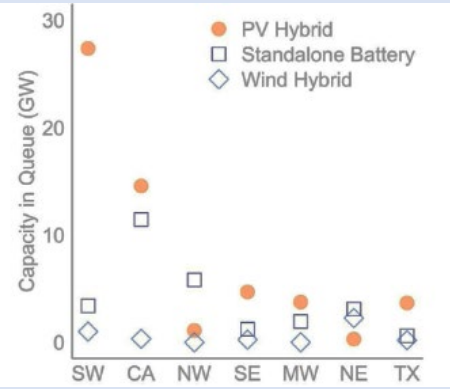
Status of Hybrid Resource Initiatives in U.S. Organized Wholesale Markets

UPDATE: May 19, 2020

Hybrid Resources Initiatives

Status: Initiatives currently underway in 5 RTOs/ISOs; discussions underway in 2 RTOs/ISOs

For the past year, developers and others around the country have had growing interest in hybrid resources involving battery storage coupled with power generation, particularly non-dispatchable solar and wind power. The significant increase in the number of hybrid resources appearing in interconnection queues is evidence of this trend. According to a study by researchers at Lawrence Berkeley National Laboratory and Electric Power Research Institute, 4.6 GW of hybrid resource capacity is online today, 14.7 GW of hybrid resources are in the immediate development pipeline, and 69 GW of hybrid resources are in select interconnection queues. Figure 1 illustrates a regional breakdown of U.S. hybrid and standalone battery projects at the end of 2018, based on ISO/RTO and additional utility queue data.



Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) have taken notice of this, and have begun to devote more time and attention to this topic. To date, all seven RTOs and ISOs are discussing hybrid resources with stakeholders in an effort to pave the way for greater participation opportunities for these resources, with five markets actively undertaking new rules development. The scope and pace of these discussions vary greatly across different regions.

Additionally, the Federal Energy Regulatory Commission has announced a technical conference on hybrid resources for July 23, 2020, and opened a docket on the subject (AD20-9), raising the prospect of a rulemaking in the near future. ESA has previously suggested that a rulemaking on hybrid resources could follow the format of Order 841, which directed RTOs/ISOs to devise a new participation model for standalone energy storage resources.

Figure 1. Hybrid Resources in Generator Interconnection Queues
Source: Lawrence Berkeley National Laboratory

The following summary tables provide an overview of the present status of hybrid resource discussions in each RTO and ISO, the scope of their discussions or initiatives, as well as their capacity accreditation approach for valuing hybrid resources in capacity markets.

Current Status by RTO/ISO

	CALIFORNIA INDEPENDENT SYSTEM OPERATOR (CAISO)
Committee	N/A (CAISO Hybrid Resources Initiative)
Status	Straw proposal underway since the fall of 2019 with revisions published in December 2019 and April 2020 following stakeholder comments. This paper will serve as the final proposal for these rule changes.
Timing	• April 29, 2020: Second revised straw proposal was released • May 7, 2020: Meeting to discuss second revised straw proposal • May 28, 2020: Comments due on second revised straw proposal • June 30, 2020: EIM Governing Body meeting (phase 1) • July 22, 2020: Board of Governors meeting (phase 1) • August 4, 2020: Draft final proposal • August 11, 2020: Meeting • November 2020: Board of Governors and EIM Governing Body meetings (phase 2)
Current Scope	Straw proposal covers forecasting, modeling and charging capability for hybrid resource (HRs) and co-located resources, market participation proposal for HRs, interconnection, market interaction, ancillary services, settlement, data and telemetry, and resource adequacy (RA).
Resources	• Original Straw Proposal (September 2019) • Revised Straw Proposal (December 2019) • Second Revised Straw Proposal (April 2020) – CAISO notes that an addendum to this straw proposal is forthcoming prior to the 5/28 comment deadline • 5/7 Web Meeting Part I; Web Meeting Part II

