UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

	)	
Hybrid Resources	)	**Docket No. AD20-9-000**
	)	

Post-Technical Conference Comments of ISO New England Inc.

Pursuant to the notice issued on August 10, 2020 in the above-captioned proceeding, ISO New England Inc. ("ISO" or "ISO-NE") respectfully submits the following post-technical conference comments. ISO-NE appreciates this opportunity to provide the Federal Energy Regulatory Commission ("Commission") with these comments regarding technical and market issues prompted by growing interest in hybrid resources. ISO-NE responds to the individual questions raised by the Commission in turn below.

I. COMMENTS

1. While this conference uses the term "hybrid resources" to refer to resources consisting of a generation resource and an electric storage resource paired together, we recognize that these resources can be configured differently, from the generation resource and energy storage resource being located at the same facility but operating separately ("co- located") to the generating facility and energy storage facility operating as one "hybrid" resource. How are these two terms used in the industry? What configurations are most common, and are there new configurations emerging?

ISO-NE interprets "co-located facilities" to mean any combination of generation and energy storage connected behind a common interconnection point. For the purposes of these comments, ISO-NE addresses the combination of *intermittent* generation (e.g., solar or wind generation) and energy storage connected behind a common interconnection point as "co-located" facilities. Co-located facilities may participate in the ISO-NE Forward Capacity Market either as separate resources or as a single resource and in the ISO-NE Energy Market either as separate assets or as a single asset.

ISO-NE interprets the prefix "hybrid" to mean the subset of co-located facilities that participate as a single capacity resource or a single Energy Market asset. Hybrid capacity resources can participate in the ISO-NE Energy Markets as a single combined asset[1] representing the entire facility. Currently, in New England, the majority of co-located facilities being constructed consist of solar photovoltaic ("PV") systems combined with lithium ion battery energy storage devices with a maximum facility output of less than 5 megawatts ("MW").

In April 2020, ISO-NE provided a training presentation[2] detailing current market participation options for co-located facilities. That presentation outlined the options for co-located facility participation discussed above. A dominant configuration has not yet emerged in New England. However, for several reasons addressed in these comments, participation as a hybrid Continuous Storage Facility ("CSF") is preferable at this time.

2. What are some of the indicators of increasing interest by developers in hybrid resources? Where and in what circumstances does interest in hybrid resources appear to be greater? Approximately what percentage of Interconnection Requests for resources in interconnection queues are composed of hybrid resources? Has there been an increase in requests by hybrid resource developers to participate in energy, capacity and ancillary services markets operated by RTOs/ISOs?

Over 75 co-located facilities either qualified in 2019 or are expected to be qualified in 2020 for Forward Capacity Market participation. These comprise over 220 MW of summer capacity and over 144 MW of winter capacity. Thirty-two of these proposed co-located facilities requested qualification as a single hybrid resource. As of the date of this filing, the majority of co-located

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[1] A single combined asset representing a hybrid Resource may be either a Continuous Storage Facility, a Settlement Only Generator (if the facility maximum output is under 5 MW and connected below 115 kV), or an Intermittent Generator (if the facility is primarily intermittent.)

[2] *See* ISO New England, *Market Participation Options for Combined Intermittent/Electric Storage Facilities* (April 2020), *available at* https://www.iso-ne.com/static-assets/documents/2020/04/20200408-co-located-market-participation.pdf (and attached to these comments as Attachment A).

facilities requesting interconnection are located on the distribution system and have requested interconnection via the state jurisdictional process. There are currently 57 MW of co-located storage resources in the ISO-NE interconnection queue.

4. We understand that increasing numbers of hybrid resources are participating as a single resource in energy, capacity and ancillary services markets operated by RTOs/ISOs. What are the advantages to the hybrid resource participating as a single resource? What are the disadvantages?

There are several advantages to participating in ISO-NE markets as a single, dispatchable resource. First, the energy storage device can be operated to offset rapid changes in the intermittent output, allowing the entire facility to more closely follow a Desired Dispatch Point. Second, the reserves issue detailed in the response to Question 12 below is avoided, because the offered maximum output for the combined asset allows for accurate reserve designations in all operating modes. Third, ISO-NE's metering and telemetry requirements need only a single metering location, and DC metering and telemetry is not required for DC-coupled facilities.

Several challenges accompany participation as a single, dispatchable resource in the ISO-NE markets. Of particular note, participants must carefully manage their offers and limits at a co-located facility, to account for issues such as: the existence of any shared facility constraints (both physical and/or contractual); any special operational requirements, such as charging the battery only from the intermittent component; the variability of the intermittent component; and periods when the intermittent output does not match what was forecasted.[3] Offer and limit management is critical to avoiding any potential for an infeasible dispatch instruction.

[3] *See* Attachment A, Slide 29.

5. What factors are driving developers' decisions in how to configure hybrid resources? For example, what factors do developers consider when deciding to either charge the storage component of the hybrid resource solely from a co-located generation resource or to charge from the grid? In addition, alternating current coupling and direct current coupling are two technical options for interconnection of hybrid or co-located resources. What factors influence developers to choose one form of coupling over another?

While ISO-NE is not aware of all of the economic drivers, it is aware that state incentive programs for energy storage in New England appear to influence wholesale market participation choices. For example, certain states encouraging the creation of co-located facilities may promulgate policies to encourage that generation and storage components be owned by different entities (e.g., the PV generator is owned by a separate, competitive third party and the storage device is owned by the local distribution company).[4] In such cases, separate wholesale market participation models may be sought despite other options potentially producing more value.

6. How can an Interconnection Customer in your region propose to interconnect a resource composed of two or more resource types, operated as a single resource at a single point of interconnection? What are the advantages and disadvantages of pairing resource types into a single Interconnection Request?

An Interconnection Customer can propose a combined resource as part of the existing ISO-NE interconnection process. ISO-NE does not impose any limitation on the number and types of devices that may connect to the same Point of Interconnection ("POI") as part of a single Interconnection Request. One advantage of a single Interconnection Request is that the paired resource types only need to complete one interconnection process.

[4] *See, e.g.,* Connecticut General Statutes § 16-244e(a) ("An electric distribution company shall not own or operate generation assets, except as provided in this section and sections 16-43d, 16-243m, 16-243u, 16a-3b and 16a-3c, provided nothing in this section or in section 16-244w shall be interpreted to prohibit or limit the ability of an electric distribution company from building, owning or operating an energy storage system").

7. What are the benefits and challenges of adding an energy storage resource to an existing generation resource? What are the benefits and challenges of adding an energy storage resource to an existing Interconnection Request that is already in an interconnection queue? What additional studies would be required to do this, and would the process be the same or different depending on whether the addition is to an existing generation resource or to an existing Interconnection Request? Also, with respect to the addition of an energy storage resource to an existing generation resource, would the new storage resource be subject to the full interconnection study process, and, if so, would any aspect of the request or study process differ from a traditional Interconnection Request for a new generating facility? Under what circumstances would the addition of an energy storage resource to an existing Interconnection Request be considered a Material Modification that would require the Interconnection Customer to go through the interconnection process again or obtain a new queue position? Please describe how this request would be processed.

An Interconnection Request is required to add an energy storage device to an existing generating facility or to an existing Interconnection Request that is already in the interconnection queue. The extent of additional studies required for these Material Modifications is dependent on the configuration of the energy storage resource and generation resource, as well as proposed operating modes.

Generally, additional studies are required for Material Modifications. Examples of Material Modifications that would require additional study include: an increase in overall output; a change in the performance of existing equipment (such as a re-tuning of inverters); and any proposal that includes charging from the grid. The required study for such a storage addition would only analyze the incremental changes introduced as compared with the original design, and as a result would likely proceed more quickly than required studies for a new generation resource Interconnection Request.

ISO-NE has identified one possible scenario where an Interconnection Request would be required to add a storage device, but additional studies may not be necessary. This case involves an existing or queued generator, such as a solar project, that is connected or proposed to be connected through an inverter and seeks to add an energy storage resource. No additional study would be required if: 1) the energy storage resource is proposed on the DC-side of the inverter, 2) no change results in the performance of the inverter and 3) the energy storage resource would only charge from the on-site intermittent generator as opposed to the grid. In this case, the parties would likely proceed directly to discussions regarding the Interconnection Agreement.

