Hybrid Storage Resource Participation in Electricity Markets

FERC Technical Conference regarding Hybrid Resources
July 23, 2020

Hybrid Resource: EPRI Tentative Proposed Definition

- EPRI: A resource facility consisting of **multiple** co-located assets comprising of multiple technologies that can potentially inject and/or withdraw energy whereas the operation of either or both technologies has **interdependencies** (physical or otherwise) between the technologies.

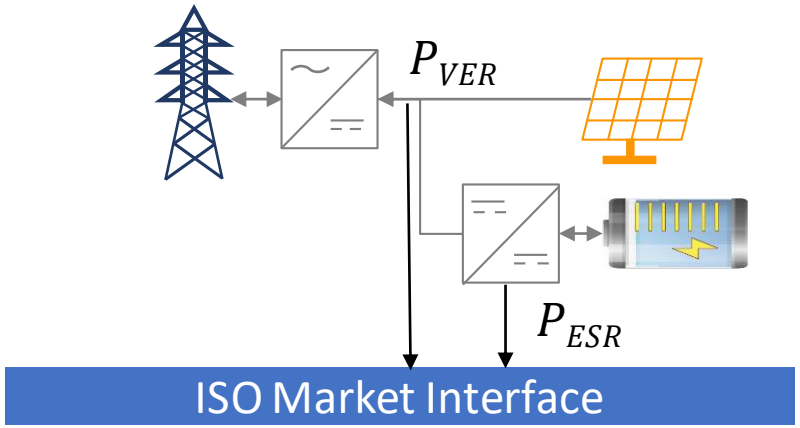
- Reasoning for differences:
  - We do not constrain it to a single market interface participation model, which supports the flexibility of our hybrid participation models proposed as shown (resource definition rather than participation model definition)
  - We highlight the interdependencies as the key difference from two co-located technologies (physical or otherwise)
  - We are not constrained by tariff-based definitions
  - **Note:** As is the case with others, the definition is preliminary and up for discussion and evolution as new learnings come in

