Energy Storage Industry Learnings Forum
Workshop 5

June 10, 2022

Using Teams – Asking questions

- Asking questions and participating
  - Click “Raise Hand” and the hosts will be notified that you would like to ask a question or participate. The facilitator will then call your name and you will be able to unmute yourself.

AESO Stakeholder Engagement Framework

ESILF transparency

- The ESILF recognizes not all of the AESO's stakeholders will be represented within the ESILF and to support the AESO's commitment to transparency, the following is regularly updated on the AESO website on www.aeso.ca:
  - Forum membership
  - Agendas
  - AESO or member presentations
  - Relevant discussion materials
  - Meeting summaries

Stakeholder participation

The participation of everyone here is critical to the learning process. To ensure everyone has the opportunity to participate, we ask you to:

- Listen to understand others' perspectives
- Disagree respectfully
- Balance airtime fairly
- Keep an open mind

Welcome and Introductions

Ata Rehman,

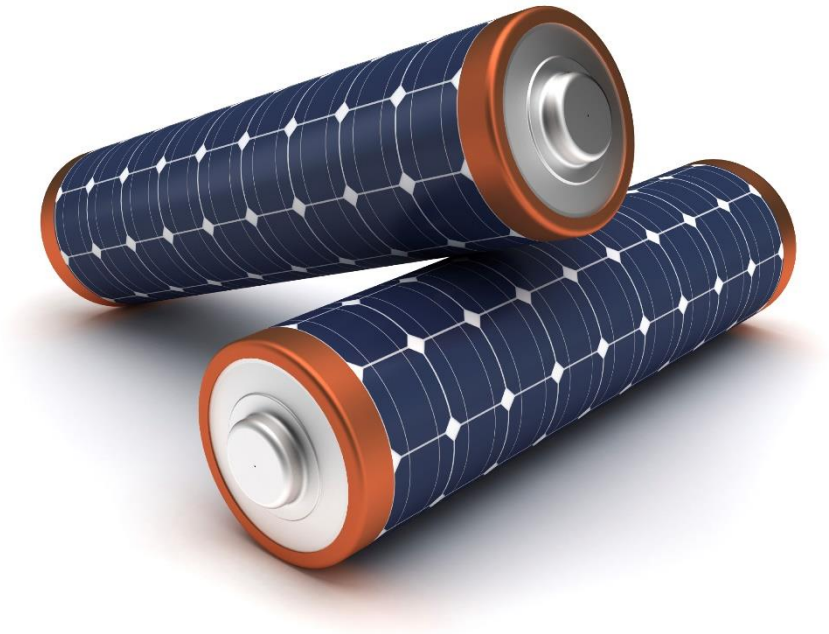
Director, Grid Planning & Operations Engineering, AESO

Agenda

Est. Time	Agenda Items	Presenter
9:30 – 9:35	Welcome & Introduction	Ata Rehman, Director, Grid Planning & Operations Engineering
9:35 – 10:00	Presentation 1 Energy Storage Standardized Solutions: Bridging the gap between traditional and renewable sources	Dan Gustafson, ABB
10:00 – 10:25	Discussion	Luis Garrido
10:25 – 10:30	Break	
10:30 – 10:55	Presentation 2 Storage on the California Grid	Gabe Murtaugh, California ISO
10:55 – 11:20	Discussion	Luis Garrido
11:20 – 11:25	Wrap up and next steps	Rob Davidson Vice President, Grid Reliability Projects and Planning
11:25 – 11:30	Quick Poll	Luis Garrido

Energy Storage Standardized Solutions Bridging the gap between traditional and renewable resources

