



**RENEW**  
Northeast

# Battery Storage Revenue for ORTP Calculation: A Proposed Amendment

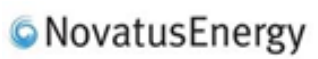
Abby Krich and Alex Worsley, Boreas Renewables LLC  
NEPOOL Markets Committee  
September 8-10, 2020



[www.renew-ne.org](http://www.renew-ne.org)  
Follow us: [@Renew\\_NE](https://twitter.com/Renew_NE)



# About RENEW



The comments expressed herein represent the views of RENEW and not necessarily those of any particular member of RENEW.

# Background: How We Got Here

- ISO has proposed to use \$1.87-2.67/kW-month (2019\$) in Energy and Reserves revenue for the battery storage technology, which RENEW believes underrepresents what a competent battery developer could earn in the NE Markets

	ISO	RENEW	Links
MC July 14-15	ISO presented their dispatch logic for the battery storage technology and proposed E&AS revenue offsets of \$1.76-\$2.33/kW-mo for the battery	Provided feedback at the MC and offline that the battery revenues looked low based on the EMM's filing in December of 2019. Without dispatch model could not provide additional feedback	<a href="#">July 14-15 CEA Materials</a>  <a href="#">Potomac's Dec 2019 Comments on IMM's Battery Revenue Assumptions</a>
MC August 11-13	ISO released their dispatch model and results. Expected E&AS revenue for the battery storage technology is \$1.87-2.67/kW-mo	RENEW in their memo again highlighted the EMM's comments regarding battery storage, including a more in depth look at the EMM's numbers, stressing the need to optimize the dispatch	<a href="#">August 11-13 CEA Materials</a>  <a href="#">RENEW Memo</a>

