October 30, 2019

VIA E-MAIL

Kara Sergeant
Department of Energy Resources
100 Cambridge St., Suite 1020
Boston, MA 02114

Re: Proposed 225 CMR 21—Clean Peak Energy Portfolio Standard

Dear Ms. Sergeant,

The Institute for Policy Integrity at NYU School of Law (Policy Integrity), WattTime, and Dr. Jeffrey Shrader of Columbia University respectfully submit to the Massachusetts Department of Energy Resources the attached comments on the proposed Clean Peak Energy Portfolio Standard.[1]

Policy Integrity is a non-partisan think tank dedicated to improving the quality of governmental decision making through advocacy and scholarship in the fields of administrative law, economics, and public policy. Policy Integrity participates regularly in proceedings before public utility commissions and has written numerous reports and articles on energy policy design.

WattTime is a non-profit entity that aims to provide research, education, and assistance on the environmental benefits of electricity use timing, and advocates for a data-driven approach to solving environmental problems.

Sincerely,

/s/ Justin Gundlach
Justin Gundlach, Attorney
INSTITUTE FOR POLICY INTEGRITY AT NYU SCHOOL OF LAW

/s/ Gavin McCormick
Gavin McCormick, Executive Director
WATTTIME

/s/ Jeffrey Shrader
Jeffrey Shrader, Ph.D.
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/s/ Burcin Unel
Burcin Unel, Ph.D.
Energy Policy Director
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[1] No part of these comments purports to present the views, if any, of New York University or its School of Law.

Comments on Proposed Clean Peak Energy Portfolio Standard

1. Introduction

Massachusetts' 2018 Act to Advance Clean Energy directed the Department of Energy Resources (DOER) to develop a program that requires retail electricity providers to supply a percentage of load during season-specific peak periods with "clean peak" resources that either supply electricity or reduce load. The 2018 Act aimed to address the fact that fossil-fired peaking resources have accounted for disproportionate shares of both electricity system costs and emissions (greenhouse gases and local pollutants) attributable to electricity consumption in Massachusetts.

Consistent with the provisions of this statutory directive, DOER developed the Clean Peak Energy Portfolio Standard (CPS) to reduce ratepayer costs while also reducing emissions from the electricity system. As DOER designed the CPS over the course of 2019, it drew on stakeholders' responses to questions, submitted in February, as well as stakeholder comments on a straw proposal, submitted in April. DOER issued the proposed CPS regulation in September. In short, the CPS is intended to steer electricity providers to shift away from reliance on fossil-fired resources to meet peak demand, and toward reliance on renewable, energy storage, and demand response resources in a way that will reduce emissions.

Although Massachusetts is the first state to adopt this sort of program, it is not the first to incentivize the adoption of energy storage for the purpose of helping to displace high-emitting resources: California's Self-Generation Incentive Program[2] and New York's Energy Storage Order each embody a similar aim.[3] Crucially, however, California discovered in the course of implementing SGIP that the program, as initially designed, *increased* rather than decreased system-wide emissions intensity.[4] California adjusted SGIP accordingly,[5] and New York,

[2] *See* Decision Modifying the Self-Generation Incentive Program and Implementing Senate Bill 412, Cal. Pub. Utils. Comm'n, D. 11-09-015, at 16 (Sept. 16, 2011) (". . . we reject Staff's recommendation to use a cost-effectiveness screen, we focus only on the [greenhouse gas emissions reduction] screen."), https://perma.cc/V7CF-KML3.

[3] Order Establishing Energy Storage Goal and Deployment Policy, N.Y. Pub. Serv. Comm'n, Case 18-E-0130, In the Matter of Energy Storage Deployment Program 10-11 (Dec. 13, 2018) [hereinafter "NY Energy Storage Order"], https://perma.cc/2XJD-KJJ2.

[4] Cal. Pub. Utils. Comm'n Staff, Revised Self-Generation Incentive Program Greenhouse Gas Staff Proposal 5 (Dec. 31, 2018), https://perma.cc/SW79-9MPS ("Subsequent SGIP storage impact evaluations have found that SGIP storage has led to a net increase in greenhouse gases . . . .").

