



MICHAEL WORRY

CEO/CTO, Nuvation Energy



JOE O'CONNOR

Business Development Engineer, Nuvation Energy



MARTIN RHEAULT

VP of Sales & Business Development, EVLO Energy Storage

WEBINAR



CHOOSING THE RIGHT ENERGY STORAGE SYSTEM

Introduction



Jin Noh
Policy Director
California Energy Storage Alliance

CALIFORNIA ENERGY STORAGE BY THE NUMBERS

**4,189
MW**

Energy storage
procured in
California

**23,000
MW**

Solar PV + storage
"hybrid" resource
projects in the CAISO
interconnection queue

**250
MW**

Behind-the-Meter
energy storage
procurement

**8,900
MW**

Utility-scale battery
storage will be
needed by 2030 ◦

**25,000
MW**

Flexible ramping
capacity needed by
2030*

**973
MW**

Long-duration
energy storage
needed by 2030 ◦

**21,841
MW**

Standalone energy
storage projects
in CAISO
interconnection queue

*CAISO estimates ◦ CPUC estimates

CESA 

CALIFORNIA ENERGY STORAGE ALLIANCE

About CESA

The California Energy Storage Alliance is the definitive voice of energy storage in California.

At 100+ members strong, CESA is committed to advancing the role of energy storage in the electric power sector.

CESA is a 501c(6) membership-based advocacy group. CESA is technology and business model-neutral and is supported solely by the contributions and coordinated activities of its members.

Our CESA Members



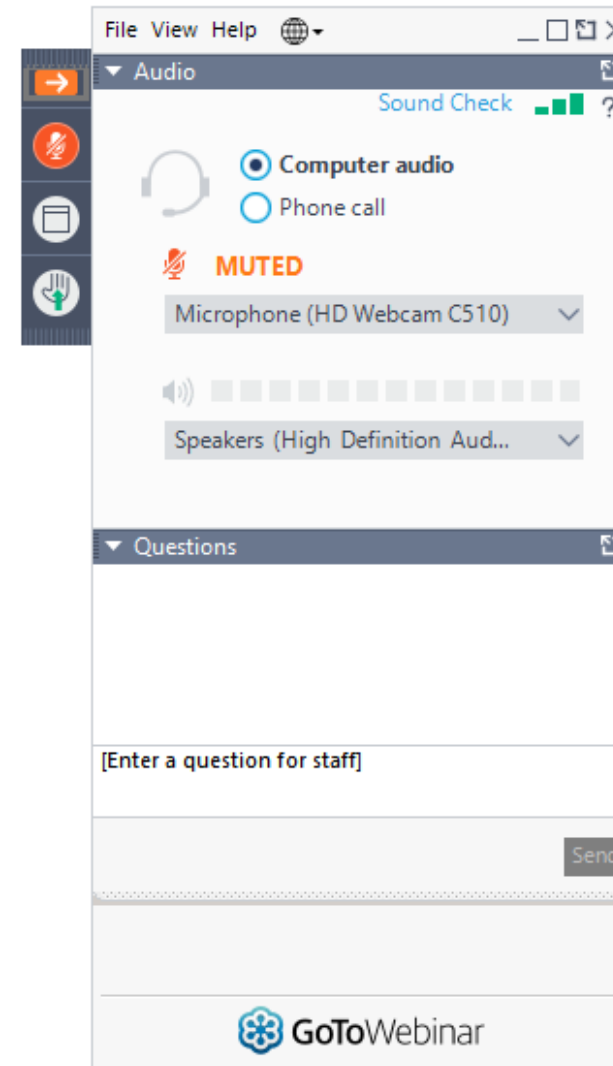
Agenda

- Welcome
- Identifying the Right Energy Storage Solution for your Needs – *Michael Worry, Nuvation Energy*
 - Nameplate vs. Usable Energy
 - Up Front Costs vs. Total Cost of Energy
- Total Cost of Ownership Comparisons – *Joe O'Connor, Nuvation Energy*
- Case Studies – *Martin Rheault, EVLO Energy Storage*
- Q&A
- Opportunities with CESA



Housekeeping

- All participants are in listen-only mode
- Webinar is being recorded and will be posted to www.storagealliance.org
- Q&A conducted through “Questions” panel in menu
- Time reserved for Q&A at the end

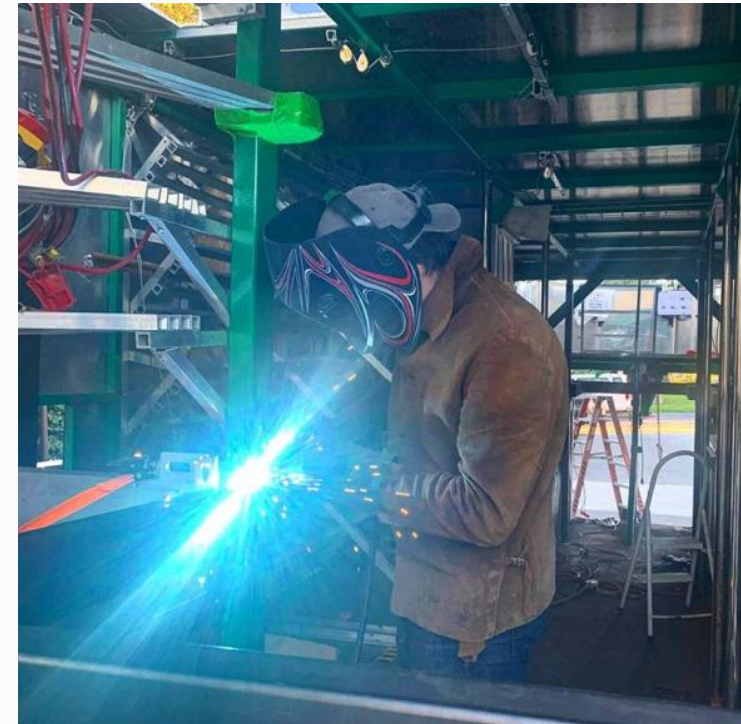


Introduction: Michael Worry

- CEO / CTO of Nuvation Energy
- Electrical Engineer, University of Waterloo, Canada
- Founded Nuvation 1997
- Day job: Energy Storage Systems



