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BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Continue Electric Integrated Resource Planning and Related Procurement Processes	Rulemaking 20-05-003 (Filed May 7, 2020)

OPENING COMMENTS OF FORM ENERGY, INC. ON ADMINISTRATIVE LAW JUDGE'S RULING SEEKING FEEDBACK ON MID-TERM RELIABILITY ANALYSIS AND PROPOSED PROCUREMENT REQUIREMENTS

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I. Introduction

Form Energy, Inc. ("Form Energy") respectfully submits these opening comments in response to the *Administrative Law Judge's Ruling Seeking Feedback on Midterm Reliability Analysis and Proposed Procurement Requirements* ("Ruling"), issued February 22, 2021, and pursuant to Administrative Law Judge Fitch's email ruling issued on March 15, 2021, which extended the opening comment deadline to March 26, 2021. Form Energy has also concurrently filed a Motion for Party Status in this proceeding, dated March 26, 2021.

Form Energy's comments primarily focus on the need for the California Public Utilities Commision ("Commission") to consider reliability in the context of multi-day weather events and to procure zero carbon resources that can meet grid needs during those periods. While Form Energy commends the Commission's effort to address mid-term emerging reliability needs, we are concerned that the Ruling has not accurately articulated the multi-day nature of the grid's

current and future reliability challenges. The Commission should adopt requirements that drive the procurement of firm and deliverable zero carbon capacity that will address mid-term reliability needs and also prepare California to maintain grid reliability over future periodic weather events. As discussed below in more detail, Form Energy's comments address and recommend the following:

- California experiences 100-hour renewable energy shortfall events once every ten years. During these events, renewable energy output is more than 25% below the 35-year average. These events typically occur in winter, but also occur in spring and fall.
- The Commission should adopt system planning standards designed to ensure that grids with high levels of renewables can maintain reliability over periodic multi-day weather events by:
    - Establishing reserve margins that address the two dimensions of energy insufficiency risks:
        - Net Peak, based on the highest single day net peak demand, and
        - Net Energy, based on the continuous 100-hour period with the lowest renewable energy output relative to average.
    - Using 1-in-10 year weather year assumptions, at a minimum, to capture low renewable generation availability as well as peak net loads;
- The Commision should define firm zero carbon resources as zero carbon resources that are physically capable of and contractually guaranteed to deliver at least a 95 percent availability factor over a ten year period, including during continuous 100-hour low

renewable energy weather events and grid contingencies reflected in 1-in-10 year standards.

- It is reasonable to require at least 1 gigawatt ("GW") of new long-duration energy storage resources to be online by June 2025 and to require that at least half of those resources be multi-day energy storage to meet firm resource requirements.
- The Commission should require at least an additional 3 GW of firm zero carbon resources to be deployed by June 2026 to align with the Ruling's "high-need" scenario, and it should establish firm zero carbon procurement requirements beyond 2026 to avoid future mid-term reliability crises and to align with the Joint Agency Senate Bill 100 Report ("SB 100 Report") findings.

Given the independent analysis Form Energy conducted to support these comments and the nature of the recommendations, the subsequent sections are structured in a narrative format rather than as responses to specific ruling questions. To the extent that Form Energy's responses can be seen as responses to specific ruling questions, however, the recommendations are most directly related to Questions 3, 4, 5, 6, 8, 11, and 33.

II. California experiences 100-hour renewable energy shortfall events once every ten years. During these events, renewable energy output is more than 25% below the 35-year average. These events typically occur in winter, but also occur in spring and fall.

Form Energy analyzed 35 years (1980-2014) of intermittent renewable generation profiles from the Commission's SERVM datasets used to conduct reliability assessments in the 2018 IRP cycle. Our goal in performing this analysis was to provide the Commission and parties with a replicable analytic basis to: 1) quantify the frequency and duration of low intermittent

generation events in California that should be accounted for in Integrated Resource Planning ("IRP") planning standards; and 2) recommend what types of portfolio and firm zero carbon resource performance is needed to maintain system reliability during these events.

