APRIL 15, 2021 | NEPOOL PARTICIPANTS COMMITTEE WORKING SESSION

Pathways to the Future Grid

Evaluating clean energy and carbon pricing frameworks as alternative market approaches to advance the region's clean energy transition

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Pathways work will evaluate two potential market approaches to decarbonization

- ISO is working with stakeholders and the Analysis Group to evaluate two market approaches that have been discussed as potential pathways to the future grid
  - Forward clean energy market (FCEM)
  - Net carbon pricing
- ISO plans to study both frameworks simultaneously and issue a final report in the first quarter of 2022 that discusses the market impacts of both approaches
- Today's discussion will not focus on sequential versus integrated clearing of an FCEM, but ISO plans to return with further discussion on this topic in May

Today's discussion focuses on several key design details

- Continued discussion of the straw FCEM and net carbon pricing frameworks
- These include consideration of key design elements that were discussed in March, but for which the straw frameworks did not recommend a specific approach, including:
  - Integration of an FCEM with existing state policies (e.g., RECs)
  - Treatment of storage resources
- Also offer a preliminary response to stakeholder comments
- Analysis Group will also kick off discussion of modeling approach and assumptions it will employ to evaluate the straw FCEM and net carbon pricing frameworks

Appreciate continued stakeholder engagement and feedback

- ISO welcomes feedback and questions associated with each straw framework put forth
  - Comments can be provided during committee discussions or in writing to Chris Geissler (cgeissler@iso-ne.com) and the Chair of the Participants Committee (or designee)
- Since March meeting, received written comments that are posted for the NEPOOL meeting
  - Comments touch on numerous topics related to the Pathways efforts, including tradeoffs between a net carbon pricing framework and FCEM, interactions with existing policies, and modeling assumptions
  - Today's discussion will consider some of these topics
  - Discussion of these topics will continue at future meetings

ISO has published two new memoranda for this meeting

- **Integration with existing state policy memo**: Provides further consideration of approaches to integrate an FCEM with existing state environmental policies
- **Storage memo**: Discusses role of storage in the region's transition and its potential treatment under FCEM and net carbon pricing frameworks
- These memoranda, as well as those published for the March meeting, are available on the NEPOOL website
- Discuss contents from these new memoranda in more detail in the slides that follow

INTERACTION WITH EXISTING STATE PROGRAMS

Background

- States have existing programs that award certificates for renewable or environmental attributes
- Stakeholders have questioned the extent to which new CECs would be integrated with the existing programs for modelling purposes
- The ISO provided some thoughts in the FCEM Scoping materials and this presentation continues those discussions
- The ISO welcomes continued feedback on this topic and looks forward to further discussion

Three Potential Approaches

- Stakeholders and the ISO are considering three potential modelling approaches for how the FCEM would interact with existing state programs
- **Approach 1**: Clean energy is a new environmental attribute that is distinct from other attributes (e.g., renewable) so that a clean resource can earn both CECs and RECs with each MWh of energy production during the delivery year
- **Approach 2**: Clean energy certificates include all environmental attributes so that a clean resource that sells CECs in the FCEM cannot also sell RECs in the delivery year
- **Approach 3**: The existing programs are discontinued and the region uses clean energy certificates to meet its environmental objectives

Overview of Six Cases

- This section presents six cases that demonstrate total payments to resources under the different approaches with different relationships between CEC demand and REC demand
- The cases consider a stakeholder concern where, under Approach 1, resources that can sell both CECs and RECs may see increased payments relative to Approach 2
  - Following stakeholders, we refer to this as “double payment”
- The cases also explore the extent to which the approaches can yield equivalent results
- For more details on these cases, please see the corresponding “FCEM and Existing State Programs” memo

Parameter Summary

		Clean 1	Clean 2	Renewable 1	Renewable 2
[1]	Unrecovered Costs	$10/MWh	$15/MWh	$20/MWh	$25/MWh
[2]	Max Certificate Award	5,000 MWh	5,000 MWh	5,0000 MWh	5,000 MWh
[3]	Qualified to Sell RECS?	No	No	Yes	Yes
[4]	Qualified to Sell CECs?	Yes	Yes	Yes	Yes

- All six cases consider the same four resources with the same parameter values
  - The “Clean” resources can sell only CECs while the “Renewable” resources can sell CECs and RECs
- Max Certificate Award is the maximum amount of RECs or CECs the resources can sell

Parameter Summary, Cont.

