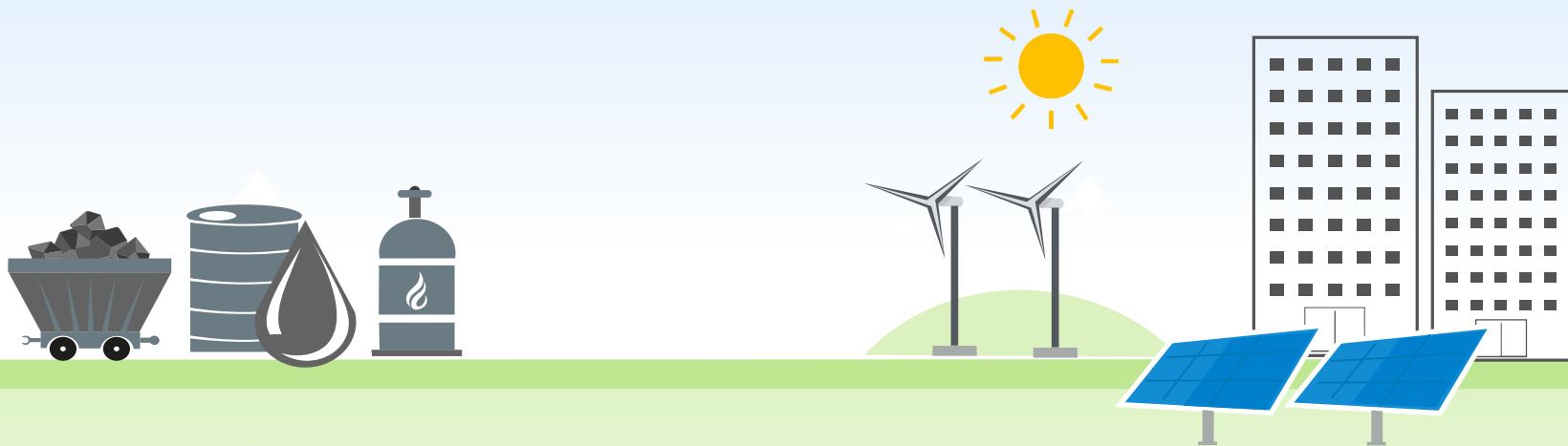




**Northwestern Energy**  
Electricity Supply Resource  
Technology Forum

T R A N S F O R M I N G   E N E R G Y   F O R E V E R

# Cheap, endless energy no longer comes from the ground



2016: Cost of Energy of Wind & Solar  
Reduced 40% since 2013



2016: 132GW of New Wind and Solar  
Capacity

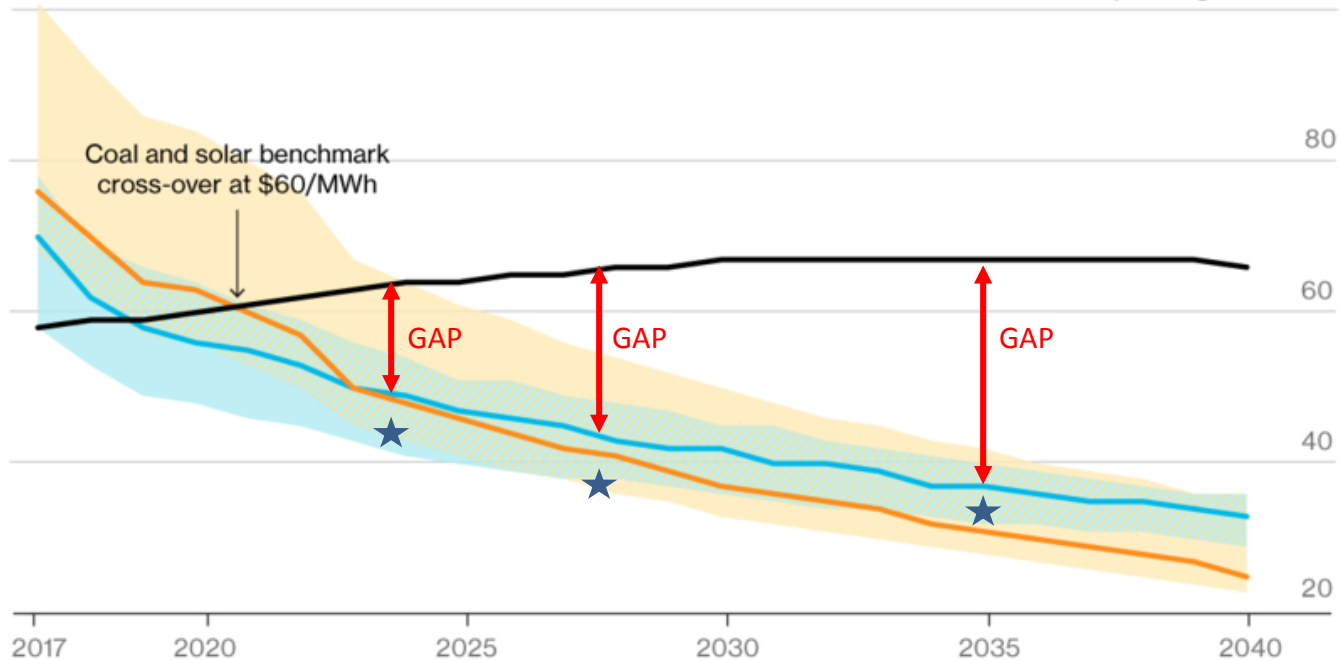


Variable & Not Dispatchable

Safe & Cost Effective Storage is the “Missing Piece”

■ Coal ■ Onshore wind ■ Large solar farms

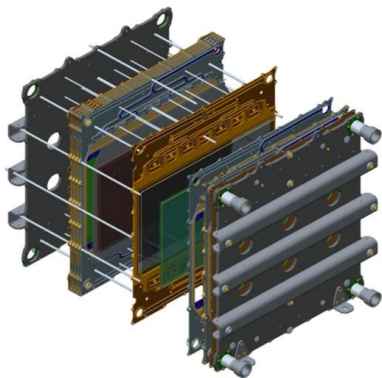
\$100 per megawatt hour



Levelized cost of energy based on realized load factors (2016 real). Source: BNEF

Bloomberg

## Battery Stack



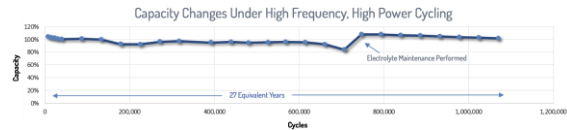
