



Modeling Energy Storage in Integrated Resource Planning in 2019-2020



CPUC Modeling Advisory Group Webinar

May 30, 2018

How Was Energy Storage Modeled in RESOLVE in the 2017-18 IRP?

Capacity
and
Investment

- Resource Adequacy (RA) value captured
 - To align with resource adequacy accounting protocols, RESOLVE assumes a resource with at least four hours of duration may count its full capacity towards the planning reserve margin
 - Shorter duration resources are derated
- RESOLVE’s investment framework decides the optimal storage duration of each candidate storage resource by choosing both power and energy capacity
- Wholesale market value captured (see subsequent slides)
 - RESOLVE optimizes for bulk system needs
- All storage devices are modeled assuming no minimum generation or minimum “discharging” constraint, allowing them to charge or discharge over a continuous range
- Ramping limitations are not modeled for storage resources - storage resources can ramp over their full operable range very quickly

Dispatch

Which Energy Storage Characteristics or Values Were Not Captured in 2017-18 IRP?

- RESOLVE modeling in the 2017-18 IRP did not capture the value of the following service domains:
 - Distribution value: Distribution deferral
 - Transmission value: Transmission deferral
 - Customer value: TOU bill management, DR program participation, Increased self-consumption of on-site generation
 - Note: Shift DR resource study included customer storage as part of supply curve.
- Hybrids (Energy storage paired with a generation resource)
 - RESOLVE adds energy storage and generation source independently
 - Does not explicitly capture benefits and constraints of co-location



STORAGE SERVICE DOMAINS AND SERVICES IN RESOLVE

Most Bulk Grid Services Included in 2017-18 IRP

- RESOLVE already captures bulk grid values of energy storage, adding and dispatching energy storage optimally to reduce fuel and emissions costs, and to offset capital expenditures (e.g., solar overbuild).
- RESOLVE may not capture all sub-hourly dispatch benefits.

| Service Domain | Service | Already in RESOLVE? | Could be Added to RESOLVE? |
|----------------------------|-----------------------------|--|--------------------------------------|
| Wholesale Market | Frequency regulation | Yes | |
| | Imbalance energy | Yes, modeled as load following | |
| | Spinning reserves | Yes | |
| | Non-spinning reserves | No | Yes, but unlikely to have high value |
| | Flexible ramping product | Yes, modeled as load following | |
| Resource Adequacy | System RA | Yes | |
| | Local RA | Yes | |
| | Flexible RA capacity | No | Yes, but unlikely to be binding |
| Additional Services | Energy arbitrage | Yes | |
| | Absorb renewable oversupply | Yes | |
| Transmission | Inertia | Yes/No: Inertial response may be satisfied by primary frequency response constraints | |
| | Primary frequency response | Yes | |

Note: service domain categories based on CPUC Storage decision.
Energy arbitrage and renewable oversupply have been added.

Locational Value Components Could be Added for 2019-20 IRP

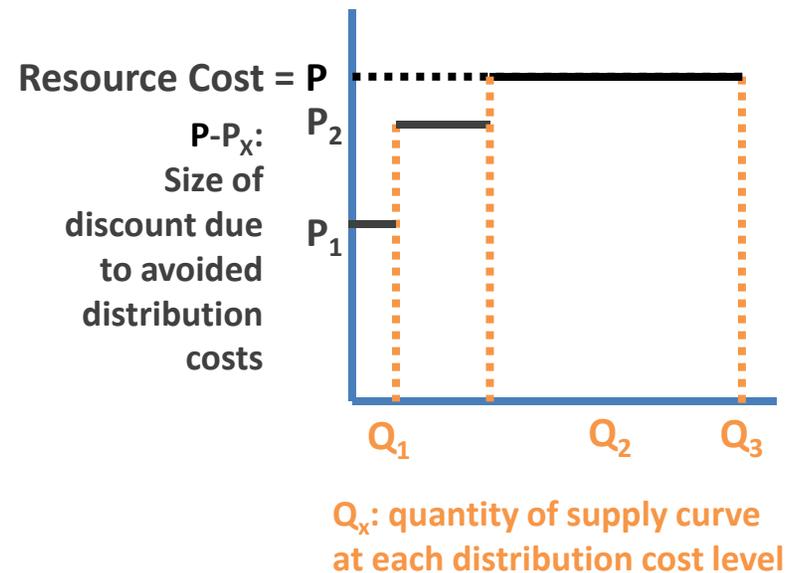
| Service Domain | Service | Already in RESOLVE? | Could be Added to RESOLVE? |
|---------------------|--|---------------------|---|
| Customer | TOU bill management | No | Customer storage dispatch would need to be constrained or modeled as a fixed shape based on customer bill minimization. Fixed shape would be calculated outside of RESOLVE. |
| | Demand charge management | | |
| | Increased self-consumption of onsite power | | |
| | Back-up power | | |
| | DR program participation | | |
| Distribution | Distribution capacity deferral | No | Yes, proposed addition to 2019 IRP modeling |
| | Reliability (back-tie) services | | RESOLVE would utilize “non-modeled” benefits as an offset to the resource cost. Specific locations could be modeled with different levels of non-modeled benefits. |
| | Voltage support | | |
| | Resiliency/microgrid/islanding | | |
| Transmission | Transmission deferral | No | RESOLVE would utilize “non-modeled” benefits as an offset to the resource cost. Specific locations could be modeled with different levels of non-modeled benefits. |
| | Black start | | |
| | Voltage support | | |