- Hobbies: Energy Storage Systems





NOVATION ENERGY

Choosing the Right
Energy Storage System
for your Specific Application



Energy Storage Systems ▪ Battery Management Systems
Energy Management Systems ▪ Field Commissioning

NUVATION OFFICIAL RESELLER

EVLO Energy Storage

- Turn-key ESS with Nuvation BMS
 - Partnership since 2018
 - Reseller agreement in 2021
 - Deliveries available in Q4 2021
- EVLO product line includes:
 - EVLO-500 - 500 kWh 10-ft ISO container
 - EVLO-1000 - 1 MWh 25-ft enclosure
 - EVLO-1650 - 1.65 MWh (coming 2023)

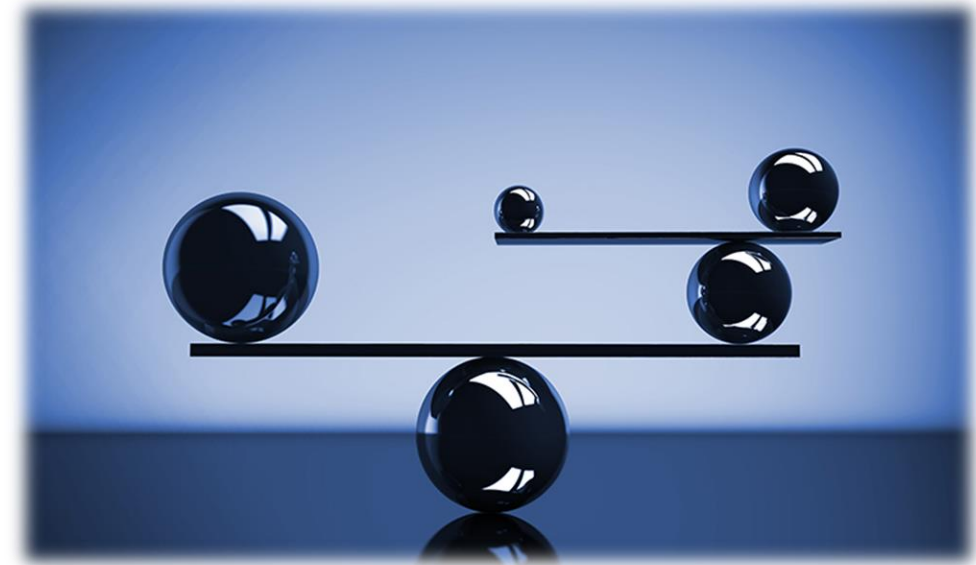


THE PERFECT ESS

What is the perfect ESS?

- No safety risk, available now, no downtime, no maintenance
- No onsite assembly, infinite cycle life, unlimited capacity
- Oh, and it's free!

Well, that isn't real, so what can I actually get?



Poll



VARIOUS ESS TYPES

Requirements oriented system design



Island Microgrid ESS

- 100% solar powered island resort off the coast of Panama
- Solar PV + ESS + Gensets
- Site controller unified control of 27 battery banks and two diesel gensets
- Augmented capacity with two types of battery systems
- AGM Lead Acid batteries



15-minute Behind the Meter ESS

- Wastewater Treatment plant in Santa Rosa, CA
- Custom ultra-compact 24-foot container for a wastewater treatment plant
- Spinning reserve, for diesel genset changeover in case of grid outage
- Demand Charge Management
- Lithium NMC high power chemistry with high energy density



5-hour Front of the Meter ESS

- Front of the meter Utility asset
- Distribution support
- 4 MW / 20 MWh
- Applications
 - Resilience & Backup Power
 - Islanding
 - Peak Shaving



Mobile ESS

- Hybrid diesel portable generator
- Shock and vibe compliant to SAE J2380 and SAE J2464
- Battery reduces peak power and variable load demands on diesel generator
- Improves voltage and frequency stability under variable load
- Cuts the generator size in half