- 9 issued patents
- 13 pending patents
- >250 claims
- Power ↑ 8X
- Energy ↑ 4X

## Fielded Systems For >3 Years



- Megawatt years of learning and field data

## 27 Year Accelerated Testing



- Over 1 million high frequency power switching cycles -> Over 27 years freq req
- Tested across complete State of Charge from 10% to 50% to 90%
- ZERO cell replacements

**90 Design Iterations → 20 Years of 'Fade-Free' Warranted Life**

# Versatile Platform that is Intrinsically Safe

## PERFORMANCE

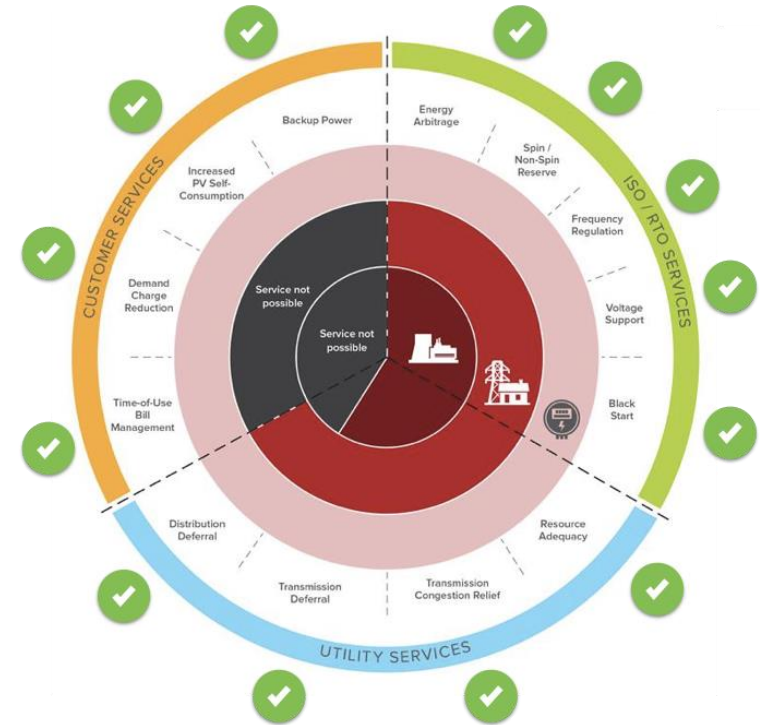
One unique battery for both long duration energy and high frequency power services. Easily stack multiple planned or unplanned services to maximize income streams.