	NEW YORK INDEPENDENT SYSTEM OPERATOR (NYISO)
Committee	Business Issues Committee (BIC) - ICAP Working Group (ICAPWG)
Status	NYISO began a HR discussion in the ICAPWG at beginning of this year (1/13 ICAPWG meeting), where they discussed plans to develop a Hybrid Storage Model for allowing large FTM energy storage resources (ESR) paired with generation, or paired DERs, to participate in its markets. The Hybrid Storage Model project will evaluate co-located ESR to receive a single schedule and dispatch signal. The project will also evaluate a "virtual hybrid" option for a bilateral transaction between a standalone renewable resource and a standalone ESR (and in this configuration, the resources would be behind separate interconnections; this would be a way to potentially claim the ITC). At the 4/14 ICAPWG meeting, NYISO gave a presentation on their proposal for their 2020 Hybrid Storage Model project, including participation proposals, existing capacity obligations, and installed capacity and unforced capacity proposals. Current discussions focus on separate metering for HRs. At the 5/11 ICAPWG meeting, NYISO discussed their hybrid storage interconnection proposal.
Timing	Launched in January 2020; planned completion of Hybrid Storage Model proposal by fall 2020 (with potential vote by the BIC at end of 2020) • Q1 2020: Initiate discussions on market concepts for HRs • Q2 2020: Continue discussions on market participation concepts for HRs; Present Market Design Concept Proposal to stakeholders • Q3 2020: Present consumer impact analysis and completed market design to stakeholders • Q4 2020: Market participation model will be developed for a potential vote at BIC by the end of 2020 • 1/13/20 ICAP Meeting Materials (Hybrid Resource Model Presentation) • 4/14/20 ICAPWG Meeting Materials (Hybrid Storage Model: Market Design Overview & Capacity Market Design Overview) • 5/11/20 ICAPWG Meeting Materials (Hybrid Storage Interconnection Proposal; capacity accreditation)
Current Scope	Development of a Market Participation Model. Will entail exploration of: • Participation in NYISO's Energy and Ancillary Services markets • Participation in NYISO's Installed Capacity markets • Settlement process • Modeling for interconnection, planning, and operations • Metering requirements
Resources	• ICAPWG Meeting Materials

	ELECTRIC RELIABILITY COUNCIL OF TEXAS (ERCOT)
Committee	Technical Advisory Committee (TAC) - Battery Energy Storage Task Force (BESTF)
Status	BESTF launched in the fall of 2019 to develop policy recommendations related to battery storage resources' integration into the grid, which subsequently added discussion of hybrid resources. There are two types of HRs under discussion in ERCOT: (1) AC-coupled resources, where each resource has its own inverter; and (2) DC-coupled resources, where resources share an inverter. ERCOT feels that existing rules and software are sufficient for AC-coupled resources (so implementation can be immediate). Therefore, the focus of the HR discussions in ERCOT is on DC-coupled resources. The BESTF work on operational and market design policies for DC-coupled resources will depend largely on a standalone storage model, which ERCOT is planning through a two-step approach: (1) rules that can be implemented in the short-term to integrate battery ESR under the "combination model" structure where resources are treated in ERCOT as a Generation and Controllable Load Resource Combination; and (2) rules that can be implemented on a longer timeline to integrate battery ESR under a "single model" structure where ERCOT will consider a DC-coupled resource as a single device for charging and discharging. At the 5/1 meeting, BESTF discussed ESR Single Model Registration and Charging Restrictions in Emergency Conditions as well as the Nodal Protocol Revision Request (NPRR) 1014 that will enable ESR integration as a single-model resource, replacing the existing "combination model" paradigm. Comments were due 5/14.

