



DER and Inverter-based Resources Subcommittee (DIRS) Solar-Battery Hybrid Resources - Final Report (Phase I)

July 1, 2021

Issue Creation

The Solar-Battery Hybrid Resources [Problem Statement](#) and [Issue Charge](#) was brought forward by PJM staff and approved by the members at the June 3, 2020 Markets Implementation Committee [meeting](#).

Issue Summary

From the key work activities of the issue charge, the DIRS worked to provide education on solar-battery hybrid resources, including the current interconnection and planning analyses related to this resource type, the electrical configurations of hybrid and co-located solar-battery hybrids, as well as any other existing PJM business rules that apply to this resource type. The subcommittee then discussed potential gaps in business rules and improvements that could be made to address the integration of this emerging class of resources in the PJM market.

Consensus-Based Issue Resolution Process

Number of Meetings and date range covering this topic: The DIRS met 12 times from August 2020 to June 2021 to discuss this issue.

Non-Binding Poll Results – stakeholders registered zero objections to moving 2 proposals forward to the MIC

Final Matrix - <https://www.pjm.com/-/media/committees-groups/subcommittees/dirs/2021/20210628/20210628-item-09-solar-battery-hybrid-solutions-matrix-post-meeting.ashx>

1. Package A

Package A provides updates to PJM's governing documents and business manuals to clarify various aspects of market participation by solar-battery hybrid resources.

First, the proposal introduces new definitions and modifies existing definitions. "Mixed Technology Facility", "Hybrid Resource", "Co-located Resource", and "Open-Loop Hybrid Resource" are newly defined terms. "Open-Loop Hybrid Resource" also gets added to the existing Energy Storage Resource definition. And finally, "Standalone Energy Storage Resource" is defined to draw distinction between Hybrid Resources and all other Energy Storage Resources. These definitions are required to clarify new resource types, draw distinction between different forms of hybrid resources, and apply new or existing business rules to each resource type.

For Co-located Resources, the proposal clarifies that market participation occurs separately for each underlying resource type. Metering and telemetry are required both at the Point of Interconnection (POI) and on one or all of



the underlying resource types behind the POI, depending on the telemetry point (MW, MVAR, state of charge, meteorological data).

For Hybrid Resources and Open-Loop Hybrid Resources, the proposal introduces participation models for solar-battery hybrids that will be similar to the existing ESR Participation Model (Order 841), except that a “solar-only mode” will be added to the ESR model, non-energy Regulation & reserves modes would be removed, and for closed-loop solar battery hybrids the ESR model lack negative MW offer parameters since these resources are physically incapable of charging from the grid.

The proposal also clarifies that solar-battery hybrid resources should report both eDART and GADS outages separately for the solar component and storage component whenever unavailable or derated. No eDART ticket is required for lack of solar irradiance, charging, nor lack of charge.

And finally, the proposal provides new reactive testing requirements for both AC-coupled and DC-coupled hybrid resources.

2. Package C

Package C is identical to Package A except for one solution option in design component #5 pertaining to the Regulation Market. Package A proposes to measure Regulation performance at the POI of the hybrid resource. Package C proposes:

“For hybrid resources, two ways to provide regulation service are available:

(1) Battery output is used to balance out intermittent renewable output, where resource response is measured at the point of interconnection meter.

(2) Battery output is not used to balance out intermittent renewable output, and resource response is instead measured independently for the battery component level using submeter output/telemetry.”

Appendix I: Supplemental Documents

Committee Page - <https://www.pjm.com/committees-and-groups/subcommittees/dirs.aspx>

Issue Tracking - <https://www.pjm.com/committees-and-groups/issue-tracking/issue-tracking-details.aspx?Issue=3423b18c-59c2-49dd-84c5-af42b1ba0256>

