What Are the Capabilities of the NGR and REM Market Models for Batteries?

Alva Svoboda
PG&E

January 2018

Disclaimer: Views expressed do not represent PG&E company positions, and are the responsibility of the presenter.

PG&E Experience with Market Facing Batteries

Two market facing batteries (sodium-sulfur technology)

- Vaca-Dixon: +/- 2MW, 12 MWh
- Yerba Buena +/- 4 MW, 24 MWh

	USE CASE	IMPLICATIONS FOR ESDER 3
1	Energy and AS: NGR Model	Limited value of incremental improvements.
2	Regulation only: REM Model	CAISO takes SOC risk; no no-pay risk.
3	Distribution interconnection constraints	Hourly availability constraints enabled in markets via OMS.
4	Customer islanding	Possibility of non-market hours exists already.
5	DERMS Pilot: Stacked distribution/market uses	Critical role of distribution optimization.

1 ENERGY AND AS: NON-GENERATOR RESOURCE MODEL

The NGR model enables batteries to build to supply all energy and ancillary service capabilities so that the CAISO markets can co-optimize and maximize revenues.

USE CASE

Regulation value streams may be significantly augmented by energy/reserve revenues. Market participant has primary responsibility for state of charge (SOC) management.

VALUE STREAMS

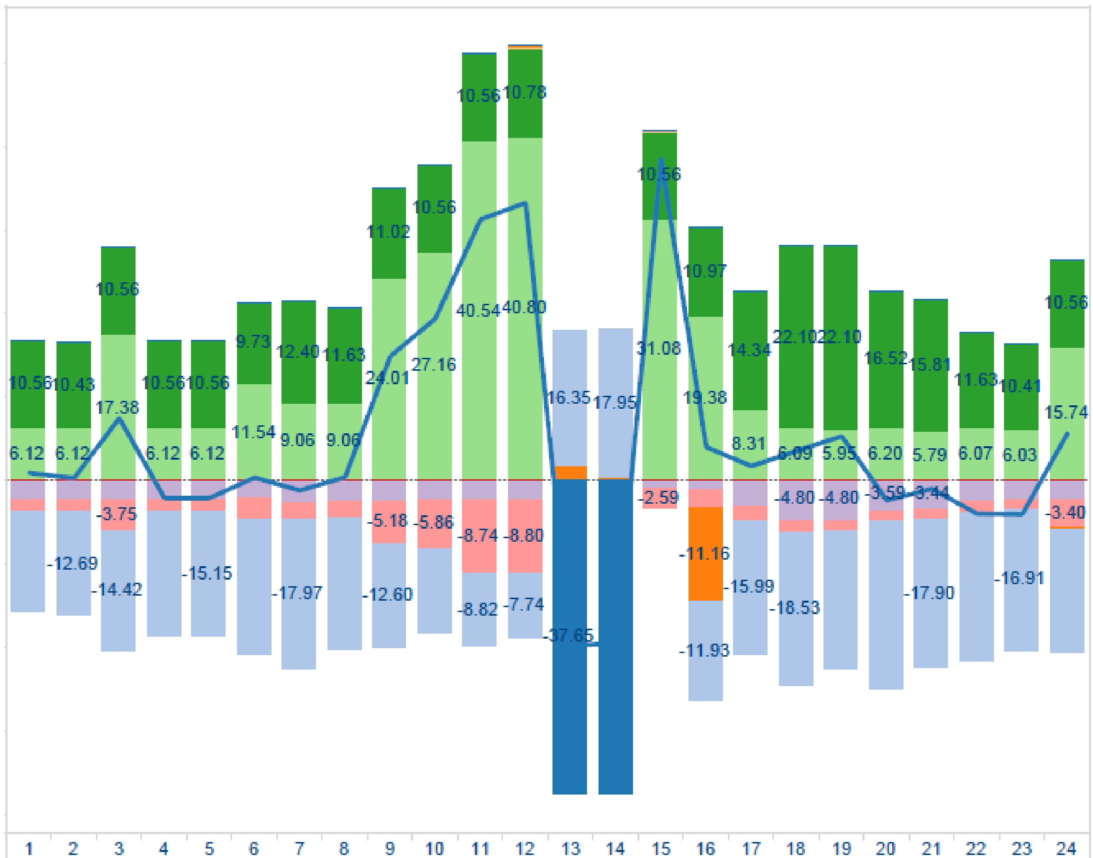
CO-OPTIMIZED ENERGY AND AS REVENUES| Market model yields solutions that maximize value while ensuring state of charge is maintained under most scenarios.

