Energy Storage

Overview and Key Risks

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BLACK & VEATCH

Agenda

- **Quick Black & Veatch Introduction**
- **Energy Storage Overview**
- **Key Risk Discussion**
  - Supplier Risk
  - Development Risk
  - Equipment Performance
  - Investment Performance
  - Innovation and Technology Risk
  - Safety/Fire
- **Questions**

Black & Veatch Introduction

Black & Veatch Overview

10,000+ Professionals

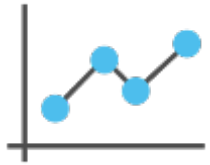
110+ offices

Six continents

7,000 active projects worldwide.

$3.5 Billion

in revenue in 2018.



Safety Performance

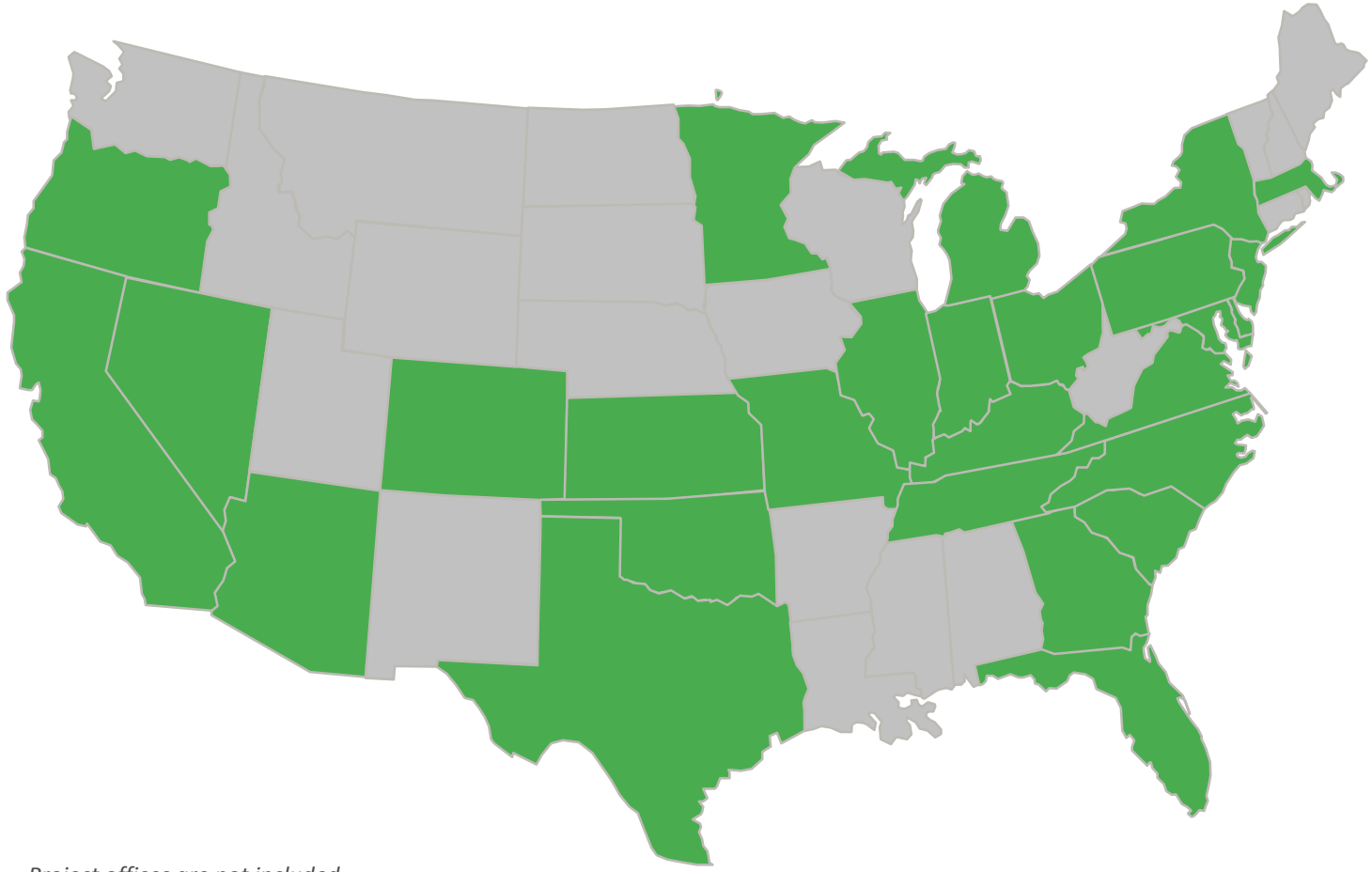
0.35

Recordable Incident Rate

0.08

Lost Time Incident Rate

United States Presence



Arizona
California
Colorado
Delaware
Florida
Georgia
Illinois
Indiana
Kansas