- Unrecovered costs represents the per MWh payment the resources would need to be economical
  - For example, for Clean 1 to be built and provide clean energy, it would need to be paid $10/MWh from either CECs or RECs
  - Note that the "Clean" resources have smaller unrecovered costs than the "Renewable" resources
  - This is a simplifying assumption and, in practice, we'd expect some "Renewable" resources to have lower costs than some "Clean" resources
- Cases assume that the markets for CECs and RECs are competitive, so that resources that set the price for CECs or RECs are paid just enough to "break even" and recover their costs

Case A: Preview

- Case A considers how the resources would clear for certificates under current market rules
  - No CEC demand
  - Only “Renewable” resources will clear for certificates
- Case A provides a baseline for Cases B through F
- Each case’s table provides certificate awards, certificate prices, and the per MWh payment to each resource

Case A: Current Market Rules, No CEC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand	8,000 MWh			
[2]	CEC Demand	-			
[3]	REC Award	0 MWh	0 MWh	5,000 MWh	3,000 MWh
[4]	CEC Award	-	-	-	-
[5]	REC Price	$25/MWh			
[6]	CEC Price	-			
[7]	Resource Revenue/MWh	$0/MWh	$0/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments	$200,000			
[9]	Total CEC Payments	-			
[10]	Total Payments	$200,000			

Case A: Fewer "Clean" Resources Clear Under Current Market Rules

- Renewable 1 clears for its entire capability so Renewable 2 is marginal as it provides 3,000 MWh of renewable energy
- Because Renewable 2 is marginal for RECs, it sets the REC price at $25/MWh
- **Key Takeaway**: Without CEC demand, no clean resource receives an award and there is no compensation for clean energy; neither clean resource is built and the region doesn't receive any clean energy beyond what is provided by the two renewable resources

Case B: Preview

- Case B introduces CECs under Approach 1
  - Resources can sell CECs and RECs with the same MWh of energy
- REC demand remains constant at 8,000 MWh but CEC demand is introduced at 9,000 MWh
- A key point of interest is the renewable resources' per MWh payments when they receive both CECs and RECs

Case B: Approach 1, CEC Demand>REC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand	8,000 MWh			
[2]	CEC Demand	9,000 MWh			
[3]	REC Award	0 MWh	0 MWh	5,000 MWh	3,000 MWh
[4]	CEC Award	1,000 MWh	0 MWh	5,000 MWh	3,000 MWh
[5]	REC Price	$15/MWh			
[6]	CEC Price	$10/MWh			
[7]	Resource Revenue/MWh	$10/MWh	$0/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments	$120,000			
[9]	Total CEC Payments	$90,000			
[10]	Total Payments	$210,000			

Case B: With Approach 1, No "Double Payment" to Renewables

- Renewables 1 and 2 receive the same REC award
- Under Approach 1, they are also awarded 5,000 MWh of CECs and 3,000 MWh of CECs, respectively
- Clean 1 clears for 1,000 MWh to meet the remainder of the CEC demand. Clean 1 is marginal for CECs and so sets the CEC price at $10/MWh
- Renewable 2 remains marginal for RECs, but because Renewable 2 receives $10/MWh for each CEC it's awarded, it only needs to be paid $15/MWh for RECs to break even. Renewable 2 thus sets the REC price at $15/MWh
- **Key Takeaway:** Resource Revenue/MWh for the two renewable resources is unchanged from Case A: the introduction of CECs under Approach 1 doesn't result in "double payment" to the renewable resources