FERC Docket – AD20-9 (related) – Technical Conference on Hybrid Resources



Appendix II: PJM Participation

Facilitator – Scott Baker

Secretary – Hamad Ahmed

Advocate – Adam Keech

Subject Matter Experts – Andrew Levitt, Darrell Frogg, Vince Stefanowicz

PJM Legal – Thomas DeVita

Appendix III: Stakeholder Participation

Last Name	First Name	Company Name	Sector
Aguilera	Jorge	Duke Energy Ohio, Inc. (EDC)	Transmission Owner
Ainspan	Malcolm	NRG Curtailment Solutions, Inc.	Other Supplier
Allen	William	Commonwealth Edison Company	Transmission Owner
Arnold	Katelyn	PPL Electric Utilities Corp. dba PPL Utilities (LSE)	Transmission Owner
Arsalan	Qamar	Public Service Electric & Gas Company	Transmission Owner
Baker	Jeff	PJM Connect	
Beam	George	PPL Elec Utilities Corp dba PPL Utilities (PPL POLR Small C&I)	Transmission Owner
Benчек	Jim	FirstEnergy Corporation	
Berton	Tyler	AEP Appalachian Transmission Company, Inc.	Transmission Owner
Bhana	Rajesh	Exelon Business Services Company, LLC	Transmission Owner
Borkoski	John	MD Public Service Commission	
Bowring	Joe	Monitoring Analytics	



Breidenbaugh	Aaron	Rodan Energy Solutions (USA) Inc.	Other Supplier
Brodbeck	John	EDP Renewables North America LLC	Generation Owner
Brooks	Richard	Reliable Energy Analytics LLC	
Buhler	Thomas	PJM Connect	
Burnham	Kat	Advanced Energy Economy (AEE)	
Burns	Kevin	Open Access Technology International, Inc.	None
Butler	Michelle	Guidehouse	
Callen	Zachary	Illinois Commerce Commission	
Campbell	Bruce	Enerwise Global Technologies, LLC	Other Supplier
Canter	David	Appalachian Power Company (AEP Generation)	Transmission Owner
Caspary	Jay	Electric Power Engineers, Inc.	
Chakragiri	Mohan	ENGIE Energy Marketing NA, Inc. (Bluestone)	Other Supplier
Cham	Edrissa	Savion, LLC	
Chang	Sean	Shell Energy North America (US), L.P.	Other Supplier
Chee	Yee Hong	MCG Energy Solutions	
Chilukuri	Kalyan	Power System Consultants	
Christopher	Mahila	Public Utilities Commission of Ohio	
Circelli	Roseanne	Public Service Electric & Gas Company	Transmission Owner
Collette	Lucas	Duquesne Light Company	Transmission Owner



Comeau	Jeremy	IN Utility Regulatory Commission	
Connelly	Nancy	Duke Energy Ohio, Inc.	Transmission Owner
Coyle	Billy	Dominion Virginia Power	Transmission Owner
Currier ES	Jeff	Dominion Virginia Power	Transmission Owner
Dailey	Michael	Northern Virginia Electric Cooperative (NOVEC)	Electric Distributor
D'Alessandris	Louis	American Transmission Systems, Inc.	Transmission Owner
Davis	James	Dominion Energy Generation Marketing, Inc.	Generation Owner
Delaney	Liz	Borrego Solar	
DeLosa	Joseph	New Jersey Board of Public Utilities	
Dibert	Meredith	Pennsylvania Department of Environmental Protection	
DiNicola	Laura	firstenergy	
Diong	Mamadou	Dominion Virginia Power	Transmission Owner
Dixon	Chad	Customized Energy Solutions, Ltd.	None
Domian	Christin	Duquesne Light Company	Transmission Owner
Drom	Rick	Rick Drom	
Dugan	Chuck	East Kentucky Power Cooperative, Inc.	Transmission Owner
EJEBE	GABRIEL	Open Access Technology International, Inc.	None
Elkins	Rachel	American Transmission Systems, Inc.	Transmission Owner
Ellis	David	Public Service Electric & Gas Company	Transmission Owner



Ericson	Christine	Illinois Commerce Commission	
Feldman	Brett	Other	
Felt	Justin	Baltimore Gas and Electric Company (Residential)	Transmission Owner
Filomena	Guy	Customized Energy Solutions, Ltd.	None
Fink	Regan	Pine Gate Renewables	
Fleisher	Madeline	Dickinson Wright PLLC	
Foladare	Kenneth	Geenex Solar LLC	Other Supplier
Ford	Adrien	Old Dominion Electric Cooperative	Electric Distributor
Foster Cronin	Denise	East Kentucky Power Cooperative, Inc.	Transmission Owner
Fuess	Christian	PBF Power Marketing, LLC	Generation Owner
Gahimer	Michael	Indiana Office of Utility Consumer Counselor (IN OUCC)	
Garnett	Bryan	Duke Energy Ohio, Inc.	Transmission Owner
Gates	Terry	Appalachian Power Company (AEP Generation)	Transmission Owner
Gilani	Rehan	ConEdison Energy, Inc.	Other Supplier
Gouin	Marlena	Pennsylvania Electric Company	Electric Distributor
Granstrand	Luke	Dominion Virginia Power	Transmission Owner
Greiner	Gary	PSEG Energy Resources and Trade LLC	Other Supplier
Guntle	Vince	American PowerNet Management, L.P.	End-Use Customer
Hanser	Erik	Michigan Public Service Commission	
Hartman	Gary	PPL Electric Utilities Corp.	Transmission Owner



