Filed Electronically

March 11, 2024

Ms. Sherri L. Golden
Secretary of the Board
New Jersey Board of Public Utilities
44 South Clinton Avenue, 1st Floor
PO Box 350
Trenton, NJ 08625 – 0350

RE: In the Matter of the New Jersey Energy Storage Incentive Program, Docket No. QO22080540

Dear Secretary Golden,

Recognizing this submission is filed after the original deadline of September 19, 2023, as set forth by the Request for Information ("RFI"), Tierra Climate Inc. ("Tierra Climate") appreciates the opportunity to provide the Board of Public Utilities ("BPU") with some late comments and recommendations in connection with the preparation of a revised New Jersey Storage Incentive Program ("NJ SIP") Straw Proposal.

Tierra Climate supports the BPU's pursuit of 2,000 MW of installed energy storage capacity by 2030 set forth by the Clean Energy Act, which will not only bolster grid reliability but also potentially accelerate electricity decarbonization in New Jersey. Simultaneously, we recognize the NJ SIP's potential to implement innovative solutions that both build upon the learnings from past programs nationwide and foster future industry developments.

Based on our experience developing an emissions reduction incentive for energy storage projects in voluntary carbon markets, Tierra Climate offers several suggestions for the Performance Based Incentive ("PBI") that will help New Jersey meets its energy storage goal while simultaneously encouraging *deliberate* emissions reductions.

Thank you again for this opportunity to provide comments on the NJ SIP, particularly regarding the PBI. We appreciate the wide-ranging perspectives and opinions on the potential directions of the PBI. Therefore, Tierra Climate is committed to working with the BPU and other interested stakeholders to ensure the NJ SIP achieves its stated goals. Please do not hesitate to reach out if you have any questions about our submissions or if we can be of further assistance.

Sincerely,

Jacob Mansfield
CEO & Co-Founder
Tierra Climate Inc.

About Tierra Climate:

Tierra Climate is an innovative technology company focused on unlocking the decarbonization potential of utility-scale energy storage systems. Tierra Climate's stated purpose is to power a clean and reliable electricity grid through transparent digital solutions. Our team boasts decades of experience across dealmaking, energy storage operations, asset optimization, and data science within wholesale power markets. Perhaps most relevant for this RFI submission, Tierra Climate holds a leadership position in the Energy Storage Solutions Consortium ("ESSC"): an industry group with over seventy member companies aimed at creating an emissions-based environmental attribute for utility-scale energy storage leveraging voluntary carbon markets. Through its efforts in the ESSC, Tierra Climate has relevant experience managing the interests of various stakeholders, running technical working groups, and drafting a methodology that serves as the basis of avoided emissions measurement, reporting, and verification. Recently, Tierra Climate also published a first-of-its-kind study evaluating the emissions performance of the entire ERCOT fleet in a white paper titled *Charging Towards Zero: Harnessing Batteries and Carbon Contracts to Accelerate Grid Decarbonization*, which is available on our website: tierraclimate.com/resources.

Please note: RFI responses provided below are based exclusively on the views of Tierra Climate and may not necessarily represent the views of other ESSC members.

Tierra Climate RFI Responses:

3.0 Incentive Structure

3.5 The Straw proposes the use of the PJM Marginal Emission Rate ("MER") signal as a basis for Performance-based Incentives for Grid Supply energy storage systems. Is or will the PJM MER be sufficiently developed to use to calculate NJ SIP Performance-based Incentives?

If structured appropriately, Tierra Climate believes that a Marginal Emissions Rate ("MER") coupled with a PBI can serve as a compelling signal for battery energy storage systems ("BESS") operators to decarbonize the electricity grid.