[5] Proposed Decision Approving Greenhouse Gas Emission Reduction Requirements for the Self Generation Incentive Program Storage Budget, Cal. Pub. Utils. Comm'n, Rulemaking 12-11-005 (May 31, 2019), https://perma.cc/FM62-6VQX.

encouraged by stakeholders to learn from California's experience,[6] paid close attention to how its own program's features would affect marginal emissions rates before finalizing its design.[7]

The sections below describe the effects of energy storage deployments on emissions in general and report on the results of an analysis of the proposed CPS using marginal emissions rates. By sharing these modeling results we aim to:

- Demonstrate that the emissions consequences of additional storage resources are sensitive to the electric grid's marginal emission rates, and hence the chosen CPS windows;
- Inform DOER about how the proposed CPS is likely to affect emissions consequences of energy storage operations in the near-term; and
- Recommend that DOER review and update the CPS windows frequently as the transition to a cleaner generation mix will alter marginal emissions rates and the emissions effects of the CPS.

2. Energy Storage and Emissions

Energy storage resources are a necessary component of a decarbonized electric grid. However, the emissions impacts of operating energy storage depend on the generation mix, and specifically its marginal emission rates. Marginal emission rates can vary widely depending on the time of day and location, based on the fuel type and efficiency of the marginal generator. The grid's marginal emission rate can be zero when a renewable resource is the marginal generator, but it skyrockets when an oil-fired plant is on the margin. Marginal emission rates are also affected by location-specific transmission constraints and other operational features of the grid.

The net effect of energy storage on emissions depends on the difference between the marginal emission rates of charging and discharging periods.[8] If an energy storage resource charges when marginal emission rates are high, and discharges when marginal emission rates are low, it will increase emissions compared to the counterfactual scenario of no energy storage.[9] Indeed, ample

[6] Comments of Policy Integrity, N.Y. Pub. Serv. Comm'n Case 18-E-0130, In the Matter of Energy Storage Deployment Program (Sept. 10, 2018), https://policyintegrity.org/documents/Policy_Integrity_Comments_on_Energy_Storage_Roadmap_w_Attachment.pdf; Joint Comments of Azure Mountain Power et al., N.Y. Pub. Serv. Comm'n Case 18-E-0130, In the Matter of Energy Storage Deployment Program (Sept. 10, 2018), https://policyintegrity.org/documents/Smart_Dispatch_and_EValue_Coalition_Comments.pdf.

[7] NY Energy Storage Order at 29 (endorsing development of valuation methodology that captures location-specific marginal CO2 emissions rates); New York State Energy Storage Roadmap and Department of Public Service/New York State Energy Research and Development Authority Staff Recommendations, App'x A 56 (June 2018), https://perma.cc/GQR2-SRJJ ("The analysis . . . presented in the Roadmap considers the carbon offset from energy storage as the delta between the marginal emissions rate (MER) when storage charges and discharges.").

[8] *See* Richard L. Revesz & Burcin Unel, *Managing the Future of the Electricity Grid: Energy Storage and Greenhouse Gas Em*issions, 42 HARV. ENVTL. L. REV. 139 (2018); Madison Condon, Richard Revesz & Burcin Unel, Inst. for Pol'y Integrity, *Managing the Future of Energy Storage* (Apr. 2018), http://policyintegrity.org/publications/detail/managing-the-future-of-energy-storage.

[9] Revesz & Unel, *supra* note 8, at 143.

academic work has demonstrated that the emissions reduction potential of various resources depends on the grid's hourly and sub-hourly marginal emission rates, and that energy storage can increase emissions.[10] As a result, an analysis of emissions impacts that relies on an *average* emissions rate will yield inaccurate results.