8. How is the maximum output of a hybrid resource calculated currently? How is the Interconnection Service request sized? For example, is it sized to the combined maximum output of each of the hybrid components, limited to a level of output that corresponds to how the resource is expected to operate, or some other amount?

The Interconnection Customer provides the hybrid resource's maximum output in its Interconnection Request as part of the existing ISO-NE process. Any Interconnection Customer can request an Interconnection Service level that is less than the maximum output of the hybrid facility by proposing the inclusion of a limiting device. Hybrid facilities are treated the same in this regard as are all other Interconnection Requests that propose a facility comprising multiple devices.

9. If a hybrid resource opts not to be studied to charge from the grid, is the resource allowed to later change its decision? If so, is this change or possibility reflected in an Interconnection Agreement? If so, how? If a hybrid resource seeks to make this type of change, is there a requirement that the resource undergo an additional study or studies?

See the Response to Question 7. Such a change would be material and would require a new Interconnection Request for additional study, as well as an updated Interconnection Agreement to reflect the change.

10. Are hybrid resources able to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs using existing frameworks or market rules? If so, how do they participate? Are market rule changes needed to enable the participation of hybrid resources? Are RTOs/ISOs exploring market rule changes, and if so, what changes are they pursuing?

Hybrid resources can participate in ISO-NE Energy Market, Forward Capacity Market, reserve market, and Regulation Market under current market rules. The ability to provide all these services without limitation is described in Configuration 3A.[5]

11. Hybrid resources consisting of more than one technology type could potentially participate in the market as the separate component parts, or as a single integrated hybrid resource. Should hybrid resources have a choice of whether to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs as each of the resource types or as a single resource type? If so, why is this flexibility important?

ISO-NE understands flexible market participation options are important because the range of possible configurations is broad. At this time, ISO-NE does not have sufficient experience to determine the type of configuration that works best for any specific mix of generation and energy storage resources. In some cases, individual state policies may favor one participation model over another, and these policies may not be uniform throughout New England and may change over time.

As discussed above, a hybrid model provides several advantages both to ISO-NE and resource owners.[6] ISO-NE, however, has a concern in the event a hybrid facility qualifies in the capacity market as an Intermittent Power Resource (rather than as a Generating Capacity Resource, which is subject to Desired Dispatch Point dispatch in the Energy Market). Under existing market rules, such qualification is permitted but only in cases where the energy storage device is small relative to the intermittent generator component. This qualification is necessary because, in the case of a relatively large energy storage device, ISO-NE believes that either the facility as a whole, or at least the energy storage device, should be subject to Desired Dispatch Point dispatch. Under existing market rules, a number of types of Intermittent Power Resources are not required to follow Desired Dispatch Points, and instead, wind and the majority of hydropower resources must meet Do Not Exceed Dispatch requirements, and PV resources are not currently required to be

[5] *See* Attachment A, Slide 15.

[6] *See* Response to Question 4.

dispatchable. Because ISO-NE current market rules do not require all facilities with dispatch capability to be subject to ISO-NE Desired Dispatch Point dispatch, this could create an inefficient and unreliable electric system should these facilities proliferate and continue to participate in the market as largely (or entirely) non-dispatchable Intermittent Power Resources.

Hybrid resources are new to New England, and their participation is evolving. A dominant participation model may emerge and it is possible that existing participation models may need to be refined. ISO-NE must weigh the costs and benefits of all participation models as additional hybrid resources come online.[7]

12. Does operating a hybrid resource as separate components (i.e., co-located) rather than as a single integrated resource create challenges for RTOs/ISOs in accurately modeling whether hybrid resources will provide operating reserves? If so, is this problem addressed if the resource operates as a single integrated hybrid resource?

At least two challenges to accurate reserve designations can arise if a co-located facility participates as two separate resources in the ISO-NE markets. Both relate to the fact that in a co-located facility, the operation of one asset can impact the capability of the other. The first challenge relates to the potential for intermittent resources to experience significant and unforeseeable changes in output in between the times when the ISO-NE dispatch software runs. During normal operations, ISO-NE System Operators attempt to issue new Desired Dispatch Points to Dispatchable Resources approximately once every ten minutes. Reserve capability for the energy storage device may be impacted by rapid and unforeseeable changes in the co-located intermittent output that occur between dispatch runs. For example, consider a facility that consists of a 5 MW PV system and a 5 MW CSF that share an 8 MW interconnection. Assume the PV is

[7] *See* Response to Question 1. For example, it is not clear that the cost and complexity of solving the reserves issue for separate resources is warranted given that another participation option is available that resolves the issue.

currently generating 3 MW and the CSF has a Desired Dispatch Point of 4 MW (i.e., it is dispatched to discharge 4 MW). Based on its offered capabilities the CSF would be designated for up to 1 MW of real-time reserves. If the PV system suddenly increased its output to 4 MW, the actual reserves available from the battery would be 0 MW due to the 8 MW interconnection limit. This over-designation of reserves could not be corrected until the next control room dispatch run.

Further, if the PV system suddenly increased its output to 5 MW, the combined output (4 MW battery in addition to 5 MW PV) would violate the 8 MW interconnection limit. To avoid violating the limit,[8] the logical solution is for the battery to reduce output by 1 MW and simply discharge 3 MW – but these changes could occur suddenly and before the next dispatch run. ISO-NE expects that there will be a large number of these facilities, and this discharge reduction could aggregate to a significant number of MW across the electric system. Given that solar output can change more frequently than the ISO executes and approves a dispatch run and issues the Desired Dispatch Points, it is not possible to accurately coordinate dispatch and account for reserves for the entire electric system while recognizing each co-located facility's interconnection limits. Market Participants must manage the operation of their facilities to achieve feasible outcomes in recognition of interconnection constraints, but in so doing they will not be following ISO-NE dispatch, which is designed to achieve an economic and reliable dispatch solution for the entire electric system.

In contrast, if the entire facility is managed as a single CSF, the ISO-NE dispatch system

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[8] Interconnection limit violations must be avoided to prevent physical damage to the facility, to the distribution or transmission facilities to which the co-located facility is connected, to other facilities located on the same distribution or transmission facilities as the co-located facility, or to prevent safety problems.

will not issue a Desired Dispatch Point or designate reserves above the difference between current and maximum facility output. If the PV output suddenly changed, the participant would simply change the battery (dis)charge MW in the opposite direction (to the extent physically possible) in order to maintain a facility output that matched the ISO Desired Dispatch Point.

The second challenge relates to reserve designations for the charging load of the energy storage device for some facilities. Most co-located facilities in New England have a common constraint that limits facility power output to a lower value than the peak output of the intermittent generator component. This shared constraint typically arises from an output limit in the Interconnection Agreement or the rating of shared inverters in a DC-coupled facility. This is a common configuration that may appeal to a developer for a smaller interconnection, given potential cost savings and the ability to share inverters (for DC-coupled facilities). If the two components of a co-located facility with a shared constraint participate in wholesale markets separately, it is not possible to designate reserves on the charging load of the energy storage device accurately because the ability for the grid to see a benefit from stopping charging is dependent on the operation of the separate intermittent generator component of the facility.[9] On the other hand, when an entire hybrid resource participates as a CSF, the CSF will offer no more than its shared constraint as its maximum output, and as a result it will not be designated for more reserves than it can provide.

13. What is the current ability of RTOs/ISOs to model hybrid resources? Is there a preferred approach?

As was detailed above in response to Question 1, ISO-NE can accommodate the

[9] *See* Attachment A, Slides 24 and 25.

participation of both combined and separate resources in either the Forward Capacity Market or co-optimized energy and reserves market. It remains a participant decision as to which participation model to choose.[10] Separate resources create several unique problems, including the reserves issue detailed in Question 12, and additional metering complexity for DC-coupled facilities. As a result, ISO-NE currently prefers the participation model where the entire facility participates as a Continuous Storage Facility.

14. Hybrid resources with certain characteristics may be able to provide essential reliability services. For example, when configured with advanced controls, these resources may be able to provide fast frequency response and dynamic voltage regulation. What considerations (e.g., models, tools, training) are needed to improve planning and operations models and utility practices to account for the various controlled operating modes of hybrid and co-located resources?