## SAFETY

Deploy near densely populated areas and high value grid infrastructure. Runs on a safe chemistry that is non-toxic, non-flammable, and non-explosive. Easy to recycle at end of life.

## VALUE

Superior ROI due to multiple income streams, 20-year life, lower O&M expense and negligible degradation across 100% state of charge.

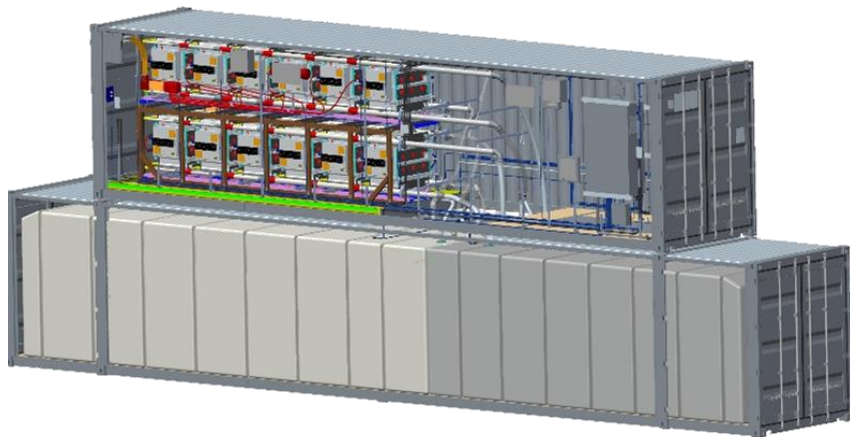


# CAPEX and OPEX Battery Assets



- Lead time ~25-30 weeks to Operational
- Battery CAPEX 2019 \$450/kWh turn-key
- \$1.8M \$/MW
- 30MW/120MWh \$54M
  
- Battery OPEX O&M + Warranty \$12k /MW
- No Variable O&M cost, no duty cycle limitations in the warranty

# All-In 1<sup>st</sup> Cost System Estimates



+



## Capital Costs

### ES

- Battery
- Extended Warranty
- Service Agreement

### Aux - Rack, Container, HVAC, Fire

- Rack
- Container
- Fire Suppression
- HVAC
- ES Container Integration

### PCS Inverter

- PCS
- Extended Warranty
- PCS Controller
- XFMR
- PCS Factory Integration

### BOS + Utility Interconnect

- DC Rails
- Switch
- Breaker
- Cable and Conduit

### PCS Site Installation/Commissioning/Delivery

- PCS Installation

### ESS Site Installation

- Civil/Land Prep/Access
- BOP Installation (Mechanical)
- Grid Tie Installation (Mechanical)
- Interconnection Installation (LV + MV)
- General Conditions
- QA/QC