Another factor that must feature in any analysis of the emissions impacts of energy storage is the energy losses associated with charging, discharging, and maintaining charge.[11] These "round-trip efficiency" losses vary by technology and can be quite high.[12] As a result, even if there is no difference in the marginal emission rates between charging and discharging periods, energy storage can increase emissions by simply increasing the amount of energy generation needed to serve the same amount of load.[13]

It is also important to note that even when energy storage is paired with a renewable generator, the grid's marginal emission rate is still the relevant factor that must be considered in order to understand the effect of energy storage on emissions compared to a no energy storage scenario. That is because the true cost of a resource includes the opportunity cost of using it.[14] If renewable energy can be sent to the grid for consumption instead of being used to charge an energy storage resource, and without any of it being lost in charging and discharging, it would displace emitting generation and hence reduce emissions based on the grid's marginal emission rate at that time. Ignoring this opportunity cost would lead to a faulty accounting of the emissions consequences of using energy storage.

Overall, the net emissions impact of energy storage depends on where, when, and how it operates, and assessing that impact requires a thorough analysis that incorporates round-trip efficiency losses as well as marginal operational emission rates. Using average emission rates, ignoring efficiency losses, or focusing only on emissions avoided during discharging periods for paired energy storage, would lead to inaccurate results.

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[10] Eric S. Hittinger & Ines M. L. Azevedo, *Bulk Energy Storage Increases United States Electricity System Emissions*, 49 ENVTL. SCI. & TECH. 3202 (2015); Joshua Graff Zivin, Matthew J. Kotchen & Erin T. Mansur, Spatial and Temporal Heterogeneity of Marginal Emissions: Implications for Electric Cars and Other Electricity-Shifting Policies 1 (2013); Duncan S. Callaway, Meredith Fowlie, & Gavin McCormick, *Location, Location, Location: The Variable Value of Renewable Energy and Demand-Side Efficiency Resources*, 5 J. ASS'N ENVTL. & RESOURCE ECONOMISTS 39 (2017); Eric S. Hittinger & Ines M. L. Azevedo, *Estimating the Quantity of Wind and Solar Required To Displace Storage-Induced Emissions*, 51 ENVTL. SCI.& TECH. 12988 (2017); Laura M. Arciniegas & Eric Hittinger, *Tradeoffs Between Revenue and Emissions in Energy Storage Operation*, 143 ENERGY 1 (2018); *Storing Solar Power Increases Energy Consumption and Emissions, Study Finds*, UTNEWS (Jan. 30, 2017), https://perma.cc/3EXG-GAML.

[11] Revesz & Unel, *supra* note 8, at 166.

[12] *Id.*

[13] *Id.*

[14] PAUL KRUGMAN & ROBIN WELLS, MICROECONOMICS 225-29 (2d ed. 2009).

3. Potential Effects of the Proposed Clean Peak Energy Standard in Massachusetts

Motivated by Massachusetts' efforts to reduce emissions using novel policy ideas, we have modeled the potential effects of the proposed CPS to encourage adding energy storage resources using WattTime's independently validated, 5-minute marginal emission rate data for the ISO-NE Southern Massachusetts sub region.[15] This model is an extension of the method of Callaway et al (2017)[16] and was independently validated by the nonprofit Rocky Mountain Institute.[17]

To understand the emissions impact of energy storage operations, we first established a baseline – no new policy scenario – by running a linear optimization model for battery owners seeking to maximize their revenue, using the methodology of Arciniegas & Hittinger (2018).[18] Next, to understand the incremental effect of the CPS, we ran the revenue optimization model under the assumption that the policy was in place. We modified the revenue optimization model to use the multipliers described in the Clean Peak Standard to incentivize discharging during the specified hours. Then, to show the sensitivity of the emission impacts to the time periods chosen, we created a new policy – Marginal Clean Peak Standard – by changing the discharging time periods to better correspond with the highest marginal emission rates in a given season, and reran the revenue optimization. We ran both the Clean Peak Standard and Marginal Clean Peak Standard scenarios with Clean Peak Certificate prices of $10, $20, and $30. Finally, for illustrative purposes, we also ran the revenue optimization model using a $1 and a $30 dollar carbon price on the wholesale energy market.