Timing	BESTF launched in Fall 2019
	• December 2019: the business case for hybrid resources was discussed.
	• March 2020: reached consensus on KTC's 11, 12, 13, and 14 (these KTC documents provide guidance on how the NPRRs and related documents are to be drafted)
	  ○ KTC 11: DC-coupled resources (various changes proposed)
	  ○ KTC 12: AC-coupled resources (no changes proposed because existing rules still work)
	  ○ KTC 13: Self-limiting Issues related to Interconnection Requests for ESRs
	  ○ KTC 15: Proxy Process for ESR Bids/Offers and A.S. Offers (for both Combo Model and Single Model)
	• 4/3/2020: KTCs 11-15 were approved by TAC
	• May 2020: plan to release NPRRs; once submitted to the Protocol Review Subcommittee, each NPRR will be reviewed at several subcommittees, including the BESTF, and eventually sent to TAC; after TAC approval, it would go to the Board of Directors for their approval.
	• May–December 2020 (near-term): implementation of a "Combo Model ESR"
	• Mid 2024 (longer-term): switch to a "Single Resource Model"

Current Scope	As stated earlier, the focus in ERCOT is on developing operational and market design rules for DC-coupled resources. The specific focus is on DC-coupled resources with solar and wind (all other technologies are out of scope). In meetings, ERCOT has specified plans to review a wide range of topics such as forecasting, participation model, mitigation, telemetry, planning studies, generation interconnection studies, energy offer/bid curve and RTM energy bidding and settlements.
Resources	• 4/1/20 BESTF Meeting Materials (includes updates on KTC 11, 12, 13, and 15) • 5/1 BESTF Meeting Materials

	MIDCONTINENT INDEPENDENT SYSTEM OPERATOR (MISO)
Committee	Market Subcommittee (MSC - primary committee); other committees are Planning Advisory Committee (PAC) and Resource Adequacy Subcommittee (RASC)

Status	• MISO is working on 22 hybrid resource issues across the broader topics of RA, planning/interconnection, and market operations. MISO planned to develop an initial participation model by March, but this has now been pushed to Q2 of 2020.
	• On 3/11/20, MISO shared the initial results from the Integrated Roadmap Stakeholder Prioritization process. MISO ranked Hybrid Resources as a low priority (because they said it would affect a small subset of market participants), but stakeholders had ranked this high. MISO recognized this discrepancy.
	• The plan was for MISO to next deliver the final prioritization workshop and provide an update on the Integrated Roadmap 5 Year Workplan on 4/8/20, but this is now postponed to 6/10/20. ESA anticipates that this issue will be dealt with in the Markets Subcommittee.
	• Hybrid capacity accreditation going forward is expected to be housed in the RASC. The hybrid issue is under the Resource Availability and Need (RAN) - Resource Accreditation (RASC010), inclusive of:
	  ○ IMM 2018-5 (hybrid accreditation)
	  ○ Hybrid Issues from the Energy Storage Task Force
	  ○ IR095 - Forward Capacity Accreditation for Renewable Resources & IR096 - Forward Capacity Accreditation for Use-Limited Resources
	• PAC has reviewed 6 Hybrid issues that relate to:
	  ○ Generator Interconnection
	  ▪ How a HR will be studied in the generator interconnection process
	  ▪ Control systems to ensure output does not exceed interconnection service level; what processes can be used to ensure that net output does not exceed interconnection service
	  ○ Surplus Interconnection
	  ▪ Identify a viable path to add ESR to existing generators for the purposes to firming capacity
	  ▪ Endeavor to clarify the material modification threshold as it applies to storage being added to queued generators and specify appropriate study assumptions
	  ○ Displacement Agreement for Hybrid Resources
	  ▪ Displacement agreements between an energy and capacity resource will be part of a Net Zero condition complicating compliance with must-offer obligations.
	  ○ Temporary violation of Interconnection Rights to provide A.S.
	  ▪ Allow HRs to briefly increase their output above their injection limits and transmission system thermal limits (but not stability limits) to provide primary frequency response and other short-duration upward A.S.