NUVATION ENERGY

NAMEPLATE VS. USABLE ENERGY

NAMEPLATE VS USABLE ENERGY

Terminology is important

Nameplate Energy

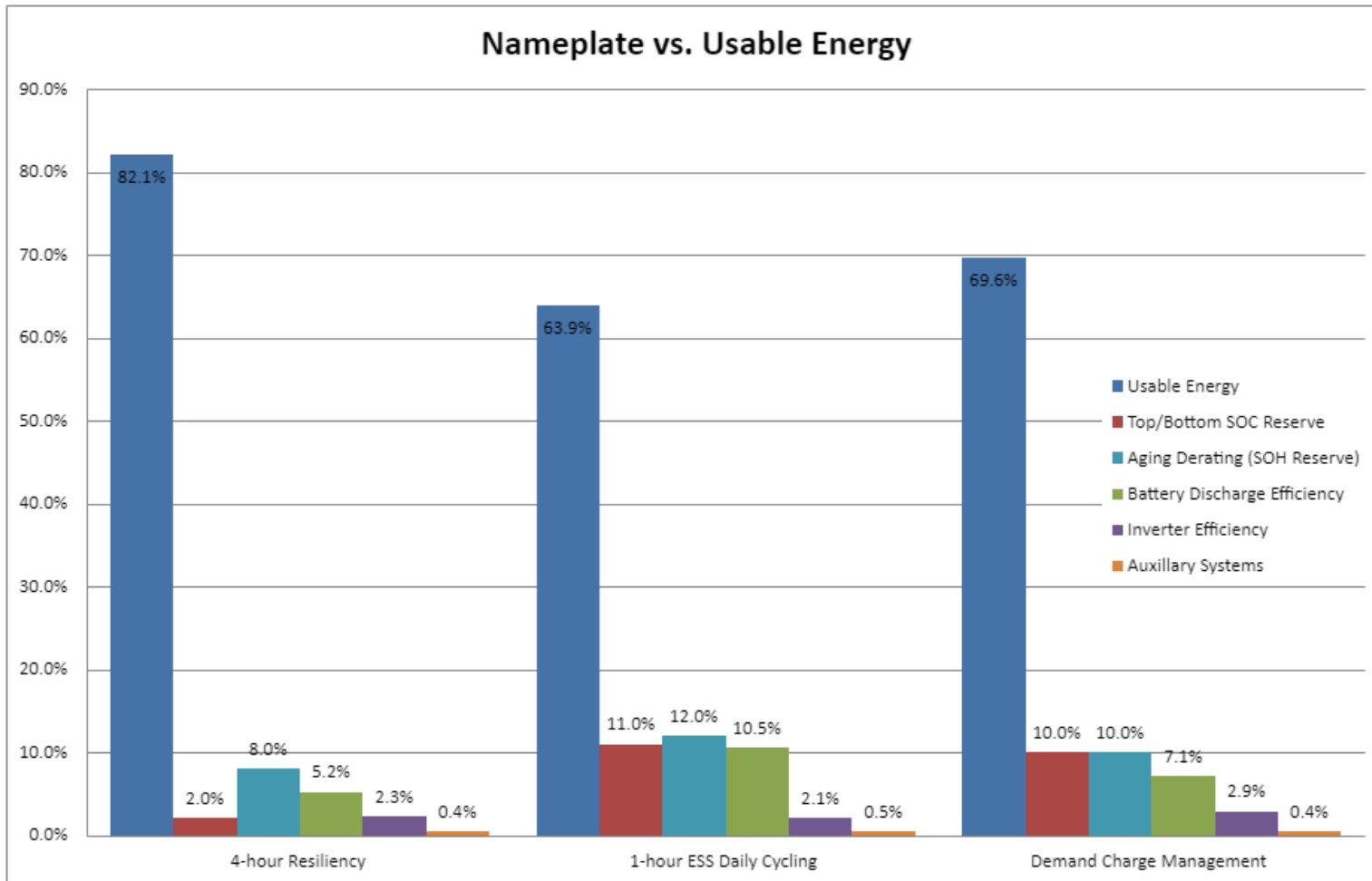
- The rated or nominal capacity typically extrapolated from the cell or module datasheet.
 - Nominal Stack Voltage (Vnom) X Capacity (Ah) = Nominal Capacity (kWh)

Usable Energy

- The amount of energy delivered at the AC meter which includes all the energy losses in the ESS
- System losses include equipment efficiency, environmental conditions, ESS use case, heat gain from PCS, wires, bus bars, HVAC loads and battery.

CALCULATING USABLE ENERGY

How much of the Nameplate Capacity is delivered?



Model the ESS to understand:

- Actual AC power delivered
- PCS and ESS voltage limits
- Reserve SOC capacity to match usecase
- Expected performance as battery ages
- Battery cell mismatch
- Efficiency loss to heat
- Environmental conditions resulting in variable auxiliary loads

NAMEPLATE VS USABLE ENERGY

How to size an ESS for site requirements

- Often RFQs require a usable AC Power and Energy for many years requiring significantly more energy capacity than the nameplate ESS rating
- When bidding a project, do you aggressively reduce the excess capacity without significant buffer?
- Or significantly oversize the system, and run the risk that other bidders under bid you?



Poll



NUVATION ENERGY

UP FRONT COST VS
TOTAL COST OF OWNERSHIP

UP-FRONT VS. LIFETIME COST

- What are all the costs we can calculate during the ESS useful life?
- **Up-front Costs**
 - Easy to calculate, but simplistic point of view
- **Lifetime Costs**
 - Must be estimated, but shows the complete picture
- How do you calculate the cost?
 - Up-front Costs + Product Lifetime Costs = Total Cost of Ownership



UP-FRONT COST

Defined and Known

- Typical known and defined costs:
 - Price of equipment, install estimate, etc.
 - Expected power and capacity
 - Product/performance warranty

LIFETIME COSTS

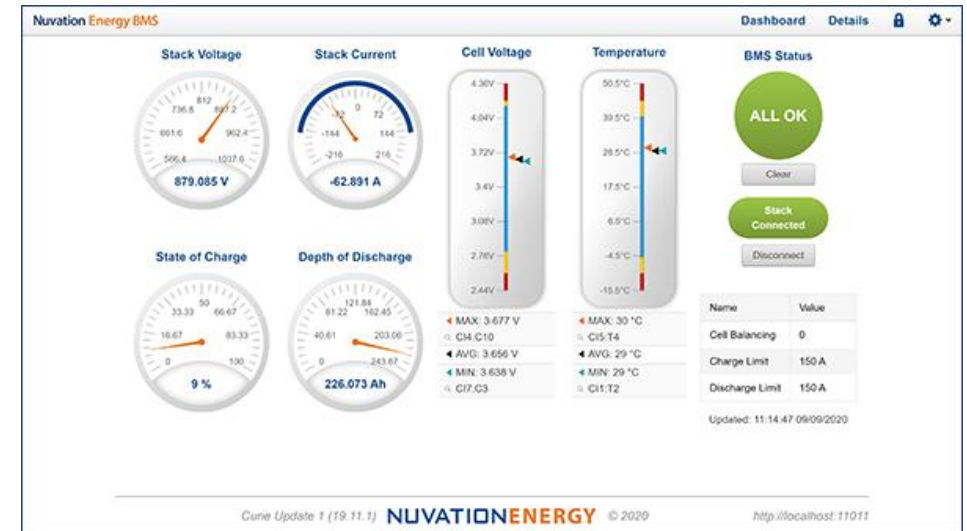
Estimated or Unknown

- Operations & maintenance
- Component repair/replacement (warranty validation, predictive maintenance)
- Planned or unplanned downtime (predictive maintenance)
- Additional engineering effort for commissioning and integration
- Schedule delays which lead to delayed revenue or financial penalties
 - Commissioning issues
 - System integration issues
 - Permitting issues
 - Delivery lead time issues