Our analysis yielded several key insights, described below, that Massachusetts policymakers should be aware of.

a. Energy Storage Increases Emissions in the Baseline Scenario of No New Policy

First, the results of this modeling shows that, consistent with the academic literature, given the current ISO-NE grid mix, a revenue-maximizing energy storage unit would increase emissions in Massachusetts under existing policy. This result is due to the fact that, while the region is decarbonizing, its marginal units are still mostly natural gas, and, hence, its marginal emission rates are relatively flat during most of the year, with the exception of winter (see Figure 1). Relatively flat emissions rates, combined with the round-trip efficiency loss of energy storage,

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[15] A working paper will be available from the authors upon request.

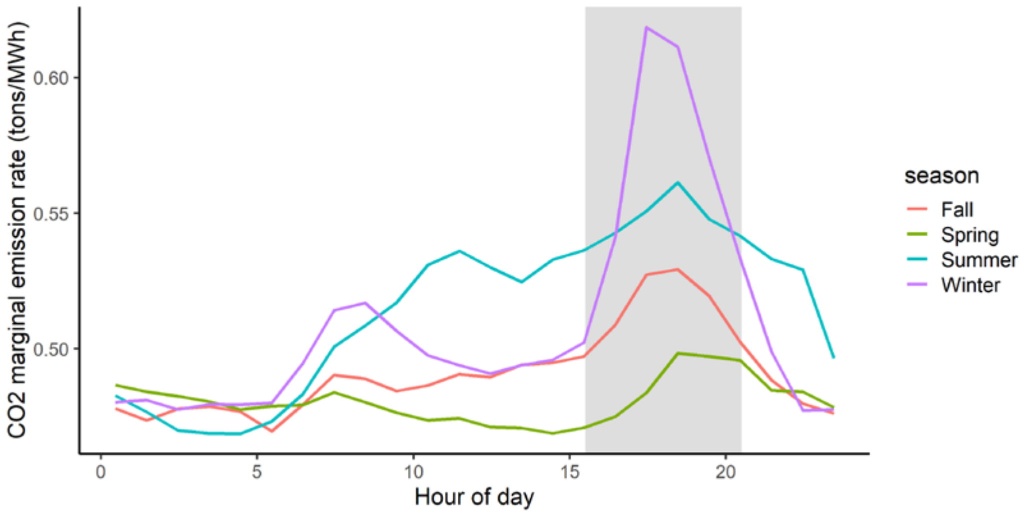
[16] Duncan S. Callaway, Meredith Fowlie, & Gavin McCormick, *Location, Location, Location: The Variable Value of Renewable Energy and Demand-Side Efficiency Resources*, 5 J. ASS'N ENVTL. & RES. ECONOMISTS 39 (2018).

[17] JAMIE MANDEL & MARK DYSON, ROCKY MTN. INST., WATTTIME VALIDATION AND TECHNOLOGY PRIMER (2017), https://perma.cc/7CWA-BGWK.

[18] We used the linear-programming method detailed in Arciniegas & Hittinger (2018) to simulate 1 year of optimal 5-minute energy arbitrage behavior for an 80MWh/20MW storage system operating with a 75% round-trip efficiency, with inefficiencies split between charging and discharging. In our analysis, due to modeling constraints, we have equal weighting between discharging and charging periods. We are in the process of updating the model to allow more flexibility, however, we do not expect that our qualitative results will change based on this update. We are happy to provide further results on request. When finalized, a working paper will be available at https://policyintegrity.org/documents/Clean_Peak.pdf.

eliminates any opportunity to reduce emissions by charging a storage resource when emissions rates are low and discharging when they are high. While there is more variation in winter marginal emission rates between peak and off peak demand hours, even that variation is not enough to overcome the negative effect of efficiency losses.