Timing	• The PAC has been discussing aspects of HRs for a number of years, such as Net Zero Interconnection. • 2/12/2010: PAC discussed more detailed status on hybrid issues related to generator interconnection, surplus interconnection, displacement agreement for hybrid resources, and temporary violation of interconnection rights to provide A.S. • 3/11/20: The MSC began discussing this at the Integrated Roadmap Stakeholder Prioritization Workshop • 6/11/20: MISO to deliver the final prioritization workshop and provide an update on the Integrated Roadmap 5 Year Workplan
Current Scope	Hybrid Resource Participation Model Development. Specific topics include capacity accreditation, planning/interconnection, and market operations.
Resources	• Committee Assignment document (shows which committees have primary responsibility for various hybrid resource topics) • 2/12/10 PAC Meeting Materials • 3/11/20 Integrated Roadmap Stakeholder Prioritization Workshop materials

	PJM INTERCONNECTION
Committee	Markets and Reliability Committee (MRC) and Capacity Capability Senior Task Force (CCSTF)
Status	PJM presented a first read at their 3/26/20 MRC meeting of a problem statement/issue charge to create a new Task Force to develop potential new rules for solar-battery hybrid resources, which make up 95% of the of co-located generation and storage HRs in the interconnection queue. The intention of the task force is to educate stakeholders on the types and MW amounts of HRs in the PJM interconnection queue, provide clarity of how existing requirements apply to solar+storage resources, and explore the necessity of new requirements and provisions for HRs which potentially include a new capacity valuation methodology. At the 4/30 meeting, PJM revised the issue charge to include wind + gas hybrids. Separately, the CCSTF is developing an ELCC method to qualify the capacity of hybrid resources, in addition to standalone storage and standalone wind/solar.
Timing	CCSTF launched April 2020 • 3/26/20: Markets and Reliability Committee meeting (discussed problem statement/Issue Charge to create Hybrid Resource Task Force) • 4/27/20: CCSTF meeting (PJM provided a brief summary on HRs and Storage as Transmission Resource and how these stakeholder efforts will be worked in parallel with the CCSTF; PJM also led a discussion of the scope of the term "limited duration resource" in the CCSTF Issue Charge) • 4/30/20: MRC meeting (Hybrid resource Issue Charge revised to include wind + gas hybrids) • 5/28/20: MRC meeting (Hybrid resource Issue Charge to be read; Task Force expected to be launched)
Current Scope	Solar-battery Hybrid Resources. Specific topics include Energy and Ancillary Services; Metering and Telemetry; Calculating capability of solar-battery hybrids in capacity market, and Market Modeling.
Resources	• PJM's FAQ on hybrid resources during the Order 841 compliance filing development process • Issue Charge and Problem Statement documents • MRC meeting materials • CCSTF meeting materials

	SOUTHWEST POWER POOL (SPP)
Committee	Markets and Operations Policy Committee (MOPC) - Supply Adequacy Working Group (SAWG), Electric Storage Resource Steering Committee (ESRSC), Market Working Group (MWG), and Operating Reliability Working Group (ORWG)
Status	• ESRSC: SPP began discussing a January 2020 paper, "Electric Storage Resource White Paper," and how to divide up roles and responsibilities to cover issues in this paper. SPP has a live document on ESRSC website to keep track of which groups have responsibility for various tasks. Task "E2" (an energy and Related Service issue) takes on the responsibility of exploring modeling of HRs as one resource for economic optimization, instead of modeling ESR and renewable energy separately. ○ Current Responsible Groups: MWG, ORWG, and SPP Staff (but roles could be in flux) • SAWG: Since the beginning of this year, SPP has been discussing a January 2020 paper on "Energy Storage Accreditation Methodology," which includes a line item for "Hybrid Resource Consideration" and requests feedback from stakeholders.
Timing	ESRSC first met in March 2020 • 3/3/20: ESRSC's first meeting, which was an overview of what ESRSC was, a review of ESRSC scope, and a review of the Electric Storage Resource White Paper • 3/13/20: ESRSC's second meeting; began the prioritization process of storage issues from the Electric Storage Resource White Paper. • 4/2/20: ESRSC reviewed the highest priority energy storage topics • 4/30/20: ESRSC discussed the status of high priority issues, including Issue E2. • 5/27/20: Supply Adequacy Working Group meeting on capacity accreditation of storage, potentially also HRs • 5/28/20: ESRSC meeting Note: a policy decision on E2 is not anticipated prior to the October MOPC meeting
Current Scope	Hybrid Resource Modelling (discussing two modeling options for renewable generation co-located with ESR: standalone modeling and HR modeling) and ELCC for HRs
Resources	• ESRSC Meeting Materials