Dan Gustafson, P. Tech (Eng)
ABB



Energy Storage Standardized Solutions

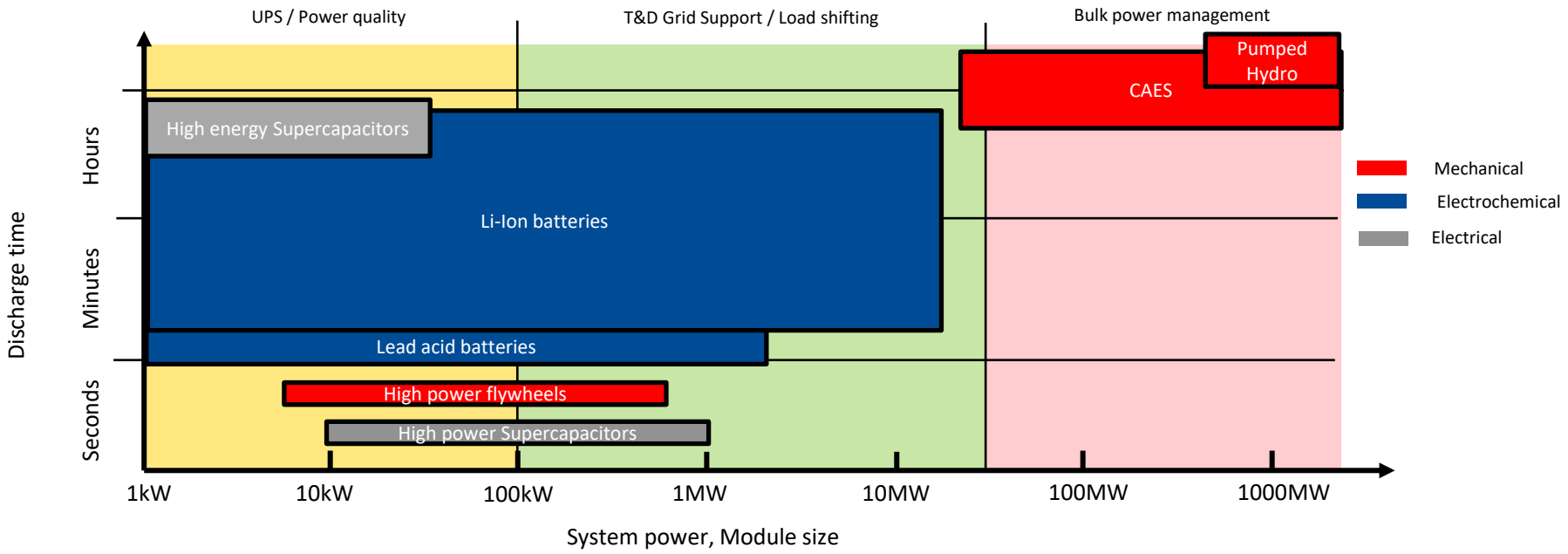
BESS – Bridging the gap between traditional and renewable sources

Dan Gustafson P.Tech(Eng)

Fixing the benefits of renewable energy

Energy Storage

Technologies



Battery Energy Storage Systems (BESS)

Integration of renewables is inevitable

Renewable Energy Revolution

However, as solar and wind-based generation capacities in electrical power networks soar, operators are finding it increasingly difficult to maintain grid stability and reliability.

Two of the principal reasons for this are:

1) Short-term variability
2) Low predictability

Both are inherent to renewable sources.

Can BESS do more?

YES! Enhance the provision and pricing of electrical energy and associated services and provide a way to optimize the entire power system.

Energy Storage Modules

Why energy storage?

How does energy storage benefit the grid and industry?

Energy storage raises the efficiency of the grid at every level by:

- Providing smooth grid integration of renewable energy by reducing variability
- Storing renewable generation peaks for use during demand peaks
- Flattening demand peaks, thereby reducing stress on grid equipment
- Providing infrastructure support as loads increase with electric vehicle use
- Decreasing or eliminating the power fees related to short time peak loads
- Maintaining generation and demand balance

Energy Storage segments and applications

There are many segments and applications for energy storage today

Segments and applications

Renewables

ESM aligns solar and wind generation peaks with demand peaks.

Utility distribution grid

ESM balances fluctuating demand without oversizing equipment.

