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Form Energy's Comments on SB 423 Workshop

Additional submitted attachment is included below.

December 1, 2023

David Erne
California Energy Commission (CEC)
Docket Unit, MS-4
Docket No. 21-ESR-01
715 P Street
Sacramento, California 95814

Re: Comments on the Lead Commissioner Workshop on Senate Bill 423 Emerging Renewable and Firm Zero Carbon Resources

Dear Mr. Erne:

Form Energy appreciates the opportunity to comment on California's planning for its transition to clean energy and the November 17, 2023, Lead Commissioner Workshop on Senate Bill 423 Emerging Renewable and Firm Zero Carbon Resources. We are excited to see CEC taking steps to evaluate the role that emerging firm zero-carbon resources can play to support a clean, reliable, and resilient electrical grid in California, including during multiday extreme weather events and during periods of low renewable generation, pursuant to SB 423. Firm zero carbon resources are the missing link to replacing fossil fuel power plants in our electricity system and achieving a reliable, zero carbon electricity grid. We hope this effort will underpin broader efforts at the CEC and other agencies to begin planning for, and ultimately achieving, a truly zero carbon, renewable and reliable electricity grid with the benefit of such resources.

About Form Energy – Enabling a Fully Renewable, Cost-Effective, and Reliable Electrical Grid

Form Energy is developing, manufacturing, and commercializing a new class of multi-day energy storage that will enable a fully renewable electrical grid that is reliable and cost-effective year-round. Our first commercial product is a rechargeable iron-air battery capable of continuously discharging electricity for 100 hours at a system cost competitive with legacy power plants. With over 600 employees, Form Energy is headquartered in Somerville, MA, with offices in Berkeley, CA, and the Greater Pittsburgh area. Our first commercial manufacturing facility is under construction in Weirton, WV, and will begin operations mid-to-late 2024, ultimately employing over 750 employees and producing 500 MW of capacity per year.

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Form Energy has over 5 GWh of projects under contract and development, with our first project expected to come online in 2024 with Great River Energy in Minnesota. Form Energy is in discussions with the CEC regarding a grant-funded 5 MW/500 MWh project with Pacific Gas & Electric, which could come online in Mendocino, California as soon as 2025. Other announced projects include:

- Two projects with Xcel Energy, including a 10 MW/1,000 MWh system at the Sherburne County Generating Station in Becker, Minnesota, and a 10 MW/1,000 MWh system at the Comanche Generating Station in Pueblo, Colorado – both expected to come online as early as 2025.
- A 10 MW/1,000 MWh project in New York, supported by a grant from NYSERDA, which will come online as early as 2025.
- A 15 MW/1,500 MWh project with Georgia Power to come online as early as 2026.
- A 5 MW/500 MWh project with Dominion Energy in Virginia, to come online as early as 2026.

These systems will be deployed in ways that maximize the utilization and flexibility of renewable resources, displace the need for natural gas generation, and provide reliable, clean energy whenever it is needed. This includes producing firm generation during the most challenging grid conditions, such as those multi-day, extreme weather events that are increasingly impacting California's electricity grid as the impacts of climate change become increasingly apparent.

Firm zero carbon resources, including multi-day storage are a key component of decarbonizing California's electricity grid.

Decarbonizing electricity is foundational to achieving carbon neutrality. As California aims to electrify a wide array of end uses – from transportation to buildings – quickly decarbonizing the electricity sector will be key to ensuring that the State realizes the greatest level of climate benefit from these efforts. Accordingly, as part of the U.S. Nationally Determined Contribution submitted at the COP26 climate conference in Glasgow, the Biden Administration set a goal of achieving zero carbon in the power sector, nationwide, by 2035.[1] The California Air Resources Board (CARB), in originally scoping scenarios for the 2022 Scoping Plan Update modeling, envisioned ongoing, rapid and deep greenhouse gas reductions in the electricity sector, including 23-30 MMT by 2030 and 0 MMT by 2035-2045.[2] Several studies,[3] including the State's 2021 SB 100 Joint Agency