In this analysis, we defined low renewable energy events as those in which actual renewable energy output is at least 25 percent below the 35-year average for consecutive hours, and we found that historically:

- California experiences 50-hour low renewable energy events *annually* on average. They are most common in winter, but they occurred in spring and fall as well;
- California experiences 100-hour low renewable energy events once in ten years on average;
- The worst case event over a 35-year period was a 142-hour period in December 2010.

Methodology

Form Energy's analysis considered hourly generation profiles over 35 years for the full list of intermittent generators included in the Commission's SERVM datasets that reflect the Commission's "Hybrid Conforming Portfolio 2030" from the 2018 IRP preferred system plan.[1] We calculated rolling 3-, 5-, and 7-day averages of renewable energy generation, and then using the average ("P50") output for each month-hour combination over the 35-year period, we compared actual output in each hour to the average. We then considered the occurrence of events in which the 3-day moving average intermittent output was at least 25 percent below P50.

Results

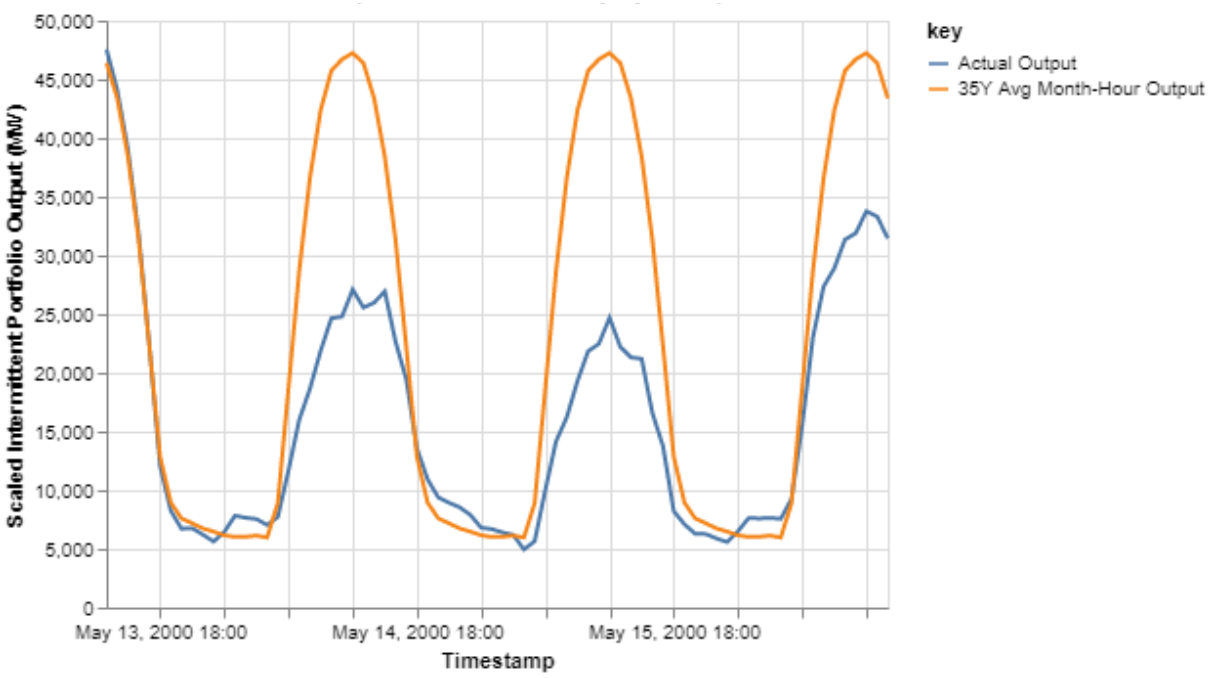
[1] The renewable energy portfolios modeled in this analysis reflect the CPUC's "Hybrid Conforming Portfolio 2030 Intermittent Generation Profiles (11-05-2018)" available at https://www.cpuc.ca.gov/General.aspx?id=6442451973. This portfolio reflects a statewide nameplate renewable energy capacity of 75 GW in 2030.

Annual 50-hour Low Renewable Energy Events

Despite California's solar-heavy generation mix, we found that periods of low intermittent outputs extending at least 50 hours are common: over the period in question, there were 22 such events, or more than one on average every two years. While these events were most common in the winter, they occurred in spring and fall as well.