Industrial loads

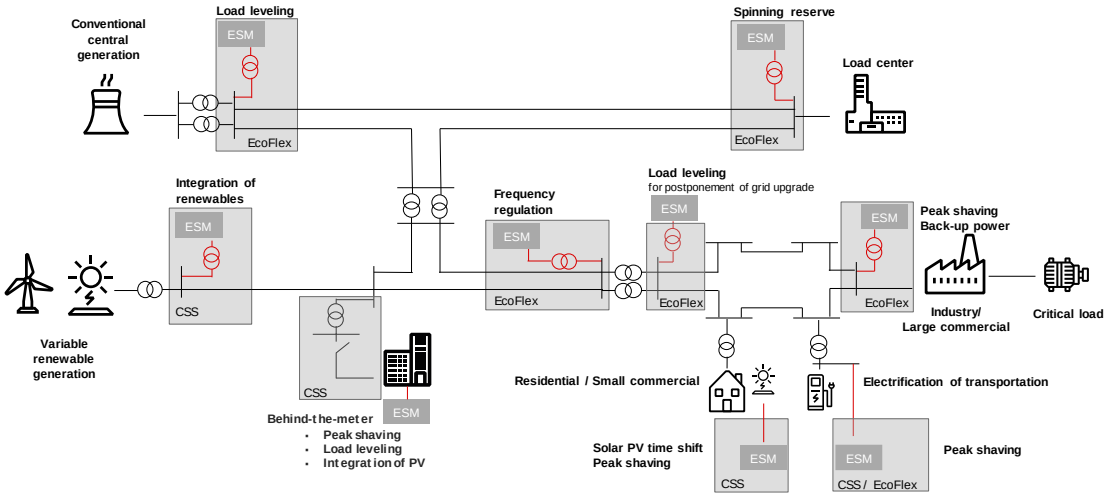
ESM provides back up power for critical loads, improves load factor and manages demand peaks

Residential and commercial

ESM lowers energy costs & improves load factor and manages demand peaks

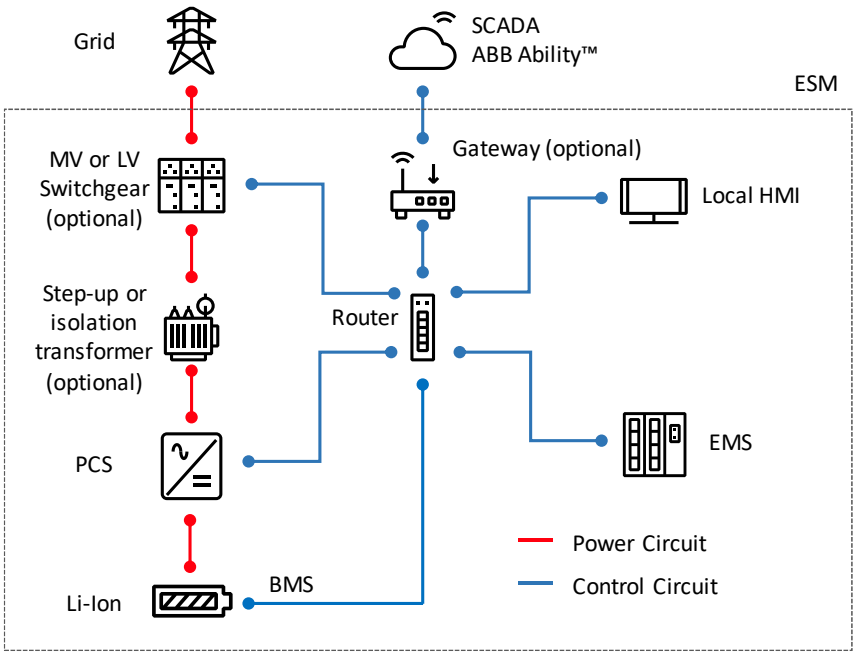
Electrification of transportation

ESM reduces demand on grid and enables fast DC charging without increasing demand charges



Product Overview

Energy Storage Module (ESM)



Integrated solution comprising:

- Power circuit:
  - **Grid connection devices** – MV or LV switchgear
  - Isolation or step-up **transformer** (optional)
  - **Power conversion system** (PCS) : AC/DC bi-directional converter
  - Energy storage batteries

- Control circuit:
  - Protection and control
  - Energy Management System (EMS) – **Control algorithms**
  - Battery Management System (BMS)
  - Customer external communication (optional) – **SCADA**

Selecting the correct Energy Storage Solution

Step - Questions to consider

Step1. Required Standard? ANSI / IEC

Step2. Application information

- peak loads management
- loads shifting
- reactive power support
- renewable energy sources integration
- frequency regulation and area load flows control
- critical load support during outage

Step3. Network connection

-voltage, -frequency, -short circuit level, -SLD (other items)

-Required active power rating (kW):

-Required useful energy storage capacity (kWh):

-Required lifetime (number of cycles):

-Required calendar lifetime (years):

Step 4 environmental conditions on site of installation

Operating ambient temperature, Humidity, Alitude:, Seismic risk:

Step 5 Enclosure

Size limitation :

Type of execution preferred: iso enclosure, outdoor operated, indoor operated.