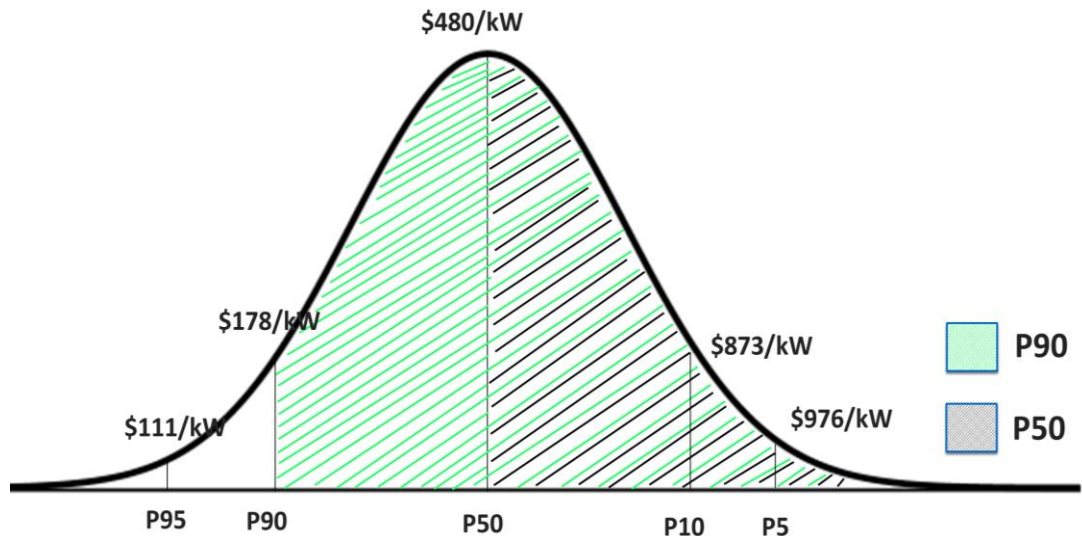
### EMS (3rd Party)

- EOS Module
- EOS Application Fee
- Fleet Control
- EOS Hardware

### Soft Costs

- Civil Engineering
- Electrical Engineering
- Permit
- PM/CM
- Developer
- Bond
- Freight/Warehousing
- Security