MODEL RISKS

STATE OF CHARGE MANAGEMENT| CAISO state of charge management is not transparent; market participants have no information about CAISO estimated state of charge in real time. In day ahead market processes, market participants can now set initial state of charge prior to IFM, so if market participant estimate is better than CAISO defaults, state of charge will be estimated more accurately in IFM processes. In real time, however, regulation energy takes and limited time horizons of multi-period dispatches result in apparent discrepancies between market assumptions about state of charge and actual state of charge.

PG&E	CAISO	ESDER TAKEAWAYS
Mature	ESDER 3 updates	Throughput cannot be perfectly managed on a daily granularity, but can be managed over time.

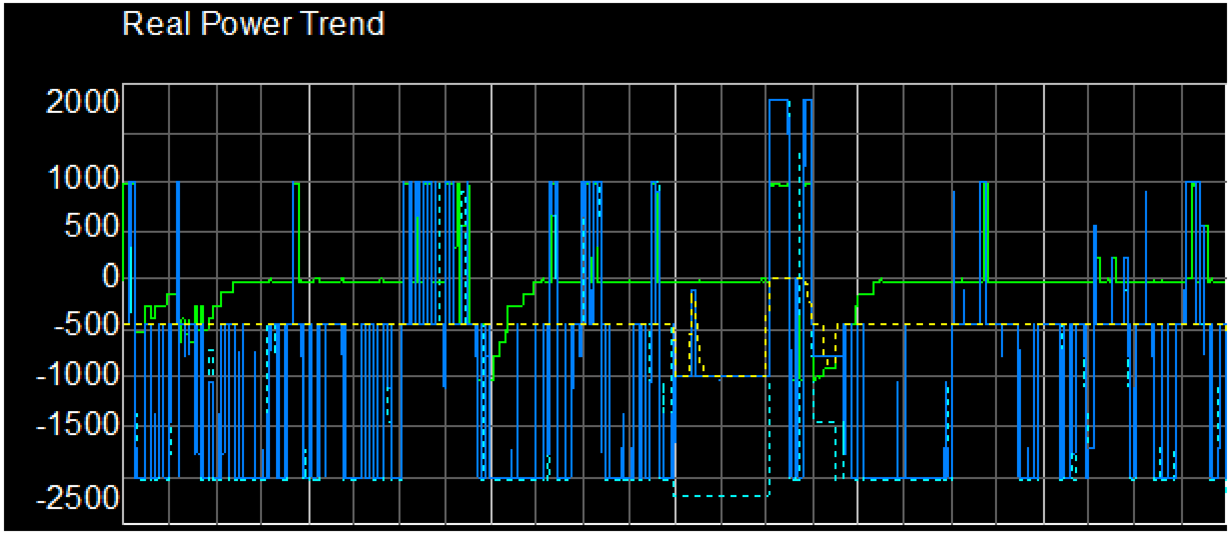
Example of NGR daily settlements including real-time adjustments



Day ahead revenues include energy and AS awards; real time costs/revenues include AS no-pay, energy buy-back, and regulation imbalance energy as well as real-time market awards.