# Summary of RENEW's Concerns and Proposed Amendment

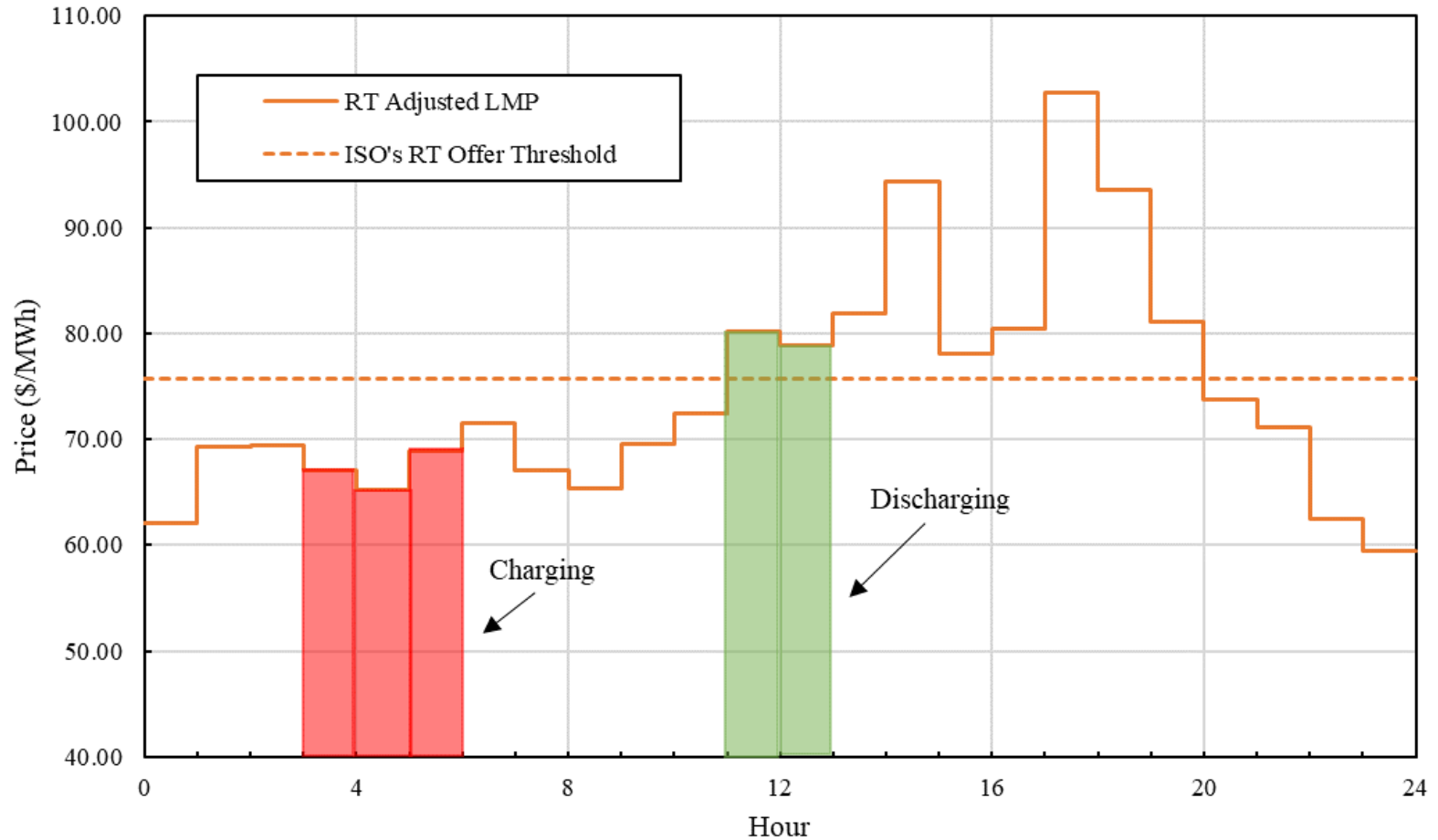
- ISO has proposed to use a dispatch model that results in \$1.87-2.67/kW-month in Energy and Reserves Revenue
- RENEW believes that dispatch model is suboptimal and does not reflect the revenues a reasonably competent Energy Storage Resource (ESR) developer could expect to receive
  - This revenue model does not follow the guidelines the EMM set forth in December of 2019 on battery dispatch models
- Based on the EMM's recommendations, as modeled by the Massachusetts Attorney General's Office<sup>1</sup>, a battery could easily expect 7-21% more E&AS revenue, simply by optimizing over Day-Ahead Market prices
- RENEW is proposing an amendment to change the way the battery storage E&AS revenue is calculated to be used in the ORTP model ISO has developed
  - This results in a final ORTP value of \$3.90-4.18/kW-mo, compared to ISO's calculation of \$4.92-5.78/kW-mo

# A Review of ISO's Battery Dispatch Model Strategy

- The unit will dispatch as soon as LMP hits threshold (the 95<sup>th</sup> percentile of LMPs for the year)
  - This threshold is constant throughout every hour of the day and every day of the year
  - Unit does not forecast price trends, so will dispatch in first hour above threshold
- Unit charges at a fixed time every day (Hours Ending 3-5)
  - These are not necessarily the three lowest price hours in the day
- Reserve Payments fall out of RT energy dispatch
  - Model is at its core an energy arbitrage model: dispatch is based on buying energy during low price hours and selling revenue in sufficiently high price hours
  - Earns more revenue from reserves but it is not optimized in any way for reserves
- DA market is decoupled from RT operations
  - Unit automatically buys back DAM-cleared energy in RT
  - DA clearing has no influence on RT dispatch
- Topping-off occurs at a set time, independent of price/market conditions

# ISO's Battery Dispatch Model: A Sample Day

Jan 8, 2017 - ISO's RT Dispatch



# Observations regarding ISO's Battery Dispatch Strategy

- There is no attempt to optimize dispatch using available data at the time of dispatch
  - Units will know the DA market prices and perhaps something about upcoming RT prices from the Coordinated Transaction Schedule (CTS) between ISO-NE and NYISO
  - This information is publicly available, completely transparent, and does not require additional modeling or forecasting
- Charging is frequently suboptimal
  - There may be historic precedent that HE 3-5 are the lowest price hours on average, but there is no guarantee that they are the lowest price hours each day
- Battery loses the ability to provide reserves as soon as it discharges
  - By discharging in the first hours above the threshold, the battery loses the ability to provide reserves for the rest of the day, even if reserve prices are increasing
- There is no ability to respond to forecasted market conditions/dynamics
  - ISO's threshold does not change throughout the year—and therefore does not capture daily, monthly or even seasonal changes in the markets



