms from a lack of resilience, and measure progress towards achieving equitable resilience.

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