As the power system transitions from large centralized resources to smaller distributed resources, including hybrid and co-located resources, there will be an increasing need and benefit for these resources to provide essential reliability services. There can be technical challenges when connecting resources to distribution systems in order for them to provide these services, such as loss of main protection or islanding protection. Available models typically have the capability to represent fast frequency response and dynamic voltage regulation. ISO-NE utilizes these models in both planning and operations environments.

15. In some cases, RTOs/ISOs require variable energy resources to provide data and forecasts of resource production based on weather and other factors. Would the same requirements apply to hybrid resources with a variable energy resource component, or how may these requirements differ?

ISO-NE will likely advocate that all hybrid facilities provide PV output forecast and other metadata, as is required for PV-only facilities, regardless of the market participation model the

[10] *See, generally,* Attachment A.

participant chooses. In addition, ISO-NE may require PV production data for these facilities to support System Planning needs.

16. Are existing dispatch systems in the RTOs/ISOs capable of dispatching hybrid resources as a single resource? What are the challenges and/or limitations of such dispatch?

ISO-NE dispatch systems are capable of dispatching hybrid resources as a single Continuous Storage Facility. However, offer management by the participant may be challenging, given the inherent difficulty in forecasting the resource's intermittent output in advance. This difficulty, however, may be mitigated if the participant uses the energy storage device to offset unanticipated changes in intermittent output.

17. What are the technical considerations regarding state of charge of the electric storage component of hybrid resources? Are there different factors pertaining to state of charge that are dependent on whether the resource is co-located or operates as a single integrated hybrid resource?

State of Charge in the Day-Ahead Energy Market.

To comply with Order No. 841, ISO-NE expects to propose "initial state of charge," "minimum state of charge" and "maximum state of charge" parameters for electric storage resources in the Day-Ahead Energy Market. Separately, the ISO is also evaluating an approach to model the forecasted intermittent output of a single hybrid asset in the Day-Ahead Energy Market; one possibility is an hourly inflow MWh parameter that could be added to the initial state of charge, minimum state of charge and maximum state of charge parameters.

State of Charge in the Real-Time Energy Market.

Currently, in the Real-Time Energy Market, ISO-NE utilizes available energy ("AE") and available storage ("AS"), instead of state of charge ("SOC"). Conceptually, these are comparable to modeling SOC because AE is equivalent to current SOC minus minimum SOC; and AS is equivalent to maximum SOC minus current SOC. However, they are different in that AE and AS have a time dimension. Energy storage devices provide six telemetered values to ISO-NE every four seconds: 15 minute AE, 1 hour AE, Total AE, 15 minute AS, 1 hour AS and Total AS. The original reason for this approach was to support aggregation of storage devices while simultaneously providing a better understanding of the aggregated state of charge. For example, consider two 1 MW / 2 MWh storage devices that are aggregated into a single 2 MW / 4 MWh asset. If the aggregated asset simply provided a current SOC of 2 MWh, ISO-NE would not be able to understand the asset's ability to respond, because the ISO would not know if the SOC was all on one storage device or if, alternatively, it was distributed between the two storage devices.

In addition, there are constraints on the asset's maximum charge or discharge dispatch. The asset's maximum charge or discharge dispatch is constrained by the 15 minute AS or 15 minute AE, respectively. This is because the real-time dispatch software is set with a 15 minute look-ahead value, and ISO-NE needs to ensure the asset can sustain its dispatch for the entire solution timespan. The asset's maximum discharge dispatch may be further constrained by the 1 hour AE to ensure one-hour sustainability for the provision of reserves, if they are provided. The Total AE and Total AS are used for multi-hour look ahead analyses.

Future Considerations for Modeling Hybrid Resources.

As ISO-NE has started to explore modeling electric storage hybrid devices, the AE/AS methodology may be easily adaptable for these devices as either separate co-located assets or a single hybrid asset. Any proposed detailed telemetry requirements for a variety of hybrid facility configurations and related revisions to the ISO's operating procedures[11] would be proposed and

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[11] ISO New England Operating Procedure No. 14, Technical Requirements for Generators, Demand Response Resources, Asset Related Demands and Alternative Technology Regulation Resources (May 8, 2020), *available at* https://www.iso-ne.com/static-assets/documents/rules_proceds/operating/isone/op14/op14_rto_final.pdf.

evaluated with stakeholders through the NEPOOL stakeholder process. It is important to note that ISO-NE allows participants to use a single storage device model, and so the participant adjusts the AE and AS telemetry to account for the anticipated intermittent device output. As a result, ISO-NE is able to support modeling the facility either as separate co-located assets or a single hybrid asset. Including time duration with total AE and AS (such as changing total AE/AS to 4 hour AE/AS) would account for intermittent resources more clearly and consistently.

If the facility is modeled as separate co-located assets, then the electric storage asset will determine the six AE/AS values that exist for the storage device, and then cap them based on the difference between interconnection limit at the POI and the current amount of power injection, after accounting for the forecasted intermittent output. For example, if an electric storage asset has a 15 minute/1 hour/4 hour AE of 2 MWh/8 MWh/8 MWh, but forecasted intermittent output only allows 1 MWh/4 MWh/16 MWh to be available without exceeding the interconnection limit, then the participant will cap the AE telemetry to 1 MWh/4 MWh/8 MWh. The ISO will constrain the maximum discharge dispatch of the electric storage device based on the capped telemetry of 1 MWh/4 MWh/8 MWh, which will result in ensuring that the intermittent forecast plus the electric storage device dispatch do not exceed the limit of service at the POI. In a similar way, AS can be capped by the participant if they are unable to charge from the grid. In this scenario, the participant would cap the AS so that it is not more than the forecasted intermittent output. The ISO will constrain the maximum charge dispatch of the electric storage device based on the capped AS telemetry, which will result in ensuring that the electric storage device charging dispatch is not more than the forecasted intermittent output.

If the facility is instead modeled as a single hybrid asset, then the participant will determine the six AE/AS values for the storage device, and then add the forecasted intermittent output capped at the interconnection limit. For example, if an electric storage asset has a 15 minute/1 hour/4 hour AE of 1 MWh/4 MWh/4 MWh, and forecasted intermittent output is 2 MWh/8 MWh/32 MWh, then the single hybrid asset AE is 3 MWh/12 MWh/36 MWh. If the interconnection is limited to 10 MW, then the participant will cap the AE telemetry to 2.5 MWh/10 MWh/36 MWh. The ISO will constrain the maximum discharge dispatch of the electric storage device based on the AE telemetry, which will ensure that the intermittent forecast plus the electric storage device storage are sufficient to meet the dispatch and do not exceed the interconnection limit.

An additional benefit of the time dimension of AE/AS is that it can account for forecasted changes to the intermittent output. For example, consider the AE telemetry of a single hybrid asset that includes intermittent PV when the sun is rising. The single hybrid asset 1 hour AE will include the forecasted PV increase, which may increase the reserve capability because the increasing PV will help support the one-hour sustainability of the hybrid asset. On the other hand, consider the same asset when the sun is setting. The single hybrid asset 1 hour AE will include the forecasted PV decrease, which may decrease the reserve capability because the decreasing PV will undermine the one-hour sustainability of the hybrid asset.

This approach relies on the participant's forecasted intermittent output. ISO-NE plans to monitor how this approach works as more electric storage hybrid devices participate in the Energy Markets. In the future, ISO-NE may require additional instantaneous telemetry readings such as the MW output of the storage and intermittent components in order to more accurately count reserves and/or constrain dispatch.

18. Do existing RTO/ISO market power mitigation rules appropriately recognize the particular operating characteristics of hybrid resources?

The ISO's market power assessment and mitigation rules are general and adequate to capture different technologies and configurations. The empirical challenge with addressing market power assessments of battery resources, including hybrids, lies in the ability to accurately capture market opportunities that reflect tradeoffs across time, across products, and across facilities in the case of hybrid facilities, while also recognizing a facility's the physical operating characteristics and state of charge. As with all new and complex technologies that emerge in the wholesale electricity markets, achieving greater accuracy in how these complex assets are modeled is an evolutionary process. Energy storage facilities' bidding behavior is monitored and assessed by market monitoring as they enter the markets and on an ongoing basis to determine if adjustments to the market power mitigation rules should be pursued.