In one of these events, shown below, intermittent generation in May 2000 lagged at least 25% below average for 51 hours, and at one point was 24 GW below expected P50 generation, with a 500 GWh shortfall in renewable energy generation.

Figure 1. Example of a typical 50-hour low renewable energy event, May 13-15, 2020

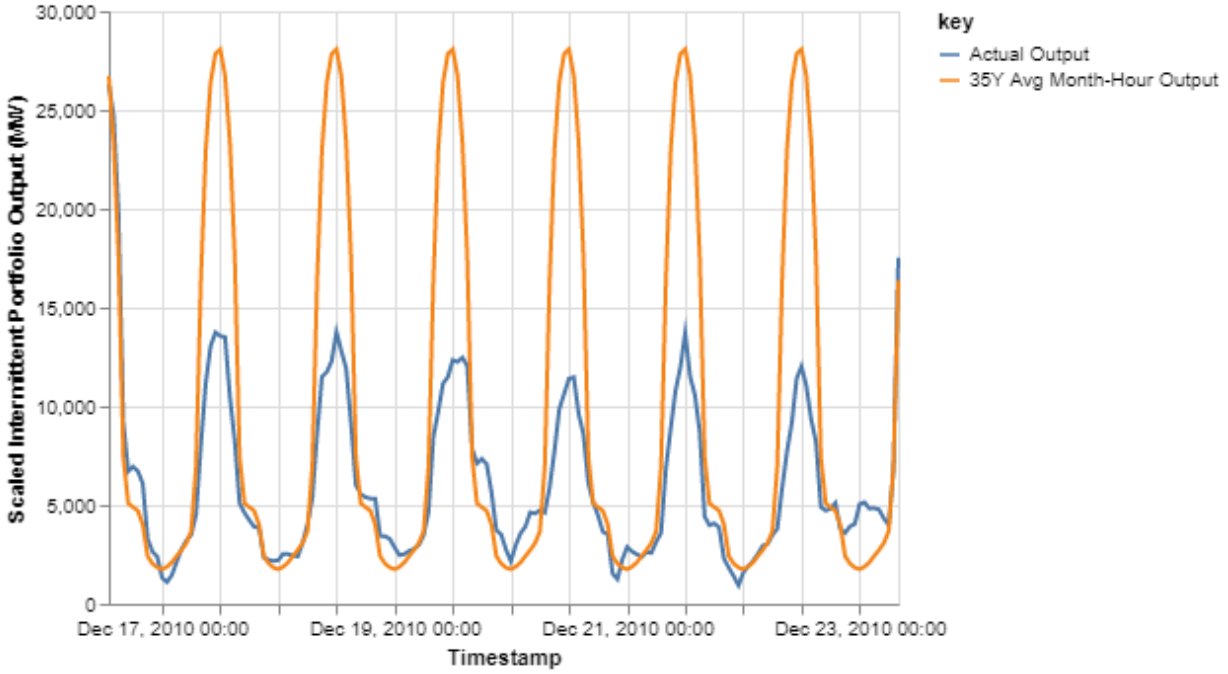


Periodic 100-hour low renewable energy events occur once in ten years

In addition to the 50+ hour low renewable events, Form identified three events over the 35-year period, or just under one event in every ten years, in which moving average intermittent generation lagged at least 25% below P50 for more than 100 consecutive hours. The longest

event, which lasted 142 hours in December 2010, resulted in nearly 600 GWh less energy being delivered from intermittent generation than during the same hours in a typical year. At one point during this event, actual output was over 17 GW, or 66% below, P50 output for the hour.

Figure 2. Longest periodic 100+-hour low renewable energy event, December 17-23, 2010



These results show that system planning standards based solely on single day peak net load are an inadequate standard to ensure grid reliability in grids with high levels of renewable energy. The Commission should adopt planning standards that ensure energy sufficiency over the majority of 1-in-10 year low intermittent generation events (i.e. that address net energy needs over periodic low generation events), as well as energy needs during periods of high net peaks.