Figure 1. Marginal Emissions Rates (tons of CO2/MWh) by Season

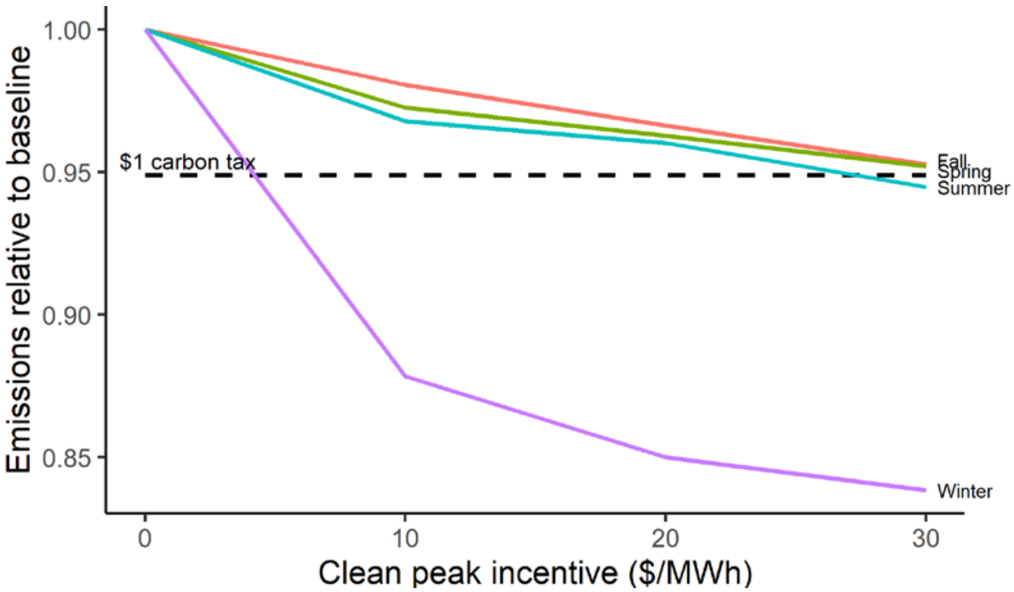


b. Clean Peak Energy Standard Does Not Reduce Emissions Substantially

Compared to the baseline, the CPS could reduce the amount of potential emissions increase caused by the use of energy storage, but only minimally. Figure 2 shows the emissions from storage, by season, under different policy scenarios relative to a baseline of not having any policy. In other words, in Figure 2, the baseline emissions from optimal energy storage operations are indexed to 1. The dashed, black line shows the emission reductions from a $1 carbon tax for comparison.

As the solid lines in Figure 2 show, the emissions compared to the baseline decrease as the Clean Peak Certificate payments go up. However, even with a $30 certificate price, the reductions would likely be minimal in spring, summer, and fall. In winter, when marginal emissions rates spike at times of peak demand, the reductions would be more substantial. Importantly, however, CPS would still reduce only the *increase* in emissions arising from energy storage deployment and operation (shown in Figure 1) during winter, but energy storage operations would still be increasing emissions.

Figure 2. Change in Seasonal Emissions Under Different Clean Peak Certificate Prices



It is also worth noting that, as shown by the dotted line in Figure 2, a very modest carbon tax of $1 per ton (or an increase in RGGI price) would, by better aligning arbitrage opportunities with emissions reduction opportunities, lead to better outcomes than CPS for most of the year, for most the credit prices. Furthermore, our analysis shows, a $30 per ton increase in carbon price, well below Interagency Working Group's Social Cost of Carbon, would cut the emissions of energy storage almost in half. In other words, a clean peak standard is a weak policy alternative to a robust carbon price.

c. Clean Peak Energy Standard Outcomes Are Sensitive to Chosen Time Windows

The success of a policy like the CPS depends on how well the chosen windows align with the daily marginal emissions peaks. Our analysis concludes that CPS leads to a minimal reduction in emissions compared to the baseline scenario because CPS fails to capture a given day's peak emissions.