MANAGE LIFETIME COSTS WITH DATA

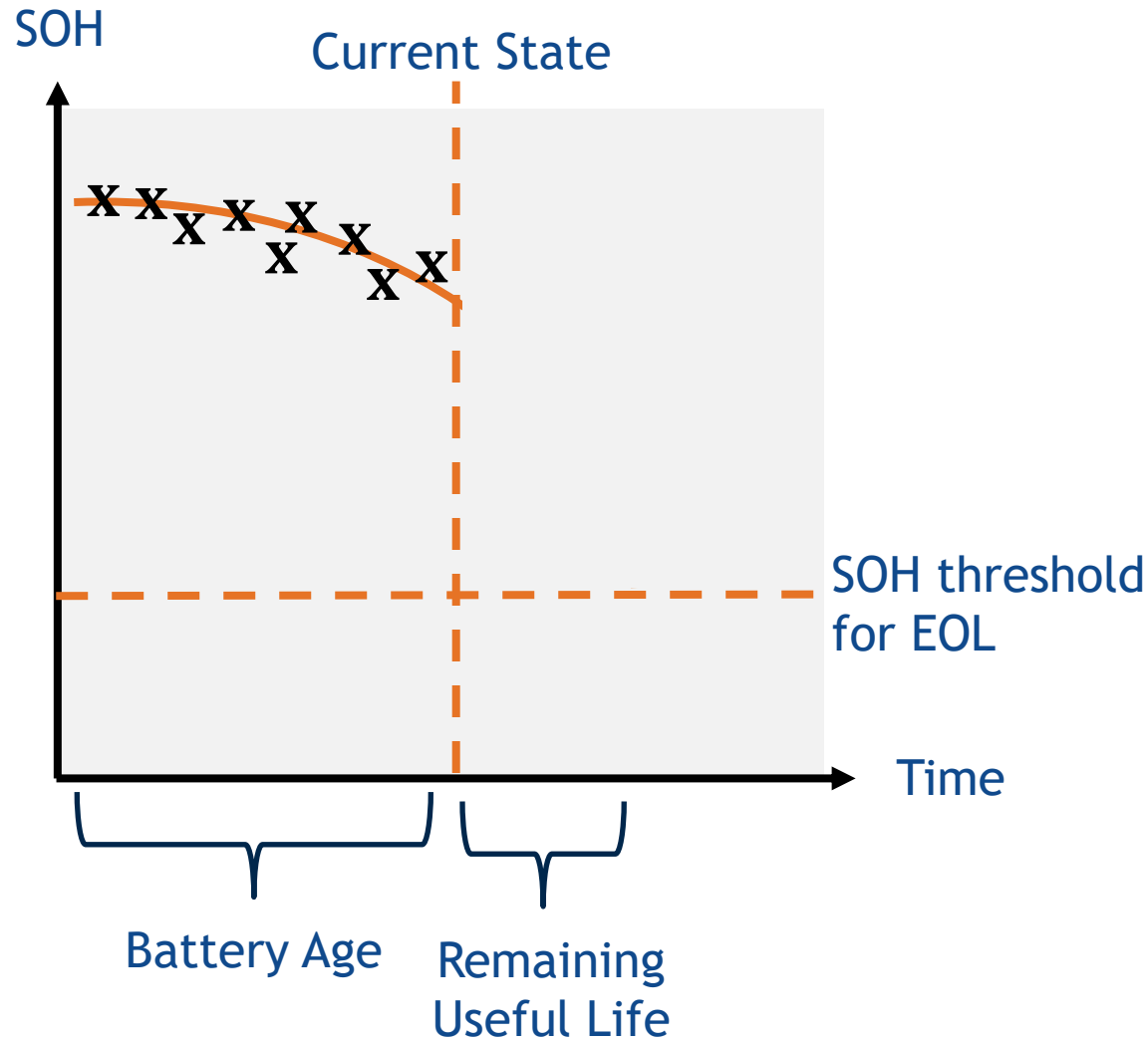
BMS data logging and deep learning

- Predict Remaining Useful Life with SOH data
- Open Wire Detection - “Discover outliers before they become a problem”
- Predictive maintenance with Nuvation's BMS self-check
- Warranty validation
 - Battery warranty tracking
 - Component replacement
 - Contactor life tracking