The results additionally provide a basis to define the meaning of "firm" resources and to assess what kinds of resources can meet that definition. Our analysis suggests that in order to be considered truly "firm," a resource and a portfolio must be able to deliver energy reliably over

periods of at least 100 hours to maintain reliability during the majority of 1-in-10 year low intermittent generation events. The short-duration energy storage resources that Commission has approved to date, for example, will be useful in mitigating short bursts of low intermittent generation; however, our analysis indicates that firm zero carbon resources must be able to deliver energy for at least an order of magnitude longer than short-duration energy storage systems are capable of providing. Specifically, we find that energy storage with at least 100-hours of duration should cover the majority of 1-in-10 year low intermittent generation events and be considered firm resources, and that a portfolio of 150-hr energy storage systems could have covered each of the most significant low generation events in the period studied.

III. The Commission should adopt system planning standards designed to ensure that grids with high levels of renewables can maintain reliability over periodic multi-day weather events.

A. The Commission should establish planning standards and reserve margins that address the two dimensions of energy insufficiency risks: 1) Net Peak, based on the highest single day net peak demand, and 2) Net Energy, based on the continuous 100-hour period with the lowest renewable energy output relative to average or the period of highest continuous net load.

We are concerned that the Commission is not using planning standards or defining resource performance requirements that are sufficient to address mid-term reliability needs. The Commission has historically set system level resource needs based solely on a planning reserve margin ("PRM") that captures *only* single day net peaks. Our analysis, and other notable studies referenced in the discussion below, show that California must begin to factor the periodic occurrence of multi-day low renewable energy output events into planning standards.

We recommend that the Commission adopt an additional planning standard: a Net Energy planning standard and reserve margin based on the continuous 100-hour period with the lowest

renewable energy output relative to average. A net energy planning standard should also account for sequential day periods of highest continuous net load.

B. System planning standards should use 1-in-10 year weather year assumptions, at a minimum, to capture low renewable generation availability and multi-day net peak loads.

The Commission's use of 1-in-2 weather year assumptions for system level resource planning does not capture the frequency and changing nature of the atypical weather events that will cause future reliability risks. Form Energy's analysis above demonstrates that continuous 100-hour periods with low renewable energy output have historically occurred at least once every ten years. Hence, while such events are atypical in that they occur with a multi-year periodicity, they pose a significant risk to reliability. As California integrates increasing quantities of weather-dependent solar and wind resources, periods with the highest loss of load risks will shift from summer peaks to multi-day winter periods of low renewable energy output. The Commission's IRP planning standards must adapt to plan for these 1-in-10 year events, at a minimum.

Multiple studies of the California grid have reached similar conclusions regarding the reliability risks of periodic weather events and the likelihood that these risks will increase in coming years. In their 2019 study, *Long-Run Resource Adequacy under Deep Decarbonization Pathways for California*, Energy and Environmental Economics, Inc. ("E3") found that multi-day periods of low renewable production are the most significant challenge to reliability. In their analysis of 68 years of weather data, E3 finds that, "loss of load events are highly correlated with the 3-day running average of solar generation."[2] CAISO has also highlighted concerns that

[2] *Long-Run Resource Adequacy under Deep Decarbonization Pathways for California* at p. 30 (https://www.ethree.com/wp-content/uploads/2019/06/E3_Long_Run_Resource_Adequacy_CA_Deep-Decarbonization_Final.pdf)

multi-day periods of low renewable energy output in winter will pose increasing risks to system reliability.[3] The 2021 SB 100 Joint Agency Report ("SB 100 Report"), found that events such as the August 2020 heat wave are "no longer outside the realm of planning contingencies."[4] IRP is a proceeding designed to identify future system risks and to ensure that procurement addresses both near and long-term needs. It would be unreasonable to adopt anything less than a 1-in-10 planning standard for system needs.