[1] https://unfccc.int/sites/default/files/NDC/2022-06/United%20States%20NDC%20April%2021%202021%20Final.pdf
[2] https://ww2.arb.ca.gov/sites/default/files/2021-09/Draft_2022SP_ScenarioAssumptions_30Sept.pdf
[3] For example, see the following:
- https://www.nrel.gov/analysis/100-percent-clean-electricity-by-2035-study.html

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Report,[4] have shown that these levels of greenhouse gas reductions at the state and national level are feasible and can be achieved at low or no cost, if firm zero carbon resources are included in clean energy portfolios. However, existing SB 100 policy still allows significant emissions by 2045 because it pertains only to retail electric sales, not all electric generation supply in California. Notably, recent CEC-sponsored research by E3, Form and UCSD on long duration storage found that the inclusion of 37 GW of long-duration and multi-day energy storage by 2045 can support a fully zero carbon power sector, without existing natural gas generation, at costs similar to SB 100 goals.[5] Additionally, the inclusion of long-duration storage and multi-day storage can significantly lower overall resource needs to achieve a zero carbon grid, ensuring reliability during a wide range of realistic weather conditions.

Yet state planning has not fully incorporated firm zero carbon resources needed to achieve these objectives, including emerging multiday energy storage technologies. For example, according to the 2022 Scoping Plan Update, the electricity sector is represented as the slowest to decarbonize, and no additional efforts are proposed to reduce electricity sector emissions below business-as-usual levels until around 2035 (see Figure below). In reality, the electricity sector could achieve similar greenhouse gas reductions as other sectors in the mid-term (e.g., by 2030) and ultimately reach zero carbon emissions cost effectively – if firm zero carbon resources are fully incorporated into the State's energy planning and procurement efforts.

- https://www.edf.org/sites/default/files/documents/SB100%20clean%20firm%20power%20report%20plus%20SI.pdf
- https://energyinnovation.org/wp-content/uploads/2020/09/Pathways-to-100-Zero-Carbon-Power-by-2035-Without-Increasing-Customer-Costs.pdf
- https://www.wartsila.com/energy/learn-more/downloads/white-papers/path-to-100-renewables-for-california

[4] Various scenarios demonstrated that SB 100 goals could be achieved as soon as 2030 at costs that are likely less than the benefits associated with doing so, based on prevailing social cost of carbon estimates and avoided cap-and-trade compliance costs, and that deploying firm zero carbon resources reduced both costs and emissions associated with meeting the goals of SB 100. https://www.energy.ca.gov/sb100

[5] https://efiling.energy.ca.gov/GetDocument.aspx?tn=250157&DocumentContentId=84879

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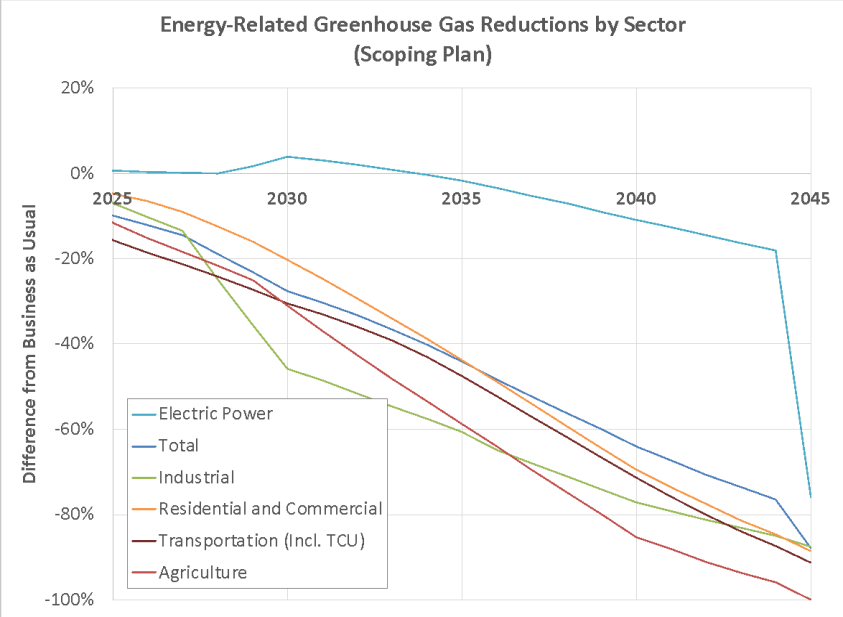

