Survey Responses

How clear are the definitions in the paper for each of the following topics?

Weighted average 1 to 5

Energy Services: 4
Transmission Services: 4.5
Ancillary Services: 4.33

Did this paper cover all the key energy storage products and services?

83.3% Yes

How well are the benefits and uses of each of the following described in the document?

Weighted average 1 to 5

Energy Services: 3.33
Transmission Services: 3.67
Ancillary Services: 3.67

One of the goals of the paper is to compare how energy storage products and traditional resources provide these services. On a scale of 1 to 5, with 1 being very poorly and 5 being very well, how does the paper make the comparison?

Weighted average 1 to 5

3.33

How adequately does the paper describe the gaps in how existing energy storage provides these services?

Weighted average 1 to 5

3

Comment	Reference	ESTF Response/Resolution
The white paper provides a good high-level description of the potential services that could be provided by ES. However, the paper does not sufficiently cover or discuss the potential challenges with providing some of the services mentioned. Additional information will be provided in the comments section of the survey.		Thanks for your comments. After consideration of your comments, the task force made modifications in specific sections addressing this comment.
Energy storage is center stage in addressing the challenges related to the transformation for a clean energy future. The question is whether a resource mix consisting of weather dependent resources (solar/wind) and energy storage can replace the need for dispatchable gas generation. And if so, how much storage will be needed. I have two other questions that go beyond the scope of the report: (1) the battery manufacturing capability—the upstream/downstream environmental impacts, material supplies, decommissioning, etc. costs for both the electric and transportation sectors and (2) an assessment of affordability—cost to consumers.		Thank you for your comment. The task force has considered your comment and believes this is outside the scope of the paper.
The paper fails to fully discuss current operation practices regarding merchant use of energy storage vs. reliability use. Many of the services cited require battery storage to not be fully discharged or fully charged, so they can stay flexible. The paper also fails to discuss the		Thank you for your comment. After further consideration, the task force believes this is outside of the scope of paper. The task force feels the paper does address some of the challenges. The comments are associated with operating strategies, which were not considered in this

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opportunity in the market to capture the best price, and the timing of discharging, and the possible need for reliability uses and the ability to peak shave. Services such as black starting require that discharge not be done below a certain level. A merchant operator may operate these resources to exhaustion without consideration of the need for black start capability. Future use of resources need to have very clear requirements on who and how they are to be used. Dual-use, marketing use and reliability use all need to have established boundaries which have not been established yet. This white paper addresses the positive of energy storage, but needs to be tempered with addressing the challenges, as well.		paper. State of Charge (SOC) is addressed in the paper.
All generation types are treated the same in many interconnection queues, adding an Energy Storage facility to an area to alleviate congestion will increase congestion because the requested product of Network Resource Interconnection Service aims to ensure all network resources in an area can be generating at the same time to serve network load. Transmission service requests also typically come in for firm service on energy storage so that developers can make a profit on the EIM market, potentially generating at the same time as other generators in the area		Thank you for your comment. Storage is not meant to be just another generator. Storage can be treated as a resource or transmission service. Storage is not always installed to compete with other resources. It can also be constructed to capture excess energy and deliver it at a later time when there is transmission capacity.

Comment	Reference	ESTF Response/Resolution
of congestion. Storage treated like all other generation in interconnection queues just leads to more congestion.		
Need to add Power Quality concerns (voltage deviation), especially for very fast ramp rates and/or resources that are connected to weak grids. The last sentence needs clarification. If the author is intending to describe AGC-induced real-power oscillations when an IBR is frequency-responsive, then this is an issue that we have observed at the Grid Operations, but this idea needs to be described in more detail. A link to a paper would be very illustrative if a paper on this topic exists.	Section 1.2.2, Ramping Capability	Thank you for your comment. The last sentence of Section 1.2.2 has been modified to address comment. As stated in the paper, inverter-based resources operating on AGC and allowed to ramp at extreme ramp rates have been known to induce grid oscillations. Regarding disturbances, rapid response from inverter-based resources can be beneficial. A link to the NERC Reliability Guideline, BPS-Connected Inverter-based Resources Performance, has been provided system oscillations.
The term synthetic inertia for IBRs can be misleading and a source of confusion since it's associated with mimicking energy extraction from stored kinetic energy from a rotating mass. This is a term that the industry is trying to eliminate to describe IBR's potential capability to respond during the inertial time period. A preferred and industry accepted term that should be used is "Fast Frequency Response." The counterbalancing only occurs if IBRs are designed and operated with FFR capability. It's not clear if all new IBR resources are capable of FFR, and if they are, it's not clear if	Section 1.2.6, Synthetic Inertia from Storage Resources	The task force appreciates your comments and modified Section 1.2.6 accordingly. The section is now called Frequency Response from Storage Resources. An exact amount of inertia has not been defined but is part of ongoing studies and analysis by the Studies Subcommittee (StS). The Changes in System Inertia Advisory Group produced a report, Changes in System Inertia that was published in 2021. A link to this report was provided in the White Paper, section 1.2.6.