OPTIONS FOR MODIFICATIONS OF OPTIMIZING ENERGY STORAGE FOR THE 2019-20 IRP

Incorporation of Distribution Deferral Value

- Energy Division is developing an approach to include distribution-level costs and benefits of DERs in IRP modeling
 - Interim approach for 2019 could better capture distribution deferral benefits of storage
 - Future IRP cycles would use detailed distribution analysis from DRP to inform distribution values and costs of energy storage among other DERs
- Increases the value of energy storage cited in the distribution system when distribution deferral opportunities are available
- May restrict the use of storage for grid optimization
 - Option for RESOLVE Modification: Restrict storage resources from providing resource adequacy. Necessary if providing distribution level services disqualifies the storage device from providing system RA.



Incorporation of Customer Value

Is customer storage responding to wholesale price signals?

Yes

- Dispatch resource from a system/wholesale perspective (RESOLVE default)
 - Assumes that customer is compensated at wholesale value (not via retail rates)
- Subtract customer values that are incremental to those already included in RESOLVE from storage capital costs
 - Example: customer value of back-up power
 - Data availability could be a challenge

No

- Resource has a fixed dispatch profile calculated outside of the model based on customer value maximization
- RESOLVE would need to be modified to include a selectable storage resource that has a fixed charging/discharging shape
- A battery with a fixed dispatch shape will always have less wholesale market value than an equivalent battery responding to wholesale signals
- Threshold question: value of inclusion depends on whether the amount of energy storage devices responding only to utility rates and not wholesale market conditions is significant
 - Potential may be limited due to significantly higher customer battery costs relative to utility-scale (example costs: Lazard Levelized Cost of Storage 3.0)

Exploring use cases

- Storage may be used for multiple applications
 - Providing services in one domain may restrict the ability of storage to provide services in another domain
- Number of storage resources that can be represented in RESOLVE must be limited due to model runtime and data complexity challenges
 - Use cases must be prioritized to those with largest potential
- Possible use cases of storage to explore in RESOLVE can be enumerated using the table on the next slide
 - Stakeholder feedback can help to identify most promising additions for 2019 IRP modeling

Exploring use cases

| <u>Use Case</u> | Dispatched in energy market or fixed shape? | Can provide system RA (yes/no) | Can provide Local RA (yes/no) | Can provide reserves: spinning (S); Primary Frequency Response (PFR); regulation (R); load following (LF) | Capital cost assumptions (utility/distributed/BTM) | Subtract distribution deferral value from capital costs (yes/no)? |
|---|---|--------------------------------|-------------------------------|---|--|---|
| <u>Use Case 1:</u> Utility Scale, located in local capacity area | Dispatched | Yes | Yes | S; PRF; R; LF | Utility-scale | No |
| <u>Use Case 2:</u> Distributed, in front of meter | Dispatched | Yes | Yes | S; PRF; R; LF | Distributed | Depends on position in distribution system |
| <u>Use Case 3:</u> Customer behind the meter, dispatched for bill minimization | Fixed Shape | No | No | None | Customer/BTM | Yes, when shape is coincident with deferral needs |
| ... | | | | | | |

Incorporation of Hybrid Resource Types

- Examples: storage and solar; storage and existing combustion turbine, etc.
- Consideration of tradeoffs for additional functionality:
 - Co-locating resources reduces capital costs due to the sharing of facilities and qualification for the Investment Tax Credit (ITC)
 - ITC rules constrain how battery units can be operated
 - Shared power infrastructure may reduce resource adequacy credit and operating range of hybrid facility relative to two independent resources
- Energy Division staff seek input from stakeholders on the above described tradeoffs and the value of adding new functionality

Difficulty to implement in RESOLVE

Low

High

Medium

Next Steps

- Stakeholders are welcome to provide comment on the presented considerations as well as other options for storage modeling in the 2019-20 IRP
- Proposed staff approach may be provided during the June or July MAG Webinar
- A more comprehensive staff approach to modeling storage resources may be provided in the RESOLVE Inputs and Assumptions document that will be released in fall 2018