Step 6 : Equipment needed to integrate the ESM system into the customer's grid. How is the ESM system planned to be integrated into the customer's grid?

7 Control of the ESM system : Desired utility Monitoring and Control Interfaces. Customer control system ? protocols for the customer ? Any Special control functions (special protection functions, local HMI etc.)

8 : Testing requirements

9 : Special requirements

Grid Inertia

Fast frequency response

Grid Inertia addresses the imbalances between supply and demand on electrical grids over very short periods of time (up to one Second)

Traditional method:

- Power plants would create enough power to cover peak demand. (Traditional plants are slow to respond).
- This power would be placed onto the grid, and if not used, the grid would dissipate it.
- Customers are often charged for having the power there incase they need it, even if they don't use it.
- Often called Mechanical inertia because the generators are direct mechanical connection (to turbine, diesel, water etc.)

Newer method:

- BESS is capable of supplying peak demands in short time order or offer supply on demand.
- On demand energy is good idea: if it is where it is required.
- Sharp inrushes are often caused by items like large motors or transformers, this makes placement possible.
- Often this is limited to very close applications as grid ripple effects can occur.

Primary Frequency Control

Secondary Frequency Control

Primary Frequency Control is autonomous stabilization of the grid immediately following an event, and secondary frequency control is slower recovery of the grid after an event.

Traditional method:

- Engine / turbine control to push vars onto the grid.
- This will help to offset the power factor created by the event.
- The generator closest to the event is the one that needs to react.
- Pushing vars is done by the generator trying to speed up but is forced to maintain frequency by generator synchronization.

Newer method:

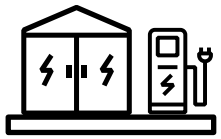
- BESS is capable of supplying peak vars by the inverter by much the same way as a mechanical generator, just electronically.
- Special programming is required to have the inverter do this.
- Sharp inrushes are often caused by items like large motors or transformers, if inverter is to be used to offset this it needs to be close to the events.
- If overshooting, this can cause ripple effects on the grid

E-Mobility solution

Energy storage combined with high power charging

Customer Challenges

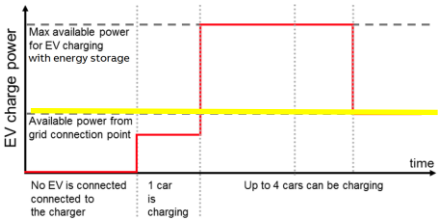
- Weak network connection on site
- Power not sufficient to charge electric vehicles
- Too costly and time-consuming to install new power line



Application

ESM control Mode

- Charging of ESM
- Charging of eV via ESM without power limit
- Charging of eV via ESM with power limit
- Charging of eV via Grid



Value

One piece delivery – Optimized site works

Factory assembled and tested – reduce site testing and commissioning

Safety – Internal arc tested portfolio for public safety

Optimized energy usage – charging energy storage when energy tariff is lower

Typical equipment

– LV Distribution board
– Energy Storage Module
– Terra HP EV chargers
– Local control
– Skid with integrated cabling

Solar/Wind Solution

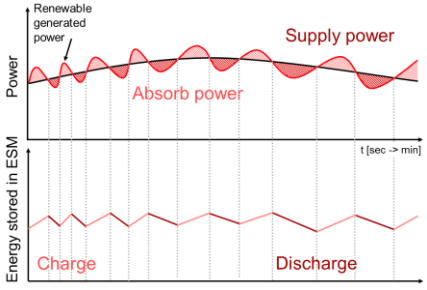
Integrated Energy Storage with Solar/Wind generation

Customer Challenges

- Solar/wind power hard to properly forecast
- Renewable generation not aligned with the demand
- Renewable mandates and incentives
- Tax benefit for storage systems?

