



1st Read Manual Language for Hybrids Phase 1a – Manual 14D and Manual 10

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PJM System Operations Subcommittee
July 7, 2022

Action Required	Deadline	Who May Be Affected
<p>Review draft revisions to Manual 10 and 14-D for first read</p> 	<p>Vote at August SOS and OC</p> 	<p>Developers of hybrid gen+storage resources Transmission owners Others</p> 

Manual 14-D:

- Section 4.1.7 SCADA
- Section 4.2.3 Metering for Individual Generators
- Section 7.1.2 Voltage and Reactive Control
- Section 7.3 eDART reporting
- Section 8.3.3 LOC rule clarification
- Section 12.2.4 Outage reporting clarification
- New Section 13 on Mixed Tech Facilities, classification and misc.
- Attachment D – Reactive Capability
- Attachment E – Reactive Tests
- Attachment L – Single MOC

Manual 10:

- Section 2.1 – Hybrid Resources report outages separately on the components

(Note changes for Hybrid Resources to Manual 18: PJM Capacity Market to include certain Hybrids in exemption from RPM must offer slated for endorsement at July MIC)

Manual 10: Pre-Scheduling Operations, Revision XX
Manual 14-D: Generator Operational Requirements Revisions, Revision XX

Manual 10, Revisions Schedule

	Committee	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Hybrid & Co-located Resources	DIRS		○ 6/20						
	SOS		7/7 ●		★ 8/1				
	MIC		7/13 ●		★ 8/10				
	OC		7/14 ●		★ 8/11				
	MRC				8/24 ●	★ 9/21			
Reserve Price Formation	SOS			8/3 ●		★ 9/1			
	MIC			8/10 ●		★ 9/7			
	OC			8/11 ●		★ 9/8			
	MRC				8/24 ●	★ 9/21			
Periodic Review	SOS					9/29 ●	★ 10/28		
	OC					10/7 ●	★ 11/3		
	MRC						10/24 ●	★ 11/16	

- *First Read*
- ★ *Endorsement*
- *Info Only*

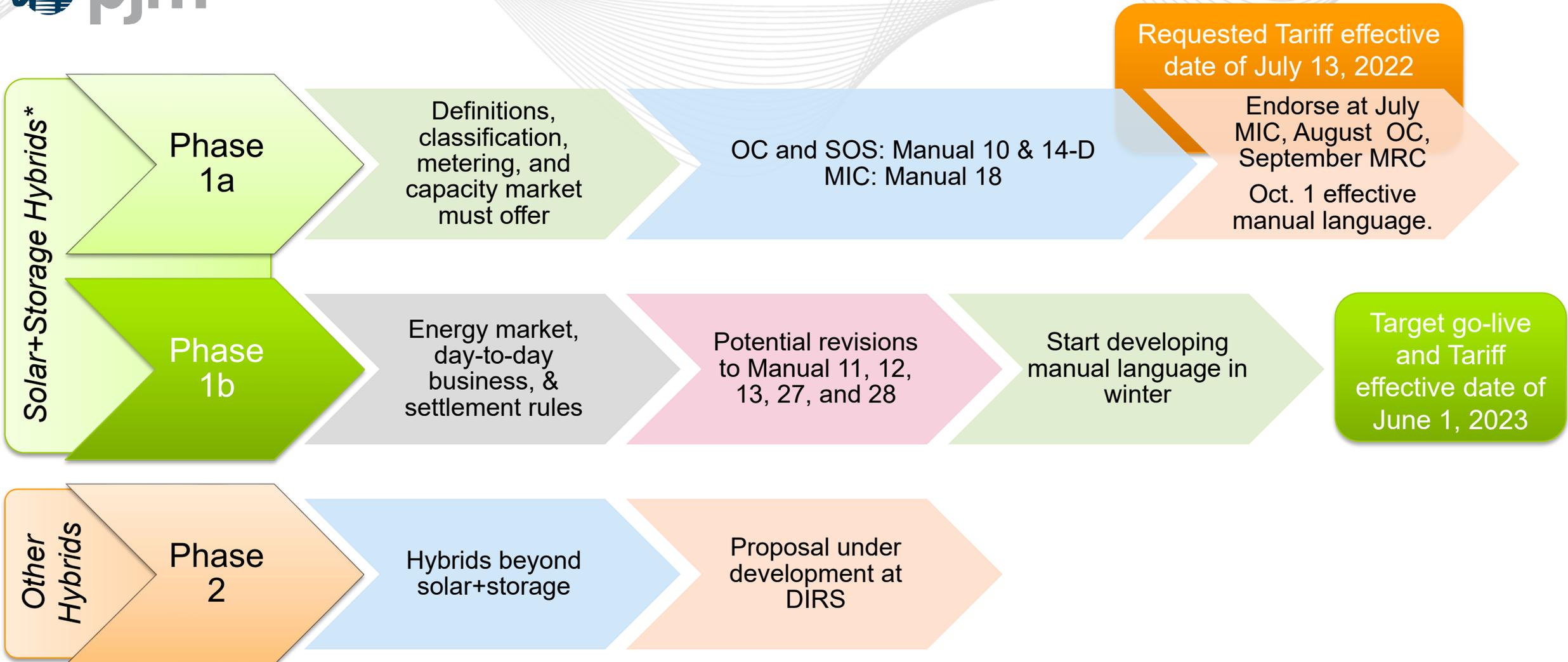


Manual 14-D, Generator Operational Requirements Revisions

	Committee	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Generation Deactivation Quick Fix	SOS		6/2 ●	★ 7/7					
	OC		6/9 ●	★ 7/14					
	MRC		6/27 ●	★ 7/27					
Hybrid & Co-located Resources	DIRS		○ 6/20						
	SOS			7/7 ●	★ 8/3				
	OC			7/14 ●	★ 8/11				
	MRC				8/24 ●	★ 9/21			
Cold Weather Operating Limits NERC Standard Revisions	SOS			8/3 ●	★ 9/1				
	OC				8/11 ●	★ 9/8			
	MRC				8/24 ●	★ 9/21			
Periodic Review	SOS					9/29 ●	★ 10/28		
	OC					10/7 ●	★ 11/3		
	MRC						10/24 ●	★ 11/16	

- First Read
- ★ Endorsement
- Info Only

Note: There will be an additional revision with changes related to FRBSR stakeholder process. The timing is still TBD.