Last August, Tierra Climate published a white paper[1] examining the carbon impact of operating BESS assets in ERCOT for 2022. To our surprise, we discovered that 80% of operating assets inadvertently *increased* greenhouse gas ("GHG") emissions. There are a variety of explanations for why batteries tend to increase emissions (including weak correlation between energy prices and MERs, roundtrip efficiency losses, and participation in ancillary services), which are detailed in our study; however, the key reason is that batteries aren't properly incentivized to reduce GHG emissions. Fortunately, we also found that a carbon contract that compensates energy storage assets for avoided emissions could flip two-thirds of the ERCOT fleet to net abating while boosting revenues as much as 20-30%, with 67% of incremental revenues occurring in shoulder months. Energy storage has tremendous *potential* to decarbonize the electricity grid; however, energy storage does not reduce GHG emissions by default as many commenters have suggested. This phenomenon is not unique to ERCOT either. In fact, a simple correlation analysis across LMP and MER data in PJM shows that GHG emissions reductions are unlikely to occur via energy price signals alone:

ISO	Location	Correlation	Range Start Date	Range End Date
PJM	Western Hub	0.11	2021-01-01 5:00:00	2024-02-01 4:00:00
	N Illinois Hub	0.13	2021-01-01 5:00:00	2024-02-01 4:00:00
	AEP-Dayton Hub	0.09	2021-01-01 5:00:00	2024-02-01 4:00:00
	Eastern Hub	0.28	2021-01-01 5:00:00	2024-02-01 4:00:00
	Dominion Hub	0.13	2021-01-01 5:00:00	2024-02-01 4:00:00
	PENELEC	0.11	2021-01-01 5:00:00	2024-02-01 4:00:00

[1] Konet, Emma., et al. "Charging Towards Zero: Harnessing Batteries and Carbon Contracts to Accelerate Grid Decarbonization." Tierra Climate and REsurety (2023). Available here: https://www.tierraclimate.com/resources

Alongside 70+ other member-companies in the ESSC, Tierra Climate is spearheading a methodology that would measure environmental performance using MERs and compensate BESS projects for avoided emissions using voluntary carbon markets. We expect this methodology to go live in 2025 and have received overwhelming support from BESS developers for this opportunity. Based on our experience, we believe the PBI as initially proposed with some modifications is feasible to operationalize and provides the highest fidelity solution for reducing GHG emissions.

The PBI prescribes using PJM MER data to determine the net emissions impact of operating BESS projects on an ex-post basis; however, several stakeholders have expressed two unique concerns about using the MER: 1) MERs are not prepared to be used today; 2) MER's are not easily operationalized. Tierra Climate believes an MER is readily available that satisfies the BPU's requirements and that such an MER can be operationalized to boost both financial and environmental performance of BESS assets.

First, MERs are sufficiently developed to be used today. We applaud PJM for being the first Independent System Operator ("ISO") to publish an MER. PJM provides MERs at a nodal granularity with >99% data quality and is well-suited to publish an MER given its access to data on marginal generating assets. Previous concerns about PJM's use of a project-specific 'annual average emissions rate' are misguided on account that the per-unit difference in emissions rate between a wind farm and a coal plant are substantially larger than the difference between a coal plan at 60% output and a coal plant at 100% output. One outstanding concern not raised is the occasional inclusion of extreme positive- and negative-values in PJM's data set, which occur due to regularizing redispatch; however, it is unclear the extent to which the BPU has engaged with PJM as a stakeholder about addressing concerns raised in the RFI.

Before moving away from the MER, Tierra Climate recommends either engaging with PJM on these issues or using a third-party MER data provider based on its data availability (>99%) and granularity (nodal-level). Such providers include REsurety and WattTime, which both have 5+ years of experience developing MERs, cover all deregulated power markets, and already support PJM MERs. For a list of additional MER data providers (albeit with different coverages), please refer to this report published by Resources for the Future ("RFF").[2] It's also worth noting that the first BESS projects likely won't be commissioned for another two years due to the PJM interconnection queue, which provides the BPU ample time to back-test MER solutions with a program administrator and other interested stakeholders.

Second, MERs can be easily operationalized by BESS project owners. The MER – also sometimes referred to as a Locational Marginal Emission (LME) – is simply analogous to a Locational Marginal Price (LMP). BESS operators have no issue handling extreme volatility in LMPs and ancillary services by combining optimization models and short-run forecasts. To operationalize a MER, a BESS operator would simply use a short-run emissions forecast and a carbon price (prescribed by the PBI) as another input to their optimization model. A BESS project operating to maximize revenue would then co-optimize across another revenue lever – avoided GHG emissions – and make operational tradeoffs insofar as it increases revenue. There is a robust market for energy price forecasts to support energy arbitrage and we expect similar innovations in short-run emissions forecasts to occur as a result of 'carbon arbitrage' mechanisms such as the PBI.