Case C: Preview

- Case C continues with Approach 1 but increases CEC demand by 10,000 MWh to 19,000 MWh
- Case C sets up a comparison between Approaches 1 and 3 in Case D
- Case C shows that a sufficiently large CEC demand can render the REC demand non-binding

Case C: Approach 1, CEC Demand>>>REC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand	8,000 MWh			
[2]	CEC Demand	19,000 MWh			
[3]	REC Award	0 MWh	0 MWh	5,000 MWh	4,000 MWh
[4]	CEC Award	5,000 MWh	5,000 MWh	5,000 MWh	4,000 MWh
[5]	REC Price	$0/MWh			
[6]	CEC Price	$25/MWh			
[7]	Resource Revenue/MWh	$25/MWh	$25/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments	$0			
[9]	Total CEC Payments	$475,000			
[10]	Total Payments	$475,000			

Case C: With Sufficiently Large CEC Demand, REC Price May be $0/MWh

- Clean 1, Clean 2, and Renewable 1 all clear for their maximum capabilities, so Renewable 2 is marginal for both RECs and CECs.
- The REC demand is no longer binding: the 9,000 MWhs of RECs awarded is greater than the 8,000 MWh of demand; the REC clearing price is $0
- **Key Takeaway**: CEC demand is still binding and Renewable 2 sets the CEC price at $25/MWh
  - This price is necessary for Renewable 2 to break even and recover their costs because, in this case, they receive no CEC revenue
- Per MWh compensation to the renewable resources is unchanged at $25/MWh; no “double payment” occurs

Case D: Approach 3, No REC Demand

- If the REC demand would be non-binding under Approach 1 as in Case C, eliminating the REC demand has no effect on CEC pricing, resource payment per MWh, or total payments to resources
- **Key Takeaway:** When CEC demand is sufficiently large compared to REC demand, Approaches 1 and 3 yield equivalent results
- For more details on Case D, see the "FCEM and Existing State Programs" memo or the Appendix slides on Case D

Case E: Preview

- Case E considers Approach 2 where renewable resources can be awarded CECs or RECs, but not both
- To ease comparison, REC and CEC demand are set to their Case B values
  - CEC demand = 9,000 MWh
  - REC demand = 8,000 MWh
- Because renewable resources cannot be awarded CECs when they earn RECs, they can produce clean energy without contributing towards clean energy demand

Case E: Approach 2, CEC Demand>REC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand	8,000 MWh			
[2]	CEC Demand	9,000 MWh			
[3]	REC Award	0 MWh	0 MWh	5,000 MWh	3,000 MWh
[4]	CEC Award	5,000 MWh	4,000 MWh	0 MWh	0 MWh
[5]	REC Price	$25/MWh			
[6]	CEC Price	$15/MWh			
[7]	Resource Revenue/MWh	$15/MWh	$15/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments	$200,000			
[9]	Total CEC Payments	$135,000			
[10]	Total Payments	$335,000			

Case E: Approach 2 Can Over-procure Clean Energy Relative to Demand

- With Approach 2, renewable resources can be compensated for either CECs or RECs, but not both
- Resource 2 is marginal for RECs and sets the REC price at $25/MWh
- Clean 2 is marginal for CECs and sets their price at $15/MWh
- **Key Takeaway**: Despite the fact that CEC demand is only 9,000 MWh, the resources sell 17,000 MWh of energy that could yield CECs
  - The remaining 8,000 MWh is used to satisfy REC demand
  - Total payment to resources in Case E ($335,000) is higher than in Case B ($210,000) despite the fact that the two approaches purchase the same quantity of certificates

Case F: Approach 2, CEC Demand is Adjusted to Account for Clean Energy Provided by REC Demand