19. Are there established best practices for metering a hybrid resource for participation in wholesale markets? For example, with one meter, or with multiple meters that provide visibility into individual subcomponents or inverters, or some other configuration?

ISO-NE believes the best practice is to meter hybrid facilities like other generation resources. Revenue quality energy metering at, or compensated to, the POI and any required telemetry representing the power flow at the POI should be required. In order to accommodate DC-coupled co-located facilities that choose to participate as separate assets, ISO-NE recently implemented changes to Operating Procedure 18,[12] Manual M-28,[13] and Manual M-RPA[14] that provide for the use of DC metering to allocate the meter data at the POI to each DC-metered asset. However, ISO-NE anticipates that these facilities may have a higher likelihood of data quality issues given the additional coordination and data hand-offs between Assigned Meter Readers and

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[12] ISO New England Operating Procedure No. 18, Metering and Telemetering Criteria (OP-18) (August 17, 2020), *available at* https://www.iso-ne.com/static-assets/documents/rules_proceds/operating/isone/op18/op18_rto_final.pdf.

[13] ISO New England Manual for Market Rule 1 Accounting, Manual M-28 (August 6, 2020), *available at* https://www.iso-ne.com/static-assets/documents/2020/08/manual_28_effective_rev62_2020_08_06.pdf.

[14] ISO New England Manual for Registration and Performance Auditing, Manual M-RPA (August 6, 2020), *available at* https://www.iso-ne.com/static-assets/documents/2020/08/manual_rpa_effective_rev_20_2020_08_06.pdf.

the Designated Entity that is involved in operating the facility, and the meter data adjustments that occur. The additional complexity and cost of metering DC-coupled facilities as separate resources is one reason a combined market participation model may be superior.

21. How do RTOs/ISOs currently calculate the capacity value of resources? Would those methods accommodate the characteristics of hybrid resources, or would new or modified methods be needed?

ISO-NE provides market participation options for co-located facilities, and will qualify a co-located facility's capacity at the same level regardless of the market participation model they choose.[15] ISO-NE does not believe changes are needed at this time, but improvements may be proposed as we gain more experience with these facilities.

23. If an Interconnection Customer proposes to add an additional resource to an already existing resource or an existing Interconnection Request, should the capacity value of the existing resource or the existing Interconnection Request be modified? Why or why not? What options exist for determining such changes to capacity value?

If the Interconnection Customer proposes to increase its capacity, it will need to qualify the additional capacity for participation in the Forward Capacity Market. In most cases, a new Interconnection Request would be needed with the end result being an updated Interconnection Agreement. *See* Response to Question 7.

24. What is the status of efforts in the RTOs/ISOs to define Effective Load Carrying Capability for hybrid resources?

ISO-NE is currently conducting Effective Load Carrying Capability analysis and will be studying hybrid resources as part of this effort. Initial results are expected in 2021.

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[15] *See*, *generally,* Attachment A.

II. CONCLUSION

ISO-NE appreciates the opportunity to provide these comments, and looks forward to working with the Commission and stakeholders to address the participation of hybrid resources in the New England wholesale markets.

Respectfully submitted,

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Dated: September 24, 2020

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Holyoke, Massachusetts this 24th day of September 2020.

/s/ Julie Horgan
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Disclaimer for Customer Training: ISO New England (ISO) provides training to enhance participant and stakeholder understanding. Not all issues and requirements are addressed by the training. Consult the effective Transmission, Markets and Services Tariff and the relevant Market Manuals, Operating Procedures and Planning Procedures for detailed information. In case of a discrepancy between training provided by ISO and the Tariff or Procedures, the meaning of the Tariff and Procedures shall govern.

April, 2020
Webex

Market Participation Options for Combined Intermittent/Electric Storage Facilities

FCM Resource and Energy/Reserve/Regulation Asset Registration Configuration Options

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Acronyms Used in Today's Presentation

Acronym	Term
AC	Alternating current
AGC	Automatic Generation Control
ATRR	Alternative technology regulation resource
CSF	Continuous storage facility
CSO	Capacity Supply Obligation
DARD	Dispatchable asset-related demand
DC	Direct current
DDP	Desired dispatch point
DNE	Do Not Exceed
FCM	Forward Capacity Market
PV	Photovoltaic
QC	Qualified capacity
SCC	Seasonal claimed capability
SOG	Settlement Only Generator
SOI	Show of Interest

Disclaimer

- Extensive participation of facilities that are comprised of both storage and intermittent generation is a new phenomenon in the New England markets. As the ISO and Market Participants gain experience with the logistical, operational, and economic considerations of such facilities, the rules governing co-located facility participation are likely to evolve. The ISO intends to work closely with Market Participants to gather feedback on all aspects of the existing constructs, which will facilitate the evaluation of their effectiveness and may eventually lead to further changes in Governing Documents and enhancement or elimination of existing participation options.
- The ISO believes that the options described herein are consistent with the currently effective Transmission, Markets, and Services Tariff, though for the reasons described above, the Tariff may not describe these options specifically or in detail (as is the case with numerous other areas of the Tariff). As always, in the event of a conflict between the Tariff and any presentation such as this, the Tariff governs, and it is the Market Participant's responsibility to understand the applicable provisions of the Tariff.

Objectives

This training:

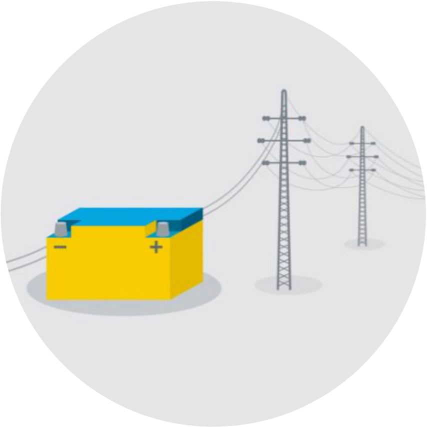
- Describes the current participation options for storage devices co-located with intermittent generation
- Summarizes the available operating configurations for co-located facilities, given the ISO's current Governing Documents and software systems
- Provides observations on each option for Participant consideration

This presentation **does not** address co-located storage and generation at end-use customer facilities, which can participate in New England markets as part of a(n):

- On-Peak Demand Resource
- Seasonal Peak Demand Resource
- Demand Response Resource

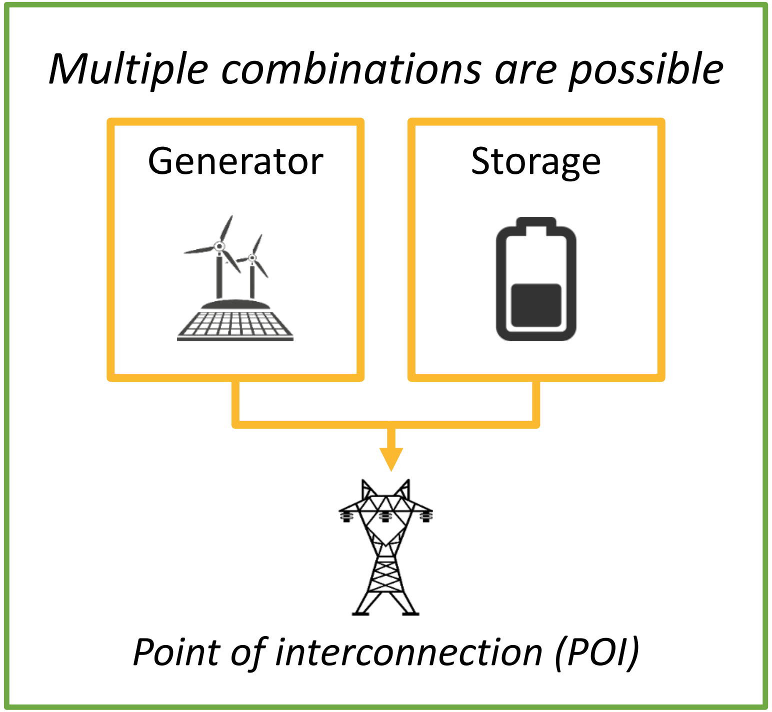
Note: We refer to the electric storage component of a co-located facility as a "battery" in this presentation for simplicity. It need not be a battery.

Contents



What do we mean by co-located facilities?

