

Fundamentals of Solar-Plus-Storage for Electric Cooperatives

Jeff Cook-Coyle

June 25, 2020



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Solar-Plus for Electric Co-ops



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Prelude: MW, MWh, and Hours

Unit	Components	Comparison to a Car
MW (MegaWatt)	Energy / Time	Miles per <u>Hour</u>
MWh (MegaWatt- <u>Hours</u>)	Energy	Miles
Hours	Time	Hours

$$\text{MWh} = \text{MW} \times \text{Hours}$$

$$1 \text{ MW} / 4 \text{ MWh BESS} = 1 \text{ MW for 4 hours}$$

$$1 \text{ MW} / 4 \text{ Hour System} = 1 \text{ MW for 4 hours} = 1 \text{ MW} / 4 \text{ MWh}$$

1. What is a BESS?

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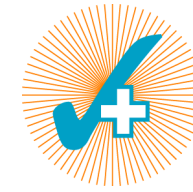
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1. What is a BESS?

- Battery Energy Storage System Components
- System Sizes
- Standard Configurations

VERIFY

BESS System Components



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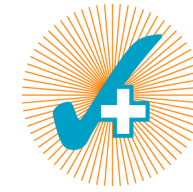
Batteries

Inverter (PCS)



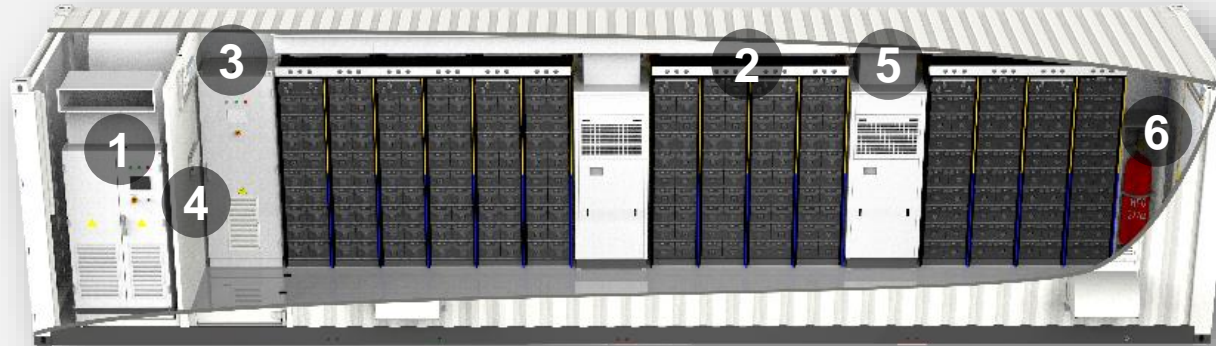
HVAC and
Fire Suppression

BESS Main Components



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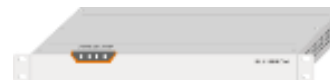
1 PCS