- Case E over-procures clean energy relative to CEC demand because CEC demand isn't adjusted to account for the clean energy provided by renewable resources that aren't awarded CECs under Approach 2
- **Key Takeaway**: Approaches 1 and 2 can yield equivalent results when CEC demand is adjusted to account for the clean energy provided by resources that are awarded RECs
- For more details on Case F, see the "FCEM and Existing State Programs" memo or the Appendix slides on Case F

Key Observations from the Six Cases

1. The cases suggest that a “double payment” problem is unlikely to occur under Approach 1
2. Approaches 1 and 3 yield equivalent outcomes when CEC demand is sufficiently large compared to REC demand
3. Approach 2 can lead to additional payments compared to Approach 1, but the two approaches can yield equivalent results when CEC demand is reduced to account for the existing REC programs

Conclusion

- Given the three observations above, the ISO proposes for stakeholder consideration that AGI assume Approach 1 for modelling purposes
- Approach 1 appears relatively simple to model, avoids the "double payment" concern identified by stakeholders, and allows for the continuation of the existing state programs
- The ISO has not finalized its thinking on this issue and welcomes stakeholder feedback on the approach proposed, particularly as it may relate to stakeholders' goals for the FCEM framework

ROLE OF STORAGE IN FCEM AND NET CARBON PRICING FRAMEWORKS

Treatment of storage requires careful consideration

- Storage is unlike other energy supply, and this introduces challenges in assessing its treatment under both frameworks
- Rather than producing electricity from a primary energy source (e.g., fossil fuel, nuclear, wind, PV), storage supplies electricity during on-peak hours by storing energy from electricity produced by other generating resources during off-peak hours
- Storage resources can contribute to the region's decarbonization by transferring energy production from higher emitting resources during on-peak hours to lower- and non-emitting resources during off-peak hours

Storage requires careful consideration under both frameworks

- ISO believes that it is important for storage to be compensated for its contributions to meeting the region's environmental objectives
- Stakeholders offered a number of observations about storage's role in the future grid at the March meeting
  - Included discussion of whether it is appropriate for storage to receive clean energy certificates for its energy supply under an FCEM
- In response to these observations, ISO indicated that it would assess how storage can be compensated for these contributions

Storage memo: key observations

- Memo uses a series of numerical examples to examine storage's treatment under both an FCEM and net carbon pricing framework
- Examples show that storage will be compensated for its marginal contributions to clean energy production under an FCEM framework even when it is not awarded clean energy certificates for its energy supply
  - Notably, awarding storage clean energy certificates would lead it to be compensated at a rate that exceeds its contributions
- Storage also will be compensated for its marginal contributions to reducing carbon emissions under a net carbon pricing framework when, as a supplier, it is not charged for carbon emissions

Clean resources will reduce energy offer prices under an FCEM

- Storage can contribute to clean energy production by transferring energy generation from resources that are not clean to those that are clean
- Under an FCEM, clean resources will reduce their energy market offer price to reflect the value of receiving clean energy certificates
  - Similar to how renewable resources may reduce their energy offer price to account for the value of RECs under current market rules
- Resources that do not produce clean energy will not reduce their energy market offer

FCEM increases energy market revenues for storage resources that increase clean energy production

- Storage can increase clean energy production by charging when the marginal supplier is clean (increasing supply from clean generators), and discharging when the marginal supplier is not clean (reducing supply from non-clean generators)
- In such cases, the FCEM will reduce the energy price when the storage resource is charging, but not when it is discharging
- This results in increased energy market revenues for the storage resource because it is now charged a lower price to consume electricity than under current market rules, but it is credited the same price when supplying electricity

Example b1 illustrates a case where storage increases clean energy production

- In this example, a storage resource's participation leads to increased energy generation by a clean baseload resource during an off-peak hour, and reduces energy generation by a non-clean peaker resource during an on-peak hour
- This results in increased total clean energy production across the off-peak and on-peak hours because the storage resource's participation effectively transfers generation from the non-clean peaker to the clean baseload resource
- It is therefore appropriate that the storage resource is compensated for this contribution