# EMM's Comments on the IMM's Battery Revenue Model for FCA 14

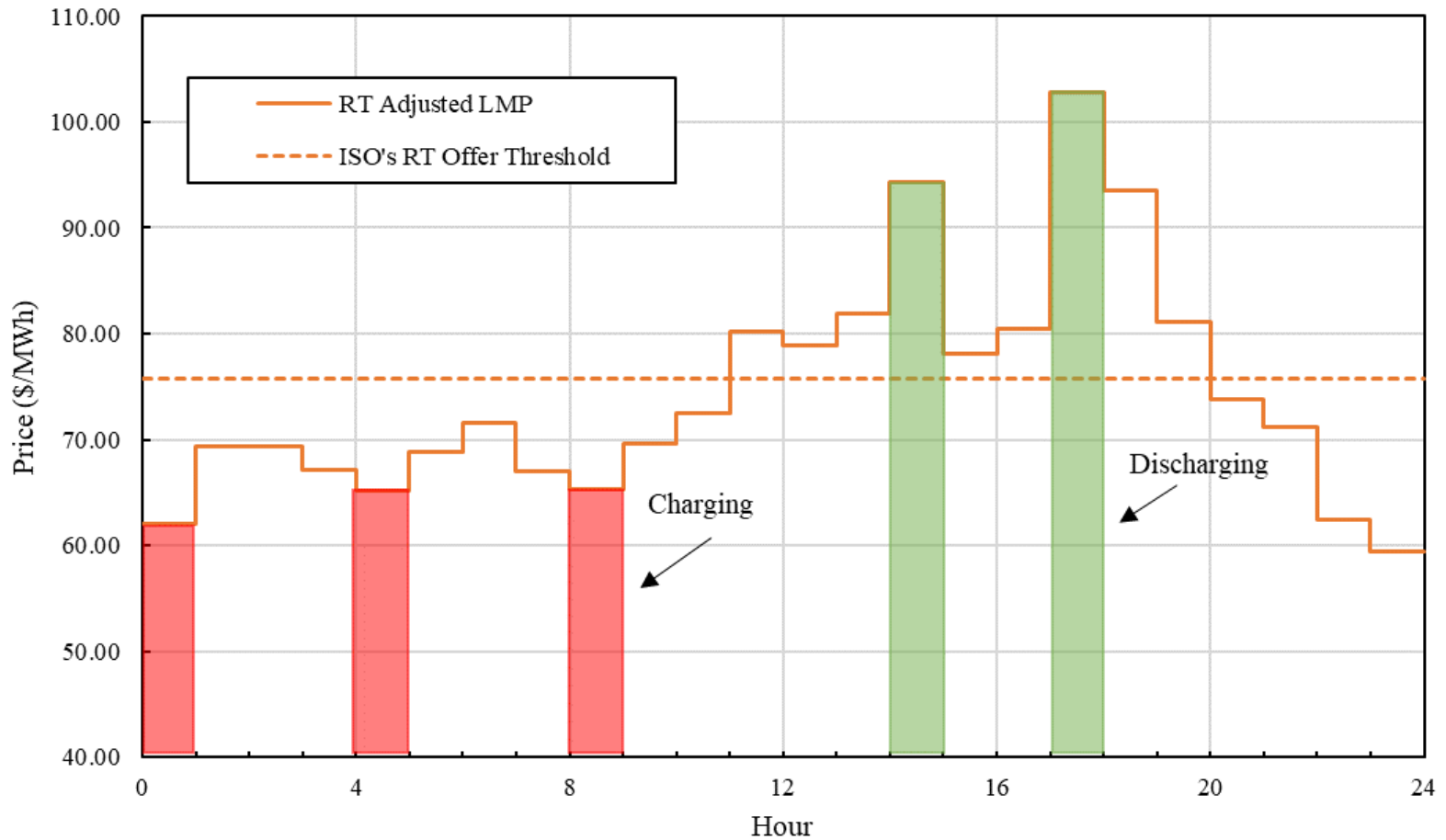
- As part of the FCA 14 resource-specific offer floor price review, there was a challenge by a market participant on the methodology the IMM used to estimate battery revenue (ER20-308)
- The EMM filed comments regarding the IMM's methodology
  - The IMM was not using available data at the time of dispatch (DAM prices and CTS schedules) to dispatch their battery unit
  - IMM methodology resulted in E&AS revenues that were “unreasonably low”
  - Comments were submitted too late to be integrated into the FCA 14 process
- The IMM's E&AS modeling for batteries has changed for the FCA 15 offer review process
  - The IMM has hired a consultant to model optimized E&AS revenues for batteries
- As part of their comments, the EMM studied three different approaches to modeling E&AS revenues