2 Battery rack



3 LV panel



4 Local controller



5 HVAC



6 FSS

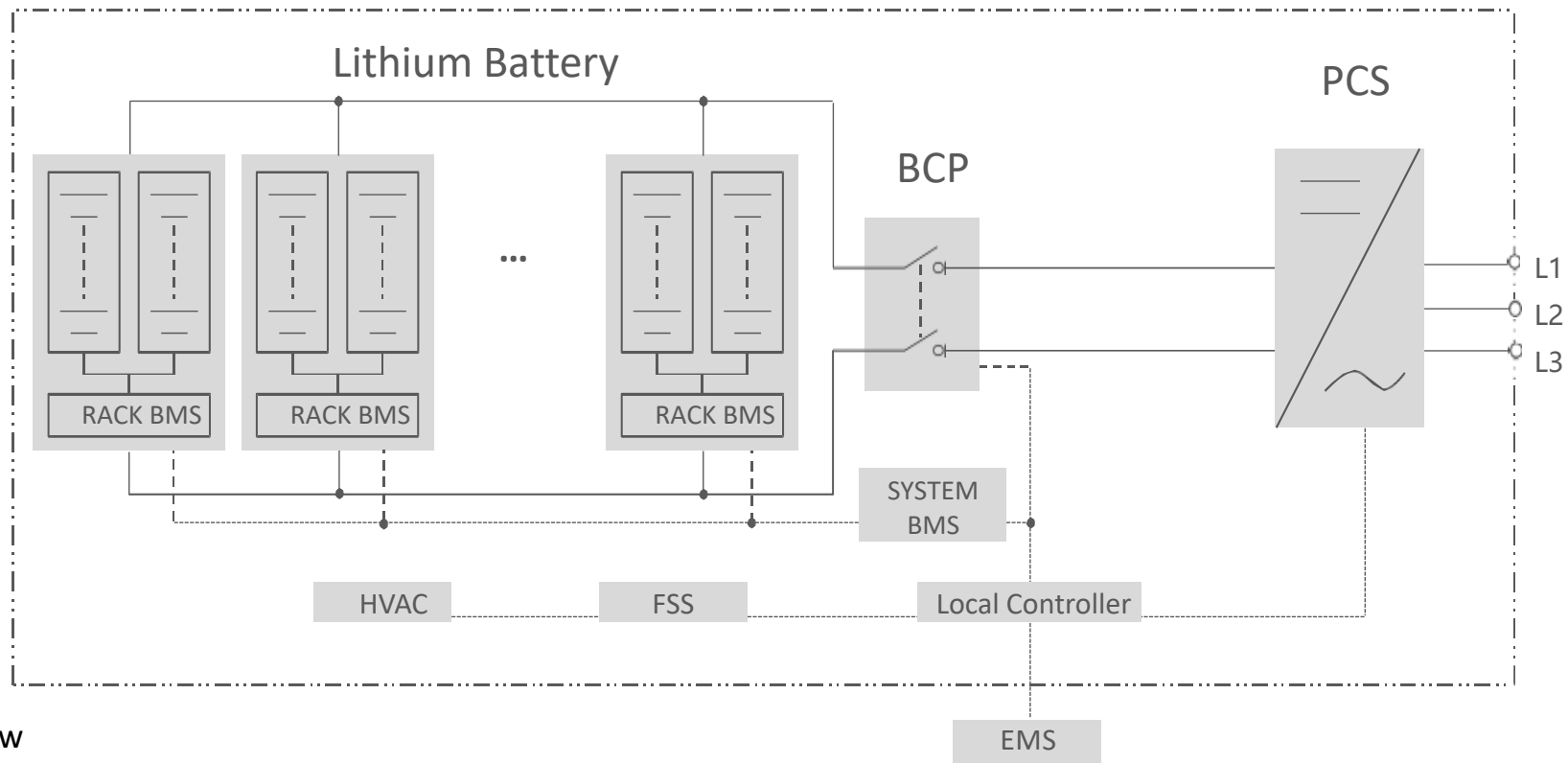
BESS System Components



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CIRCUIT DIAGRAM



Standard Systems



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Sungrow 1 MW / 4 MWh

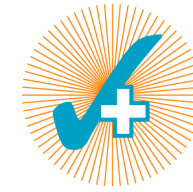


Tesla Megapack 0.7 MW / 3 MWh
Tesla Powerpack 50 kW / 232 kWh

Fluence "Edgestack"
Power and Energy Unknown



System Configurations



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Sungrow	Tesla	Fluence
1 MW / 2 MWh	1.5 MW / 3 MWh	Not Announced
1 MW / 4 MWh	0.75 MW / 3 MWh	
2.5 MW / 5 MWh	50 kW / 1.6 Hour	
1 MW / 1.5 MWh	50 kW / 2 Hour	
2.5 MW / 3 MWh	50 kW / 4 hour	

2. Other Considerations

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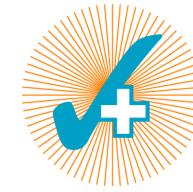
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2. Other Considerations