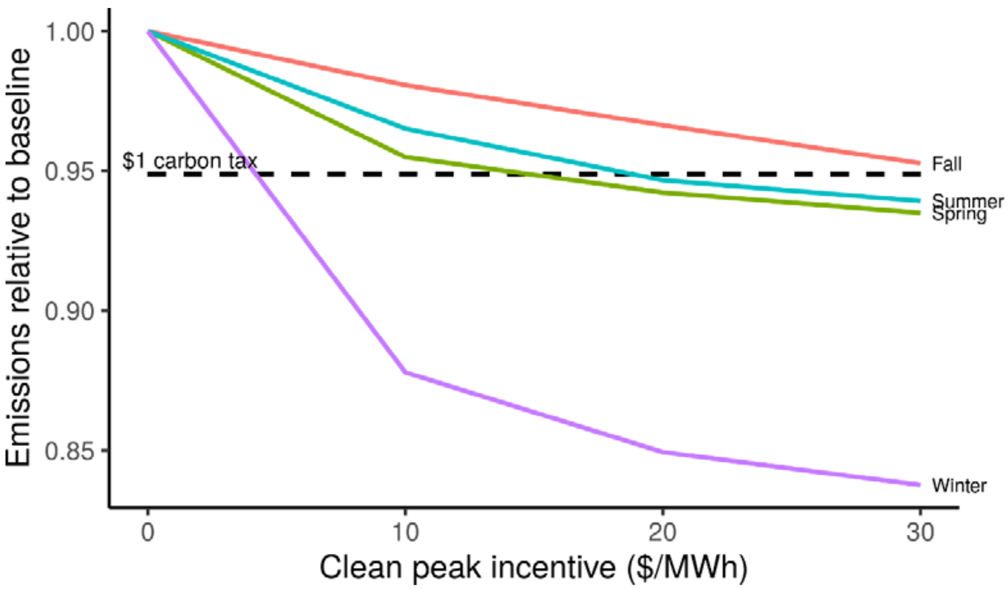
To show the sensitivity of CPS to the chosen discharging windows, we have also analyzed a version of the policy that we call the Marginal Clean Peak Standard, in which we modified the discharging windows to better correspond with the highest marginal emission rates:

Table 1. Marginal Clean Peak Windows

Season	Peak Hours in Proposed CPS	Alternative Peak Hours
Winter	4-8 pm	*same*
Spring	4-8 pm	5-9 pm
Summer	3-7 pm	5-9 pm
Fall	4-8 pm	*same*

Figure 3 shows the emissions under our Marginal Clean Peak scenarios. Even this minor adjustment in the seasonal windows compared to the proposed rule caused a significant change in emissions outcomes. As the comparison of Figure 2 and Figure 3 shows, emission outcomes are markedly different in summer and spring, when the proposed CPS discharging windows are especially misaligned with the daily peak emission windows.

Figure 3. Change in Seasonal Emissions Under Alternative Peak Hours



4. Conclusions

Our analysis concludes that, given ISO-NE's grid mix, energy storage currently offers limited direct emissions reduction potential in Massachusetts. Even so, our comments should not be interpreted as arguing against state support for energy storage resource deployments or policies designed to steer those deployments to reduce emissions (or to just keep emissions from increasing).

On the contrary, we recognize that energy storage will be a crucial part of the clean electricity grid of the future, and encourage DOER to continue making support for energy storage part of its overarching decarbonization agenda. However, we also urge DOER to more carefully consider the emission implications of its policies. Specifically, we suggest that DOER consider taking the following interim steps:

1. Modify the current discharging windows in the proposed rule to better align with the current marginal emissions rates. While this change would not reduce emissions, even a slight adjustment of CPS could reduce the expected increase significantly.
2. Establish a schedule for regular (a) re-examinations of CPS program emissions performance and, based on their findings, (b) adjustments to the windows of time designated as "peak" to maximize emissions reduction potential as the generation mix

changes over time by aligning those windows with marginal emission rates. Although DOER would have to adjust CPS parameters regularly, establishing a schedule would make the timing of those adjustments predictable.

3. When the generation mix has shifted and there are clear windows of time when charging or discharging storage can lead to lower emissions based on marginal emissions rates, make receipt of CPS certificates wholly conditional on a showing that the operation of qualifying resources reduced emissions. Such modification could help avoid the unintentional outcomes that could arise, similar to the earlier SGIP outcomes.