- Storage and generator devices share the same point of interconnection with the electric grid
- There may or may not be a shared constraint that limits the maximum output of the facility to a level below the sum of each component's capability
- Facility characteristics and the participation option selected will determine which wholesale market services a co-located facility can provide



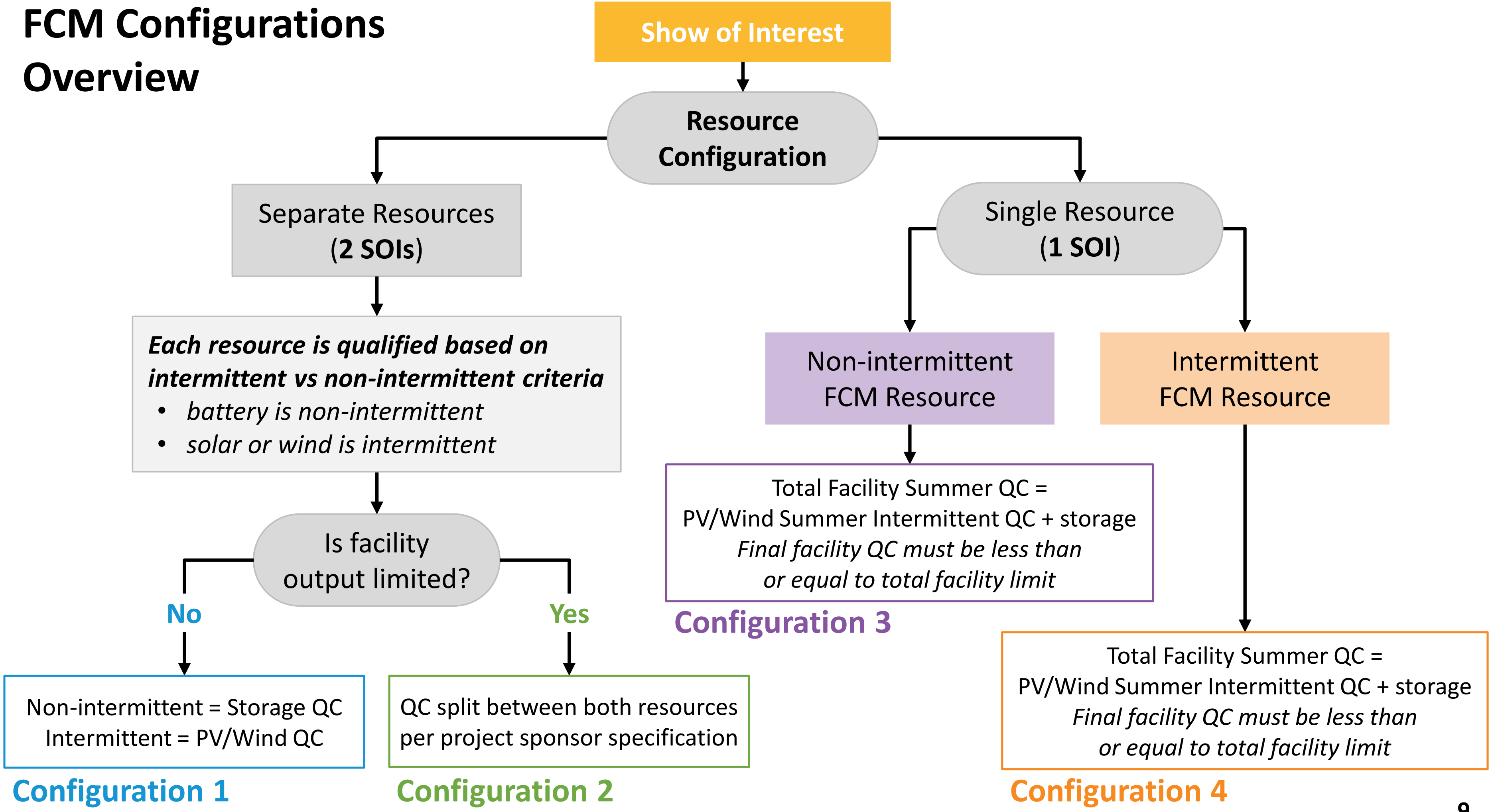
Generating Capacity Resources Vs. Registered Assets

Market Structure and Terminology Review

- **Generating Capacity Resources participate in the Forward Capacity Market**
  - These ***resources*** must be associated with one or more ***assets*** that participate in the energy market
  - Capacity for the resource is delivered by its associated assets in the form of energy and/or reserves
  - Generating Capacity Resources may be qualified as intermittent or non-intermittent
- **Assets participating in the energy market as generators may or may not be associated with Generating Capacity Resources**
  - Generator asset types include settlement only generators, dispatchable generators, non-dispatchable generators, and DNE dispatchable generators
  - A CSF consists of a dispatchable generator (for output), dispatchable asset related demand (for input), and an ATRR
- **In this presentation, "resource" will refer to the Generating Capacity Resource participating in the FCM, and "asset" will refer to the generator asset participating in the energy market**

Forward Capacity Market (FCM) Participation

FCM Configurations Overview



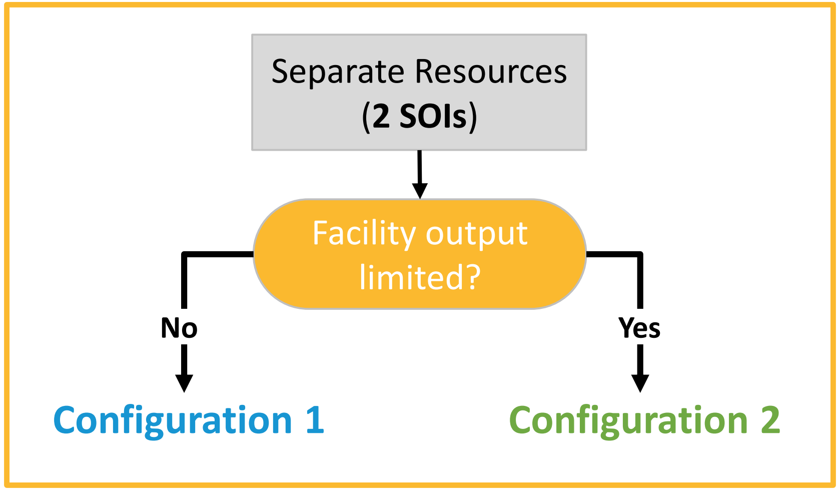
Co-located facility qualifies as two separate FCM resources

Configuration 1 & *Configuration 2*

Two FCM Resources

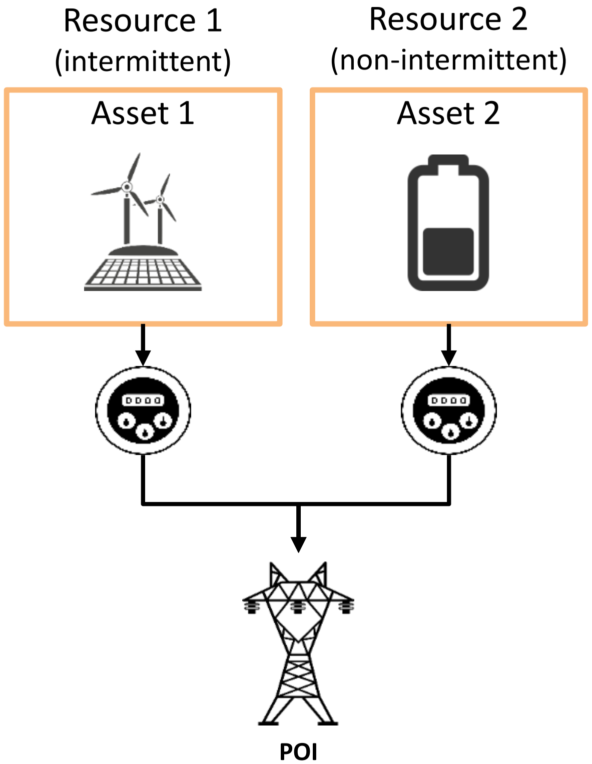
- Co-located facility qualifies as two separate FCM resources:
  1. Battery component qualifies in FCM as non-intermittent Generating Capacity Resource
     - Registered in energy market as CSF or Settlement Only Generator
  2. Intermittent component qualifies in FCM as Intermittent Power Resource
     - Registered in energy market as Settlement Only Generator, non-dispatchable PV, or DNE dispatchable generator
- Is there a facility limitation?