SB 423 analysis should underpin planning for zero-carbon electricity sector.

Given the above, SB 423 serves a critical role in unlocking the potential to fully decarbonize the electric grid and achieve the state's goals. We hope the CEC and other state agencies will use the SB 423 analysis and report as a foundation to fully incorporate firm zero carbon resources into the State's clean energy planning moving forward. We appreciate that the CEC took the initial step in the Draft 2023 IEPR of evaluating the role hydrogen can play as a firm zero carbon resource to displace fossil gas generation in 2045, pursuant to SB 1075 (Skinner). We encourage CEC to use the SB 423 process to fully evaluate the full suite of firm zero carbon resources, including emerging, multiday energy storage technologies, capable of displacing fossil gas generation, in order to support a complete evaluation of optimal approaches to decarbonizing the electricity sector while minimizing emissions and negative community impacts, through SB 100 and other processes.

As noted in previous comments,[6] we encourage the CEC to evaluate, through the SB 100 process, scenarios that would at least align electricity sector emissions reductions with those envisioned in other sectors in the 2022 Scoping Plan, and in line with California's carbon neutrality law and U.S. commitments under the Paris Climate Accord. This would translate to SB 100 scenarios that:

- Result in emissions of 20-30 $MMTCO_2$ in the sector by 2030;
- Cap total emissions from the electricity sector in all scenarios at <8.6 $MMTCO_2$ in 2045;
- Achieve 0 $MMTCO_2$ in the electricity sector in the 2035-2045 timeframe; and

[6] https://efiling.energy.ca.gov/GetDocument.aspx?tn=253125&DocumentContentId=88330

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- Include the costs associated with direct air capture to remove associated emissions from the atmosphere in the costs of greenhouse gas emitting resources.

We hope CEC will use the results of the SB 423 report to inform the forthcoming SB 100 report and specifically include scenarios that reflect the outcomes and objectives described above.

The SB 423 evaluation should adhere to the statutory definition of firm zero carbon resources and focus on conditions needed to fully replace the role of conventional natural gas generation on the power grid.

SB 423 includes a clear statutory definition of firm zero carbon resources. That definition is that "firm zero-carbon resources" are:

> electrical resources that can individually, or in combination, deliver zero-carbon electricity with high availability for the expected duration of multiday extreme or atypical weather events, including periods of low renewable energy generation, and facilitate integration of eligible renewable energy resources into the electrical grid and the transition to a zero-carbon electrical grid.[7]

Thus, there is no need for the CEC to propose an alternate "working definition" as was discussed in the workshop materials.[8] We urge the SB 423 evaluation to adhere to the statutory definition and avoid any arbitrary generalization or deviations from that definition.