Although we recommend using a minimum 1-in-10 weather standard, the Commission should consider using 1-in-20 weather year standard to capture increased uncertainty in both energy demand and generation availability caused by climate change. Atypical weather events are becoming increasingly common in California. Based on analysis by the California Energy Commission ("CEC"), the six day August 2020 extreme heat wave, which precipitated rolling blackouts, was a 1-in-30 weather event for August. However, when temperature trends due to climate change are considered, the event is more appropriately considered a 1-in-20 event.[5]

Form Energy's analysis shows that a 1-in-10 weather year planning standard, combined with other measures recommended in the discussion that follows, should be the minimum that the Commission adopts if it wishes to ensure that the grid can reliably accommodate higher levels of renewables. However, it would be prudent for the Commission to adopt a conservative 1-in-20 weather year standard at least temporarily in IRP until the Commission provides

[3] *See* CAISO's March 23, 2020 comments filed in the CPUC's Resource Adequacy Proceeding at p. 4-5 available at https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M330/K052/330052136.PDF.
[4] *2021 SB 100 Joint Agency Report* at p. 45 (https://efiling.energy.ca.gov/GetDocument.aspx?tn=237167&DocumentContentId=70349)
[5] *Final Root Cause Analysis: Mid-August 2020 Extreme Heat Wave* at p. 40 (http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf)

evidence that the use of 1-in-10 planning standards would not pose an unreasonable risk and cost to Californians and until it adopts reliability metrics to replace LOLE.

C. The Commission should adopt effective unserved energy and loss of load hours as metrics to replace loss of load expectation-based reliability standards.

Reliability risks and ratepayer costs are not well reflected in existing 1-in-10 loss of load expectation (LOLE) standards, which do not capture the duration, magnitude or cost to society of loss of load events. As Texas experienced this winter, these costs can be extraordinary, and policy makers need to use reliability metrics to help them assess the risk of high cost loss of load events. We are concerned that periodic weather events may pose compounding reliability risks because both California's energy demand and energy supply are now weather-dependent. We are also concerned that neither the use of 1-in-10 weather years nor the use of 0.1 LOLE metrics will guard against these high cost multi-day reliability failures. Reliability metrics should appropriately capture these risks and lead to resource portfolios that ensure the grid has sufficient firm resources. Reliability standards based on effective unserved energy and loss of load hours would both provide more actionable indicators of whether resource portfolios are likely to result in reasonable or unreasonable societal costs, because they provide a method to quantify the cost of loss of load events and the firmness of resource portfolios.

IV. The Commision should define firm zero carbon resources as zero carbon resources that are physically capable of and contractually guaranteed to deliver at least a 95 percent availability factor over a ten year period, including during continuous 100-hour low renewable energy weather events and grid contingencies reflected in 1-in-10 year standards.

The Commission has never defined the meaning of firm or the performance that it expects of firm zero carbon resources. To be firm, zero carbon resources should be available

when the grid needs them most: during the periods of highest net peaks, and during periods when the grid experiences the longest periods of low renewable energy output. Firmness is a measure of a resource's availability relative to the shape of a target operating profile. A firm resource does not necessarily have the same characteristics as a baseload resource. Baseload resources are defined as those with a high capacity factor, which is only an indicator that a resource produces a high amount of energy relative to its nameplate capacity, regardless of whether the resource was available at the time and shape it is needed.

We recommend that the Commission define firm zero carbon resources as those zero carbon resources that are physically capable of and contractually guaranteed to deliver at least a 95 percent availability over a ten year period, including during continuous 100-hour low renewable energy weather events and grid contingencies. California needs to cultivate a portfolio of zero carbon resources with this level of availability in order to achieve its SB 100 goals and prudent reliability standards with high levels of renewable energy.

We recommend that the Commission establish a 95 percent effective availability factor performance requirement because this standard is common in contracts, in particular with natural gas resources. Requiring this standard of firm zero carbon resources establishes a pathway to retiring natural gas generators in California. However, we recommend that a 95 percent availability factor should be a guaranteed performance *floor* and not a ceiling. Higher levels of availability are possible to achieve cost-effectively, and there may be compelling reasons for the Commission and load serving entities ("LSEs") to pursue higher levels of availability.

Additionally, we recommend that firm zero carbon resource availability should be guaranteed over at least a ten year period and should also guarantee availability over the longest

sequential periods when grid reliability risks are highest: during multi-day weather events that significantly lower renewable energy output, and during periods of highest net peak demand.

V. It is reasonable to require at least 1 GW of long-duration energy storage to be online by June 2025 and to require that at least half of those resources be multi-day energy storage to meet firm resource requirements.