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they are operating with FFR enabled and if they are being operated with sufficient headroom. The paper would benefit by having these needs identified. There are currently no requirements for resources to maintain frequency responsive reserves or headroom to respond to underfrequency events. This document should provide some guidance or recommendation for Balancing Authorities to consider headroom requirements, especially if these ES resources are providing both market and transmission services. The last two sentences need to be clarified. The grid frequency is the prime dictating point that needs to be maintained. So, if the system inertia decreases, then IBR would need to ensure it. Not aware of any quantifiable studies that can relate the system inertia with the amount of IBR needed. This document should briefly discuss it and guide how this can be done or, at a minimum, encourage others to do such study-related projects.		
Increased penetration of IBRs and retirement of traditional synchronous machines may significantly reduce system strength. This may pose challenges for ES to operate as expected and to maintain dynamic stability. This paper should include a discussion about grid forming capabilities as an option for ES	Section 1.3.3, Improve Dynamic Stability	Thank you for your comments. After consideration, the task force added a new Section 1.2.7 Inverter-based Controls Considerations in response the concern about momentary cessation. Section 1.3.3 Improve Dynamic Stability is now section 1.3.1.

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resources to improve dynamic stability under high IBR penetration. This paper doesn't discuss the challenges of Momentary Cessation and disturbance ride-through, which are significant challenges with IBRs in general. A blanket statement that ES improves dynamic stability is unsupported by recent historic events.		
None of the technologies are 100% efficient because they all have inherent losses. Additional clarification is needed to illustrate this limitation for ES.	Section 2.4, Observations and Gap Analysis, Time Shifting, Storage Solution	Thanks for your comment. The task force believes this comment is out of scope of this paper.
The paper should discuss the regulatory barriers for dual/multi-use.	Section 3.1, Transmission Deferral and Congestion Relief	Thanks for your comment. The task force believes this comment is out of scope of this paper.
Paper should discuss the challenges of balancing economic usage of ES vs preserving capacity for relief.	Section 3.3, Observations and Gap Analysis, Duration of Relief, Storage Solution	Thanks for your comment. The task force believes this comment is out of scope of this paper.
Overall, I think that this paper does a good job of clearly laying out the services that energy storage resources can provide to the grid. That being said, I think the paper could have done more by highlighting unique aspects of the Western Interconnection and specific areas where energy storage could have an impact. It would have aligned better with WECC's mission if it were a little more Western-focused.		Thank you for your comment. After consideration of your comments and feedback received from a previous discussion at the ESTF meeting, the task force took the approach of keeping the paper neutral.

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The discussion about the resource mix changing is being driven by Renewable Portfolio Standards (RPS) is no longer really correct. RPSs have fallen out of favor since many states have hit and exceeded their objectives. Some states have removed their RPS altogether. States are now setting clean energy targets or carbon-free goals, but beyond that, the changing resource mix is also being driven by economics and not just policy.		Thanks for your comments. After consideration, the task force modified the paragraph in the Executive Summary by adding "and support efforts to meet zero-carbon emission resource goals."
Page 5 in the State of Charge Section states that gas and coal have an unlimited supply. In my opinion, this is an overstatement. Gas is limited by the availability of gas in the pipeline and coal by the amount of coal that can be stored onsite. Maybe firm vs. variable fuel supply is better as opposed to unlimited. Some would argue that fossil fuels are just a form of long-duration energy storage.	Section 1.2.1 State of Charge Visibility and Management	Thank you for your comment. The task force modified the section by deleting "an unlimited fuel supply" and replacing it with "high-capacity factors.
On Page 6, there is a discussion around AGC and ramping of energy storage. Is this truly an energy storage characteristic, or is it actually an inverter-based resource characteristic (i.e., batteries)? Since the storage technologies are not necessarily specific (i.e., batteries, pumped storage, etc.), there are probably a few other instances where the description identifies an	1.2.2 Ramping Capability	Thank you for your comment. The task force considered your comments and modified the sentence in the section to read "Inverter-based energy storage resources providing Automatic Generation Control (AGC) have been known to cause real-time operational challenges when allowed to ramp at their highest rate."

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IBR issue and presents it as a storage technology issue.		
When discussing "generating capacity," I think the discussion is a little confusing. I think the takeaway should be that storage can provide firm capacity for a limited period of time, but it talks about ramp rates. Again, it talks about fast ramp rates (MW/second vs. MW/minute), which is valid for IBRs, like batteries, but not all storage technologies. I think the goal of this section should be to address the need for storage to meet capacity needs during peak or net peak.	Section 2.4 Observations and Gap Analysis	Thank you for your comments. The task force modified this section to address your concerns.