ADVANCED BATTERY ANALYTICS

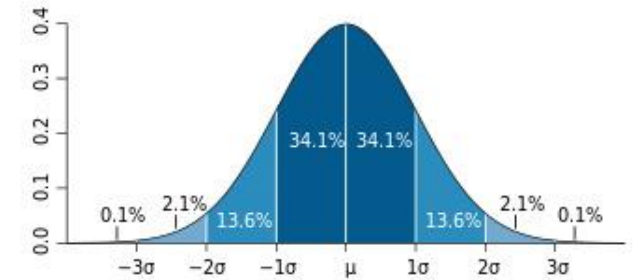
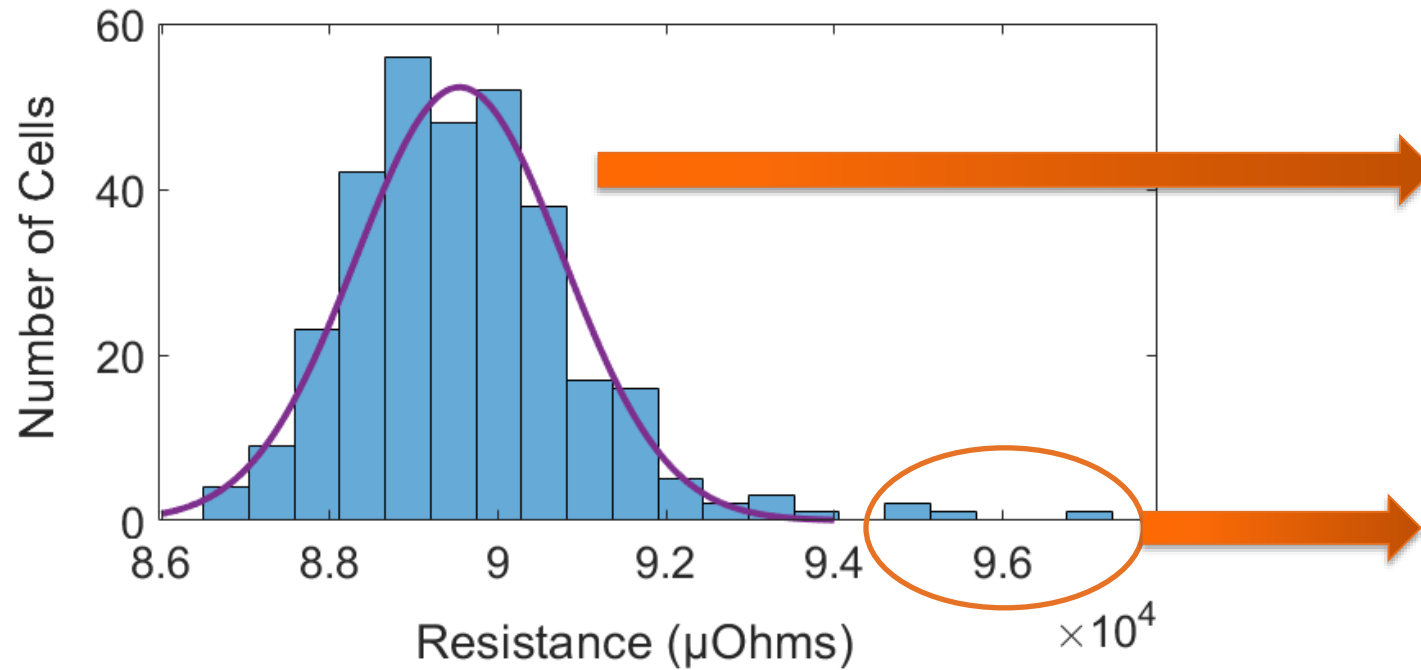
State-of-Health vs. Remaining Useful Life



- State of Health is the current health of the battery. Based on capacity and resistance.
- Remaining useful life is the predicted, estimated time to failure.
- Same data used for battery warranty tracking can also enable cloud calculations of remaining useful life prediction.

PERFORMANCE: TRANSPARENCY

An intelligent BMS provides increased detailed transparency of battery status, such as per cell SOH and impedance.



Several cells lie outside the 99% confidence interval and are considered outliers (replacement targets).

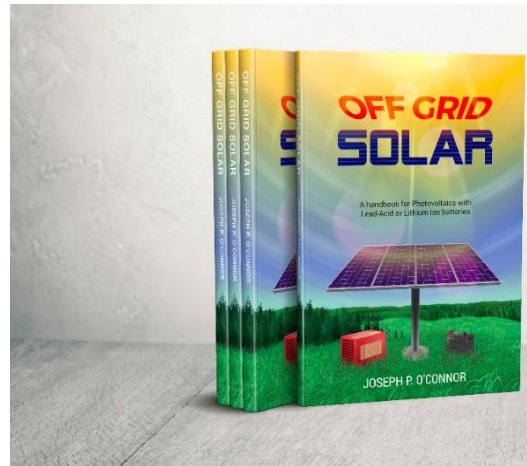
A histogram was generated for the individual cell resistances in the high voltage battery pack.

NUVATION ENERGY

TOTAL COST OF OWNERSHIP
COMPARISONS

NEXT SPEAKER, JOE O'CONNOR

- Business Development Engineer, Nuvation Energy
- Masters in Manufacturing Engineer, Cal Poly San Luis Obispo / NYU Tandon
- SolarCity, Mercedes-Benz Energy
- Day job: Energy Storage Systems
- Hobbies: Energy Storage Systems



TOTAL COST OF OWNERSHIP

Comparing three system designs

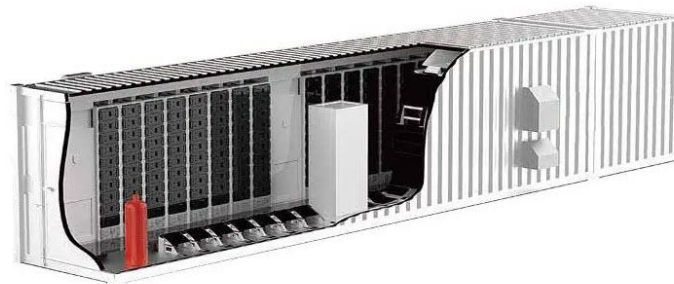
- Comparing three different parameters:
 - Hardware
 - Soft / Ongoing Costs
 - Risk of Schedule Delays



63'L x 12'W x 13'H concrete enclosures

A: LFP Field Installed ESS

- Very Large-sized Concrete ESS Enclosure
- Major components shipped separately and installed onsite



Large ISO container

B: NMC Factory Assembled ISO Container ESS

- Large-sized Factory Assembled ESS container
- NMC Highest energy density



29'L x 6'W x 10'H custom enclosure

C: LFP Factory Assembled Enclosure ESS

- Medium-sized Factory Assembled ESS enclosure
- LFP fire safe chemistry

TOTAL COST OF OWNERSHIP

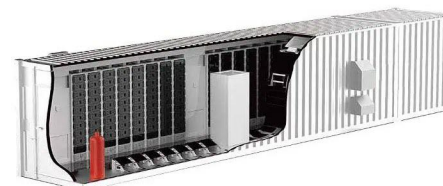
Trade offs: Hardware



Category	A: Field Installed LFP	B: Factory Container NMC	C: Factory Enclosure LFP
Initial price of system	\$	\$\$\$	\$\$
Battery module installation	\$\$\$	None	None
Crane or forklift for moving containers	\$\$\$ (Crane)	\$\$ (Crane)	\$ (Forklift)
Financial risk of thermal event	\$\$	\$\$\$	\$