# EMM's Three Dispatch Methodologies for Calculating Battery Revenues

	Description
Approach 1: Perfect Knowledge	“The ESR has perfect foresight of 5-minute real-time prices for the entire day and constructs its hourly offers to maximize the EAS net revenues... Given that this approach assumes a perfect forecast of 5-minute prices, it is an over-estimate of what a resource could actually earn.”
Approach 2: DA Knowledge	“The ESR is scheduled optimally based on day-ahead energy prices, which is possible because all 24 hours of the day-ahead market are cleared simultaneously. The resource would receive additional net revenues from sale of spinning reserves in the real-time market... <u>Given the limited sophistication of this approach, this represents the minimum that an ESR developer could reasonably expect to receive in EAS net revenues.</u> ”
Approach 3: Continuous Update  <i>Note: This was the EMM's recommended approach</i>	“The ESR continuously updates a forecast of the minimum and maximum prices over the remainder of the day based on: (a) price forecasts published for the Coordinated Transaction Scheduling (“CTS”) process between ISO-NE and the NYISO, which look ahead 150 minutes, and (b) prices from the day-ahead market. Each month, the ESR determines real-time charging and discharging adjustment factors that would have maximized EAS net revenues in the previous month if the adjustment factors had been used to develop bids and offers relative to the continuously updated minimum and maximum price forecasts.”