The working definition and related conversation seem to risk introducing some ambiguity and questions that we hope will be resolved in the SB 423 report. In particular:

- The working definition implies that any resource eligible for the RPS may qualify as a firm zero carbon resource, which is in conflict with the statute. The working definition refers to resources that "…reliably produce zero-carbon electricity on demand, ensuring a consistent and stable power supply for extended periods…" While firm zero carbon resources certainly fit this definition, not all resources that fit this definition meet the statutory requirements of SB 423, which specify that firm zero carbon resources produce "for the expected duration of multiday extreme or atypical weather events." Slide 13 suggests that solar or wind projects paired with lithium-ion storage should be considered firm zero carbon resources. While certain pairings could, potentially achieve such an outcome, we urge the CEC to clarify that only resources that can provide power with high

[7] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB423
[8] According to slide 12, the working definition is "Firm Zero-carbon Resources are resources or combination of resources that reliably produce zero-carbon electricity on demand, ensuring a consistent and stable power supply for extended periods and/or are eligible for the Renewable Portfolio Standard (RPS)."

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availability **for the expected duration of multiday extreme or atypical weather events** qualify as firm zero carbon resources, such that appropriate costs and operational considerations relevant to resources that meet that definition can be considered.

- The report should clarify that round-trip efficiency is not a relevant metric when determining if a resource is a firm zero carbon resource. Roundtrip efficiency does not pertain to a resource's ability to meet the definition in SB 423, which emphasizes high availability during multi-day weather events and periods of low renewable generation. Further, if the SB 423 evaluation does include a measure of roundtrip efficiency in characterizing firm zero carbon resources, it should apply roundtrip efficiency (rather than just electricity generation efficiency) to hydrogen resources, as well. State planning documents, including the recent Draft IEPR,[9] consistently assume hydrogen production, especially for power sector applications, will come from electrolysis. State law also defines electrolysis as energy storage.[10] A fair characterization of various firm zero carbon resources, therefore, should account for the roundtrip efficiency of hydrogen generation as including conversion losses associated with electrolysis production, as well as hydrogen transportation and storage.
- The report should also clarify that annual capacity factor (Slide 17) has no bearing on whether a resource is firm or dispatchable. For example, it is possible for a resource to have a high annual capacity factor while also not being available during multi-day periods of grid stress.

The SB 423 Report should be structured to answer the pressing questions about how firm zero-carbon resources can help facilitate the complete decarbonization of the grid and support reliability.

We encourage the evaluation to include a thorough and complete analysis beyond 2033 to identify the number of days over which multi-day events are likely to occur under decarbonization scenarios. The workshop seems to assume that multiday extreme or atypical weather events translate to 3-day events. While three days may be appropriate, a more thorough analysis would be useful to ensure a complete evaluation of the resources needed to support a zero-carbon, reliable electricity grid. Without such an analysis, the Report will not necessarily provide insights into how firm zero-carbon resources will support the grid in reality over the long run.

The Appendix of the workshop slides described an initial analytical framework to understand multi-day extreme and atypical weather events that occur at least as frequently as once per ten years. That analysis, however, only uses data from a single ten-year period. This is insufficient to understand historic probabilities for events likely to occur once every 10 years because it overlooks any event that did not occur in that ten year period. Looking over a greater number of

[9] https://efiling.energy.ca.gov/GetDocument.aspx?tn=253086
[10] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1369

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years is required in order to determine what events are significantly likely to occur within ten years, and the analysis should not be limited to events that actually did occur within a specific ten-year period. We encourage the SB 423 report to include a much deeper evaluation of historic and expected future grid conditions to understand the likely duration of multiday extreme and atypical weather events.

We appreciate and support recommendations for further research on Slide 38, including modeling out to 2045 and considering other reliability indicators like expected unserved energy and loss of load hours. We also appreciate recognition in slide 43 that future grid constraints in a renewable-heavy grid are likely to include both capacity *and energy* constraints. This is an important finding to highlight in the SB 423 report and incorporate into future analyses and planning.

We encourage a similar evaluation to the one presented in slide 43 considering constraining grid conditions in the winter, as well. For example, some studies have found that cold, dark winter weeks will become the main reliability constraint in the future for California's electricity grid.[11]

The Report should analyze the ability of firm zero-carbon resources to support the grid during multi-day events, in accordance with the statute.