	INDEPENDENT SYSTEM OPERATOR NEW ENGLAND (ISO-NE)
Committee	NEPOOL Reliability Committee (RC) and NEPOOL Markets Committee (MC)
Status	ISO-NE staff has discussed this topic offline but has not formally taken it up. • RC: will cover hybrid resources in so far as it impacts operating procedures • MC: will handle corresponding conforming changes to the manual On 3/30/20, the RC sent out notification saying that co-located facility participation will evolve and be vetted through the NEPOOL stakeholder process. The RC compiled the range of options by which co-located intermittent generation and electric storage can participate in the forward capacity, energy, reserves, and regulation markets. They shared a link to a training webinar that took place on 4/8/20 to inform market participants of options for co-located resource participation. They also have an ISO Training mailing list that you can sign up with to receive notifications about this first training webinar and other upcoming trainings (just send an email to this email address to request to be added). Lastly, they shared a link to a form where you can indicate your interest for a new co-located resource or modify an existing co-located resource.
Timing	• 4/8/20: Webinar training described the current participation options for ESR co-located with intermittent generation and summarized the available operating configurations for co-located facilities. Specifically, they talked about how (1) co-located facilities can qualify as two separate forward capacity market resources (and how they can register); and (2) co-located facilities can qualify as a single forward capacity resource (and how they can register). • 4/22/20: RC discussed metering and telemetry rules for co-located resources • 5/12/20: MC discussed metering requirements for DC-coupled resources.
Current Scope	Market Participation (participation of co-located intermittent generation and ESR in forward capacity, energy, reserves, and regulation markets), and DC-metering for co-located resources.
Resources	• April 8th webinar recording and slides • Subscribe to ISO Training Mailing List: isolist-isotraining-subscribe@mail.iso-ne.com • Show of interest form • 4/22/20 RC meeting materials • 5/12/20 MC meeting materials

Comparison of Hybrid Resource Initiative Scopes

ISO/RTO	Forecasting	Market Mitigation /Physical Withholding	Market Participation & Software Scheduling (MOOs)	Capacity Accreditation and MOO rules	Offer Parameters (bidding flexibility; RT offer updates)	Interconnection (queue position; interconnection constraint; study scenarios)	Resource Planning	Metering & Telemetry
CAISO	X		X	X	X	X		X
NYISO			X	X			X	X
ERCOT	X	X	X		X	X	X	X
MISO	X		X	X	X	X	X	X
PJM			X	X			X	X
SPP				X			X	
ISO-NE			X	X				X

Issue in Brief: Capacity Accreditation

	CAPACITY ACCREDITATION APPROACHES
CAISO	Co-located Resources: Methodologies for co-located resources have not changed. Currently, wind and solar resources are evaluated via ELCC; ESR are evaluated based on its Pmax and 4-hour duration sustained output. These Qualifying Capacity (QC) methodologies are applied to each co-located resource and each resource ID would receive a standalone QC and Net Qualifying Capacity (NQC). CAISO did not see any issues with the current counting rules, so they did not propose modifications in the Straw Proposal. Hybrid Resources: Currently, there are no established rules for this. CAISO proposed in the Original Straw Proposal (OSP) to use existing QC methodologies for solar and ESR components and add them together. Since the OSP was issued, the California Public Utilities Commission (CPUC) issued a Policy Decision that would set HR QC at the greater value of the components rather than the sum, on an interim basis. CAISO proposed adopting this "greater of" methodology in their December 2019 Revised Straw Proposal, which several stakeholders said they were not in favor of in their comments in January 2019. The second revised straw proposal was released on 4/29/2020, however capacity accreditation will still ultimately depend on what the CPUC adopts; comments on the second revised proposal are due 5/28/2020.
MISO	TBD. Discussions are still at an early stage. This issue is part of the current MISO 2021 Integrated Roadmap Work Plan prioritization process. Discussions will take place after the 6/10/20 Integrated Roadmap Workplan update. Moving forward, HR accreditation is expected to be housed in the RASC. Based on recent discussions, MISO seems to presently be leaning towards more of a QC process based on a 4-hour capability and less based on ELCC.
ISO-NE	TBD. In February 2019, ISO-NE had capacity market trainings that mentioned co-located facilities and said they will be treated as separate resources but did not provide details. A webinar training on 4/8 webinar discussed the QC and capacity qualification.
PJM	PJM has said that it plans to calculate the capability of solar-battery HRs in their capacity market. On 4/7, a new ELCC task force—PJM CCSTF—had its first meeting. CCSTF intends to develop an ELCC methodology for limited duration resources such as ESR over the next 8 months. The specifics of the methodology are still TBD.