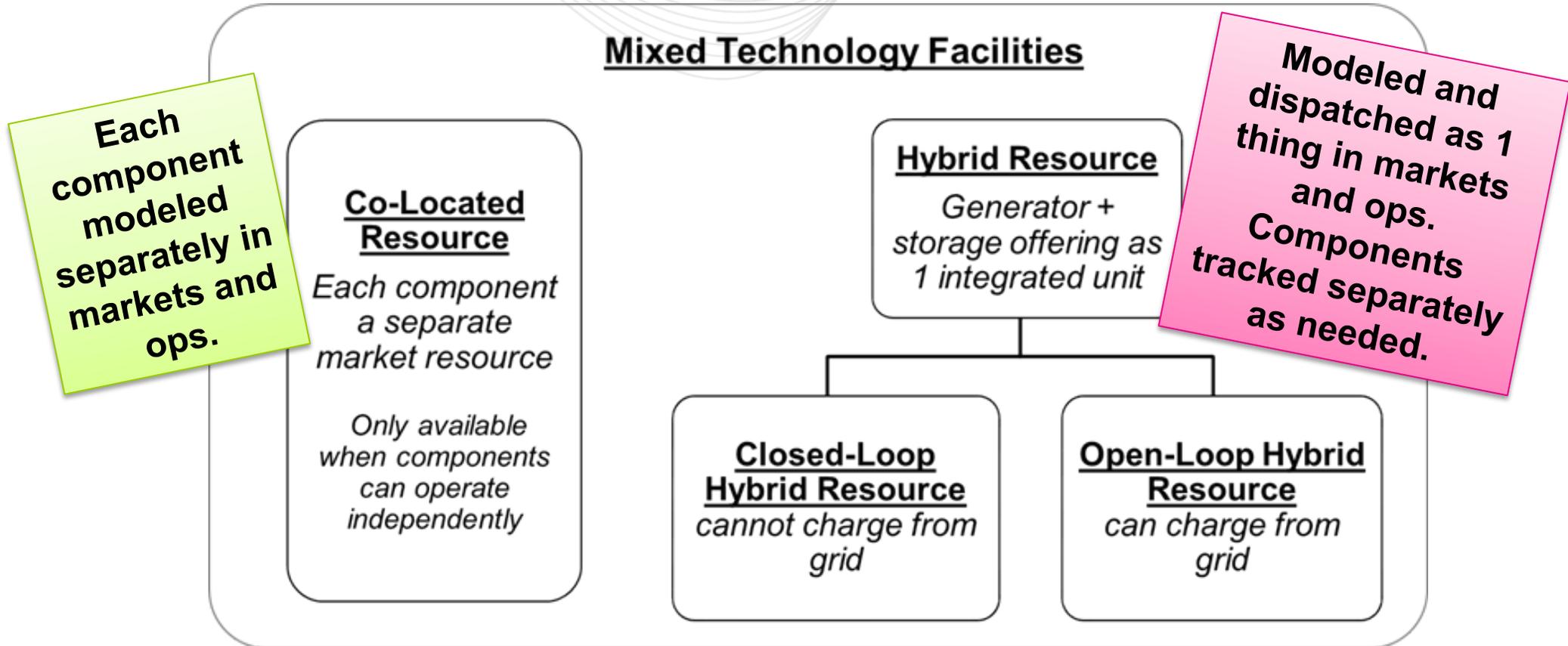


*Proposal endorsed by MC on Jan. 26, 2022. Initial filing March 22 in Docket ER22-1420. Re-filed w/ errata May 13 in same docket. <https://www.pjm.com/directory/etariff/FercDockets/6590/20220322-ER22-1420-000.pdf>