During the workshop, it was suggested that it may be appropriate to prioritize evaluation at the net peak of a single day, rather than multi-day reliability events. This would conflict with statutory requirements and we encourage the SB 423 evaluation to focus on multiday events, as called for in the law. This could include, but is not limited to, the ability of resources to meet net peak over several sequential day events. However, as highlighted in the analysis, in the near future, multiday events are likely to introduce both energy and capacity constraints (slide 43), with primary challenges shifting from net-peak to overnight (slide 37). Accordingly, the SB 423 analysis should focus on those resources capable of providing power both during net-peak, overnight, and at any other time during the course of expected multiday extreme and atypical weather events.

We appreciate and support the inclusion of long duration energy storage, including iron-air batteries, as firm zero carbon resources (slide 13). We encourage the SB 423 report to include and highlight those long duration and multi-day energy storage technologies that are capable of meeting the statutory definition of firm zero carbon resources. As noted on slide 14, long duration energy storage is one of the few firm zero carbon resources capable of operating with zero emissions. We suggest changing the representation of carbon capture from "zero emissions" to "low emissions," similar to hydrogen, to ensure an appropriate characterization of emissions in the report.

[11] See slide 10 at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=230840&DocumentContentId=62469

We specifically encourage the SB 423 report to emphasize that stand alone long-duration and multi-day energy storage technologies are eligible and valuable firm zero-carbon resources, and that they do not need to be co-located with or paired with renewables to meet the statutory definition of firm zero carbon resources.

We note that stand-alone wind and solar are not firm zero carbon resources, unless paired with sufficient storage to make it so. However, pairing those resources with portfolios of energy storage resources like long duration and multiday storage can result in a firm zero-carbon resource option, and the report should better clarify this. The report should also address the potential to pair offshore wind with long duration storage, which may represent an especially attractive option to create firm zero carbon resources in the future that could be a significant step in achieving the state's decarbonization goals.

Shortfalls in current energy modeling tools and assumptions represent a significant barrier to deployment of firm zero carbon resources in California.

SB 423 requires the CEC to identify barriers to deployment of firm zero carbon resources and to propose solutions to deploying firm zero carbon resources, and we appreciate the initial review of categories of barriers and potential solutions included in the presentation (slide 20). While each category of firm zero carbon resource may face unique barriers, there are key overarching barriers embedded in state energy planning that hinder the deployment of all firm zero carbon resources.

State agencies have not yet included firm zero carbon resources or the conditions that would support their deployment in their energy planning. For example, state energy planning – including in the Scoping Plan, SB 100 report, and Integrated Resource Planning (IRP) – has yet to evaluate scenarios that would achieve zero carbon emissions in the power sector. By not exploring such scenarios, the state undervalues firm zero carbon resources and perpetuates a reliance on existing natural gas generation. (Those studies that do ask this question, including several cited above, do find an increased role for firm zero carbon resources and added emissions and cost benefits.)

Furthermore, many capacity optimization modeling tools and assumptions are not designed to fully account for the value or need for firm zero carbon resources because they optimize resource needs over small subset of sample days rather than a full year of hourly grid operations. By its nature, such a modeling approach cannot capture the impacts of multiday weather events or reflect the value of multiday storage to economically balance renewable energy resources across seasons. Additionally, capacity optimization is often based on average weather conditions rather than multiple weather years that reflect actual weather variability that causes the highest

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reliability risks and system costs. This approach undervalues firm zero carbon resources and fails to identify both near and long-term economic opportunities for these resources.