TOTAL COST OF OWNERSHIP

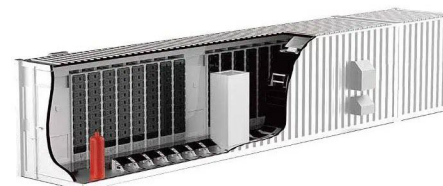
Trade offs: Soft/Ongoing Costs



Category	A: Field Installed LFP	B: Factory Container NMC	C: Factory Enclosure LFP
20-year performance guarantee	\$\$	\$\$\$	\$\$
Augmentation (install more batteries)	\$\$	\$\$\$	\$
Training skilled labor	\$\$\$	\$	\$
Maintenance/Component replacement	\$	\$\$	\$

TOTAL COST OF OWNERSHIP

Trade offs: Risk of Schedule Delay



Category	A: Field Installed LFP	B: Factory Container NMC	C: Factory Enclosure LFP
Commissioning/integration Risks	\$\$	\$	\$
Permitting/regulatory Risks	\$\$	\$\$\$	\$
Delivery lead time Risks	\$	\$\$\$	\$\$

So then, what is the best system design for our growing ESS industry?

It depends on your goals.

Martin Rheault

VP Sales & Business Development, EVLO

- + 20 years in power sectors (Energy Storage, Wind, Solar and T&D)
- + Served as interim CTO since September 2020
- + Electrical Engineer
- + Led the development, design and construction of Canada's largest merchant BESS



EVLO by Hydro-Québec

Established in 1944, Hydro-Québec, the largest renewable energy producer in North America, created a fully owned subsidiary to support utilities delivering safe and sustainable high-capacity energy storage solutions.

24.2 TWh
NET ELECTRICITY US EXPORT

202.7 TWh
NET ELECTRICITY SALES

10.9 B\$
REVENUES FOR 2020

64.7 B\$
TOTAL ASSETS

36.7 GW
INSTALLED HYDRO CAPACITY

161,000 mi
TRANSMISSION AND DISTRIBUTION LINES

99%
CLEAN ENERGY

Who Are We?

EVLO Energy Storage designs, installs & operates energy storage systems to power a brighter future.

VISION

In a world undergoing an intense energy transition, our solutions drive the integration of renewable energy and the resilience of tomorrow's power grids.

MISSION

Our cutting-edge expertise and utility legacy establish us as the leaders in environmentally responsible storage. We design, install and operate accessible, safe and efficient energy storage solutions.

Our patented, eco-friendly battery chemistry is the culmination of 40 years of research by our Hydro-Québec's advanced innovation lab

+100 employees

EVLO is a turnkey energy storage system and service provider

EVLO's energy storage product line ranges from compact commercial solutions to large utility-scale solutions



EVLO Sustainable Storage Solutions

EVLO offers unrivalled technology for a greener future.



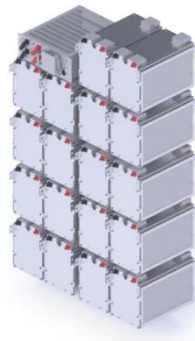
HARDWARE INNOVATION

- + Safe LFP chemistry
- + Advanced safety features
- + Long cycle life
- + Utility-friendly design
- + High-density site layout
- + High-energy density
- + Simplified installation
- + Improved maintenance access
- + Extreme temperature package



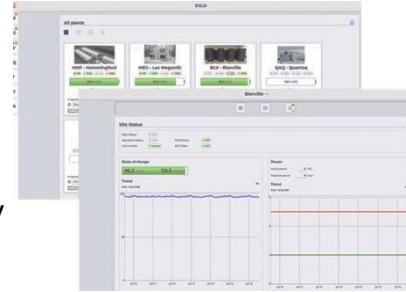
OPERATIONS & MAINTENANCE

- + Remote monitoring & operations
- + Preventive maintenance
- + State of health reporting
- + Spare part strategy



SOFTWARE INTELLIGENCE

- + Fully integrated SW suite
- + Optimizes system performance and safety
- + Flexible use case stacking
- + Modern remote monitoring solution
- + High-speed grid interactive response
- + Warranty and risk data management solution
- + NERC CIP ready (cybersecurity)



ADDED-VALUE SERVICES

- + Project management
- + Simulation/Modelling
- + Commissioning
- + Recycling program
- + Power system consulting
- + Financing



Thermal Runaway Challenges & Mitigations

EVLO has developed a series of advanced safety features to minimize thermal runaway effect, such as explosive gases emission.

NFPA 855 STANDARD SUPPORTS TWO MITIGATION APPROACHES:

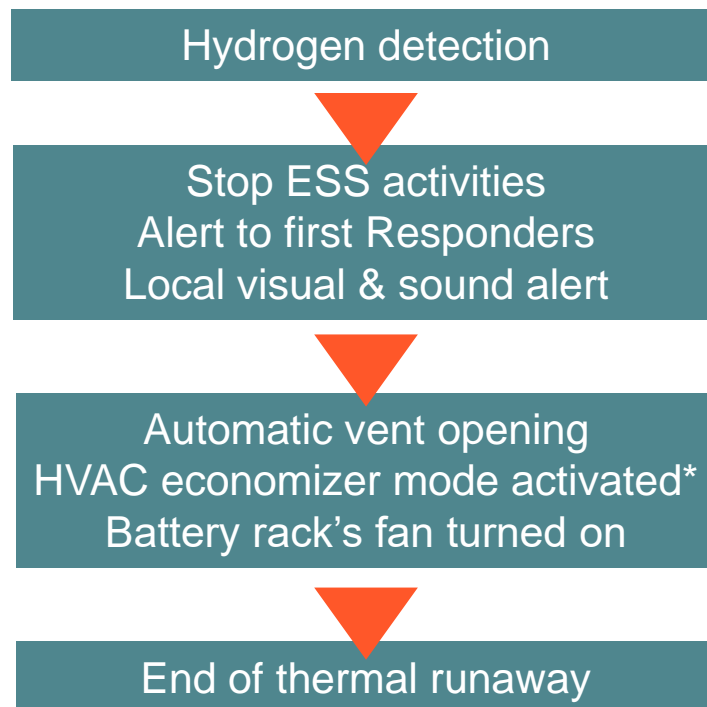
- NFPA 68:
Deflagration Panels
Allows accumulation of hazardous gases but in case of deflagration, it is “executed” in a controlled manner