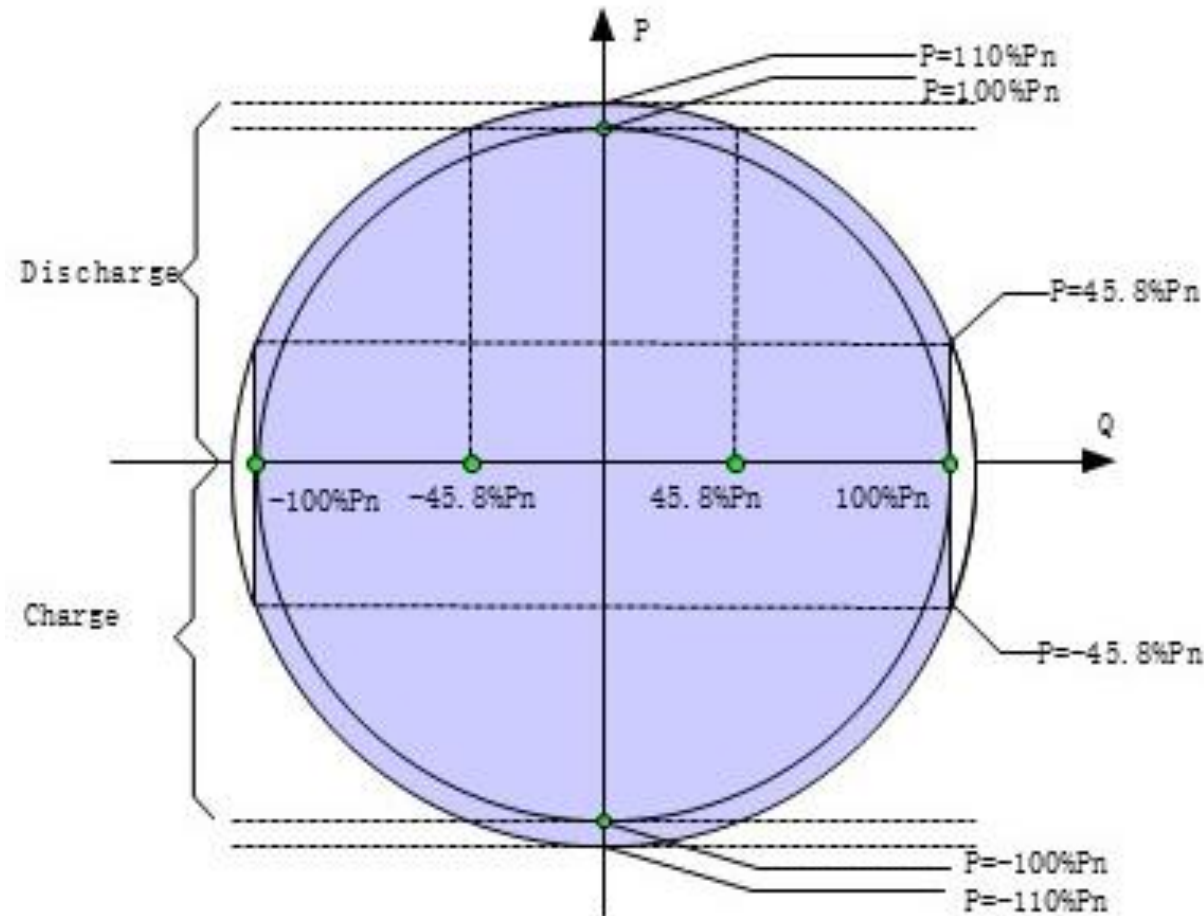
- Real and Reactive Power
- Safety
- BESS Applications
- Degradation

Real and Reactive Power



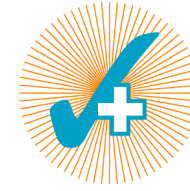
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Graph Courtesy: Sungrow