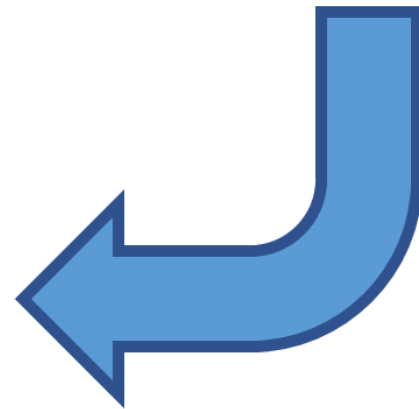
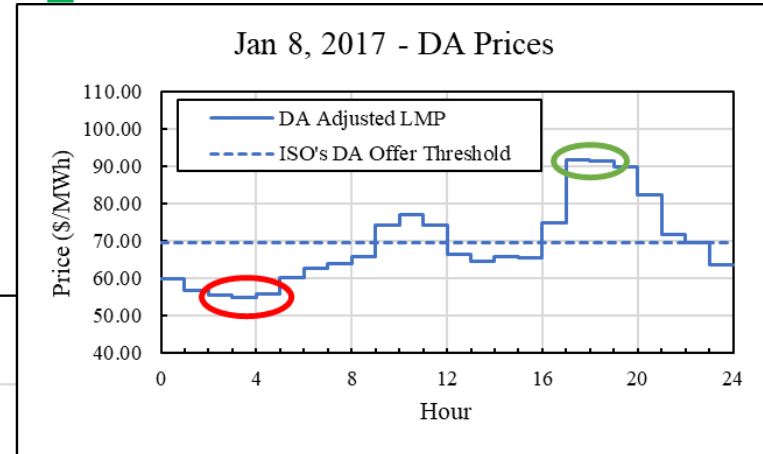
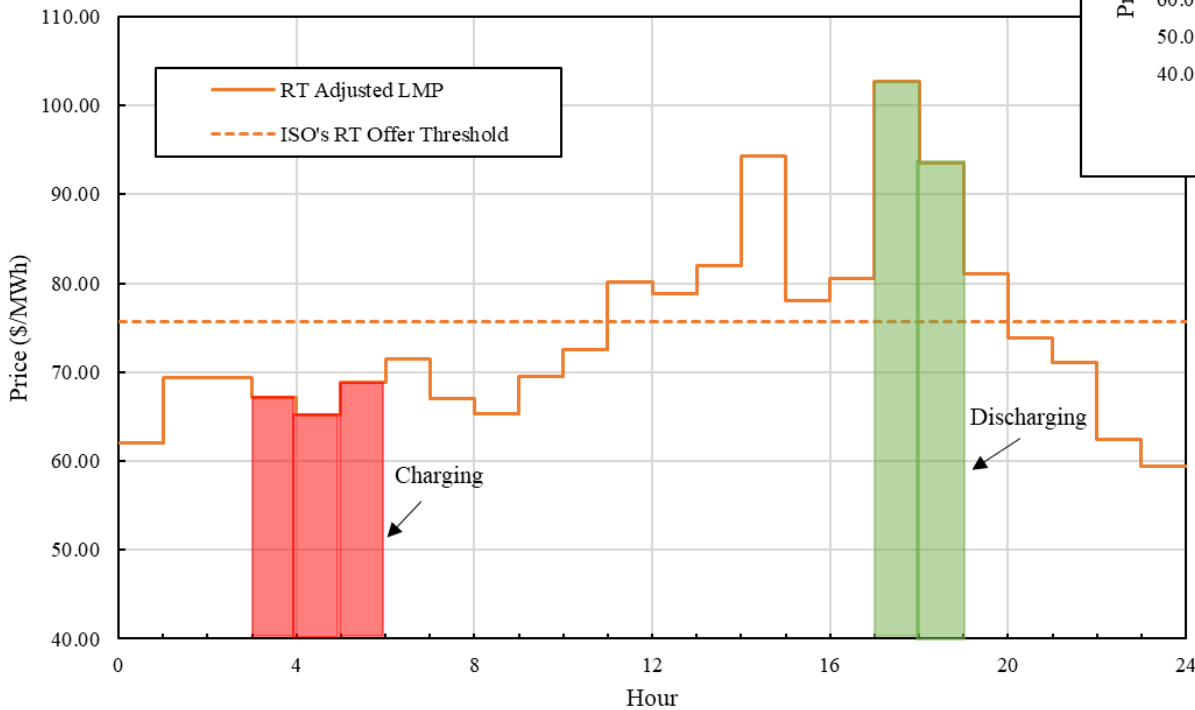
# EMM Approach 1: Perfect Foresight

Jan 8, 2017 - Perfect Foresight



# EMM Approach 2: Using DAM Prices to Schedule RT Dispatch

Jan 8, 2017 - DA Information



# Observations from Optimization Based Modeling Approaches

- More optimal outcomes: the revenues received under all three of EMM's approaches are greater than CEA's approach
  - The battery unit is able to earn more revenue even if it only looks at DA prices to inform its decision to dispatch in RT (EMM Approach 2)
  - EMM's calculated E&AS values are shown on slide 15
- A competent ESR owner should be assumed to use publicly-available information known prior to dispatch
  - This is a transparent method for determining E&AS revenues
  - Does not rely on price forecasts
- These approaches require, by definition, a linear programming optimization algorithm
  - These are common and not difficult to implement, and we believe should have been appropriately within CEA's scope of work

# The EMM's Approach 2 was modeled by the MA AGO with the LMP data used in the ORTP Recalculation Process

- The MA AGO published a memo describing a methodology for modeling optimized battery revenues in the context of the FCA 16 ORTP recalculation process using the “Approach 2” described by the EMM
  - This is Agenda Item 6.A.ix
- The MA AGO model derived an alternative, conservative real time energy and reserve net revenue value of \$2.63/kW-mo assuming the FRM sunset
  - \$2.99/kW-mo if the FRM is maintained
  - It is conservative because it ignore CTS information utilized in EMM’s “Approach 3” that yields additional revenue any “reasonably competent ESR owner could achieve”
- RENEW believes the MA AGO’s numbers are an accurate representation of the minimum real time energy and reserve revenues an ESR developer could expect to earn in the ISO-NE Energy and Reserve Markets
  - “Given the limited sophistication of [Approach 2], this represents the minimum that an ESR developer could reasonably expect to receive in EAS net revenues.”