Hybrid Resource Participation Model Options

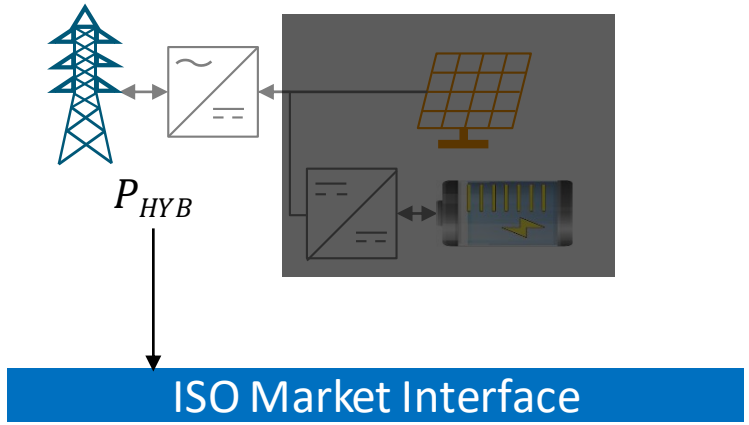
Energy and Ancillary Service Market

Option 1: Separate Independent Resources

$P_{HYB} = P_{VER} + P_{ESR} \leq P_{XFR}$

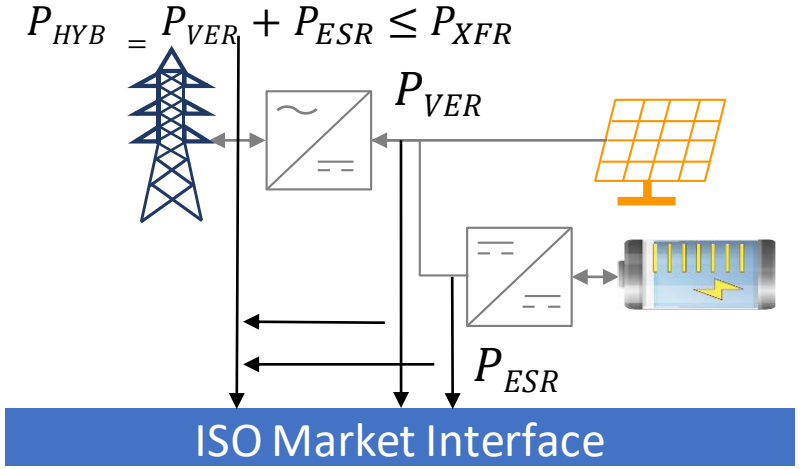


Option 2: Single Hybrid Resource, Self-Management

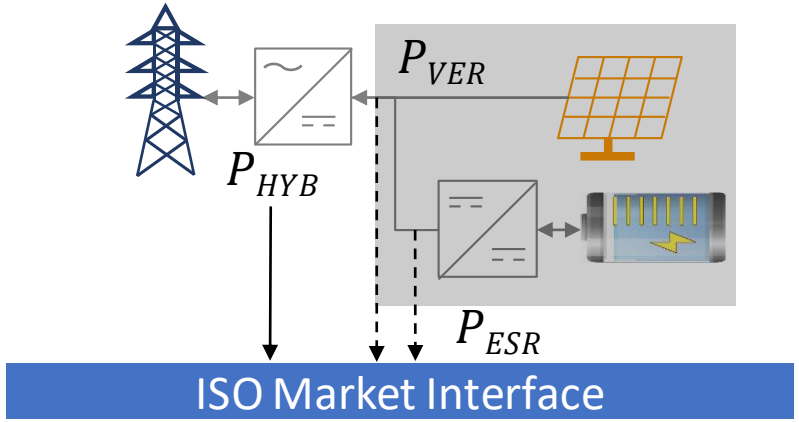


Option 4: Separate Resources, Linked

$P_{HYB} = P_{VER} + P_{ESR} \leq P_{XFR}$



Option 3: Single Hybrid Resource, ISO-Managed Feasibility



Capacity Valuation of Hybrid Resources

EPRI Study Questions

Can you treat all hybrids the same way?

If not, what are the main factors that impact contribution?

How much do these factors impact relative capacity value?

Key Observations on Resource Adequacy (RA)

- Quantification of RA from traditional resources ignored operations and operational impacts
  - 200 MW unit with 7% Forced Outage Rate with 8-hour start-up time and 8-hour minimum down time had same contribution as 200 MW unit, 7% FOR, with 10-minute start-up time and no down time constraint
- Unique capabilities of electric storage resources and Hybrids simply cannot ignore operations in determining contribution
- Simulation-based analyses for capacity value emerging over simplistic methods
- One size does not fit all – many characteristics, static and operational can impact contribution

Hybrid Renewable + Storage Resource Modeling Differences

Energy Constraints

1. State of charge (SOC) influences when capacity is available
2. Economic dispatch influences state of charge
3. Lower SOC (MWh) results in lower likelihood of sustained capacity availability during critical periods

Operational Constraints

Charging influenced by:

- Renewables' pairing (Solar / Wind)
- Coupling arrangement (DC / AC)
- Over-panneling practices at solar plants
- Influence of incentives (Investment Tax Credit)
- Operational mode and economic dispatch
- Capacity ratio (Plant inverter to storage)
- Storage duration
- Background storage and renewables penetration in the system
- Net load forecast error