# CAISO EIM Ancillary Services Modeling

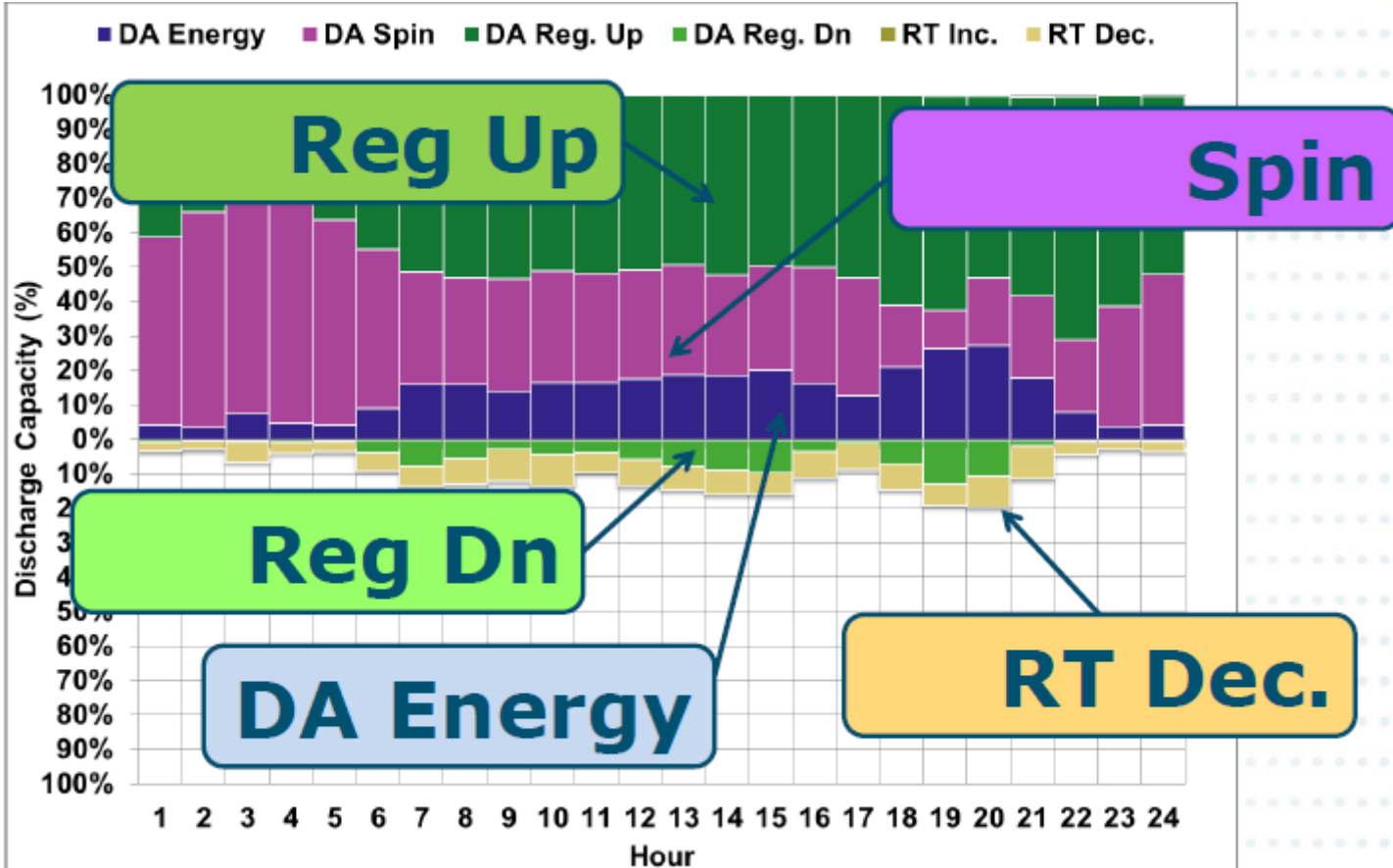


Market Service Income Estimates (\$/kW/Year)				
	Low	High	Mean	1 SD
Arbitrage	\$35	\$65	\$50	\$21
Regulation	\$125	\$225	\$175	\$71
Spin	\$45	\$120	\$83	\$53
Capacity	\$100	\$200	\$150	\$71
Savings onsite Reg	\$ 0	\$100	\$50	\$70

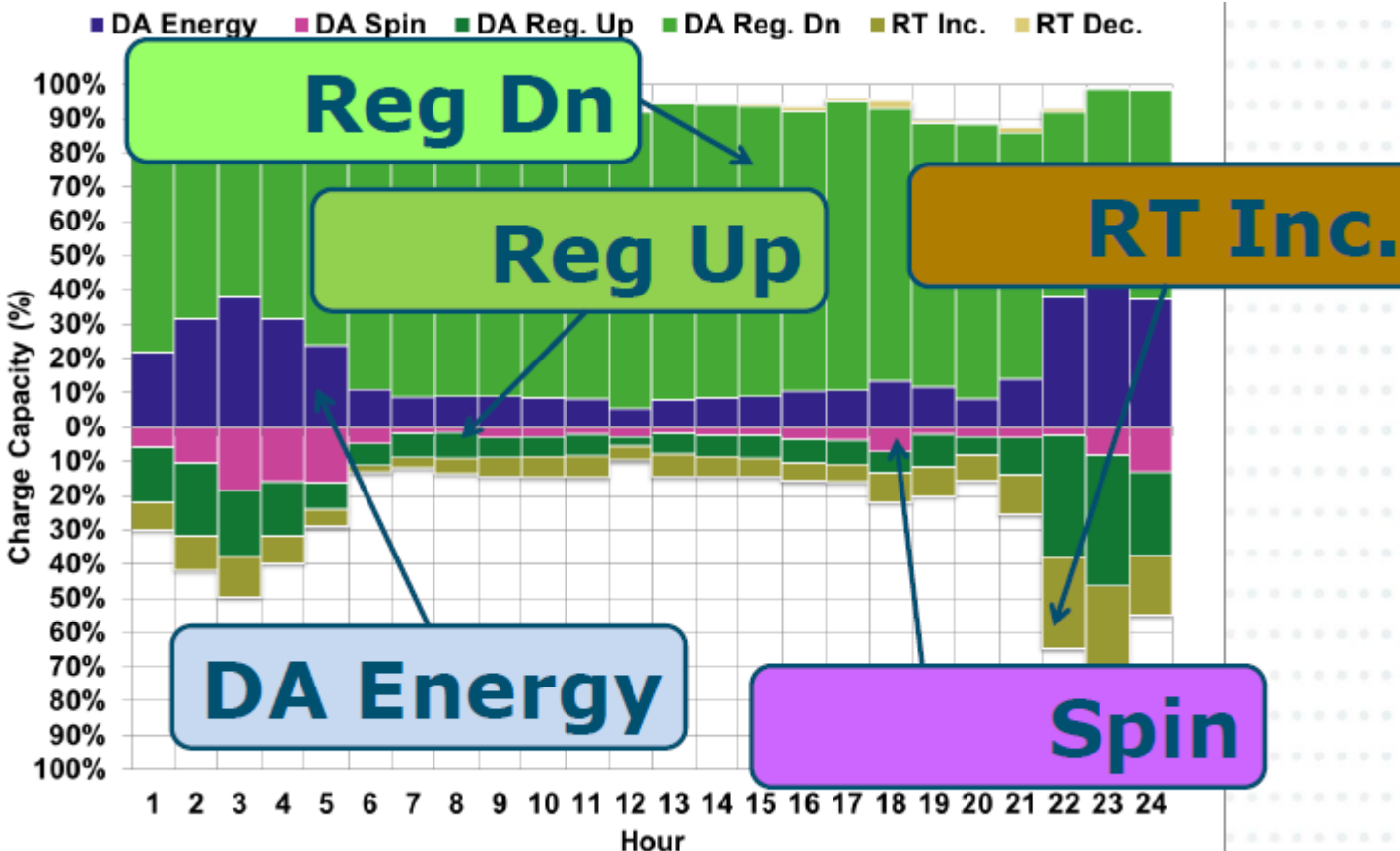
- P50: 50% Chance Annual Revenue > the P50 values.
- P90: 90% Chance Annual Revenue > the P90 values.