Safety

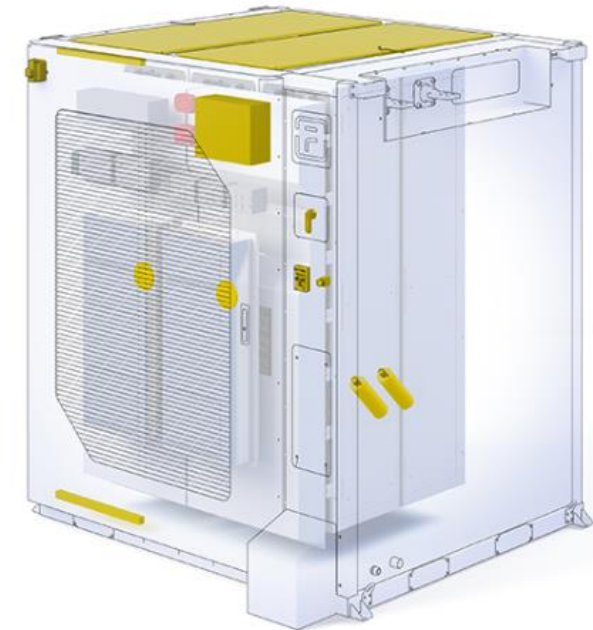


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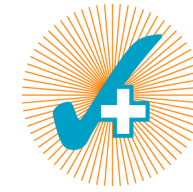
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- Fire Detection
 - Smoke, Heat
- Fire Suppression
 - Water shower and/or mist
 - Heptafluoropropane (HFC-227ea/FM200)
- “Deflagration”
- Passive Shutdown
- Key Standards:
 - NFPA 68 (includes deflagration vent specs)
 - UL9540A (in-depth protocol to document how system reacts to fire)

FLUENCE
A Siemens and AES Company



BESS Applications



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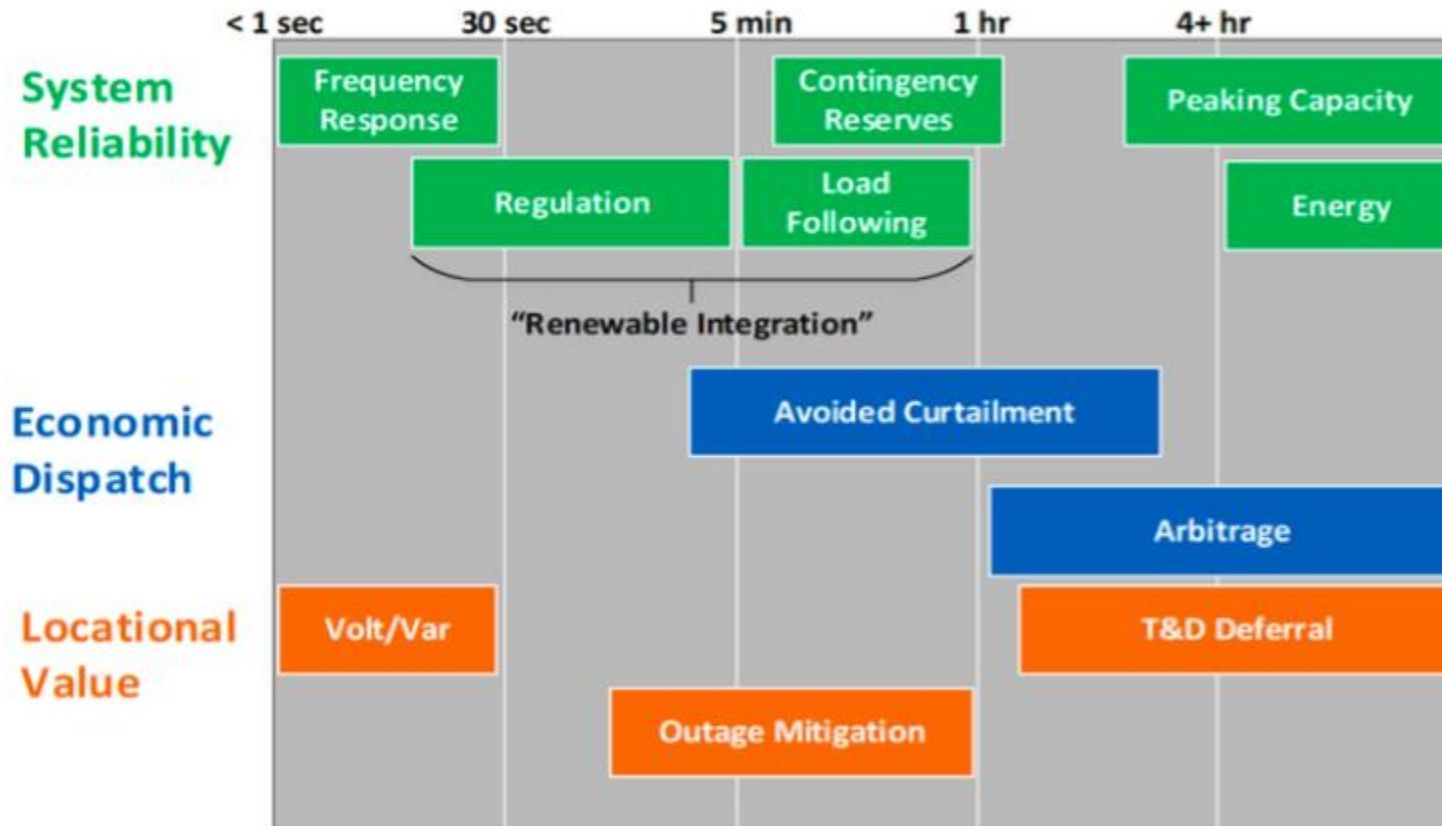