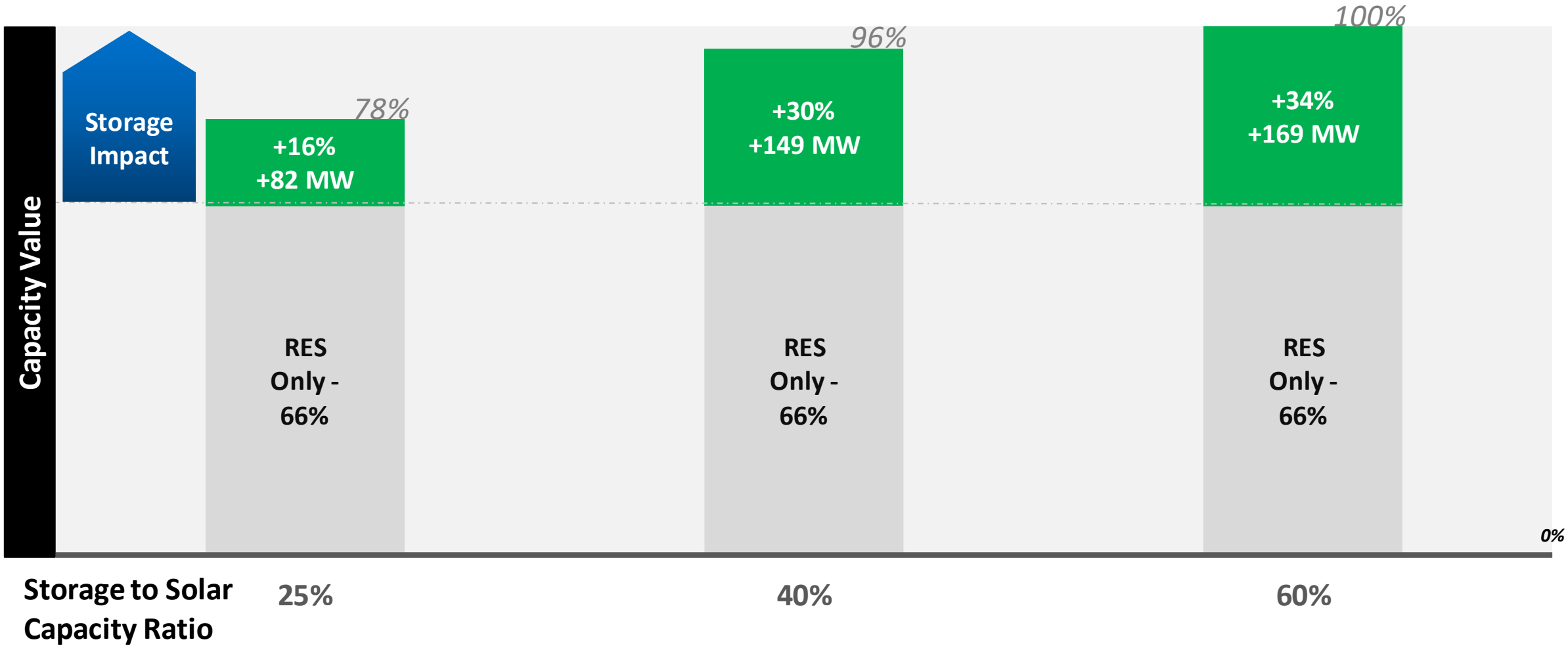
7 Questions EPRI study sought to answer

1	How does a hybrid resource's operational mode affect the marginal capacity value?
2	How does the capacity value of storage combined with solar change as a penetration of solar?
3	How does the capacity value of storage combined with renewables change vary by storage to the inverter capacity ratio?
4	How does storage duration affect hybrids' marginal capacity value?
5	How does the combination of storage with wind or solar differ?
6	Does the coupling mechanism affect marginal capacity value?
7	Does provision of operating reserve affect marginal capacity value?

None of these questions were answered comprehensively. Rather, they were answered for a particular system with other features fixed to provide insights. Each system and scenario will be different.

How Does The Storage To Solar Capacity Ratio Affect Marginal Capacity Value?

500 MW Solar, 4 Hrs. Storage, near term background solar, 100% ITC



Saturation of value from incremental storage capacity occurs between 40% and 60% for solar in the near term

Summary of Study Outcomes

Highest Significance

- Linked technologies (e.g. wind+ storage vs solar + storage)
- AC/DC coupling
- Amount of existing storage capability in system

Large Initial Impact, then Saturation

- Degree of self charging
- Storage capacity to plant export capacity ratio
- Storage duration

Less Significant but Material

- Operational charging mode

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