Application

- Battery energy storage system with solar/wind power generation
- Equipped with energy management system
- Frequency regulation



Value

One piece delivery – simple installation

Factory assembled and tested – reduce site testing and commissioning.

Safety – Internal arc tested, mitigate site safety risks.

Capacity firming – Increase reliability and improves efficiency of the renewable plant

Tax and regulatory incentives – Potential tax benefits or incentives for clean grid technology

Typical equipment

- MV switchgear
- Distribution transformer
- Compact ESM
- Renewable integration
- Local control

Industry/large commercial solution

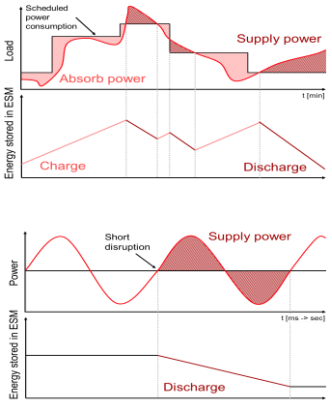
Large scale Energy Storage for industry/large commercial customer

Customer Challenges

- Electricity bill based on peak demand charge
- Power quality issues such as voltage drop, power factor (active/reactive power)
- Critical load that needs back up power
- Local limits (laws) on renewable energy without a BESS system?

Application

- Scalable energy with modular system
- Peak shaving, Power quality



Value

Pre-Engineered solution – Schedule improvement

Scalability – modular design

Factory assembled and tested – reduce site commissioning.

Transportation - Robust structure

Safety - Mitigate the risk of site safety issue.

Save expenditure – reducing peak demand and charging during the night

Power quality – Improve power quality

Picture

Large-scale Utility Solution

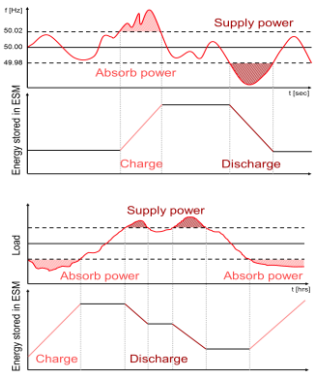
Scalable energy storage for grid utility customer

Customer Challenges

- Economic and population growth leads to increasing demand for power
- Coal plant retirements, reducing baseload power capacity
- Growth in renewables, reducing reliability on the electrical grid
- New power generation plant costs too much and takes long time
- Economic power generation by load leveling
- High-cost existing peaking plants

Application

- Scalable energy storage with modular system
- Frequency Regulation, Load leveling



Value

Pre-Engineered solution – Schedule improvement

Scalability – modular design

Transportation - Robust structure

Factory assembled and tested – reduce site commissioning

Safety - Mitigate the risk of site safety issue

Frequency Regulation – Increases reliable operation of the grid

Load leveling – Postponement of investments in grid

Picture

Questions?