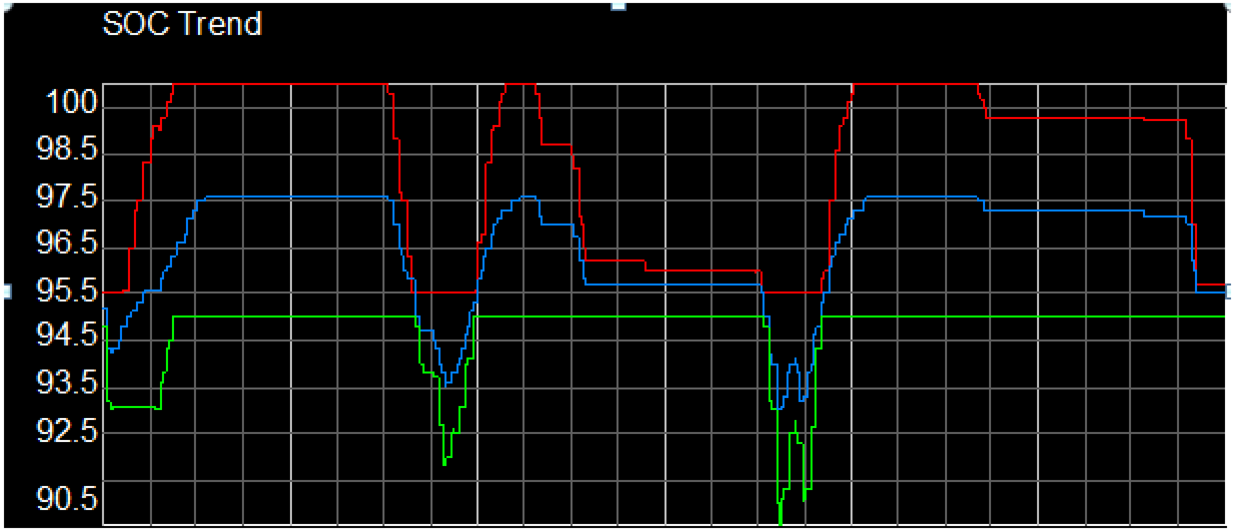
Example of NGR regulation and real-time dispatch

Regulation energy usage patterns must be considered in bidding AS.



Example of NGR state of charge management with regulation awards

Market participants can manage SOC based on expected regulation energy usages.



REGULATION ONLY: REGULATION ENERGY MANAGEMENT MODEL

The REM model enables batteries to supply regulation capabilities, requiring CAISO operations to manage SOC to maintain these capabilities. Arbitrage is not possible through energy bids, though market participants may deviate uninstructed, especially when not constrained by regulation awards.

USE CASE

Consistent high regulation revenues, regulation energy risk relatively low, SOC management difficult, short cycle time (model is probably required if cycle time is less than one hour).

VALUE STREAMS

MAXIMIZED REGULATION VALUE STREAMS| (a) Disparate records for asset transfer/payment makes tracing movement through supply chain challenging (b) High administrative burden to settlements. More broadly, PG&E has opportunity to shape a nascent technology.

CAISO STATE OF CHARGE MANAGEMENT| State of charge risk is significantly mitigated (though not eliminated) by CAISO state of charge management. All state of charge management, like all energy charge/discharge while regulating, is treated as imbalance.

MODEL RISKS

MISSED ARBITRAGE OPPORTUNITIES

Resource cannot bid into energy markets. Deliberate uninstructed deviations are frowned upon.

REGULATION RISK

State of charge management may not be possible during many periods when managing state of charge conflicts with direction of regulation need.

PG&E
Mature

CAISO
Regulation risk

ESDER TAKEAWAYS

For long cycle batteries, REM is a fallback if arbitrage revenues are small; for short cycle batteries, REM is a necessity.

3 Distribution interconnection constraints

Hourly limits on charge or discharge may be imposed on wholesale resources on distribution feeders based on bi-directional flows across interfaces or reliability concerns behind interfaces.

USE CASE

Interconnection operating constraints placed on market-facing batteries to avoid distribution upgrades.

VALUE STREAMS

NEAR-TERM CONCERN ADDRESSED| Distribution interconnection studies indicated that expensive upgrades of equipment would be required to support unconstrained use of the batteries. However, the operations that would have caused distribution limits to be exceeded could be characterized as not normally coincident with maximum resource or system value.

MODEL RISKS

TRADEOFF BETWEEN STATIC AND DYNAMIC CONSTRAINTS| Static constraints reduce revenue opportunities for batteries; dynamic constraints require active management and are unlikely to address all contingencies.