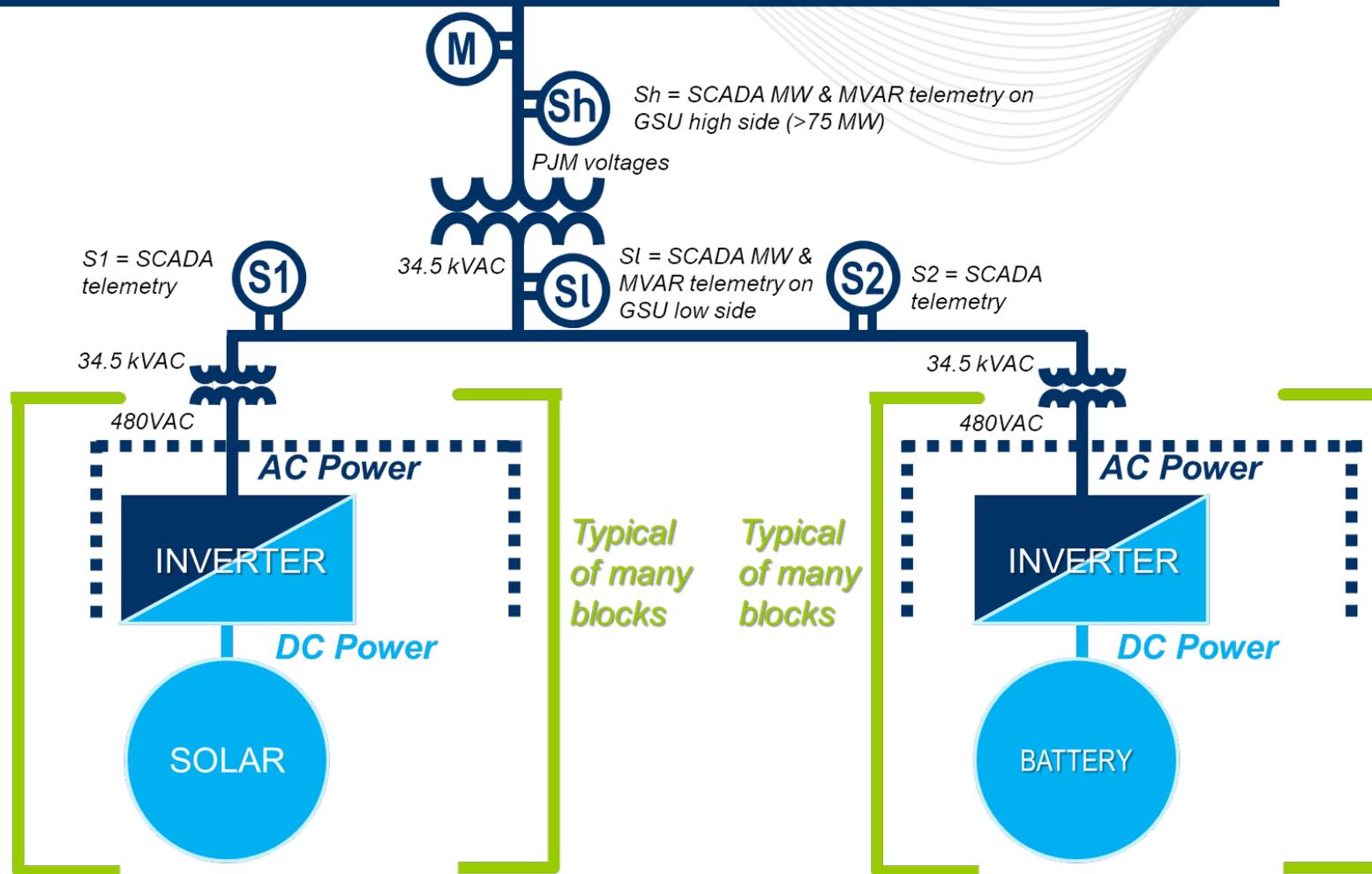
Any time a generation resource has a limitation preventing the unit from achieving eDART Reportable MW, an eDART ticket is required. The eDART Reportable MW is the MW value that is the basis for outage reporting in eDART. It varies by resource type and is not to be confused with RPM committed MW value.

Resource Type	eDART Reportable MW
For Capacity Resources	Total RPM (Owned) iCAP (Committed + Available) MW
For Energy Resources, Energy Storage Resources, wind and solar units	Based on nameplate rating
For units that are dynamically transferred into PJM, including pseudo-tied, dynamically scheduled, and block scheduled units	Capacity commitment
For those units inside PJM and dynamically transferred out of PJM	Based on full nameplate rating
For units that are partially behind the meter (load offset)	Based on nameplate rating minus the maximum load the unit expects to serve (year round)
<u>For an inverter-based component of a Hybrid Resource</u>	<u>Based on the nameplate MW rating of the component</u>