The FCEM compensates the storage resource for these clean energy contributions via increased energy market revenues

- This compensation takes the form of an increased price spread between the on-peak hour when the storage resource sells electricity, and the off-peak hour when it buys electricity
  - The energy price decreases in the hour when it is charging (that is, buying energy) by the full value of these clean energy certificates
  - The energy price does not change in the hour when it is discharging (that is, selling energy)
- The increased energy market revenue reflects the marginal value of its contributions to clean energy production
  - The storage resource's revenues increase by $10 per MWh of energy charged, the value of a clean energy certificate, because the energy price when it is charging decreases by this amount

Compensation should align with, but not exceed, a resource's contributions to clean energy

- If the storage resource also received clean energy certificates, this would result in it being compensated twice for its clean energy contributions
- **First**, it would receive increased energy market revenues (as explained on the previous slide)
- **Second**, it would now also receive revenues from clean energy certificates
- Such compensation would therefore exceed its contributions to clean energy production

Certificates should be awarded to suppliers that produce clean energy

- As illustrated in example b2, awarding clean energy certificates to storage resources (in addition to their energy revenue increases) may allow them to receive certificates when they do not increase clean energy production
- Awarding certificates could then cause storage resources to charge and discharge (cycle) when not improving system efficiency or environmental outcomes
- Awarding certificates for such cycling will also reduce the quantity of clean energy certificates that are available to other types of generation, and may adversely impact the region's ability to increase its clean energy production

Storage under net carbon pricing framework

- Memo considers the same examples under a net carbon pricing framework
- Examples illustrate that, when storage resources are not charged for carbon emissions, they are appropriately compensated for their marginal contributions to reducing carbon emissions
- The logic is similar to that for clean energy production under the FCEM framework

Storage under net carbon pricing framework

- The energy price will account for the carbon emissions of the marginal supplier, where the price adder will be larger during periods when the marginal emissions rate is greater
- Thus, if the storage resource transfers energy generation from periods where the marginal supplier emits carbon at a higher rate to those where it emits carbon a lower rate, a net carbon price will increase the energy market price spread
- This increase in the price spread will reflect the storage resource's marginal contribution to reducing carbon emissions
- Illustrated in examples c1 and c2 of the memo

Net carbon pricing compensates storage for environmental contributions under a broader set of conditions

- Under a net carbon pricing framework, storage will generally see increased revenues when its participation reduces carbon emissions
- This includes instances when this reduction in carbon emissions does not result in greater clean energy production
- For example, examples b2 and c2 of the memo shows how a net carbon price will increase storage's revenue when transferring energy production from a higher- to lower-emitting resource, whereas an FCEM framework will not

Storage memo: key takeaways

- Storage is compensated for its marginal contributions to clean energy production under an FCEM framework via increased energy market revenues
- Awarding storage clean energy certificates would lead it to be compensated at a rate that exceeds its contributions, inconsistent with sound market design
- Under a net carbon pricing framework, storage is compensated for its marginal contributions to reducing carbon emissions when it is not charged for carbon emissions

CONTINUED ASSESSMENT OF OTHER FRAMEWORK DETAILS

ISO response to stakeholder comments

- ISO appreciates the thoughtful comments regarding FCEM elements, and broader modeling considerations, including those regarding negative prices and potential changes to the forward capacity market
  - ISO continues to assess several of the comments regarding broader modeling considerations as we move into that part of the study discussion
- Today we have some preliminary observations regarding a request that the FCEM framework should provide clean energy certificates be awarded to low-emitting resources

ISO does not propose to a model clean energy certificates being awarded to emitting resources