The Ruling proposes that at least some of the capacity procured in response to the retirement of the Diablo Canyon Nuclear Plant and gas units using once-through-cooling should be firm, and it proposes to address this need in part by requiring 1 GW of new long-duration energy storage resources by June 2025. Form Energy supports this recommendation; however, we recommend that the Commission further require that at least half of these long-duration energy storage resources (>500 megawatts ("MW")) be multi-day energy storage with the ability to meet the definition of firm zero carbon resources that we find is necessary to meet reliability needs.

There is evidence from our modeling to support a conclusion that, within the Commission's definition of long-duration storage, only multi-day energy storage resources can perform as firm zero carbon resources. The Commission currently defines long-duration energy storage as energy storage resources that have a duration of 8 hours or more, which includes multi-day energy storage that can act as a firm zero carbon resource. As we discuss below, there is reason to conclude that long-duration energy storage resources with durations of 10-hours, and potentially all those with durations far less than a day, may not provide sufficient firming capacity to meet mid or long-term system needs. It is prudent and part of a least-regrets procurement strategy, for the Commission to ensure that at least 500 MW of long-duration energy storage resources are multi-day storage resources that are firm.

We additionally recommend that the Commision reconsider how it models and frames long-duration storage as a resource class. It is apparent from the Commission's IRP modeling assumptions and the Ruling's assumptions about "long development lead times" that the Commission associates long-duration energy storage primarily with pumped hydro resources. We hope the Commission will recognize in future IRP modeling and procurement directives that long-duration storage is a diverse resource class, with significant variations in technology types, performance and configuration that warrant distinctions between long-duration storage resources that are daily-cycling (i.e. can dispatch at most for a single day without recharging) and those that are multi-day storage, which can cycle daily to balance hourly load and can also dispatch continuously at capacity over multiple days and therefore act as a firm zero carbon resource.

VI. The Commission should require at least an additional 3 GW of firm zero carbon resources to be deployed by June 2026 to align with the Ruling's "high need" scenario.

The Commission should direct LSEs to procure resources in 2026 according to the High Need scenario reflected in Ruling Table 1 (10.4 GW by 2026), rather than the Mid Need scenario as the Ruling recommends. We are concerned that the Commission continues to structurally overstate the ELCC values of wind and solar resources, as well as energy storage with durations far less than 24-hours, which warrants additional prudence when establishing procurement targets to satisfy reliability needs. We believe the Commission's ELCC values continue to be overstated due to two shortcomings common to all ELCC modeling that we have seen:

- ELCC models presume that all or a majority of existing fossil and firm resources continue to persist. These resources provide a firming service. Without such resources in the portfolios modeled, the ELCC value of variable renewables and daily-cycling storage would likely be far lower.

- The Commission's ELCC modeling considers typical weather years and does not consider periodic weather years that drive real-world reliability risks. The Commission's adopted ELCC values therefore do not accurately reflect the ability of variable resources to meet reliability needs in 1-in-10 weather years.

As has been well-documented in a variety of studies, including multiple sources referenced in these comments, the ELCC values of variable renewable generation and short-duration energy storage decrease as their penetrations increase. The Commission has yet to consider the ELCC value of 8+ hour energy storage systems; the ELCC study developed for IRP only considered 4-hour batteries.[6] Consequently, the Commission has little analytic basis to conclude that 8-hour or 10-hour storage, for example, will contribute meaningfully to system reliability under future portfolios with high levels of renewables. E3 modelled both 4- and 10-hour energy storage systems and found that even 10-hour storage systems "are significantly shorter than multi-day storage that would be needed to ride through the primary reliability challenges" of multi-day low renewable energy events in winter.[7] The E3 analysis finds that, in order to ensure reliability in a deeply decarbonized grid, some form of firm generation capacity is needed, with firm capacity defined as "electric energy resources that can produce energy on demand during extended periods of time in which wind and solar energy are not available."[8]

We support the Ruling's commitment to pursuing a prudent least-regrets procurement strategy, which the Commission can support by requiring an additional 3 GW of firm zero carbon

[6] *See* Astrape Consulting *Energy Storage Capacity Value on the CAISO System, Final Report*, January 17, 2020, available at ftp://ftp.cpuc.ca.gov/energy/modeling/CPUC%20ES%20Final_2-12-20.pdf
[7] *Long-Run Resource Adequacy under Deep Decarbonization Pathways for California* at p. 36 (https://www.ethree.com/wp-content/uploads/2019/06/E3_Long_Run_Resource_Adequacy_CA_Deep-Decarbonization_Final.pdf)
[8] *Id.* at 57-58

resources by 2026. Such procurement is also likely to provide significant portfolio cost savings benefits, as described below.