Substantive Items in Manual 14-D Revisions



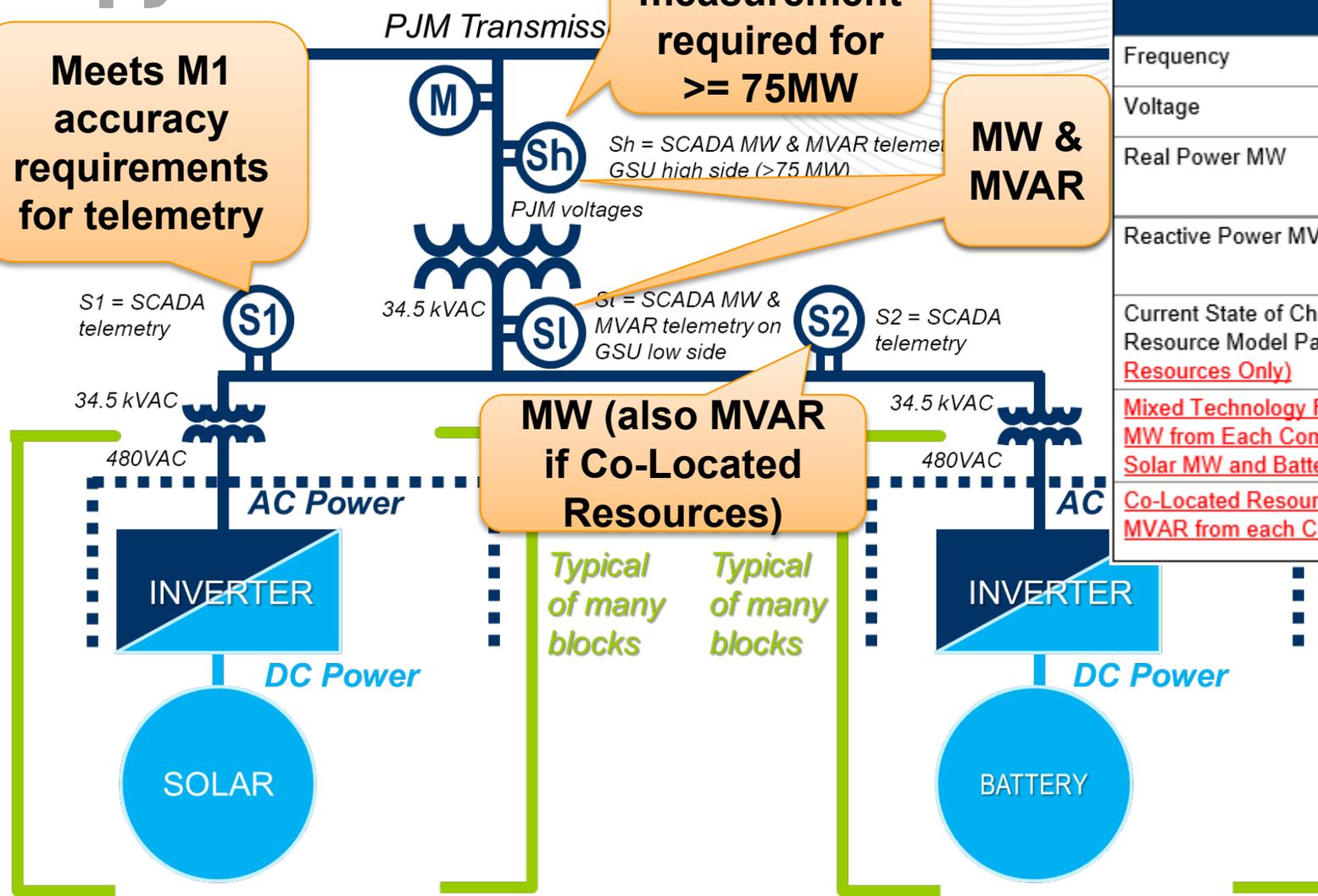
PJM Transmission Facilities



Section 4.2.3 Metering for Individual Generators

Metering and Telemetry

Meets M1 accuracy requirements for telemetry



High-Side measurement required for $\geq 75\text{MW}$

MW & MVAR

MW (also MVAR if Co-Located Resources)

Real Time Instantaneous Data Sent To PJM	
Frequency	1/1000th of HZ (i.e. 60.001 Hz)
Voltage	1/10th of kV (i.e. 69.1 kV)
Real Power MW	1 MW integer (i.e. 52 MW) required, but PJM will accept greater precision if available
Reactive Power MVAR	1 MVAR integer (i.e. 42 MVAR) required, but PJM will accept greater precision if available
Current State of Charge (Energy Storage Resource Model Participants <u>and Hybrid Resources Only</u>)	1 MWh remaining
<u>Mixed Technology Facilities Only—Real Power MW from Each Component Technology (e.g., Solar MW and Battery MW).</u>	1 MW integer (i.e. 52 MW) required, but PJM will accept greater precision if available
<u>Co-Located Resources Only—Reactive Power MVAR from each Co-Located Resource</u>	1 MVAR integer (i.e. 42 MVAR) required, but PJM will accept greater precision if available

Section 4.1.7 SCADA

Section 4.2.3 Metering for Individual Generators

Orange boxes are a summary of revision substance, see redlines for specific language

Note:

For wind and solar Generating Facilities, an eDART ticket is required when the wind farm / solar park is unavailable or derated. Lack of wind or solar irradiance does not require an eDART ticket.

For Energy Storage Resources, an eDART ticket is required when the ESR is unavailable or derated. Charging or lack of charge does not require an eDART ticket.

For ~~solar-battery~~ ~~Hybrid Resource~~ ~~Generating Facilities~~, an eDART ticket is required when either component of the ~~facility~~ resource is unavailable or derated. No eDART ticket is required for lack of wind, solar irradiance, charging, nor lack of charge.

Section 7.3

Note:

Due to the impact of planned/unplanned solar resource outages on solar power forecast accuracy, solar and solar-storage hybrid resources shall report any outage of one megawatt or more with duration of one hour or longer. ~~Outages shall be submitted on aggregate plant capacity by outage type.~~

Section 12.2.4

eDART Outages of the components of a Hybrid Resource are reported separately for each component.

Section 13.2

7.1.2 Voltage and Reactive Control

Over-voltage and under-voltage protection systems must be capable of allowing abnormal system operations within PJM post-contingency operating limits. Momentary voltage fluctuations are permitted provided they neither disturb service provided by PJM or the Generator on their respective systems nor hinder PJM from maintaining proper voltage conditions on its system.

All Generators must install and have available field-excitation regulators, or equivalent electronic controls (voltage regulators). When a generator field-excitation regulator, or equivalent electronic control (voltage regulator) is replaced, and the replacement voltage regulator includes a Power System Stabilizer (PSS), the PSS should be commissioned and placed in service after notifying PJM using the email address NERC.Transmission.Planner@pjm.com. The reactive output of the generator must be regulated in the manner specified by PJM and/or the Transmission Owner. PJM Transmission Owners must supply and communicate voltage schedules and a low and high voltage bandwidth to all Generation Owners in their zone and PJM for applicable generators meeting the following criteria:

- individual generating units greater than 20 MVA
- generators that aggregate to 75MVA or greater connected to a common bus (for Mixed Technology Facilities, such aggregate quantity is calculated across all the generating units of all technology types connected to a common bus—e.g., the sum of all inverter MVA ratings sharing a Point Of Interconnection at the Mixed Technology Facility)

8.3.3 Real-time Operating Reserve Settlement

PJM will use the Short-Term wind power forecast in the calculation of Lost Opportunity Cost for standalone wind resources in real-time. Hybrid Resources with a wind component are not subject to this provision. Further detail on the calculation can be found in Manual 28.