		dba PPL Utilities (LSE)	
Hasan	Prusha	Advanced Energy Economy	
Heinle	Frederick	Office of the Peoples Counsel	
Heitmeyer	Chad	Appalachian Power Company (AEPSCO)	Transmission Owner
Hoatson	Tom	West Deptford Energy, LLC	Generation Owner
Hohenshilt	Jennifer	Talen Energy Marketing, LLC	Generation Owner
Holdbrook	Ruth	Northern Virginia Electric Cooperative (NOVEC)	Electric Distributor
Horning	Lynn Marie	Customized Energy Solutions, Ltd.	None
Horstmann	John	Dayton Power & Light Company (The)	Transmission Owner
Hull	Gerit	American Municipal Power, Inc.	Electric Distributor
Hunter	Benjamin	BSHunter	
Hyzinski	Tom	GT Power Group	
Iler	Arthur	Indiana Office of Utility Consumer Counselor	
Janicki	Diane	Boston Energy Trading and Marketing LLC	Other Supplier
Jardot	Gina	NRG Curtailment Solutions, Inc.	Other Supplier
Jett	William	Duke Energy Business Services LLC	Transmission Owner
Jewell ES	Kelsi	Dominion Virginia Power	Transmission Owner
Jha	Monica	PCI	
Johnson	Augustus	Dominion Virginia Power (EDC)	Transmission Owner
Johnson	Bethany	PPL Electric Utilities Corp. dba PPL Utilities (TO)	Transmission Owner



Johnson	Carl	Customized Energy Solutions, Ltd.	None
Johnson	Nathaniel	Appalachian Power Company (AEP Generation)	Transmission Owner
Johnston	David	Other	
Kauffman	Brian	Enel X North America, Inc.	Other Supplier
Kayne	Samuel	Delaware PSC	
Kelly	Stephen	Brookfield Renewable Trading and Marketing LP (BSMH)	Other Supplier
Kennedy	Thomas	Commonwealth Edison Company	
Kilgallen	Kevin	Avangrid Renewables, LLC	Generation Owner
Knodel	Brook	Iowa Utilities Board	
Koehler	Nicolas	Appalachian Power Company (AEP Transmission)	Transmission Owner
Kogut	George	New York Power Authority	Other Supplier
Kozhuharov	Dimitar	State Commissions	
Lee	Thomas	Enerwise Global Technologies, LLC	Other Supplier
Legates	Katherine	Appalachian Power Company (AEP Generation)	Transmission Owner
Levitt	Benjamin	IHS Markit	
Lieberman	Steven	American Municipal Power, Inc.	Electric Distributor
Lopez-Lopez	Anthony	Hill Top Energy Center, LLC	Generation Owner
Lousos	Alexandros	AMP Transmission, LLC	Transmission Owner
LOWE	CONNIE	Dominion Virginia Power	Transmission Owner
Lyakhovich	Leonid	Public Service Electric & Gas Company	Transmission Owner



Mabry	David	McNees Wallace & Nurick LLC	
Mariam	Yohannes	Office of the People's Counsel for the District of Columbia	
martin	Valerie	Federal Energy Regulatory Commission	
mason	julie	Duke Energy Ohio, Inc.	Transmission Owner
MASON	Ray	Other	
McCormick	Katharine	Illinois Commerce Commission	
McInerney	Timothy	Commonwealth Edison Company	Transmission Owner
meridionale	Kevin	Jersey Central Power & Light Company	Transmission Owner
Midgley	Sharon	Exelon Business Services Company, LLC	Transmission Owner
Nester	Mike	Dominion Virginia Power (EDC)	Transmission Owner
Newman	Jonathan	AES Energy Storage, LLC	Generation Owner
Nix	Emma	Jersey Green Energy LLC	Other Supplier
Norton	Chris	American Municipal Power, Inc.	Electric Distributor
Ondayko	Brock	AEP Energy Partners, Inc. (AEP Gen Resources)	Transmission Owner
Parker	Amanda	Pennsylvania Electric Company	Electric Distributor
Parkison	Sara	University of Delaware	
Peoples	John	Duquesne Light Company	Transmission Owner
Polka	Joseph	Duquesne Light Company	
Pratt	Nicholas	PPL Electric Utilities Corp. dba PPL Utilities (TO)	Transmission Owner
Price	Ruth	Delaware Division of the Public Advocate	