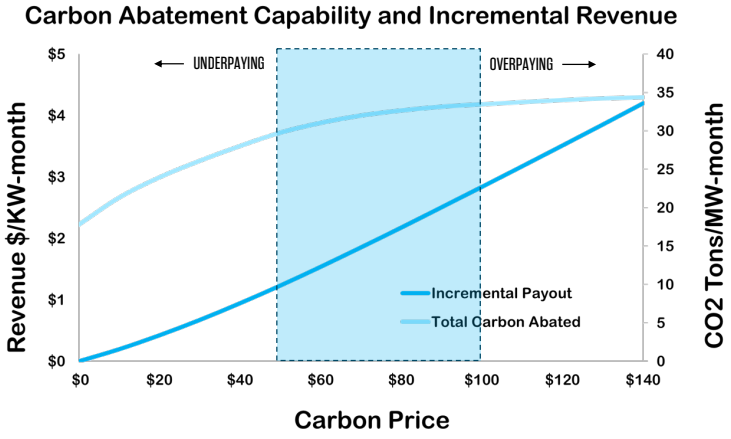
This approach is also feasible in the real world. For instance, Hecate and WattTime shared in a prior public comment that they were able to reliably co-optimize for energy revenue and GHG emissions reductions using a NJ BESS project, resulting in substantially more emissions reductions than a BESS optimized exclusively for revenue maximization. In addition, Icetec also expressed optimism in a prior public comment on the PBI's operational feasibility based on its real-life experience deploying a carbon signal for several distributed energy resource customers. Both instances support the feasibility of the PBI in real world applications.

[2] Palmer, Karen., et al. "Options for EIA to Publish CO2 Emissions Rates for Electricity." Resources For The Future (2022). Available here: https://media.rff.org/documents/Report_22-08.pdf

3.6 Is there a different methodology that can be used to determine Performance-based Incentives, such as a Peak Demand Reduction program?

Tierra Climate does not believe a Peak Demand Reduction ("PDR") program will result in GHG emissions reductions for several reasons outlined in 3.8 below. That said, Tierra Climate has several specific recommendations for how to improve the PBI proposal leveraging an MER:

1. *Restructuring Minimum Requirement as Voluntary Pay-for-Performance:* Tierra Climate recommends the BPU remove the minimum abatement requirement of 10 pounds of CO2e/KWh and instead structuring the incentive as a pay-for-performance baselined against zero. In other words, BESS projects should be compensated for any GHG emissions reductions greater than zero. This recommendation would simplify program administration and monitoring substantially and pay any energy storage asset that verifiably avoids emissions. Based on the results from our ERCOT analysis, we suspect that most (if not all) BESS projects in NJ will likely be net-emissive in which case the risks of compensating for incidental emissions reductions are small. This also ensures participation in the PBI is completely voluntary, enabling BESS owners to operate projects in the highest valued service, whether that may be providing an ancillary service, responding to a PJM Capacity Performance event, or capturing an energy arbitrage in hours that are more lucrative than hours that carry an emissions reduction. Lastly, this recommendation maximizes the potential for value stacking by owners/operators based on prevailing market signals across energy and ancillary services, ensuring goals of the SIP are achieved at the lowest costs for New Jersey ratepayers.
2. *Set Fixed Price Denominated in GHG Emissions ($ / metric tonne CO2e):* Tierra Climate recommends the BPU set a fixed price for all participating BESS projects based on the quantity of GHG emissions avoided. Based on our ERCOT analysis, we found that $100/tonne CO2e was optimal to drive GHG emissions reductions and boost project economics by as much as 20-30%. For context, this hypothetical carbon price of $100/tonne CO2e is substantially lower than prominent estimates of the social cost of carbon ("SCC"), such as the RFF's 2022 estimate of $185/tonne CO2e[3] and the EPA's 2023 estimate of $190/tonne CO2e[4]. However, more NJ-specific analysis would have to be conducted to ensure the carbon price isn't set too low (whereby the asset could've abated more but was underpaid) or too high (whereby the asset couldn't abate more and was overpaid), which Tierra Climate is happy to assist in. In addition, the carbon price would need to be re-evaluated on an annual basis. Below is a graph borrowed from our ERCOT white paper where we found a specific asset's optimal price point was between $50-100/tonne CO2e based on its location and lack of participation in ancillary services:



[3] Rennert, Kevin, et al. "Comprehensive evidence implies a higher social cost of CO2." Nature 610.7933 (2022): 687-692.
[4] Environmental Protection Agency. "Report on the social cost of greenhouse gases: Estimates incorporating recent scientific advances." (2022).

3. *Limit Applicability to Front-of-the-Meter ("FOTM") Assets:* Tierra Climate recommends that the BPU limit applicability of the PBI to FOTM assets and exclude any Behind-the-Meter ("BTM") assets from participating. Undoubtedly, BTM assets have tremendous potential to decarbonize the grid; however, BTM assets pose additional monitoring challenges to verify a distributed resource's environmental benefits. For instance, the presence of other BTM resources like onsite diesel generation may affect emissions performance yet prove difficult to monitor. In addition, BTM assets that choose to operate in such a way as to reduce GHG emissions for a Commercial & Industrial ("C&I") load may already receive 'credit' in the form of reduced Scope 2 emissions inventories under the Greenhouse Gas Protocol's Scope 2 Guidance.
4. *Establish A Cap on Total PBI Payments:* Tierra Climate recommends the BPU compensate BESS projects on a first-come first-served basis up to a cap established on total PBI annual payments. This recommendation would allow BPU to budget for the total PBI payments while also encouraging competition for PBI payments amongst operating BESS projects. However, more NJ-specific analysis would have to be conducted to ensure the total PBI cap isn't set too low or too high, which Tierra Climate is happy to assist in. In addition, the total PBI payment cap would need to be re-evaluated on an annual basis.
5. *Settle PBI Payments on a Monthly Basis Using Historical MERs:* Tierra Climate recommends the BPU settle the PBI and compensate BESS projects on a monthly cadence using historic MERs either produced by PJM or a third-party provider. In addition, Tierra Climate recommends the BPU pay BESS projects for total avoided emissions on a monthly basis. For example, if a project abates 100 tonnes CO2e in the first fifteen days of the month but then induces 50 tonnes CO2e in the remaining fifteen days of that month, the BPU should only compensate the BESS project for the net 50 tonnes CO2e across the entire month. We believe this will simplify program administration of the PBI and allow BESS projects to recognize revenue from the PBI concurrent with incurring possible opportunity costs in energy and ancillary markets.
6. *BPU Should <u>Not</u> Provide a Short-Run MER Forecast:* Against the recommendations of some public commentors, Tierra Climate strongly recommends against the BPU publishing a short-run MER forecast to be used in BESS operators' optimization models. As previously mentioned in 3.5, there is robust demand for service providers that offer LMP forecasts and we anticipate the same to occur for MER (i.e., LME) forecasts should an incentive like the PBI be created. This will also reduce the administrative burden of the PBI whereby a program administrator is not responsible for the accuracy or precision of an MER forecast nor for maintaining the data analytics required to reliably produce a forecast. Instead, enterprising service providers and BESS operators can develop innovative solutions to maximize the earning potential of the PBI. Tierra Climate already sees this occurring with the ESSC and efforts within the voluntary carbon market.

3.8 What degree/percentage of Peak Demand should be targeted for reduction? What effect would such a program have on GHG emissions?

While a PDR program may *seem* easier to implement, Tierra Climate believes that a PDR program would not accomplish the objectives of reducing GHG emissions, may inadvertently *increase* GHG emissions, and would be rather involved to improve GHG emissions performance. As discussed in 3.5, LMP and MER data points are not strongly correlated, which poses two unique challenges to a PDR program: 1) the inability to predict peak intervals that coincide with high MERs; 2) the inability to predict off-peak intervals that coincide with low MERs. A PDR program that simply encourages more off-peak to peak charge-discharge cycles is unlikely to reliably reduce GHG emissions.