- As noted in the FCEM scoping memo, the ISO generally seeks to align design elements with three criteria:
  1. Consistent with stakeholder preferences
  2. Sound market design principles
  3. Simple to model
- Numerous stakeholders have signaled support for a more limited eligibility criteria
- This clean energy definition may be more complex, especially if it also includes the introduction of partial certificates
- Net carbon pricing may offer information about how such an approach would affect market outcomes
- Welcome stakeholder feedback on this broader eligibility criteria

ISO continues to evaluate a conceptual ICCM approach for modeling purposes

- At the March meeting, the ISO provided a memo offering some initial thoughts on a conceptual ICCM approach that could be considered in the modeling efforts
- Stakeholders have expressed interest in understanding an ICCM construct further, including:
  - Clearing and pricing outcomes, and how they may differ between sequential and integrated clearing
  - How the modeling efforts can accommodate integrated and/or sequential clearing of these products
- Continue to welcome stakeholder feedback on this topic
- ISO plans to assess these questions further, and return to stakeholders with more information at future meetings

ISO looks forward to working with stakeholders to evaluate Pathways to the Future Grid

- With the help of stakeholders and the Analysis Group, ISO will evaluate market outcomes under the forward clean energy market and net carbon pricing frameworks
- Welcome stakeholder feedback on these efforts, including the two frameworks to be studied
- Look forward to discussing the modeling approach at future stakeholder meetings
- Share final report on modeled market outcomes with stakeholders in the first quarter of 2022

APPENDIX: INTERACTION WITH EXISTING STATE PROGRAMS, CASES D AND F

Appendix: Case D, Approach 3, No REC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand		-		
[2]	CEC Demand		19,000 MWh		
[3]	REC Award	-	-	-	-
[4]	CEC Award	5,000 MWh	5,000 MWh	5,000 MWh	4,000 MWh
[5]	REC Price		-		
[6]	CEC Price		$25/MWh		
[7]	Resource Revenue/MWh	$25/MWh	$25/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments		-		
[9]	Total CEC Payments		$475,000		
[10]	Total Payments		$475,000		

- CEC demand at 19,000 MWh, REC demand set to 0 MWh

Appendix: Approaches 1 and 3 Will Yield the Same Results When REC Demand is Not Binding

- Renewable 2 is still marginal for CECs as the other resources clear for their entire capabilities
- Renewable 2 sets the CEC price at $25/MWh
- **Key Takeaway**: Approaches 1 and 3 will yield the same results when REC demand is not binding, as occurred with Case 3
  - If REC demand is binding, Approach 1 will yield different outcomes than Approach 3
  - Without REC demand, fewer renewable resources and more clean (but not renewable) energy resources would likely clear

Appendix: Case F, Approach 2, CEC Demand<REC Demand

		Clean 1	Clean 2	Ren. 1	Ren. 2
[1]	REC Demand	8,000 MWh			
[2]	CEC Demand	1,000 MWh			
[3]	REC Award	0 MWh	0 MWh	5,000 MWh	3,000 MWh
[4]	CEC Award	1,000 MWh	0 MWh	0 MWh	0 MWh
[5]	REC Price	$25/MWh			
[6]	CEC Price	$10/MWh			
[7]	Resource Revenue/MWh	$10/MWh	$0/MWh	$25/MWh	$25/MWh
[8]	Total REC Payments	$200,000			
[9]	Total CEC Payments	$10,000			
[10]	Total Payments	$210,000			

- To avoid over-procuring CECs relative to demand, CEC demand is reduced to account for REC demand

Appendix: Approaches 1 and 2 Can Yield the Same Results When CEC Demand is Adjusted to Account for REC Demand

- Renewable 2 is marginal for RECs and sets the REC price at $25/MWh
- Clean 1 is marginal for CECs and sets the CEC price at $10/MWh
- Per MWh payments to the resources (Row [7]) and total payments (Row [10]) are identical across Cases B and F
- **Key Takeaway**: It is possible to achieve the same outcomes with Approaches 1 and 2 by adjusting CEC demand to account for REC demand