Summary of revision substance, see redlines for specific language

- A Co-Located Resource must meet all the provisions for the corresponding resource type.
- A Hybrid Resource is a unique resource type, and (unless otherwise stated) is not automatically subject to the provisions that apply to its component types.
 - *A Hybrid Resource with a solar component must meet those requirements for solar parks specified in Section 12 of M14-D. A Hybrid Resource with a wind component must meet those requirements for wind farms that are specified in Section 8.1 and 8.2 of M14-D.*
- A Mixed Tech Facility can participate as separate Co-Located Resources when can operate independently. These criteria must **all** be met:
 - Can charge from grid
 - Sum of component MW \leq Max Facility Output
 - Component MW at an inverter-based Mixed Tech Facility is derated vs. total inverter MVA ratings to account for reactive capability and internal losses.

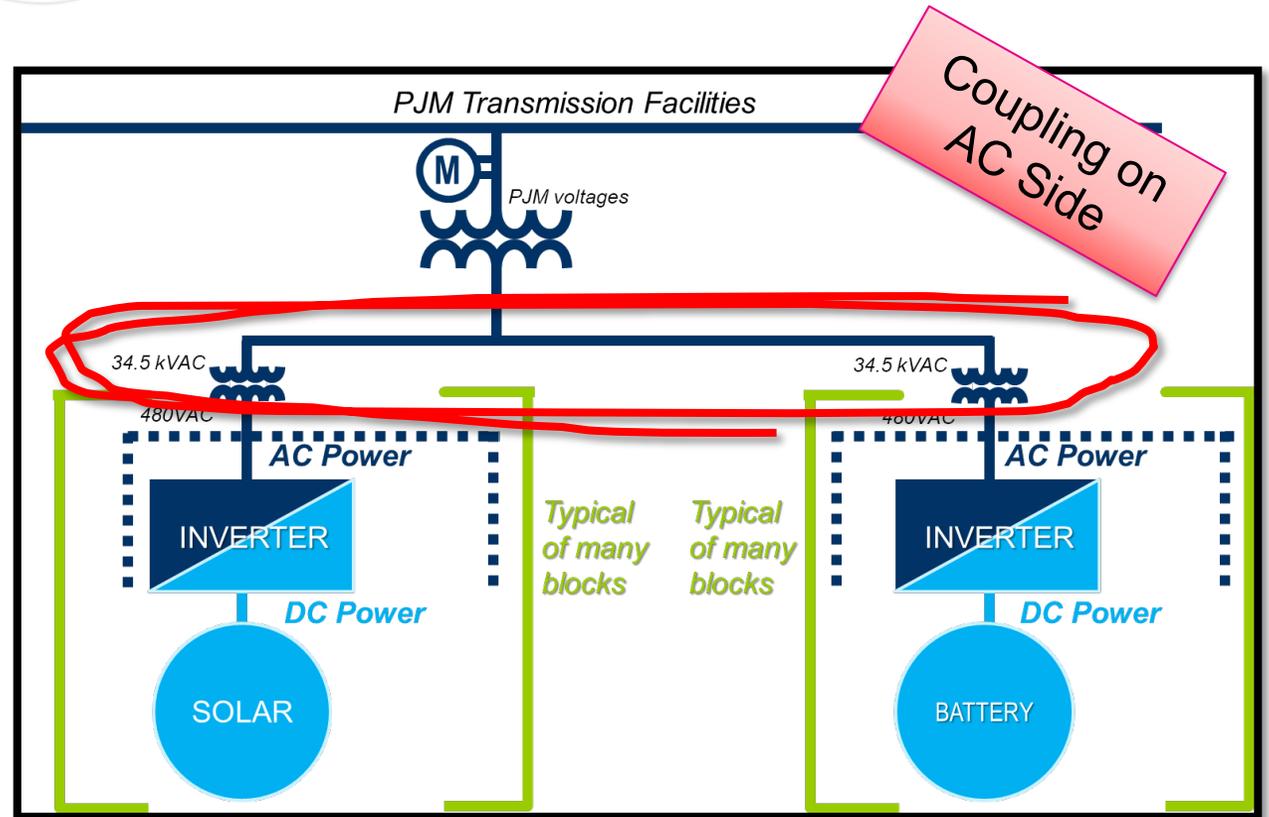
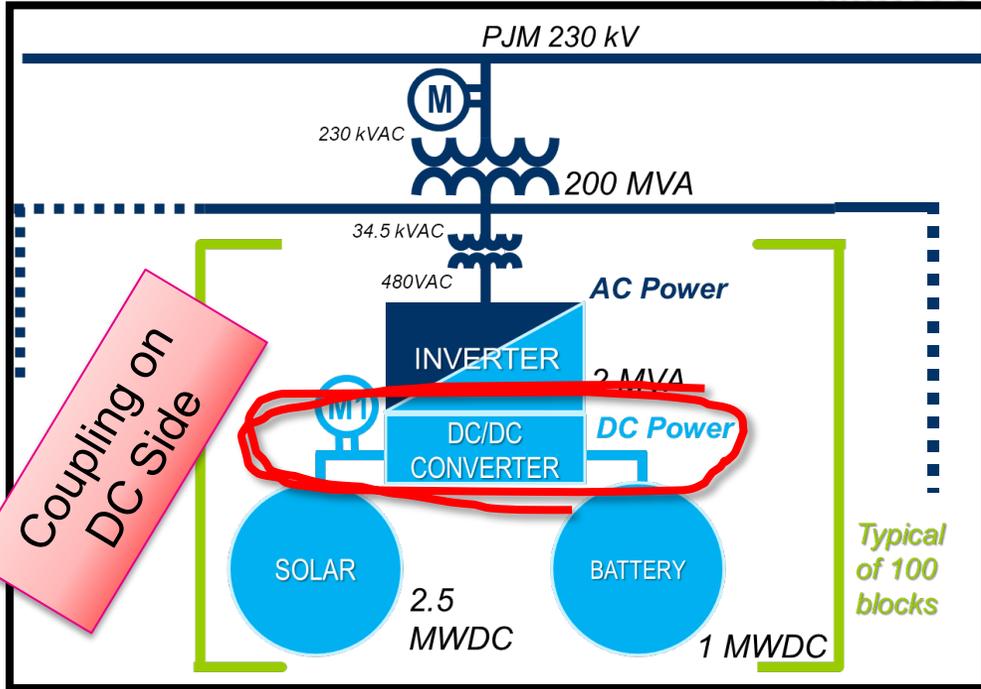
Summary of revision substance, see redlines for specific language