OR

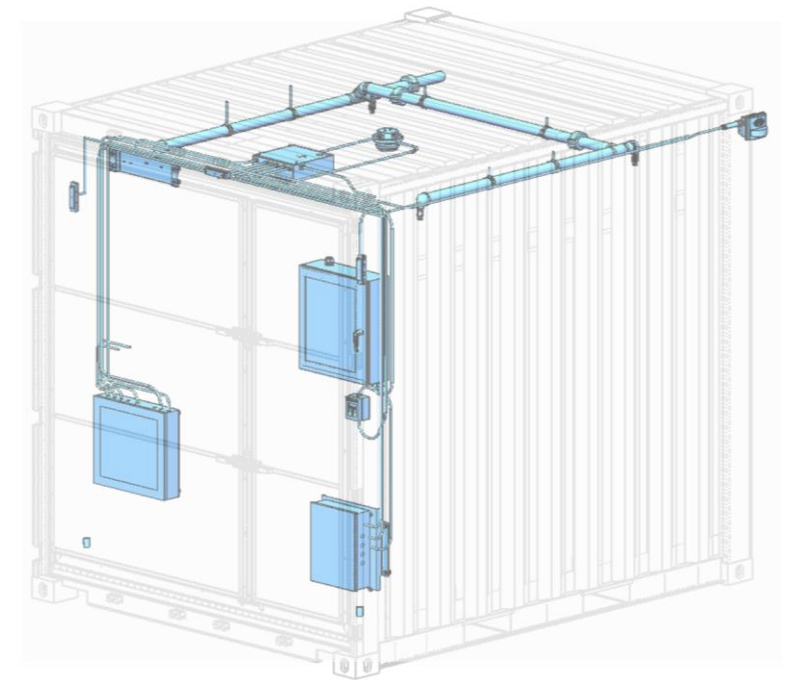
- NFPA 69:
Active Ventilation
Maintain explosive gases concentration below 25% of the Lower Flammability Limit (LFL)

**EVLO's
choice**

SEQUENCE OF EVENTS

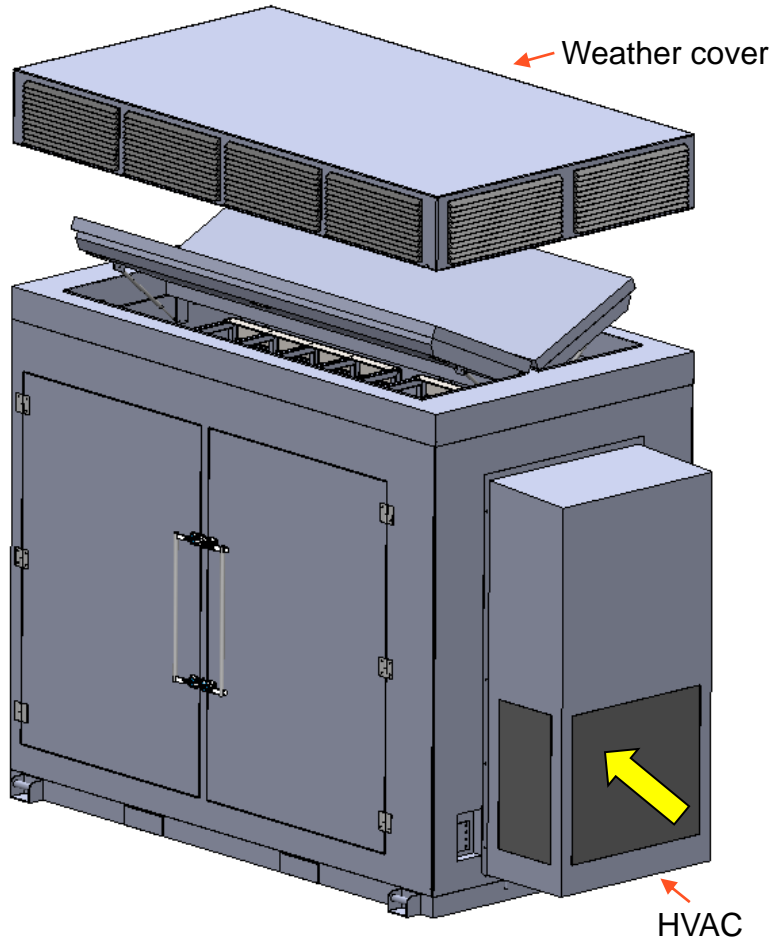


SAFETY FEATURES

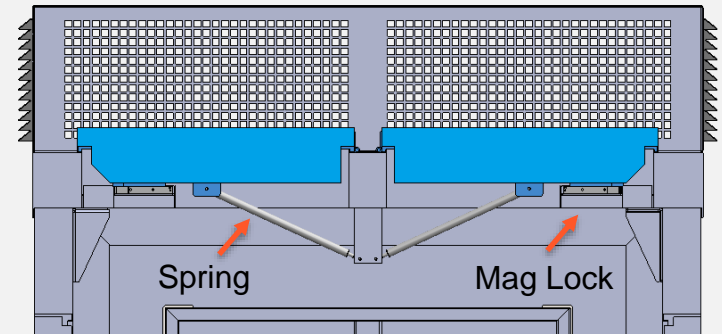


Thermal Runaway Automatic Management

In order to be compliant with NFPA 69, EVLO Engineering team has developed an innovative way to perform active ventilation