NYISO	Three capacity accreditation options were discussed at the 4/14/20 and 5/11/20 ICAPWG meetings. Option #1: Hybrid renewable and ESR systems that are separately metered will get separate capacity values, which will then be summed for an overall capacity value for the whole hybrid system. Option 1 follows existing intermittent power resource and ESR models. The hybrid system component would be behind a single point of interconnection. Option #2: Hybrid renewable and ESR share one meter and capacity would follow the DER aggregation rules approved by FERC (these have not yet been implemented but are anticipated by mid-2021) with prorating if the DER is an energy limited resource. Combining the renewable and storage under this DER rules with a duration requirements option means that they can only quantify and model the capability as one unit. Option #3: Hybrid renewable and ESR share one meter and capacity would follow the ESR rules (based on duration) approved by FERC, but not yet implemented. Currently, there is a minimum 4-hour duration requirement, but when the DER rules take effect in mid-2021, 6 hours will be required for 100% of the capacity payment at penetrations under 1,000 MW (capacity payments will be prorated for 4- and 2-hour durations). After 1,000 MW of penetration, 8 hours will be needed for 100%. NYISO proposed to continue the 2020 Hybrid Market Design Project into 2021.
ERCOT	N/A
SPP	The "Energy Storage Accreditation Methodology" paper from January 2020 includes a line item for hybrid resources. Astrape Consulting has been involved in modeling efforts for this, including some configurations of ESR and solar hybrid projects, but only considered DC-coupled systems. Feedback indicated a need for additional modeling for a broader variety of Solar + ESR ratios and varying penetration levels for ESR and solar. Thus, AC-coupled system modeling was requested. SPP has focused some of their efforts on stand-alone ESR for ELCC at this time, but these studies will be a continuous process going forward. SAWG is currently trying to reach consensus on how to address ESR of varying durations (further HRs are anticipated thereafter).

Further Information

For more information on this summary, contact ESA at info@energystorage.org

	ADDITIONAL RESOURCES
ESA and Grid Strategies LLC	Enabling Versatility: Allowing Hybrid Resources to Deliver Their Full Value to Customers • This paper assesses barriers to and proposes solutions for enabling storage-plus-generation hybrid resource deployment on the bulk power system, particularly in organized wholesale markets administered by RTOs and ISOs. The authors developed the materials and recommendations discussed in the paper through interviews with developers of hybrid resources, grid operators, and transmission owners, as well as our own analysis.
Energy Systems Integration Group	Hybrid Power Plants - Flexible Resources to Simplify Markets and Support Grid Operations (working draft) • In this paper, the authors suggest that future deployment of energy resources on the electric power system will increasingly be in the form of Hybrid Resources and offer their approach for how hybrid resources can participate in current wholesale markets (with existing market rules and energy management systems) as resources that are treated comparably to conventional resources.
LBNL and EPRI	Hybrid Power Plants Are Growing Rapidly: Are They a Good Idea? • New research from LBNL and EPRI look at the operational benefits and drawbacks, relative costs and benefits, and industry trends toward hybrid power plants. Resources include an article and a webinar.