- A Mixed Tech Facility that is eligible to be either Hybrid or Co-Located has to pick one approach, but can switch:
 - Once per five years if capacity resource
 - Once per year if not capacity resource

maximum MW withdrawal from the grid (charging.)

10. For a Hybrid Resource consisting entirely of inverter-based components, a single D-curve is tested. Such facilities are tested consistent with the provisions for inverter-based Hybrid Resources specified in the table "TESTING REQUIREMENTS SUMMARY" in Attachment E below.
11. For a Mixed Technology Facility participating in markets as multiple Co-Located Resources, multiple D-curves are tested (one D-curve for each unit at the site). For a Mixed Technology Facility not consisting entirely of inverter-based resources, one D-curve may be tested for each unit at the site.
12. For a Hybrid Resource, the composite reactive capability curve shall represent the most conservative capability of the combined Generating Facility at each net MW injection point. See examples in Figures 15 & 16 below.

Education Note (This Slide Not Part of Manual Revisions): AC-Coupled vs. DC-Coupled Mixed Tech Facilities



Explanation of revision substance, see redlines for specific provisions

An AC-coupled Hybrid Resource has two (sets of) electrical machines (i.e., inverters), and so shows a D-curve that reflects conservative conditions.

In particular, for the solar to feed the battery, both the solar inverters and the battery inverters need to do an AC power conversion. This leaves less inverter capability available for reactive.