Discussion

Luis Garrido, Project Manager,
AESO

Storage on the California Grid

Gabe Murtaugh, Storage Sector Manager
California ISO

Storage on the California Grid

March 31, 2022

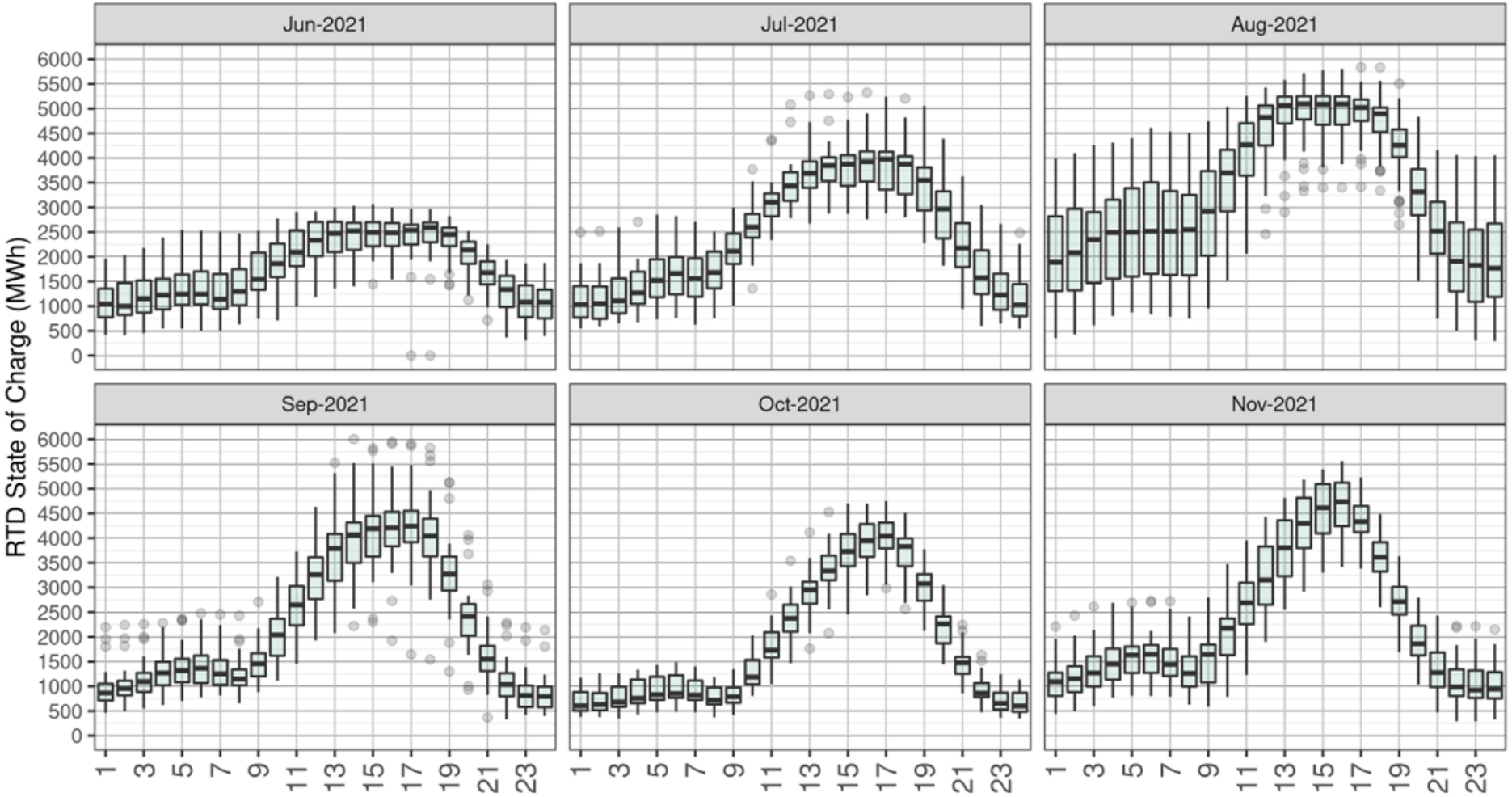
Gabe Murtaugh,
Storage Sector Manager

AESO's Energy Storage
Industry Learnings Forum

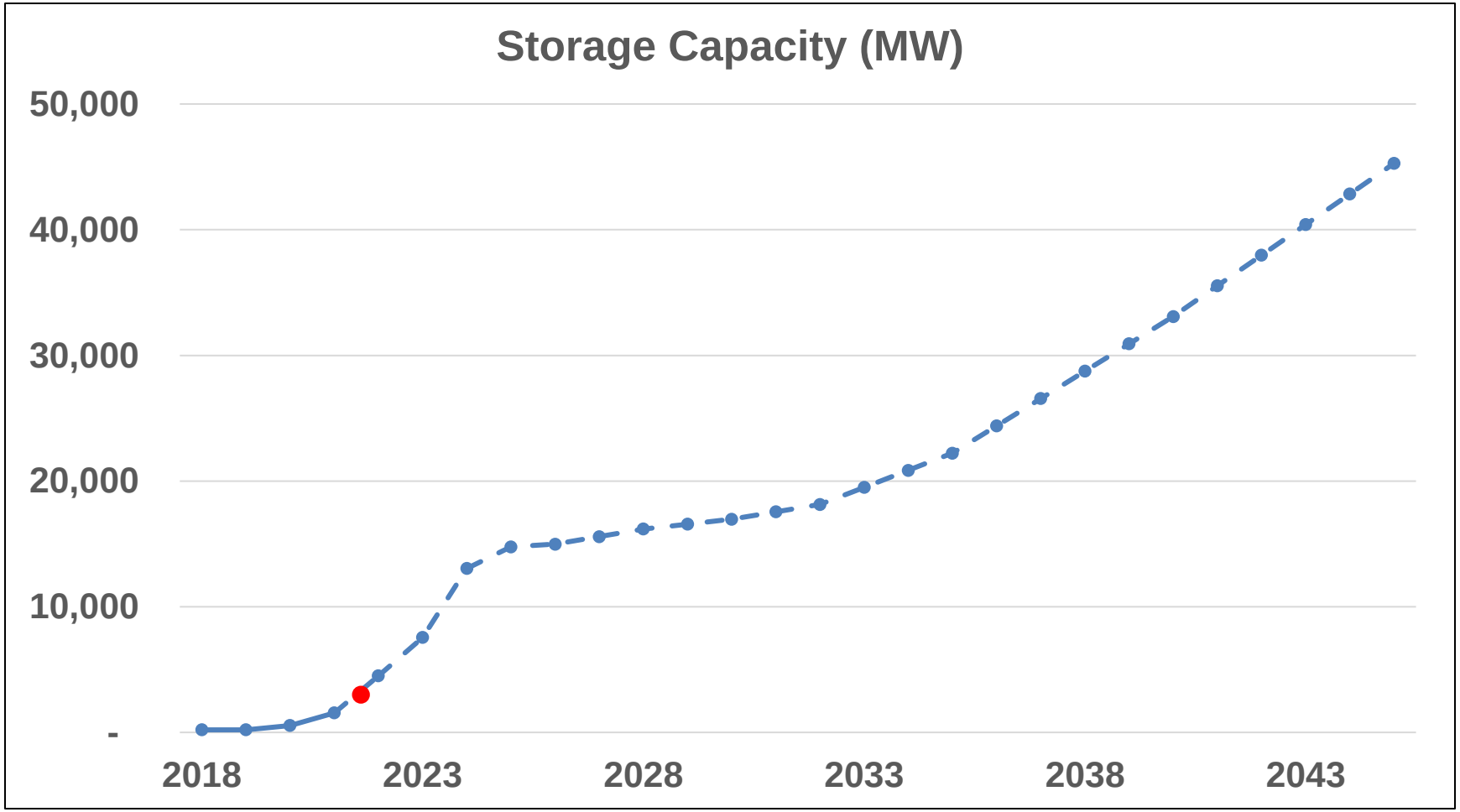
California is rapidly deploying storage on the system

- California has a system that peaks at just under 50 GW in the summer
- Storage makes up just under 3 GW of generation
  - Most of this capacity interconnected within the last 2 years
  - ISO anticipates another 1 GW of storage generation interconnecting within the next two months, bringing the total installed up to 4 GW
- Storage resources primarily provide energy shifting services, moving energy from the lowest priced hours of the day to the highest priced net load peak hours
- Storage resources are eligible to provide ancillary services in the California market
  - The ancillary markets are much smaller than the energy markets and are not the primary revenue stream for storage resources

As storage deployment increased last summer, energy moved also dramatically increased



The integrated resource plan calls for massive buildout of storage to reach 2045 GHG goals



California collaborates with other systems around the world to develop new tools for operating storage

- The California market includes a model that tracks state of charge while dispatching storage resources
  - Resources are never instructed to operate outside of their upper or lower energy limits
  - The model accounts for round trip efficiencies
- The ISO ensures storage resources are sufficiently charged to provide ancillary services in real-time
  - We have experienced challenges with insufficient state of charge
- The ISO is adding new functionality to exceptionally dispatch storage resources to hold state of charge
- US Government tax rules are resulting in contracting that prevents full participation of storage in the market

Storage presents key market design challenges that must be addressed in organized energy markets