# Comparison of CEA, EMM, and MA AGO Energy & Reserve Revenues

(No FRM) EAS Method	\$/kW-yr	\$/kW-month	\$/yr (avg)	Percent Increase from CEA's Analysis
CEA	\$22.39	\$1.87	<b>\$3,358,131</b>	--

*ISO Proposal*

(No FRM) EAS Method	\$/kW-yr	\$/kW-month	\$/yr (avg)	Percent Increase from CEA's Analysis
EMM Approach 1: Perfect 5-min Knowledge	\$56.00	\$4.67	<b>\$8,400,000</b>	<b>150%</b>
EMM Approach 2: DA Knowledge	\$30.00	\$2.50	<b>\$4,500,000</b>	<b>34%</b>
EMM Approach 3: Continuous Information	\$34.00	\$2.83	<b>\$5,100,000</b>	<b>52%</b>

*Recommended  
By EMM*

(No FRM) EAS Method	\$/kW-yr	\$/kW-month	\$/yr (avg)	Percent Increase from CEA's Analysis
Mass AGO: Perfect Hourly Knowledge	\$50.46	\$4.21	<b>\$7,569,000</b>	<b>125%</b>
Mass AGO: DA Knowledge	\$31.54	\$2.63	<b>\$4,730,619</b>	<b>41%</b>

*RENEW  
Recommendation*



\* CEA and MA AGO results reflecting With FRM scenario are included in Appendix 1

# RTM and TMSR are only part of E&AS Revenues

- Mass AGO only modeled RTM and TMSR revenues
- In CEA’s model, Regulation, DAM, and RTM/TMSR participation are all independent of one another
- RENEW does not propose changes CEA’s DAM or regulation revenues, or changes to the scarcity, ESI, and PFP E&AS adders

Year	ISO DAM Revenue (No FRM)	PPI Escalation to 2019\$	(2019\$)	(2025\$)
2017	\$79,730	1.0460	\$83,398	\$93,920
2018	-\$1,862	1.0008	-\$1,864	-\$2,099
2019	\$42,845	1.0000	\$42,845	\$48,250
		<b>Average:</b>	<b>41,460</b>	<b>\$46,690</b>



\* CEA values reflecting With FRM scenario are included in Appendix 1



# RENEW's Proposed E&AS

- Battery E&AS revenue made up of:
  - Conservative Massachusetts AGO net real-time energy & reserve revenue
  - CEA DAM revenue
  - CEA regulation revenue
- No change to CEA's scarcity, ESI, and PFP E&AS adders (not shown below)

EAS Method	Energy & Reserve (\$/kW-mo)	Energy & Reserve (\$/kW-yr)	Energy & Reserve (\$/yr)	Regulation (\$/kW-mo)	Regulation (\$/kW-yr)	Regulation (\$/year)	DAM (\$/yr)	Total (\$/kW-mo)	Total (\$/yr)	Percent Increase from CEA's Analysis
CEA (No FRM) (E&AS)	\$1.87	\$22.39	\$3,358,131	\$1.90	\$22.84	\$3,425,714	Included	<b>\$3.77</b>	<b>\$6,783,845</b>	--
RENEW (No FRM)	\$2.63	\$31.54	\$4,730,619	\$1.90	\$22.84	\$3,425,714	\$46,237	<b>\$4.56</b>	<b>\$8,202,570</b>	<b>21%</b>

# Integration with ISO's ORTP Model and Results

- Using the E&AS revenue values presented on the previous slide in ISO's ORTP model results in an ORTP for the Battery Storage project between \$3.90-4.18/kW-mo
  - Done by changing cells G17:H17 on the "E&AS" tab in the ORTP discounted cash-flow model to \$8,202,951/kW-yr for FRM-Sunset column and \$8,838,889/kW-yr for the With-FRM column