Note: Settlement Only Generator qualification is an option only for facilities with a combined output below 5 MW and connected below 115 kV.



Two FCM Resources With No Facility Limitation

Qualified Capacity (Configuration #1)



Intermittent (Solar)

Solar AC Nameplate: Example - 10 MW

- Solar qualified as intermittent FCM Resource
- Intermittent data submitted with the New Capacity Qualification Package is used to determine qualified capacity
- Solar Summer Qualified Capacity (QC) = ~4.0 MW
- Solar Winter QC = 0.0 MW

Battery

Usable AC Energy: Example - 3 MWh

Max AC Discharge Rate: Example - 1.5 MW

- Battery qualified as non-intermittent FCM Resource
- Battery QC = Min(Max AC Discharge Rate, Useable Energy/2) = 1.5 MW

Summer QC

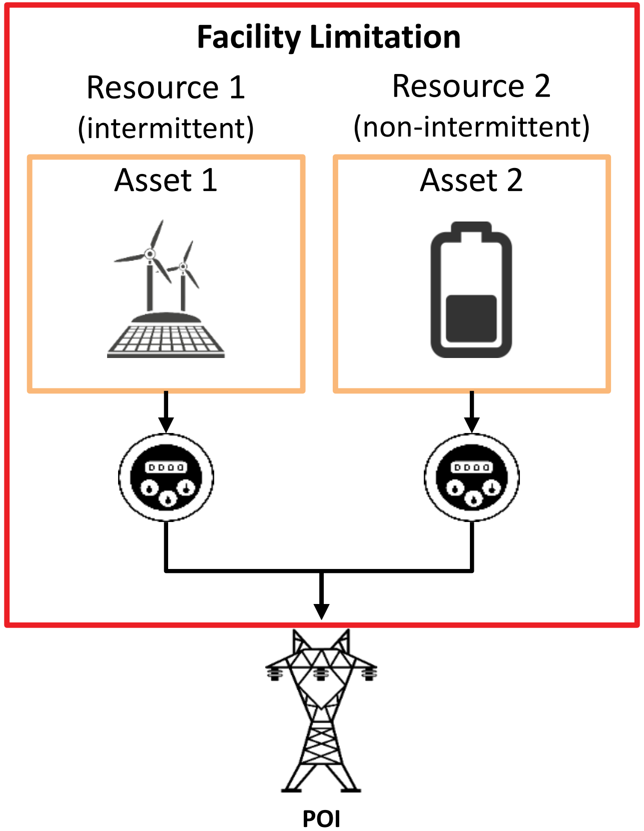
- Battery will be issued a QC of 1.5 MW
- Solar will be issued a QC of 4.0 MW

Winter QC

- Battery will be issued a QC of 1.5 MW
- Solar will be issued a QC of 0 MW

Two FCM Resources With Facility Limitation

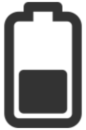
Qualified Capacity (Configuration #2)



Intermittent (Solar)

Solar AC Nameplate: 10 MW
Solar Summer QC = ~4.0 MW

Facility Output Limitation
Total facility limitation = 3 MW



Battery

Usable AC Energy: 3 MWh
Max AC Discharge Rate: 1.5 MW

- Battery QC = Min(Max AC Discharge Rate, Useable Energy/2) = 1.5 MW

Total Facility QC can not exceed Total Facility Limitation

Project Sponsor will select how to allocate the QC:

- Summer QC (example allocation)
  - **Battery issued a QC of 1.0 MW**
  - **Solar issued a QC of 2.0 MW**
- Winter QC
  - **Battery issued a QC of 1.5 MW**
  - **Solar issued a QC of 0 MW**

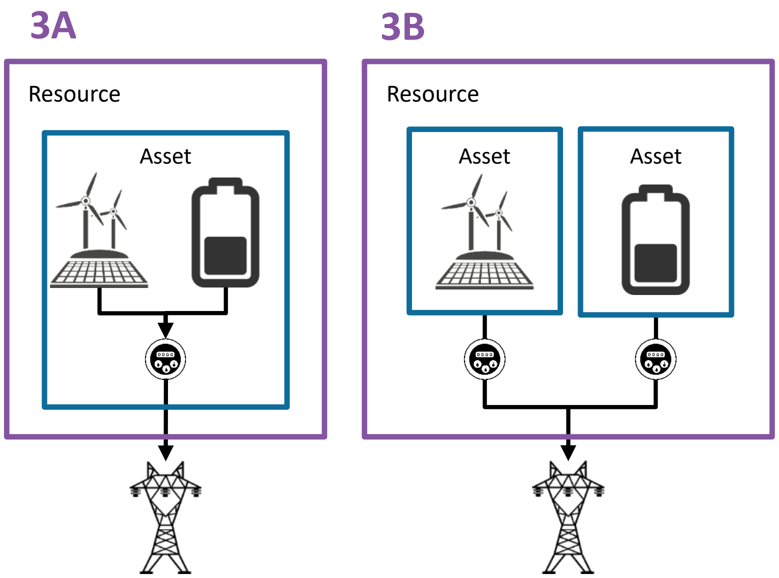
Co-located facility qualifies as a single FCM resource

Configuration 3 & Configuration 4

Single FCM Resource *(Configuration #3)*

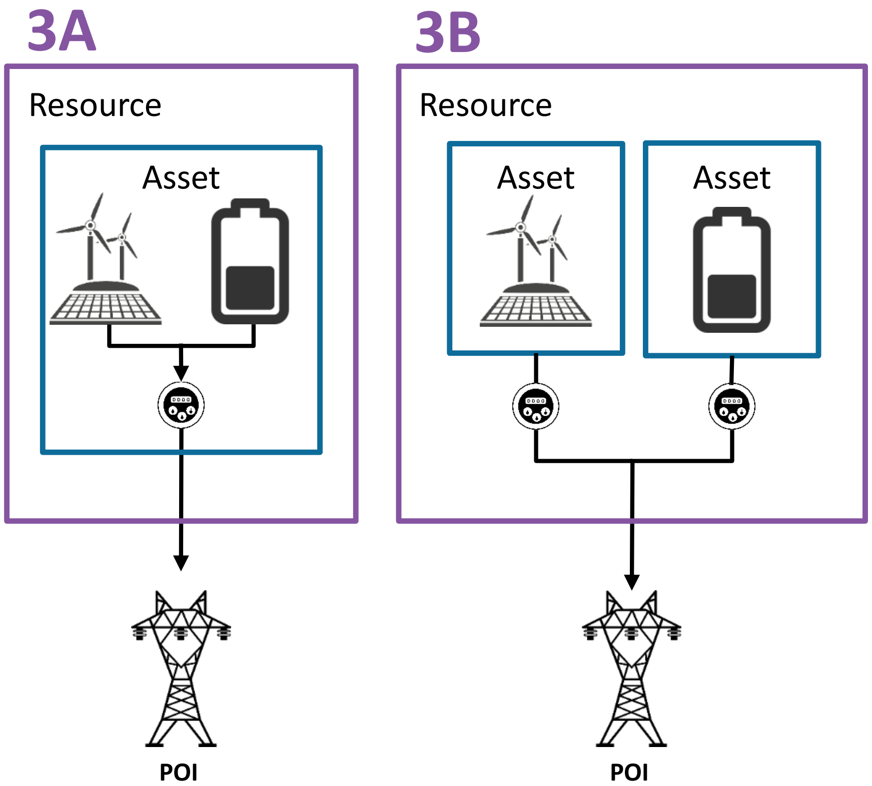
Non-intermittent Generating Capacity Resource

- Co-located facility qualifies in the FCM as a single *non-intermittent* Generating Capacity Resource
- Facility may register in energy market as either
  - A single non-intermittent "hybrid" asset *(Configuration #3A)*
    - CSF or Settlement Only Generator
  - Two separate assets *(Configuration #3B)*
    - Battery component as
      - CSF
      - Settlement Only Generator
    - Intermittent component as
      - Settlement Only Generator
      - non-dispatchable PV
      - DNE dispatchable