VII. The Commission should adopt at least a 1 GW per year firm zero carbon procurement requirement in 2027 and 2028 to avoid future mid-term reliability crises, provide stable long-term procurement signals, and align with SB 100 report findings.

There is a growing body of evidence from the California Energy Agencies' modeling and others that California needs to accelerate the pace of renewable energy and short and long-duration energy storage deployment in order to meet its SB 100 goals. There is also evidence that firm zero carbon resources in particular have the potential to lower the cost, land impacts, and reliability challenges associated with meeting SB 100 goals. We recommend that the Commission use this opportunity to establish at least a 1 GW annual procurement target for firm zero carbon resources in 2027 and 2028 to further support mid-term grid reliability, make continued progress toward SB 100 goals, and provide project developers with stable long-term procurement signals necessary to bring California's load serving entities a diverse set of resource options.

The Joint Agencies' SB 100 Report included a Generic Zero-Carbon Firm Resources Scenario, which modeled firm zero carbon technologies and found that the inclusion of such resources has the potential to significantly reduce needs for utility-scale solar and battery storage and can reduce total resource cost by three percent (~$2 billion in 2016 dollars).[9] Several studies, including the SB 100 Report, have found that California needs to establish a multi-GW-per-year pace of deploying renewable energy and short and long-duration energy storage to meet SB 100

[9] *2021 SB 100 Joint Agency Report* at p. 13. This analysis uses a cost of $60/megawatt-hour for zero-carbon firm technologies to calculate total resource cost. (https://efiling.energy.ca.gov/GetDocument.aspx?tn=237167&DocumentContentId=70349)

goals. Without firm zero carbon resources, SB 100 Report modeling indicates that California would need to deploy solar, wind and short-duration storage at a pace of approximately 6 GW each year in order to meet SB 100 decarbonization targets. Under this SB 100 core scenario, more than 50 GW of short- and long-duration energy storage are projected to be needed by 2045.[10] The Commission's IRP modeling comes to similar conclusions regarding procurement needs but finds that longer-duration storage, in particular, will be needed in coming years. A modeling study conducted by Strategen on behalf of the California Energy Storage Alliance found that between 2 and 11 GW of long-duration energy storage will be needed by 2030 in order to meet SB 100 goals, while between 45 and 55 GW will be needed by 2045.[11]

Rather than waiting to attempt just-in-time procurement in coming years when future reliability issues emerge, the Commission should set procurement targets now to promote the steady adoption of firm zero carbon resources. A modest annual procurement mandate extending beyond 2026 to at least 2028 would ensure continued movement towards SB 100 goals while allowing load serving entities to benefit from continued technology cost declines over time. Such a mandate would also provide stability that industries need to scale up their efforts to meet California's long-term needs. The adoption of the Renewable Energy Portfolio standard provided long-term signals to the solar and industry in California, which eased access to capital and allowed the industries to invest in the California workforce needed to bring projects online. The

[10] *2021 SB 100 Joint Agency Report* at p. 75 (https://efiling.energy.ca.gov/GetDocument.aspx?tn=237167&DocumentContentId=70349)

[11] *Long Duration Energy Storage for California's Clean, Reliable Grid* at p. 79 (https://static1.squarespace.com/static/5b96538250a54f9cd7751faa/t/5fcf9815caa95a391e73d053/1607440419530/LDES_CA_12.08.2020.pdf)

Commission now has the opportunity to provide the same type of signals for emerging firm zero carbon technologies like multi-day energy storage.

VIII. Conclusion

Form Energy appreciates the Commission's commitment to addressing urgent reliability risks as they arise and to emphasize the importance of procuring firm zero carbon resources to meet both reliability-driven IRP planning standards and California's climate goals. We look forward to working with the Commission and parties on these important issues.

Respectfully submitted,

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