For a PDR program to reliably reduce GHG emissions, the battery must capture a 'carbon arbitrage' spread (between charge and discharge) that exceeds the roundtrip efficiency losses (i.e., 10-15% of consumed energy). Unfortunately, it is infeasible that the BPU could prescribe 'peak demand' intervals that consistently coincide with high MERs given that hourly MERs are dynamic and change day-to-day. In addition, the BESS must charge using a marginal resource that is meaningfully 'cleaner' than the marginal resource the BESS will

displace by discharging.[5] Otherwise, a BESS project charged during off-peak baseload coal (or natural gas) generation – 10-15% of which will be consumed in losses – and discharged during the 'peak' with marginal natural gas generation will increase GHG emissions. It's also worth noting that what is deemed 'marginal' varies widely based on location on the grid, which means that prescriptive peak intervals cannot be 'one-size-fits-all' and reliably reduce GHG emissions. If the BPU (or a program administrator) were to update or adjust these intervals to account for changes in the MERs across times and geographies, this would substantially increase the cost of administering the PDR. In other words, the PDR isn't precise enough to reliably ensure GHG emissions reductions and improving the PDR's emissions reduction efficacy requires potentially complicating the PBI more than the original proposal with our recommendations in 3.6. Alternatively, Tierra Climate recommends in 3.6 that the BPU leave predicting MERs to the wide market of innovative forecast service-providers.

PDR programs inadvertently increasing GHG emissions is well researched and documented. For instance, the California Self-Generation Incentive Program, which many commentors have pointed to as a PDR template, was found to have increased GHG emissions in its 2017 SGIP Advanced Energy Storage Impact Evaluation report: "while successful at reducing system peak demand, system costs and customer demand overall, continue to result in a net increase in greenhouse gas (GHG) emissions and fall short of the efficiency goals of the program." In addition, the Massachusetts Clean Peak Standard is likely producing higher GHG emissions without meaningfully changing BESS operating behavior. Here is an excerpt from a study published in 2021 by researchers from Columbia University, New York University, and WattTime[6]: "[the] Clean Peak does not lead to large emission reductions compared to the no-policy baseline… because the policy design only reinforces the inherent incentive of a storage unit to discharge during high-demand, high-price hours, the policy does not induce much change in behavior. With or without the policy, storage units are most likely to discharge during periods of high demand and charging during periods of low demand." Lastly, an earlier study conducted by the Wisconsin Department of Administration Division of Energy[7] evaluating a similar PDR program found that peak demand reduction ran counter to emissions reductions: "the results indicate that energy savings in off-peak hours and particularly winter off-peak hours produce the highest emissions savings. This places the objectives of demand reduction and emission savings in direct opposition." In all three examples, the results are consistent with our expectations for New Jersey: a PDR (albeit well intended) will likely increase GHG emissions.

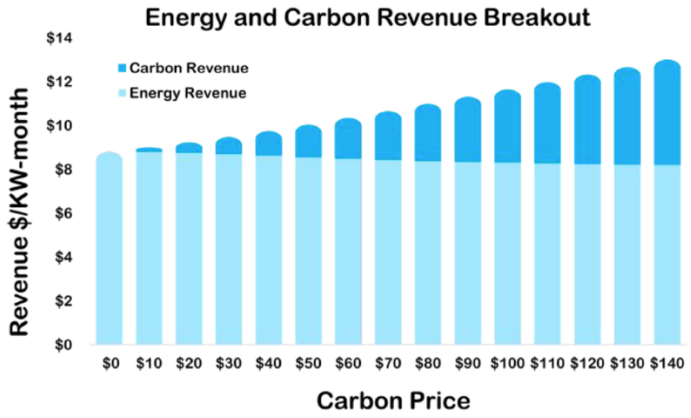
3.15 What provisions should be included in the program for monitoring, reporting and evaluation in order for deployed projects to maintain eligibility for incentives that are paid over time?
Based on Tierra Climate's recommendation in 3.6(1), the BPU should allow any BESS projects operating in New Jersey to elect to participate in the PBI, recognizing that some projects may not actively pursue GHG emissions reductions in a revenue-maximizing optimization approach. For all BESS projects that elect to participate in the PBI, the BPU must simply have access to hourly meter data to verify when the BESS project charged and discharged as well as corresponding MER data at the same level of granularity (i.e., hourly and at the resource node). As mentioned in 3.6(5), the BPU should settle the PBI on a monthly cadence and reassess PBI parameters such as fixed price and overall PBI program size on an annual basis.