Procniar	Jason	Buckeye Power, Inc.	Electric Distributor
Purdie	Michael	Dominion Virginia Power	Transmission Owner
Quier	David	PPL Electric Utilities Corp. dba PPL Utilities (TO)	Transmission Owner
Rahimi	Farrokh	Open Access Technology International, Inc.	None
Rahmes	Lawrence	Electric Power Engineers	
Reagan	Ryann	New Jersey Board of Public Utilities	
Reder	Wanda	PPL	
REILLY	Jim	Reilly Associates	
Robinson	Becky	visra energy	
Rodriguez	Tomas	Organization of PJM States, Inc.	
Rohrbach	John	Wabash Valley Power Association, Inc.	Electric Distributor
Rooney	Alexa	PPL Electric Utilities Corp. dba PPL Utilities (TO)	Transmission Owner
Rosenblatt	Alex	Duquesne Light Company	Transmission Owner
Rouland	James	PPL Electric Utilities Corp. dba PPL Utilities (LSE)	Transmission Owner
Rumsey	Amanda	PPL Electric Utilities Corp. dba PPL Utilities (TO)	Transmission Owner
Rutigliano	Tom	Natural Resources Defense Council	
Sailers	Bruce	Duke Energy Ohio, Inc. (EDC)	Transmission Owner
Sarkel	Edward	New Jersey Board Of Public Utilities	
Sasser	Jonathan	Customized Energy Solutions, Ltd.	None



Scarpignato	David	Calpine Energy Services, L.P.	Generation Owner
Schisler	Kenneth	Enerwise Global Technologies, LLC	Other Supplier
Segner	Sharon	Silver Run Electric, LLC	Transmission Owner
Seireg	Bahaa	Rockland Electric Company	Transmission Owner
Sharkazy III	William	PPL Electric Utilities Corp. dba PPL Utilities (LSE)	Transmission Owner
Shearer	Evan	Duke Energy Business Services LLC	Transmission Owner
Skumanich	Bill	RTR Energy Solutions LLC	None
Smith	Mark	AEP Energy Partners, Inc. (AEP Retail)	Transmission Owner
Sorrels	James	AEP Appalachian Transmission Company, Inc.	Transmission Owner
Stair	Kyle	Peak Power Inc	
Stein	Ed	Ohio Edison Company	Electric Distributor
Stern	Alexander	Public Service Electric & Gas Company	Transmission Owner
Stupar	Rob	Invenergy Energy Management LLC	Generation Owner
Svenson	Heather	Public Service Electric & Gas Company	Transmission Owner
Swalwell	Brad	Tangent Energy Solutions, Inc.	Other Supplier
Sweeney	Rory	GT Power Group, LLC	None
Taylor	Robert	Commonwealth Edison Company	Transmission Owner
Thomas	Sharon	Energy Storage Association	
Thundiyl	Kevin	Exelon Generation Co., LLC (NEV_XLON)	Generation Owner
Tighe	Andrea	CAPS	
Tobia	James	FirstEnergy Services	



Tyler	Catherine	Monitoring Analytics	
Walker	Jacqueline	Duke Energy Business Services LLC	
Warchol	Jerry	Dominion Virginia Power (EDC)	Transmission Owner
Watson	Betty	Affirmed Energy LLC	Other Supplier
Webster	John	Icetek.com, Inc.	Other Supplier
Wehnes	Kathleen	Maryland Department of the Environment	
Wehr	Christopher	Ohio Edison Company (EDC)	Electric Distributor
Wharton	Matthew	Guidehouse Inc	
Whitehead	Jeffrey	GT Power Group	
Whitmoyer	Bernie	Jersey Central Power & Light Company	Transmission Owner
Willey	Amy	Delaware Public Service Commission	
Wisersky	Megan	Madison Gas & Electric Co.	Other Supplier
Wray	Gizelle	Solar Energy Industries Association (SEIA)	
Xenopoulos	Damon	Other	
Yi	Jin An	jinan	
Yoo	Kyungjin	Monitoring Analytics	
Younes	Vivian	PPL Electric Utilities Corp. dba PPL Utilities (LSE)	Transmission Owner