OUTAGE MANAGEMENT SYSTEM| Daily clearances are required for dynamic hourly limitations.

PG&E
In progress

CAISO
In progress

ESDER TAKEAWAYS

Batteries can be optimized in the wholesale markets subject to dynamic operating constraints, using OMS. OMS utilization requires further clarification.

4 Customer islanding

The Yerba Buena battery's installation was co-located with a customer which received islanding services from the battery until leaving the location

USE CASE

Islanding service entailed separating from grid automatically when battery was to be used to serve customer load.

VALUE STREAMS

CUSTOMER POWER QUALITY AND DEMAND CHARGE MANAGEMENT| Configuration of distribution-level battery and connected customer enabled battery to switch to serving customer load when both were disconnected from the grid; moreover, disconnection from grid was resource/customer initiated, so could potentially be used for demand charge management as well as power quality.

RISKS

LIMITS ON REVENUE STREAMS| Islanding produced periods of up to half an hour of imbalance deviations, and automatic islanding might not allow participation in ancillary service or other reliability markets.

CUSTOMER DEPARTURE| Transition to no customer or new customer requires substantial reconfiguration and monitoring of equipment previously overseen by customer.

PG&E
Partially tested

CAISO
Under development

ESDER TAKEAWAYS
Limited hourly availability may be handled via a combination of OMS and "disconnection" from grid during periods of unavailability. Complexities are on retail side, not CAISO market side.

5 DERMS Pilot: Stacked distribution/market uses

Extending utility-scale battery optimization tools to optimize DER aggregation wholesale market participation, subject to constraints, has enabled PG&E to better understand the implications of PG&E- and non-PG&E-controlled resources/aggregations participating in wholesale markets

USE CASE

Optimized wholesale market participation by DER aggregations (CAISO defined resources), subject to constraints

VALUE STREAMS

NEAR-TERM CONCERN ADDRESSED| Address optimization of wholesale market participation by DER aggregations subject to non-market constraints, including distribution system constraints, individual resource constraints, and constraints on retail energy bill impacts.

RISKS

DISTRIBUTION OPERATOR ROLE| Distribution operator role has not been fully defined, and aggregators and CAISO have expressed the view that they are capable of taking on this role.

CONFLICTING PARTICIPANT OBJECTIVES| While this model is capable of bidding/scheduling correctly subject to constraints, the actual business processes around incorporating constraints are not defined or implemented.

PG&E
Testing

CAISO
Testing

ESDER TAKEAWAYS
Full exercise of DERP registration process / distribution optimization is still under development.

PG&E Experience with Market Facing Batteries

TAKEAWAYS FOR ESDER 3	
1	The NGR model provides co-optimized revenues from all energy and AS markets, and with bid flexibility and SOC initialization, does a good job of managing SOC for batteries with cycle time allowing energy scheduling.
2	The REM model enables regulation to be sold from batteries with cycle times that do not allow energy scheduling; CAISO manages SOC risk.
3	Distribution interconnection constraints can be captured in OMS, and allow less than full AS ranges to be offered into the markets.
4	Customer islanding provides a model for limited hours of NGR/REM market participation, but requires participant-side technology and resolution of non-CAISO DER tariff issues.
5	Distribution grid optimization enables maximum value to be realized from a set of resources (including grid-scale batteries and DERs) for multiple uses.

PG&E Experience with Market Facing Batteries

	CONCLUSIONS: PG&E RECOMMENDATIONS
1	The existing NGR model is reliable and robust, and can be adjusted to participant needs. Significant costs of incremental changes may outweigh unknown incremental benefits.
2	The REM model is appropriate for small or short-cycle batteries.
3	Battery/DER market operations can be constrained to respect static distribution grid limits without further market enhancements.
4	Dual use operations are possible with clear demarcation of market versus customer-driven operations. If clear demarcation is not possible, consider an enhanced PDR model rather than a weakened NGR model.
5	NGR/DER market treatment should allow distribution grid optimization to enable value maximization subject to dynamic grid constraints and customer usage.