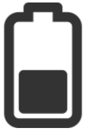


Single Non-Intermittent Generating Capacity Resource

Qualified Capacity (Configuration #3)



Intermittent (Solar)
Solar AC Nameplate: 10 MW
Solar QC = ~4.0 MW



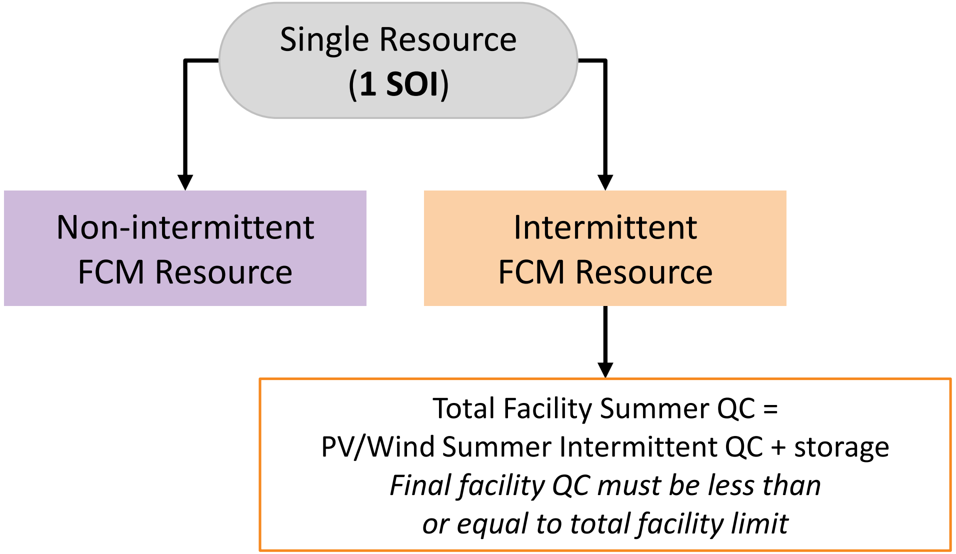
Battery
Usable AC Energy: 3 MWh
Max AC Discharge Rate: 1.5 MW
Battery QC = 1.5 MW

Facility Limitation
Total facility limitation = 5.5 MW

- Facility qualified as non-intermittent
- Total facility Summer QC = Intermittent QC + [Min(Max AC Discharge Rate, Useable Energy/2)]
- Total facility Summer QC = 4.0 + 1.5
- Total Facility Summer QC = 5.5 MW (but could not be above any facility constraint)
- Total Facility Winter QC = Battery QC = 1.5 MW

Single Intermittent Power Resource *(Configuration #4)*

- Co-located facility qualifies in the FCM as *a single* Intermittent Power Resource
- Facility must be predominately intermittent
- Facility registers in energy market a single intermittent "hybrid" asset
  - Settlement Only Generator
  - Non-dispatchable PV
  - DNE dispatchable

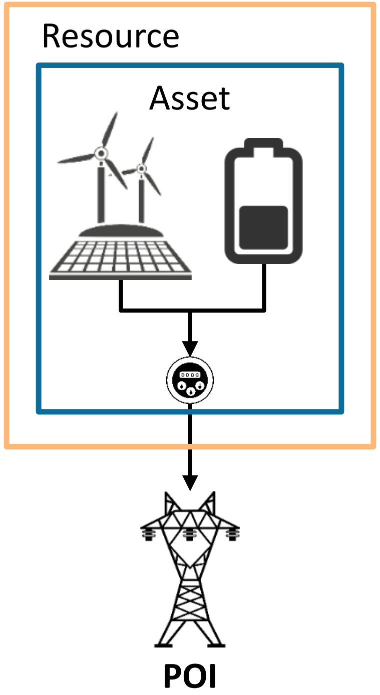


Configuration 4

Single Intermittent Power Resource

Qualified Capacity (Configuration #4)

The intermittent component is the predominant portion of the asset



Intermittent (Solar)
Solar AC Nameplate: 10 MW
Solar QC = ~4.0 MW

Battery
Usable AC Energy: 3 MWh
Max AC Discharge Rate: 1.5 MW
Battery QC = 1.5 MW

Facility Limitation
Total facility limitation = 3 MW

- **Facility qualified as intermittent**
- **Total facility Summer QC = Intermittent QC + [Min(Max AC Discharge Rate, Useable Energy/2)]**
- **Total facility Summer QC = 4.0 + 1.5 = 5.5 MW** (if no facility limitation)
- **Total facility Summer QC = 3 MW** (due to facility limitation)
- **Total Facility Winter QC = Battery QC = 1.5 MW**

Energy Market Registration Options

Note: FCM Participation is Not Required to Participate in Energy and/or Ancillary Service Markets

Co-located devices register as *two separate* Energy Market assets

Asset Registration Options For Intermittent Component

Configuration 1, Configuration 2, and Configuration 3B

Co-located devices registering as *two separate* Energy Market assets

Intermittent component may register as:

Option	Applies to	Notes
Settlement Only Generator*	Any, if facility is eligible	• No telemetry required • Participates in Real-Time Energy Market as price taker • Cannot provide reserves or regulation
Non-dispatchable generator	PV	• Telemetry required • Participates in Day-Ahead and Real-Time Energy Markets • Cannot provide reserves or regulation
DNE dispatchable generator	Wind, intermittent hydro	

** Option only for facilities with a combined output below 5 MW and connected below 115 kV*

Asset Registration Options For Battery Component

Configuration 1, Configuration 2, and Configuration 3B

Co-located devices registering as *two separate* Energy Market assets

Non-intermittent component may participate as:	
Option	Notes
Settlement Only Generator	• No telemetry required • Participates in Real-Time Energy Market as price taker • Cannot provide reserves • May also be registered as an ATRR and provide regulation, with required telemetry
Continuous Storage Facility	• Telemetry required, AGC SetPoint/DDP for battery only • Participates in Day-Ahead and Real-Time Energy Markets • Eligible to provide reserves* and regulation

** Caveat: With current systems, cannot be designated for reserves in cases where there is a common limiting element (see slides 24-25)*

Separate Energy Market Assets

DC-Coupled vs. AC-Coupled

Co-located devices registering as *two separate* Energy Market assets

If intermittent generator and battery do not share inverter(s), they are AC-coupled

- Current Governing Documents support metering and telemetering requirements for these configurations

If intermittent generator and battery share the same inverter(s), then they are DC-coupled

- In this case, Governing Document changes are needed to allow for the DC metering and telemetering required for separate asset treatment
- This is in progress, and it is anticipated that the changes will be effective later in 2020
  - The Reliability Committee is expected to begin discussion on Operating Procedure 18 (OP-18) in Q2 2020. Please check the RC committee page for materials as they become available.
  - The Markets Committee is expected to begin discussion of clarifications to the ISO-NE Manuals M-28 and M-RPA in Q2 2020. Please check the MC committee page for materials as they become available.

Separate Energy Market Assets

Battery Component Registered as CSF – Reserves Issue

Co-located devices registering as *two separate* Energy Market assets

- Issue arises if there is a common limiting element that is rated for less than the maximum output of the intermittent generator
  - This situation is especially common with DC-coupled assets sharing an inverter, and can also occur if the interconnection agreement limits the facility output to below the maximum output of the intermittent component
  - See example on next slide
- Existing ISO software may designate an inaccurately high amount of reserves on a CSF in cases where a shared constraint is more limiting than the intermittent output plus the charging load
- ISO is studying possible ways to solve this issue
- Given the ISO's requirements for accurate reserves accounting, ISO must disallow reserves designation for these facilities if they participate as separate assets until a solution is designed and implemented
- This issue may apply to *Configuration 2* and *Configuration 3B*

Separate Energy Market Assets

Battery Component Registered as CSF - Reserves Issue Example

Co-located devices registering as *two separate* Energy Market assets

- DC-Coupled Facility
  - 5 MW shared inverter
  - 8 MW PV as Intermittent Generator
  - 4 MW/8 MWh CSF
- Assume that the PV is producing more than 5 MW and that the excess is stored in the CSF (otherwise it would be lost (spilled))
- If the CSF is charging, ISO systems presume the ISO can dispatch it at any time to stop charging and provide energy
  - The charging load, which could go to zero, is the reserves designation on the DARD component of the CSF given current ISO software
- However, due to the 5 MW facility limit, if the CSF stops charging no additional energy can be provided to the grid (it would be spilled) – so in this case the charging load is not providing reserves