If California is to achieve a truly zero carbon, reliable electricity grid and transition away from legacy fossil fuel power plants, it needs to plan to do so. The SB 423 report provides an important opportunity to begin taking steps in this direction, and we strongly encourage the CEC to include in the report recommend changes to energy planning to address barriers to deploying firm zero carbon resources and decarbonizing California's electricity grid. These recommendations should include:

- In the SB 100 report, incorporate findings from the SB 423 evaluation and develop scenarios that achieve 0 $MMTCO_2$ in the electricity sector in the 2035-2045 timeframe. Additionally, ensure that all scenarios at least align decarbonization outcomes in the electricity sector with those in other sectors and with requirements in AB 1279, which requires:
    - Achieving a range of emissions of 20-30 $MMTCO_2$ in the electricity sector by 2030.
    - Capping total emissions from the electricity sector in all non-0 $MMTCO_2$ scenarios at <8.6 $MMTCO_2$ in 2045.
    - Including the costs associated with direct air capture to remove associated emissions from the atmosphere in the costs of greenhouse gas emitting resources.
- CARB should update energy planning targets for the electricity sector to align with expected reductions in other sectors and achieve 0 $MMTCO_2$ in the 2035-2045 timeframe.
- Improve energy demand, dispatch, and capacity modeling methods and assumptions at the CEC and CPUC to appropriately value firm zero carbon resources and allow the state to plan for a clean, reliable electricity grid without the need for conventional power plants to serve in contingencies. This includes:
    - Develop and use 8,760-hour/year models for energy and procurement planning.
    - Ensure that hourly demand forecasts and renewable generation profiles are correlated to the same weather year and:
        - Account for multiday extreme and atypical weather events, including periods of low renewable energy generation and 1-in-10 year, 1-in-20 year, and 1-in-40 year events; and
        - Reflect a common approach to incorporating climate change into long-term energy planning.
- Transition the Strategic Reliability Reserve away from legacy fossil fuel generators to firm zero carbon resources.

The SB 423 Report should recommend pathways for additional procurement of emerging firm zero carbon resources, per the statute.

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In addition to the recommendations above, SB 423 requires the report to recommend solutions to overcoming identified barriers to deploying firm zero carbon resources, including "pathways for additional procurement of those resources by load-serving entities…or a central procurement entity." We hope the SB 423 report will include a thorough and deep evaluation of barriers and propose specific solutions to address them, including additional procurement by load-serving entities and the Department of Water Resources through the Strategic Reliability Reserve and pursuant to SB 1373 (Garcia).

We recommend that the CEC highlight that all energy storage procurement programs to date have prioritized low-cost capacity (in kW), rather than low cost stored energy (in kWh), which, in concert with Resource Adequacy program design, has created a state preference for 4 and 8-hr storage, rather than longer-duration storage resources that can deliver firm zero carbon capacity. We encourage the CEC to highlight the value of firm zero carbon resources in both the near and long-term to maintain reliability and affordability. Further, we urge the CEC to include in its report finding that it is imperative for California to rapidly develop a market for these resources before 2030 so that the state is prepared to deploy many gigawatts of firm zero carbon capacity per year between 2030 and 2045.

Finally, the report should encourage fully funding the state's array of investments in the energy sector and increasingly orienting relevant programs to support firm zero carbon resources, including emerging technologies and multi-day energy storage. This includes:

- The Strategic Reliability Reserve, including investments made by the Department of Water Resources and through the Distributed Energy Backup Assets Program.
- The Clean Energy Reliability Investment Plan, which specifically calls for support for supporting emerging technologies and long-duration energy storage.[12]
- Potential central procurement of resources through the Department of Water Resources, pursuant to AB 1373.
- Clean energy programs at the CEC, including the long duration energy storage program and green hydrogen program.

Thank you again for the opportunity to comment on the Lead Commissioner Workshop on Senate Bill 423 Emerging Renewable and Firm Zero Carbon Resources, and for all your work to deliberately and effectively advance California's clean energy goals. Please do not hesitate to reach out with any questions or follow up items.

Sincerely,

[12] See pg. 17 at: Erne, David, California Energy Commission. 2023. Clean Energy Reliability Investment Plan. California Energy Commission. Publication Number: CEC-200-2023-003-CMF. https://efiling.energy.ca.gov/GetDocument.aspx?tn=249029

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