- California is currently developing a new storage model
  - Will capture the relationship between state of charge and price
- Price “spreads” matter more for storage than peak prices
  - Storage profit is determined by buy and sell energy prices, and cycling costs
- Outcomes for storage resources may be very different in the day-ahead market compared to the real-time market
  - The day-ahead market anticipates needs across the entire day
  - The real-time market compares bids and prices and positions the market for needs across a relatively short horizon
  - The day-ahead horizon may also need to be increased to accommodate long-duration storage
- Eventually markets may need to compensate storage for holding state of charge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Discussion

Luis Garrido, Project Manager,
AESO

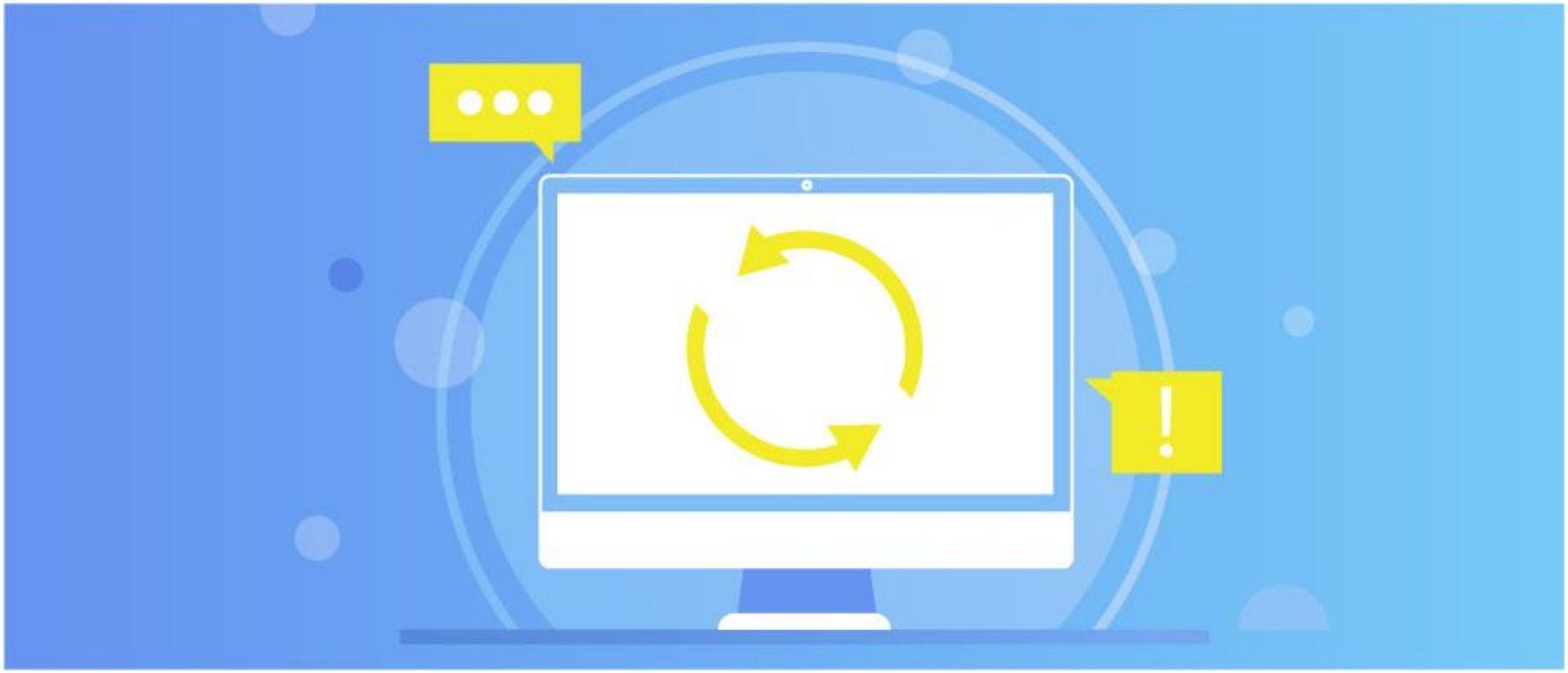
Wrap Up

Rob Davidson,
Vice President, Grid Reliability
Projects and Planning

Wrap up and next steps

- Poll will be sent out for members input on the future of ESILF
- **Please send your Energy Storage questions to:**
  - Email: energystorage@aeso.ca

Contact the AESO



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Thank you