3.16 How can BPU structure NJ SIP Performance-based Incentives to both promote value stacking and prevent double compensation?
Tierra Climate believes the PBI using MERs can simultaneously drive greater overall revenue and GHG emissions reductions. The PBI provides a compelling way for BESS operators to value stack emissions

[5] Hittinger, Eric S., and Inês ML Azevedo. "Bulk energy storage increases United States electricity system emissions." Environmental science & technology 49.5 (2015): 3203-3210. Available here: https://cedmcenter.org/wp-content/uploads/2017/10/Bulk-Energy-Storage-Increases-United-States-Electricity-System-Emissions.pdf
[6] Shrader, Jeffrey G., et al. "(Not so) Clean Peak Energy Standards." Energy 225 (2021): 120115. Available here: https://jeffreyshrader.com/papers/clean%20peak%20-%20published.pdf
[7] Erickson, Jeff, et al.. " Peak Demand Reduction vs. Emission Savings." Wisconsin Department of Administration Division of Energy (2004). Available here: https://www.aceee.org/files/proceedings/2004/data/papers/SS04_Panel5_Paper08.pdf

reductions on top of other existing activities such as energy arbitrage to make more revenue and abate more GHG emissions. Based on Tierra Climate's ERCOT analysis, payment for avoided emissions results in more BESS cycles (still within the OEM cycling warranty), especially in instances where energy arbitrage is insufficient to cover the costs of battery degradation.

If a BESS project starts pursuing revenue stream B (e.g. avoided emissions), the operator begins to incur opportunity costs in revenue stream A (e.g. ancillary services); however, the BESS when properly co-optimized will only do so if the combination of A plus B earns more revenue than A on a standalone basis. The incremental revenue uplift (net of opportunity costs) depends on the relative value of all qualified services available to the BESS project. Below is a graph borrowed from our ERCOT white paper demonstrating this principle for a specific asset simulated at different carbon price points:



At present, the majority of BESS revenue is driven by a select number of weather events accompanied with extreme price volatility. Consequently, BESS projects financially underperform in most shoulder months. Since the 'carbon arbitrage' is open year-round, we found in our ERCOT study that 67% of incremental carbon revenues would occur in shoulder months, which could result in positive follow-on effects like improved BESS project debt financing. In short, Tierra Climate believes the PBI has a unique opportunity to encourage value stacking and improve overall project economics.

5.0 Other Questions

5.8 Please provide any other comments on the NJ SIP.

As next steps, Tierra Climate recommends the BPU commission a feasibility study in partnership with PJM to examine the potential impact of the PBI in New Jersey and address the following questions:

(i) What is the expected emissions profile of BESS projects in New Jersey absent the PBI?

(ii) What carbon price is required under the PBI to change the emissions profile of BESS projects in New Jersey?

(iii) What is the total PBI payment cap required to result in the optimal amount of emissions reductions while simultaneously avoiding overpaying?

(iv) To what extent would emissions compensation differ based on MERs provided by PJM versus a third-party provider, such as REsurety or WattTime?

Given our prior work and subject matter expertise on BESS emissionality, Tierra Climate is happy to contribute in any way to a BPU-commissioned feasibility study. Assuming the PBI feasibility study results are positive, Tierra Climate would highly recommend the BPU appoint a program administrator to outline the rules of the program and then provide a third comment period specifically focused on the PBI. This would satisfy the requirements of N.J.S.A. 52:14B-4 by providing ample opportunity to stakeholders to respond to a more concrete proposal and evaluate the merits of the PBI.