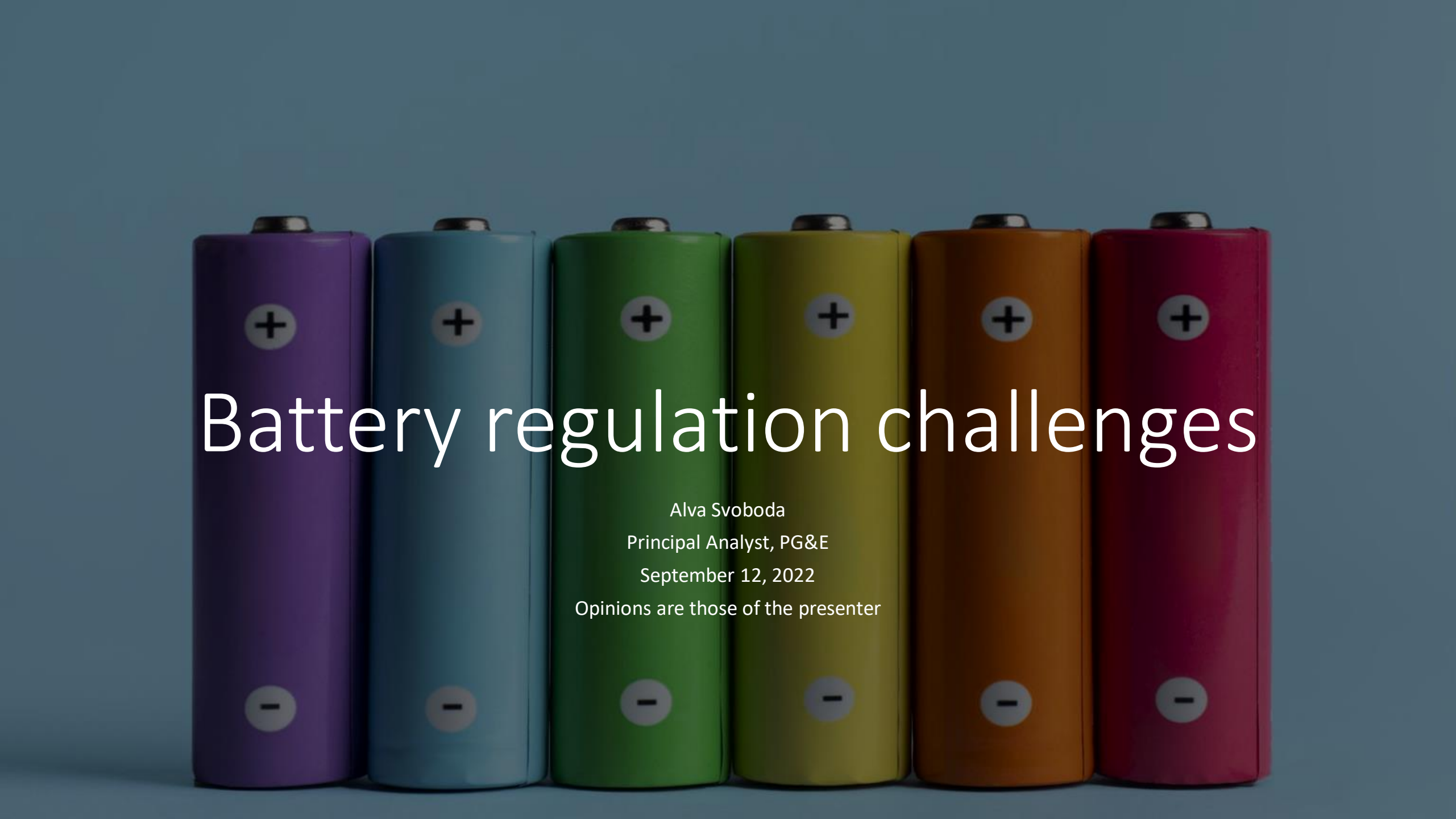

Battery regulation challenges

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Opinions are those of the presenter

Experience relevant to proposed enhancements

Regulation SOC buffer energy bid requirement

State of charge calculation including regulation energy

A need to address underlying issues?

Regulation SOC buffer energy bid requirement

I believe an important nuance is being missed in discussing the regulation SOC buffer energy bid requirement

Energy bids available in the market do not necessarily allow regulation capability (regulation SOC buffer) to be preserved:

- Market optimization may not utilize energy bids in a way that preserves regulation SOC buffer
- Energy bids may be taken independent of need to manage SOC for regulation, and even counter to capability in later periods
- Even when energy bids are dispatched to preserve SOC buffer for regulation, worst case energy takes may make such dispatch ineffective (e.g. discharge nets to zero with 100% reg down energy takes)

State of charge calculation including regulation energy

I believe empirical regulation take parameters would have different effects in the day ahead and real time markets, and that these effects might be counter-productive in the real time markets

Day ahead, regulation energy take parameters will tend to lead to “balanced” procurement of regulation (and possibly energy) in such a way that an “optimal” state of charge trajectory is obtained over the day

In real time, regulation energy take parameters may tend to conflict directly with SOC telemetry and in some situations yield consistently incorrect dispatches

Combination of regulation SOC buffer energy bid use and estimated effects of regulation on SOC

- Recent heat wave has convinced me that both enhancements are needed, that they can work in combination, but that they may be ineffective or even counterproductive if
  - Bids cannot be effectively used within market processes, requiring manual operator steps that are already available and effective (though probably cumbersome)
  - Regulation take parameters are inaccurate and in particular instances cause SOC estimates to be systematically worse than they would have been in the absence of parameters (especially in periods of 50-100% takes, which are exactly the periods that cause regulation SOC buffer limits to be exceeded)

Proposal to enhance regulation energy bid requirement

Ensure that unencumbered energy bid are available in real time to address SOC issues (i.e., do not take energy bids day ahead that encumber regulation awards, and insert bids to cover regulation awards in real time).

Manage SOC within individual intervals/hours based on worst case adverse takes rather than long-term averages: i.e., constrain regulation awards within an hour based on a worst case adverse take (e.g., 100% take in adverse direction, or maybe 95% confidence interval take)

Calibrate RT reduction in regulation awards so that only the amount needed to ensure feasibility is reduced, and only in the required direction; combine automatic reduction in regulation awards (no pays in real time) with use of energy bids. This may avoid consistent need to take batteries off of AGC in order to use energy bids to manage SOC.

Consider use of a forecast of SOC/regulation energy rather than fixed historical values; use confidence intervals to bound regulation awards Use these values to estimate SOC in future intervals (or over DA market horizon), but constrain deployment within hour based on worst case take.

Longer term solutions

Unbalanced use of regulation over many hours is not how regulation is intended to be utilized. It is possible that CAISO is allowing intermittents, or biases in forecasts, to cause a need for regulation to be used in only one direction over many hours. This issue could be addressed in regulation algorithms (i.e., by limiting regulation awards, or by deploying some "counterflow" regulation to manage the prevailing deployment) rather than via "band-aid" fixes.

Is there a possibility that imbalance reserves and/or flexible ramping could be procured to manage regulation capability of batteries?

There is a need for regulation down capability from intermittents as a potentially more economic solution to the need for regulation down. Also, BCR costs of regulation down may not show up in the market, yielding an incorrect underestimate of uneconomic regulation down costs.