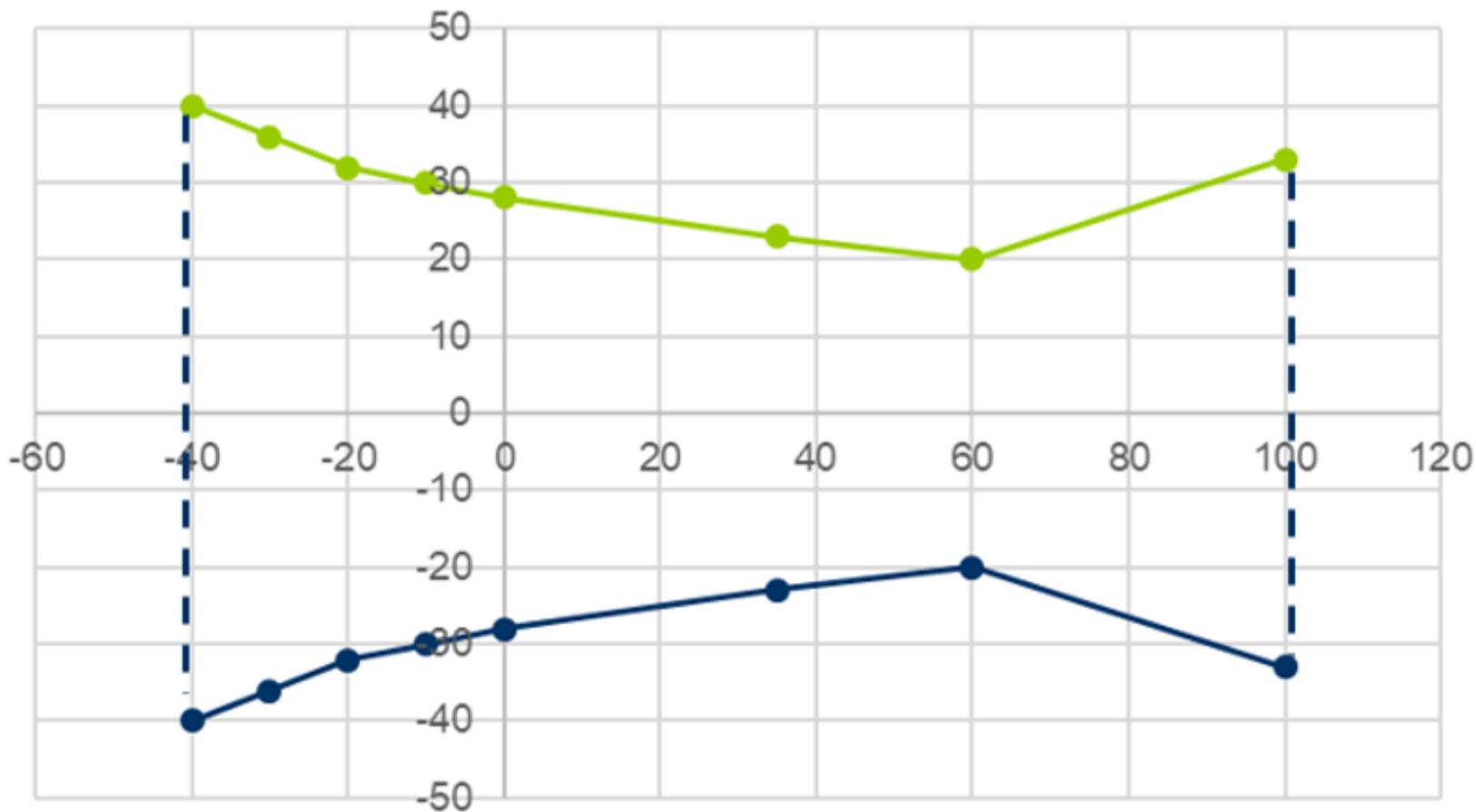


Exhibit 15: Example of inverter-based AC-coupled open-loop Hybrid Resource with 100 MW solar and 40 MW battery.

Explanation of revision substance, see redlines for specific provisions

A DC-coupled Hybrid Resource has a single (set) of electrical machines (i.e., inverters), and so shows a more typical D-curve.

In particular: the solar would feed the battery directly, without needing AC power conversion. This leaves more inverter capability available for reactive.

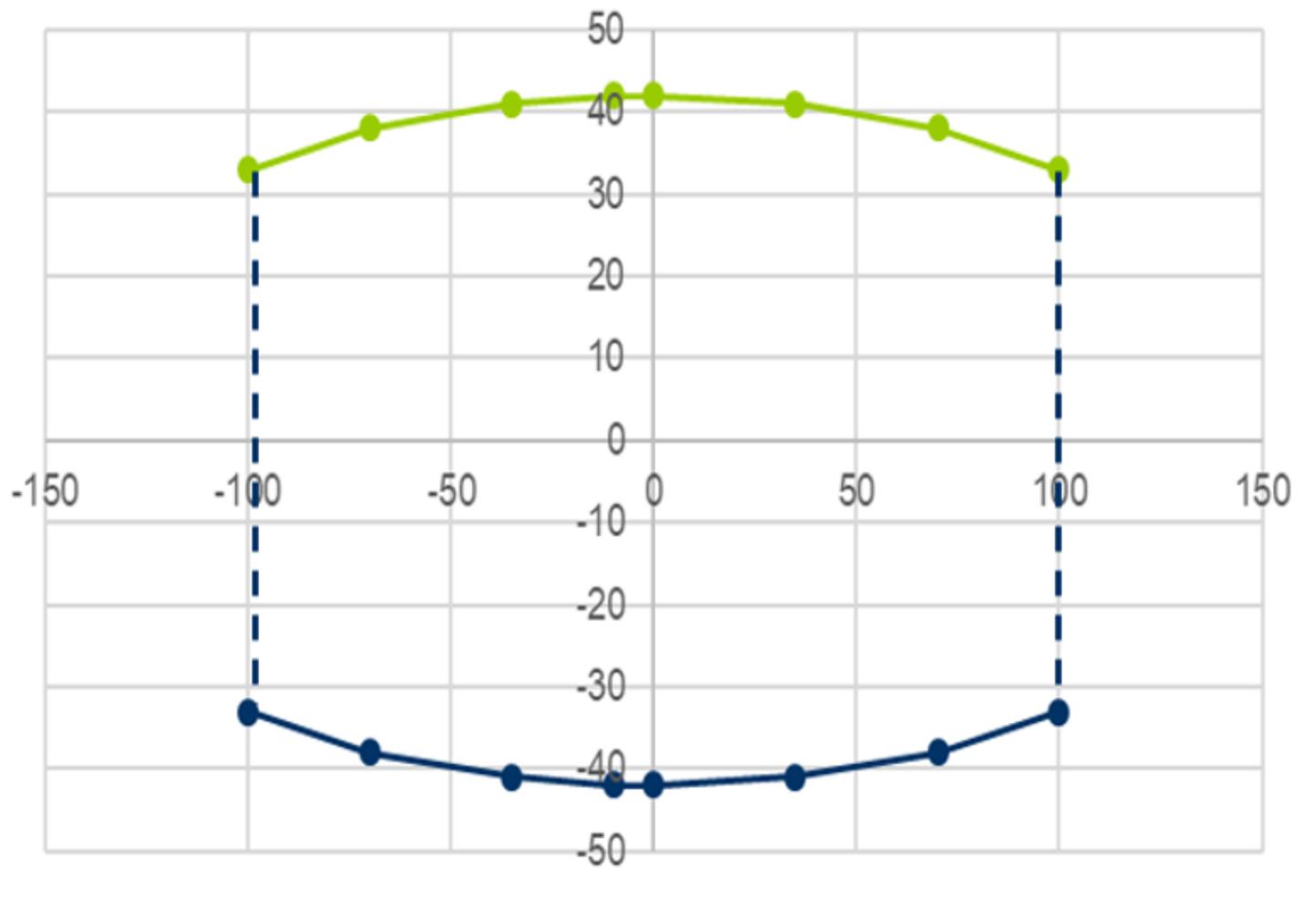


Figure 16: Example of inverter-based DC-coupled open-loop solar-storage Hybrid Resource with 100 MW solar and 100 MW battery.