(2019\$)	FRM Sunset & ISO ESI	FRM Sunset & NEPOOL ESI	FRM & No ESI
ISO's ORTP (\$/kW-mo)	\$5.757	\$5.778	\$4.921
RENEW's Proposed ORTP (2019\$/kW-mo)	<b>\$4.162</b>	<b>\$4.181</b>	<b>\$3.896</b>

# RENEW's Proposed Amendment: Sample Redline

## NEPOOL ESI and FRM Sunset

### III.A.21.1.1. Offer Review Trigger Prices for the Forward Capacity Auction.

For resources other than New Import Capacity Resources, the Offer Review Trigger Prices for the ~~twelfth Forward Capacity Auction (for the~~ Capacity Commitment Period beginning on June 1, ~~2025~~2021) shall be as follows:

Generating Capacity Resources	
Technology Type	Offer Review Trigger Price (\$/kW-month)
<u>Simple Cycle</u> <del>e</del> Combustion <del>t</del> Turbine	\$ <u>6.35</u> <del>46.503</del>
<del>e</del> Combined <del>e</del> Cycle <del>g</del> Gas <del>t</del> Turbine	\$ <u>9.10</u> <del>87.856</del>
<del>o</del> On-s <del>s</del> Shore <del>w</del> Wind	\$ <u>0.000</u> <del>11.025</del>
<u>Energy Storage Device – Lithium Ion Battery</u>	<del>\$4.18</del> <u>15.778</u>
<u>Photovoltaic Solar</u>	<u>\$11.014</u>

# Questions?

Abby Krich

President, Boreas Renewables, LLC

[krich@boreasrenewables.com](mailto:krich@boreasrenewables.com)

Alex Worsley

Boreas Renewables, LLC

[worsley@boreasrenewables.com](mailto:worsley@boreasrenewables.com)

# Appendix 1: E&AS Revenues With FRM

# Comparison of CEA's Revenue Assumption and the Mass AGO's Calculations – With FRM

(With FRM) EAS Method	\$/kW-yr	\$/kW-month	\$/yr (avg)	Percent Increase from CEA's Analysis
CEA (E&AS)	\$32.05	\$2.67	<b>\$4,807,528</b>	--
Mass AGO: Perfect Hourly Knowledge	\$50.71	\$4.23	<b>\$7,607,196</b>	<b>58%</b>
Mass AGO: DA Knowledge	\$35.84	\$2.99	<b>\$5,375,295</b>	<b>12%</b>

# DAM Revenues from ISO's Dispatch Model – With FRM

Year	ISO DAM Revenue (With FRM)	PPI Escalation to 2019\$	(2019\$)	(2025\$)
2017	33,590	1.0460	35,136	39,569
2018	34,655	1.0008	34,684	39,060
2019	29,210	1.0000	29,210	32,895
		<b>Average</b>	33,010	\$37,175

# RENEW's Proposed E&AS With FRM

- Battery E&AS revenue made up of:
  - Conservative Massachusetts AGO net real-time energy & reserve revenue
  - CEA DAM revenue
  - CEA regulation revenue
- No change to CEA's scarcity, ESI, and PFP E&AS adders (not shown below)

EAS Method	Energy & Reserve (\$/kW-mo)	Energy & Reserve (\$/kW-yr)	Energy & Reserve (\$/yr)	Regulation (\$/kW-mo)	Regulation (\$/kW-yr)	Regulation (\$/year)	DAM (\$/yr)	Total (\$/kW-mo)	Total (\$/yr)	Percent Increase from CEA's Analysis
CEA (with FRM) (E&AS)	\$2.67	\$32.05	\$4,807,528	\$1.90	\$22.84	\$3,425,714	Included	<b>\$4.57</b>	<b>\$8,233,242</b>	--
RENEW (With FRM)	\$2.99	\$35.84	\$5,375,295	\$1.90	\$22.84	\$3,425,714	\$37,175	<b>\$4.91</b>	<b>\$8,838,184</b>	<b>7%</b>