Kentucky
Maryland
Massachusetts
Michigan
Minnesota
Missouri
Nevada
New Jersey
New York
North Carolina
Ohio
Oklahoma
Oregon
Pennsylvania
South Carolina
Tennessee
Texas
Virginia

Project offices are not included.

B&V Has Been in Energy Storage for 30+ Years

Lake Lenexa Dam
Johnson County, KS

Feasibility & Project Design

Economic Analysis and Strategy Studies

Assessment of 3 types of BESS for Shell Wind

NYISO & MISO Interconnect Strategy for Beacon Power

Support LADWP ES procurement target

1985 1990 2000 2010 2019

Pumped Hydro

Ultracapacitors

Battery Energy Storage Systems

Spring Creek Pumped Storage FERC licensing

OE on multiple AES Energy Storage sites

IE on multiple Solar + Storage sites

IE and Owner's Engineer

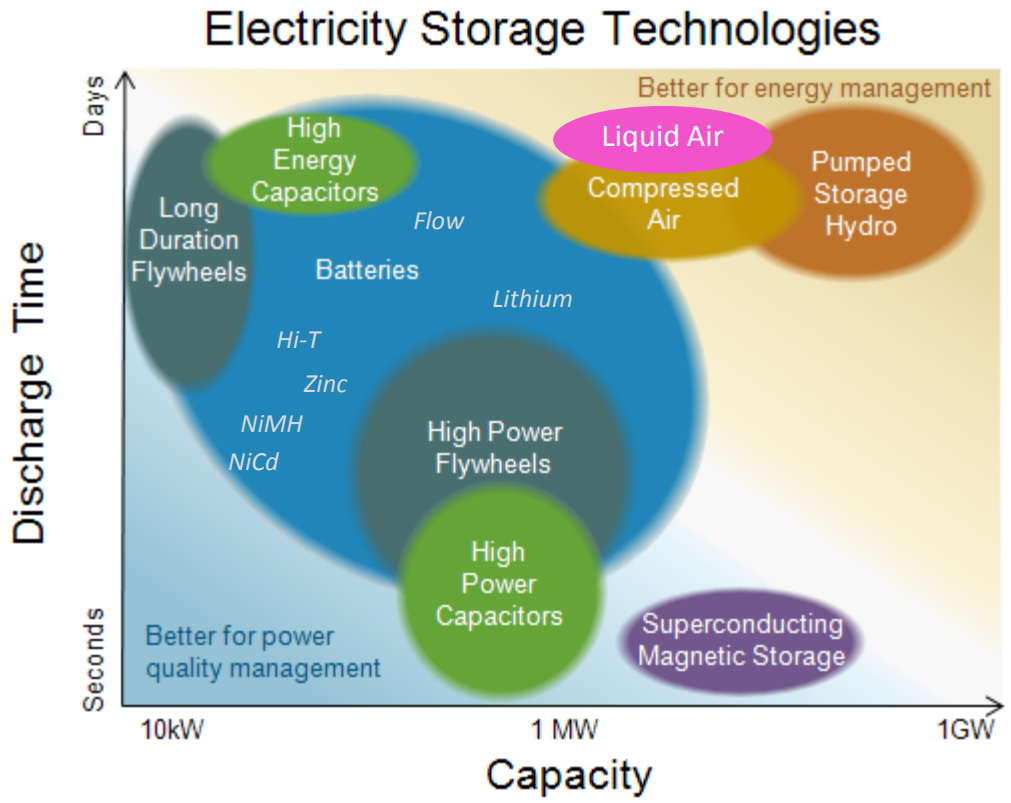
EPC on 45 Tesla Stationary Storage sites