Attachment E: Reactive Capability Testing

<p><u>DC-COUPLED INVERTER-BASED HYBRID RESOURCES</u></p> <p><u>Max MW Output = fully discharging/producing</u></p> <p><u>Min MW Output = fully charging with no production (or 0 MW net output if facility cannot charge from grid)</u></p>	<u>MAX</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>MAX</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
	<u>ZERO</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>ZERO</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
	<u>MIN</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
<p><u>AC-COUPLED INVERTER-BASED HYBRID RESOURCES</u></p> <p><u>Max MW Output = fully discharging/producing</u></p> <p><u>Min MW Output = battery fully charging and generation at 0 MW (if facility cannot charge from grid, omit this point)</u></p> <p><u>Zero net MW point must reflect the most conservative capability at that power level, for example with a battery at full charging and generation output matching as close to battery charge power as practicable.</u></p> <p><u>Max inverter operating point = generation as close to full output as practicable and battery at full charging</u></p>	<u>MAX</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>MAX</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
	<u>MAX INVERTER OPERATING POINT</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>MAX INVERTER OPERATING POINT</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
	<u>ZERO</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>ZERO</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
	<u>MIN</u>	<u>MAX LAG</u>	<u>WHEN LIMIT REACHED</u>
	<u>MIN</u>	<u>MAX LEAD</u>	<u>WHEN LIMIT REACHED</u>
<p><u>*Additional test points may be required if these do not capture the most restrictive capability scenarios.</u></p>			

A single MOC must be responsible for dispatch interactions (i.e., there must be a single operational contact) for all Co-Located Resources at a single Mixed Technology Facility, following either Option 1 or Option 2 below.

Option 1: PJM Operations would prefer a model where there is a single MOC Generation Dispatcher (single operational contact) responsible for the entire jointly owned resource operations. The single contact would be responsible for all day-ahead and real-time bidding into PJM Systems (Markets Gateway), process an SCED basepoint, real-time communications with PJM Dispatch, as well as providing accurate outage information within eDART. Settlements can be allocated by PJM based on ownership shares.

...

Option 2: The alternate solution would still require a single MOC Generation Dispatcher (single operational contact) for manual real-time communications with PJM Dispatch, where the operational nature of the situation requires live verbal communications. Each owner/off taker of a jointly owned resource would still be able to interact directly with PJM Dispatch for market related matters, and with Markets Gateway, providing day-ahead offers and hourly updates. The single operational contact would be responsible for all manual real-time communications with PJM Dispatch, as well as providing accurate outage information within eDART. PJM SCED would send individual basepoints to each owner/off taker. Settlements will model individual owner/off takers of a jointly owned resource.

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**1st Read Manual Language for Hybrids
Phase 1a – Manual 14D and Manual 10**



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APPENDIX: MIC REVISIONS FOR INFORMATION PURPOSES

- Add Hybrid Resources to the exemption from the Capacity Market must offer rule currently applied to Intermittent Resources and Capacity Storage Resources.
- E.g., Manual 18 Section 5.4 “Sell Offers in PJM”
 - “Intermittent Resources, Capacity Storage Resources, Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources, Demand Resources, and Energy Efficiency Resources are not required to submit a Capacity Performance sell offer segment.”
- This provision is currently in Manual 18 sections 4.7.1, 5.4.1, 5.7.1, and 5.8.1

Section 4.7.1 “Resource Position for Generation Capacity Resources”

- “For an RPM Auction, a party’s Daily Unoffered ICAP for a generation resource is equal to the party’s Minimum Available ICAP Position minus the Offered ICAP in the party’s sell offer. Effective with the 2020/2021 Delivery Year, the Daily Unoffered ICAP for Capacity Storage [Resources](#), Intermittent [Resources](#), [Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), and Environmentally-Limited Resources is not applicable since these resources are not subject to a Capacity Performance must offer requirement.”

Section 5.4.1 “Sell Offers in RPM”

- “With the exception of Intermittent Resources, Capacity Storage Resources, [and Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), each Generation Capacity Resource with available capacity that is capable or can reasonably become capable of qualifying as a Capacity Performance Resource must submit a Capacity Performance sell offer segment.”
- “Intermittent Resources, Capacity Storage Resources, [Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), Demand Resources, [and](#) Energy Efficiency Resources are not required to submit a Capacity Performance sell offer segment.”

Section 5.7.1 “Participation in the Base Residual Auction”

- “Following a Base Residual Auction, a party’s Daily Unoffered ICAP for a generation resource is calculated and is equal to the Available ICAP Position minus the Offered ICAP in the party’s sell offer. Effective with the 2020/2021 Delivery Year, the Daily Unoffered ICAP for Capacity Storage [Resources](#), Intermittent [Resources](#), [Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), and Environmentally-Limited Resources is not applicable since these resources are not subject to a Capacity Performance must offer requirement.”

Section 5.8.1 “Participation in the Incremental Auctions”

- A party’s Minimum Available ICAP Position represents the minimum amount that must be offered into an RPM Auction. A party’s Minimum Available ICAP Position on a unit for an RPM Auction is equal to the minimum Daily Minimum Available ICAP for such unit during the Delivery Year. Effective 2020/201 Delivery Year, a party’s Minimum Available ICAP for the summer/winter season will also be calculated in the Capacity Exchange system; however, Capacity Storage [Resources](#), Intermittent [Resources](#), [Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), and Environmentally Limited Resources are exempt from the Capacity Performance must offer requirement.”
- A party’s Daily Unoffered ICAP for a specific unit is calculated by adding the sum of any Daily Unoffered ICAP for such unit in prior RPM Auctions to Daily Unoffered ICAP amounts transacted through a party’s approved unit-specific bilateral sales/purchases. Effective with the 2020/2021 Delivery Year, the Daily Unoffered ICAP for Capacity Storage [Resources](#), Intermittent [Resources](#), [Hybrid Resources consisting exclusively of components that in isolation would be Intermittent Resources or Capacity Storage Resources](#), and Environmentally-Limited Resources is not applicable since these resources are not subject to a Capacity Performance must offer requirement.

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