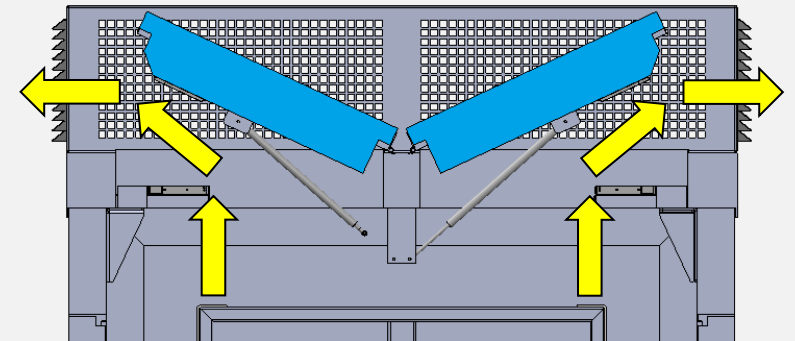


➤ Normal Operating Mode



EVLO 1000 SIDE VIEW

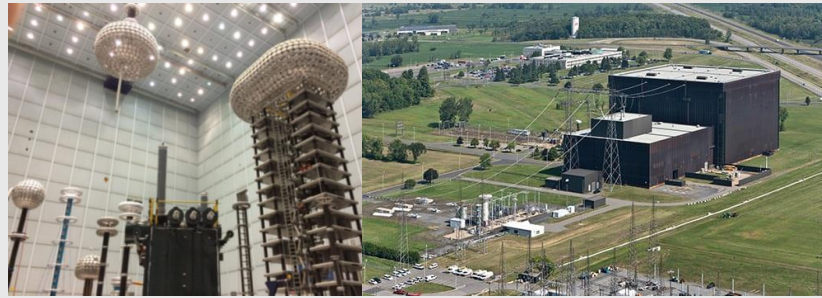
➤ Active Ventilation Mode



EVLO 1000 SIDE VIEW

At the Heart of a World Class Research Center

IREQ Campus is the innovative strength of Hydro-Québec, where EVLO's battery and energy storage technologies were developed.



IREQ

HYDRO-QUÉBEC RESEARCH CENTER

- + High Voltage Lab (1971)
 - HV and EHV substation transfer testing and commissioning
 - TYPE test for any new equipment to be deployed in the grid
- + 735 kV pioneer
- + Fundamental research
- + Grid and equipment modeling and simulating
- + Chemistry and advanced material research labs
- + Advanced robotic labs for grid inspection
- + +200 researchers in power systems
- + High performance calculating center (CASIR)



EVLO's Headquarters and Labs

EVLO's BESS testing site:

- ▶ Full size energy storage systems
- ▶ Field integration test (FIT)
- ▶ Customer specific testing
- ▶ Certification
- ▶ Training

CENTER OF EXCELLENCE IN TRANSPORTATION ELECTRIFICATION AND ENERGY STORAGE

A world-class innovation hub in the field of battery materials for electric vehicles and energy storage applications.

- ▶ 100+ patent families
- ▶ 40+ years of innovation

The Right Sizing for Each Use Case

At EVLO we invest our efforts in modeling and simulating up front, to guarantee down the road the success of your project.

RESILIENCY - MICROGRID



LAC-MÉGANTIC, CANADA

Following the 2013 railway disaster, Lac-Mégantic rebuilt uses EVLO to be part of the microgrid and to integrate ~1,700 solar panels

- + Peak shaving, solar energy integration, islanding, resilience
- + System size: 0.6 MW / 0.6 MWh
- + Energy storage product: EVLO 300
- + Client: Hydro-Québec
- + Commissioning: 2021

INTEGRATION - RENEWABLES



TONNERRE PROJECT, FRANCE

EVLO will provide grid stability during unforeseen circumstances and help balance the power transmission system with frequency regulation (50 Hz)

- + Grid stability, resilience
- + System size: 9 MW / 9 MWh
- + Energy storage product: EVLO 500
- + Client: RTE, France
- + Commissioning: 2021

BACKUP POWER - TRANSMISSION



SUBSTATION, LA VERENDRYE, CANADA

Using batteries instead of diesel generators to maintain the utility services during upgrade work on a remote transportation line

- + Resilience, backup power, peak shaving
- + System size: 4 MW / 20 MWh (5 hours)
- + Energy storage product: EVLO 1000
- + Client: Hydro-Québec
- + Commissioning: 2022
- + GHG savings: 3495 t

Key Takeaways

- > Application / cycling definition is crucial
- > Safety attributes should be weighted in the procurement process
- > Testing facilities are important to enable field integration tests “FIT”
- > Financial strength of solution providers is a box to check early

Get in Touch

EVLO is a highly skilled organization thrilled to contribute to accelerating the transition to renewable energies



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THANK YOU!
QUESTIONS?



*Accelerate Your Energy
Storage Project*



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**ENERGY
MANAGEMENT
PRODUCTS**



**ENERGY
STORAGE
SOFTWARE**



**BATTERY
MANAGEMENT
PRODUCTS**



**ENERGY
STORAGE
SYSTEMS**

A photograph of the Golden Gate Bridge in San Francisco, California, taken during sunset. The bridge's iconic orange-red towers and suspension cables are silhouetted against a warm, orange and purple sky. The water of the bay is visible in the foreground, and the bridge spans across it. The image is used as a background for the top half of the slide.

JOIN OUR DEFINITIVE VOICE:

ADVOCACY THAT YIELDS RESULTS.

- **Receive** powerful market intelligence
- **Influence** and educate key stakeholders
- **Access** industry experts
- **Network** and build partnerships
- **Develop** new business opportunities
- **Gain** recognition as an industry leader at our events and web presence

Contact: Grace (gpratt@storagealliance.org)



Thank you!

Get in touch:
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