EPC

Energy Storage Overview

Storage Technology – Power & Energy, Size & Duration

ENERGY (MWh)
"Duration"



POWER (MW) "Size"

- **Others:**
  - **PtG: Power to Gas**
    - **SNG Synthetic Natural Gas**
    - **H2 Hydrogen for prime movers or fuel cells**
  - **CAES: Compressed Air Energy Storage. "Co-fire"**
  - **LAES: Liquefied Air Energy Storage. "Thermal"**

Source: EIA "Electricity storage technologies can be used for energy management and power quality"

Benefits of Energy Storage

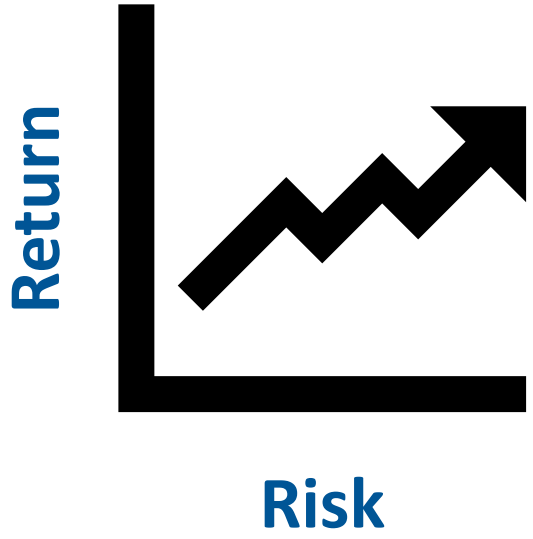
- **Store energy for later use (demand side)**
  - Emergency Back-up, Black Start
  - Time of Day energy price arbitrage
  - Reduce Demand Charges (storing power)
  - Reduce Peak Generation needs
- **Ancillary services**
  - Frequency Regulation; Add/Draw VAR; Ramp Rate Control; Capacity Firming
- **Manage capacity constrained production (supply side)**
  - e.g. store excess DC power at an oversized solar plant
- **Reduce need for transmission & distribution infrastructure**

Recent Market Trends

- Prices for battery packs and power electronics as low as ever and declining by ~10% and ~5% per year for the next 3-5 years
- Hybrid systems that add value and avoid costs
  - Solar plus storage – value added by capturing clipped energy and curtailed energy
  - Gas turbine / Hydro plus storage – instantaneous spinning reserve (vs 5 or 10 minutes) / faster response, higher ramp rates
- Resiliency valuation (east coast Sandy, west coast Aliso Canyon)

Hot Topics

- **How does energy storage compare to a natural gas peaker?**
  - Technically feasible: proven (Hawaii “PV-Peakers”)
  - Economically justified: more so in the future as storage equipment prices drop
    - *Far more so* <u>if</u> gas price increases. Economic Justification $\propto Gas\ price$
- **Li material supply. More abundant than Cu or Pb.**
- **Co material supply. Manufacturers racing to reduce.**
- **Recycling. Combination of 1) Second Life and 2) Maturation of Processing**