FIGURE 3.8 – Use Case Applications for Batteries

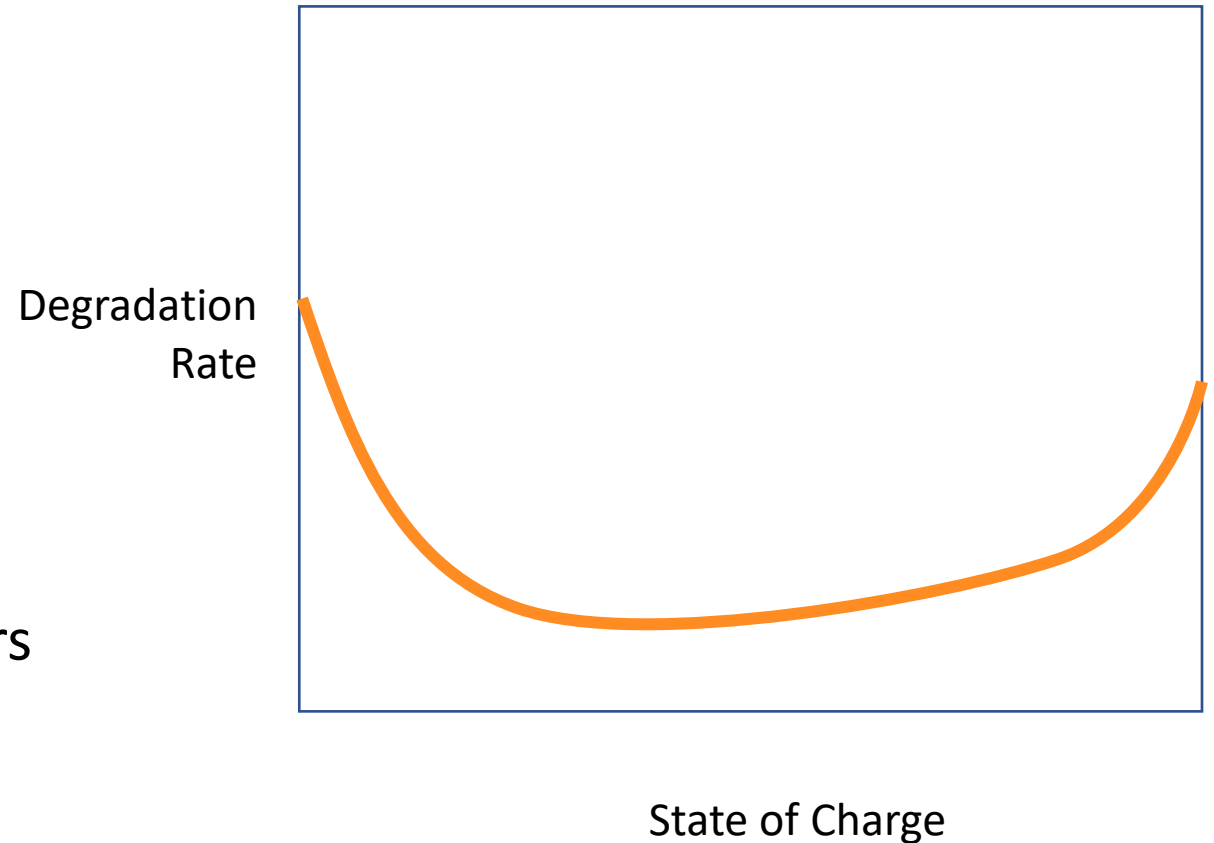


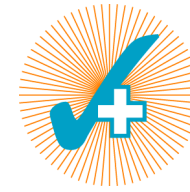
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Degradation – Drivers