# Ancillary Services on Discharge



# Ancillary Services on Charge



# Battery Diversity in NWE

## Utility Ownership

- T&D Deferral
- Ancillary service value
- Avoided peak costs

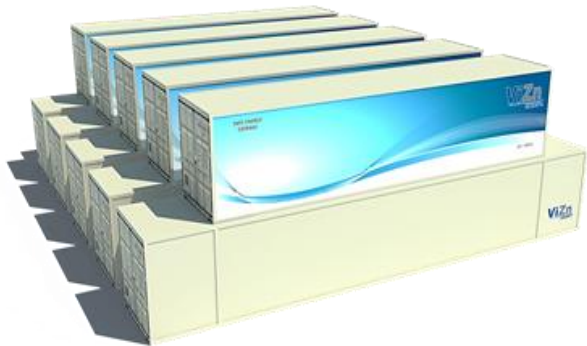
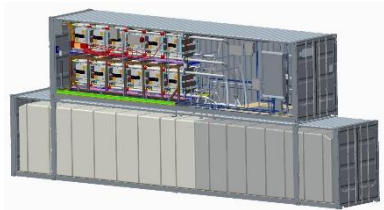
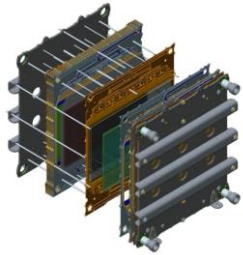
## Wholesale Market (merchant)

- Arbitrage from Day ahead and real time markets, LMP trading
- Ancillary Service Revenue
- Utility open enrollment for critical resources
- Couple with RE plants

## Behind the meter Customer side

- Retail bill savings (demand, energy)
- Demand Response
- Microgrids (backup, high RE)

# ViZn... The Best Solution For a BIG Problem...



- Building largest flow batteries in each location: North America, Central America, India & Europe
- Low Capex ; Low Opex
- 20 Years w/ zero fade
- Power & energy services in one → up to 1.5X the \$/MW/Y
- >40% better T&D Utilization
- Tier 1 partners → turn-key solutions and global fulfilment

Thank You



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20 Year Batteries That Safely Deliver Unlimited Energy AND Power Services With ZERO Degradation