Key Risk Discussion

Company/Supplier Risk

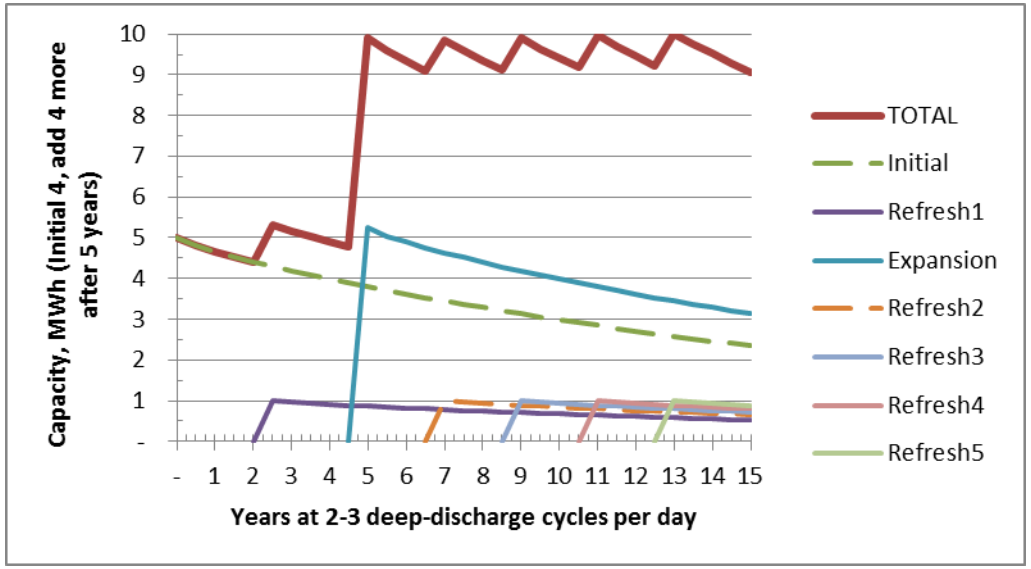
- Investors want to be sure equipment will work and can be maintained adequately during its expected life
- Risk of Insolvency
  - Warranty duration & performance
  - O&M agreement performance
  - Spare parts availability
- Mitigation (3rd party replacements; Declining costs)
- Supplier Competition - good for industry and pricing, but challenges incumbents

Development & Construction Risk

- As with most energy infrastructure projects several risks exist during development
  - Design – review engineering so project operates as intended
  - Permitting and Siting
  - Delivery and Schedule (weather)
  - Worker Safety
- After commercial operation, risks arising from construction include
  - Useful life of the overall system & major maintenance expectations
  - Full wrap warranty of the whole system (typically a few years)
  - Some system suppliers also provide O&M services
- Decommissioning & reuse / recycling of cells

Equipment Performance Risk

- Value Stack Challenges – Can't capture many
- Storage performance drivers include:
  - Duration and depth of cycles
  - Number of cycles
  - Design and technology used
- Mitigate with overbuild or additional racks for future upgrades



Investment Performance Risk

- Expected Performance drives the economic decision to invest in a project
  - Production estimate modeling risk & uncertainties
- Off-taker risk is more broadly considered post PG&E
- Incentive Policy changes or step downs
  - ITC, state RPS standards
- Other Financing Risk
  - Underlying rates, credit risk
- Few projects to date have had bank/lender financing (deal size not yet there)

Innovation and Technology Risk

- Industry currently focused on Lithium ion evolved from mobile devices and EV
  - Arrays of small modular cells may not be optimal for utility scale
- Other technologies may still come to prominence
  - Lithium Metal
  - Flow Batteries
  - CAES
  - Hydrogen

Safety and Fire Risk

- Recent fires have drawn headline attention and focus on improvement
- Like other power technologies Energy Storage has safety risks
- Can be mitigated with proper training and procedures
  - Prevention (monitoring, shut-down)
  - Mitigation (protection, containment, training)
- Other safety risks:
  - high voltage risks (common to other electric equipment)
  - chemical burns or hazardous gases

ESA: Investigation of Arizona fire will help inform industry's future

Source: Energy Storage News

Safety and Fire Standards

- **UL 1973 - Safety Standard for Batteries used in Stationary… Applications**
- **UL 9540 - Standard for Energy Storage Systems and Equipment**
- **UL 9540 A – Large Scale Fire Test Method**
  - **Addresses requirements of IFC 608 and NFPA 855**
  - **Evaluates thermal runway propagation at multiple levels: Cell, Module, Unit and Installation**

Challenges: Costly and lengthy regime for manufacturers, exacerbated by flux in products, standards and codes

Key Themes

- **Energy Storage has multiple dimensions of complexity (contrasted to solar)**
  - **This adds optionality and value but also increases risk**
  - **BESS can lean to grid asset (vs. power generation) so may want to finance as such**

- **We're still at early stages of industry maturity**
  - **Technology, Standards, Protocols are all still evolving rapidly**

- **Sponsors and Lenders need reasonable surety of cash flows in order to invest**
  - **Uncertainties and relative inexperience will make financing more costly**

QUESTIONS?

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Thank you

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