- Temperature
 - Heat is the enemy
- State of Charge
 - Resting, Max, Min
- Rate of Discharge
 - 1C = Batt. Discharge in 1 Hour
 - 0.5C = Batt. Discharge in 2 Hours
 - 0.25C = Batt. Discharge in 4 Hours





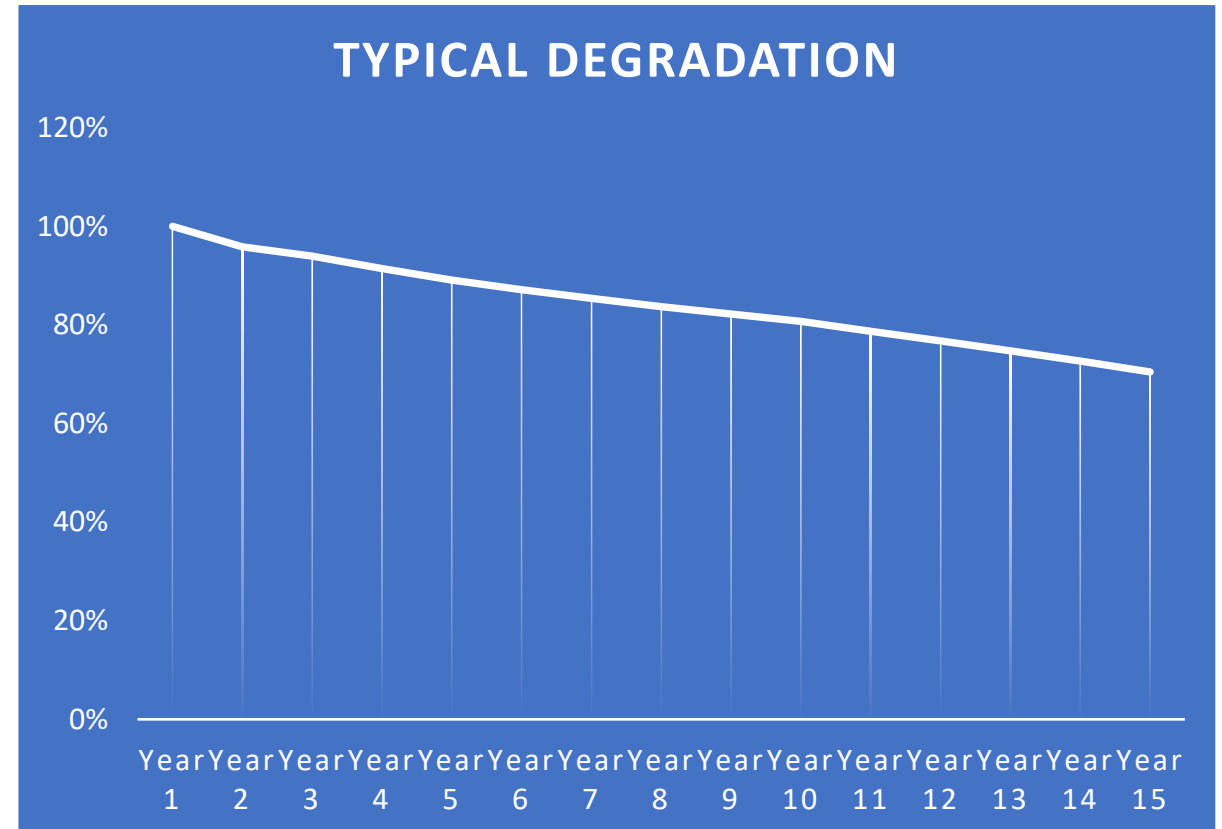
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Degradation – Types

- VERIFY** Standing – 0.5% / Year
- VERIFY** Variable – 1.5% Per 365 Cycles
- VERIFY** Cumulative – 3% Per Year

How Will You Account for Degradation?



Resting State of Charge of 50%
365 2-hour Discharge Cycles
2 - 4% annual degradation

“Is there a best way to design a BESS?”

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“Is there a best way to design a BESS?”

- Keep in Mind What is Available on the Market
- Understand how to Accommodate Degradation
- Match the System Size to the Applications
- Safety Requirements and Standards



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