Co-located facility registers as single “HYBRID” Energy Market asset

Entire Facility Asset Registration Options (*Configuration 3A* & *Configuration 4*)

Entire facilities may register as:

Option	Notes
Settlement Only Generator *Configuration 3A and* *Configuration 4*	• No telemetry required; not dispatchable • Participates in Real-Time Energy Market as price taker • Cannot provide reserves • May also be registered as an ATRR and provide regulation, with required telemetry
Continuous Storage Facility *Configuration 3A only*	• Telemetry required, AGC SetPoint/DDP for the entire facility • Full participation in all markets: Energy (Day-Ahead and Real-Time), Reserves, Regulation, FCM • Will need to adjust Available Energy and Available Storage to account for combined intermittent plus battery capability
Intermittent generator: **non-dispatchable PV or DNE dispatchable** (if wind or intermittent hydro) *Configuration 4 Only*	• Facility must be predominately intermittent • Generator Asset telemetry is required • Cannot provide regulation or reserves • Dispatch point for entire facility; DNE dispatch requirements if wind or intermittent hydro • Under this option, Energy Market offers and Dispatch Instructions exclude charging load • Any charging load must be included as part of a Load Asset if the facility will charge from the grid

Observations on the Configurations

General Observations for CSFs at Co-Located Facilities

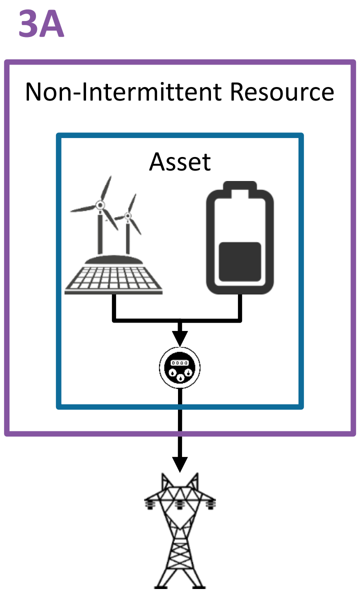
- **Participants and Designated Entities will have to carefully manage their offers and limits associated with a CSF at a co-located facility to account for things like:**
  - The existence of any shared facility constraints (both physical and/or contractual)
  - Any special operational requirements, such as charging the battery only from the intermittent component
  - The variability of the intermittent component
  - Periods when the intermittent output does not match what was forecasted
- **Such offer and limit management will be critical to avoiding any potential for an infeasible AGC SetPoint/DDP**

Configuration 1 and *Configuration 2* - Separate Resources/Assets

- May have separate Lead Market Participants
- Any required Designated Entities must be the same for all assets at a co-located facility
- Due to separate treatment, each component will be settled independently
- It is anticipated that, in case of DC-coupled assets:
  - Both whole facility AC metering and DC sub-metering will be required
  - For facilities requiring telemetry (≥5 MW and/or CSF or ATRR), DC telemetering will also be required
  - Assigned Meter Readers must be the same
- Continuous Storage Facility charging load, even when supplied by the on-site intermittent asset, is subject to applicable Real Time Load Obligation cost allocations
- In addition, if the battery is registered as a Continuous Storage Facility:
  - Reserve designation issue may apply if there is a facility constraint
  - Offer management complexity due to separate asset impacting CSF capability

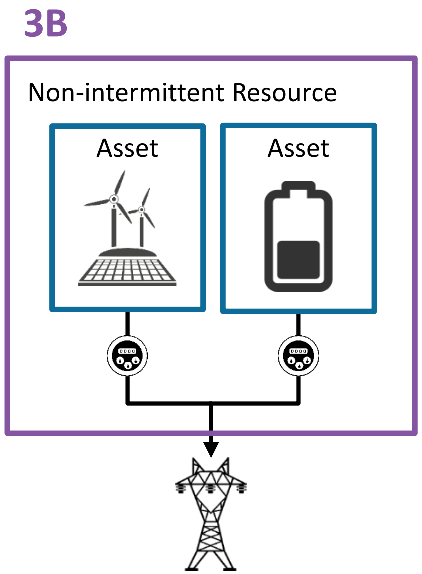
Configuration 3A – Single Non-Intermittent Resource - Hybrid Asset

- The facility is managed and optimized as a whole, and any shared constraint is reflected in offer so full available reserves can be designated (for non-Settlement Only assets)
- DC metering is not required for DC-coupled systems; whole facility metering and any required telemetry are at the AC point of interconnection
- Battery charging from onsite intermittent component is done outside the market and is not subject to Real-Time Load Obligation cost allocations
- Must have one Lead Market Participant and Designated Entity
- The charge/discharge schedule of the battery might require modification when the participant's forecast of intermittent output is different from actual output



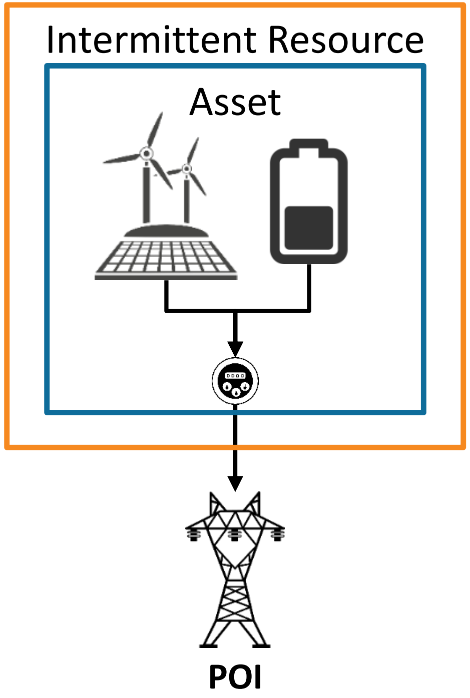
Configuration 3B – Single Non-Intermittent Resource - Separate Assets

- Assets may have different Lead Market Participants but must have a single Assigned Meter Reader and Designated Entity
- DC metering and telemetry is required for DC-coupled systems
- If battery is registered as a CSF:
  - Reserve designation issue may exist if there is a facility constraint
  - CSF charging load, even when supplied by the on-site intermittent asset, is subject to applicable Real Time Load Obligation cost allocations
  - Offer management complexity due to separate asset impacting CSF capability



Configuration 4 – Intermittent Power Resource – Hybrid Asset

- Configuration will not provide reserves or regulation
- DC metering is not required for DC-coupled systems participating as an entire facility; whole facility metering and any required telemetry is at the AC point of interconnection
- Battery charging from onsite intermittent component is done outside the market and is not subject to Real-Time Load Obligation cost allocations
- Any battery charging from the grid must be reported in a separate Load Asset
- Must have one Lead Market Participant



Summary of Configurations

Configuration	New Capacity Qualification*	Existing Capacity Qualification	Asset(s) Seasonal Claimed Capability (SCC)**
1 and 2: Two Resources, two Assets, with or without facility limitation	Expected Median Output of intermittent during Reliability Hours plus lower of: 50% usable stored energy and maximum discharge rate of battery	Intermittent is average of past 5 SCCs for each season; non-intermittent is median of past 5 SCCs for each season	Median output over reliability hours for intermittent; average output over two hours for non-intermittent
3A: One Resource, One Asset, Non-Intermittent	Expected Median Output of intermittent during Reliability Hours plus lower of: 50% usable stored energy and maximum discharge rate of battery	Median of past 5 SCCs for each season	Average output over two hours
3B: One Resource, Two Assets, Non-Intermittent	Expected Median Output of intermittent during Reliability Hours plus lower of: 50% usable stored energy and maximum discharge rate of battery	Median of the sum of Asset SCCs for past 5 years for each season	Median output over reliability hours for intermittent; average output over two hours for non-intermittent
4: One Resource, One Asset, Intermittent	Expected Median Output of intermittent during Reliability Hours plus lower of: 50% usable stored energy and maximum discharge rate of battery	Average of past 5 SCCs for each season	Median output over reliability hours

* New Capacity Qualification will not exceed facility limitation
** SCC cannot exceed Establish Claimed Capability, which is constrained by Network Resource Capability, reflecting any facility limits

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