NAGF / ESIG Storage & Hybrids Workshop 2019

Energy Storage Overview and Market Drivers

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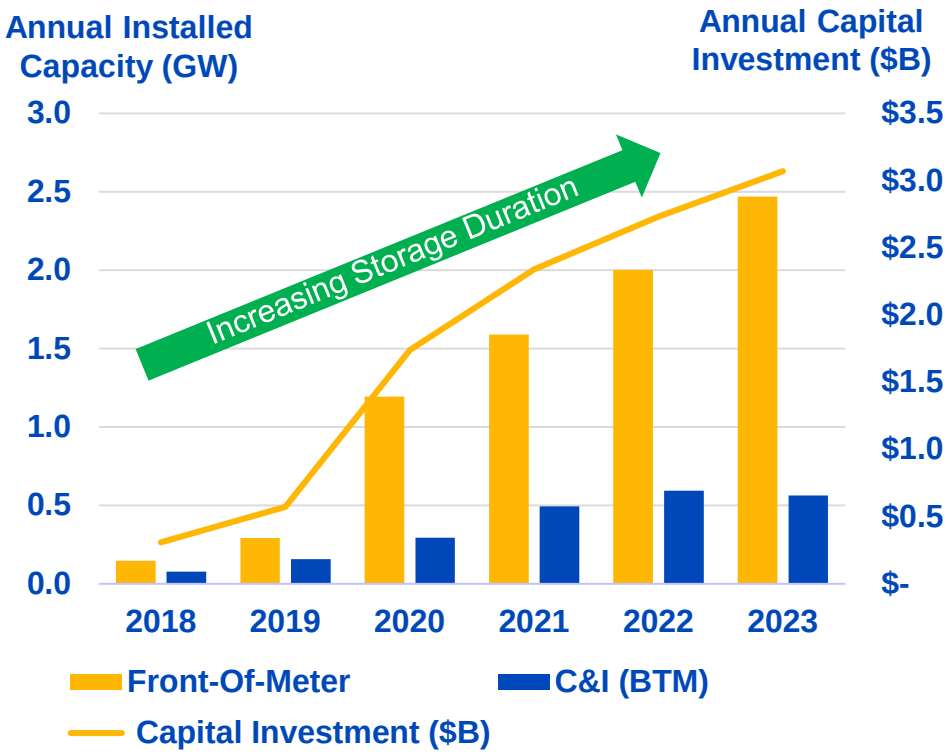
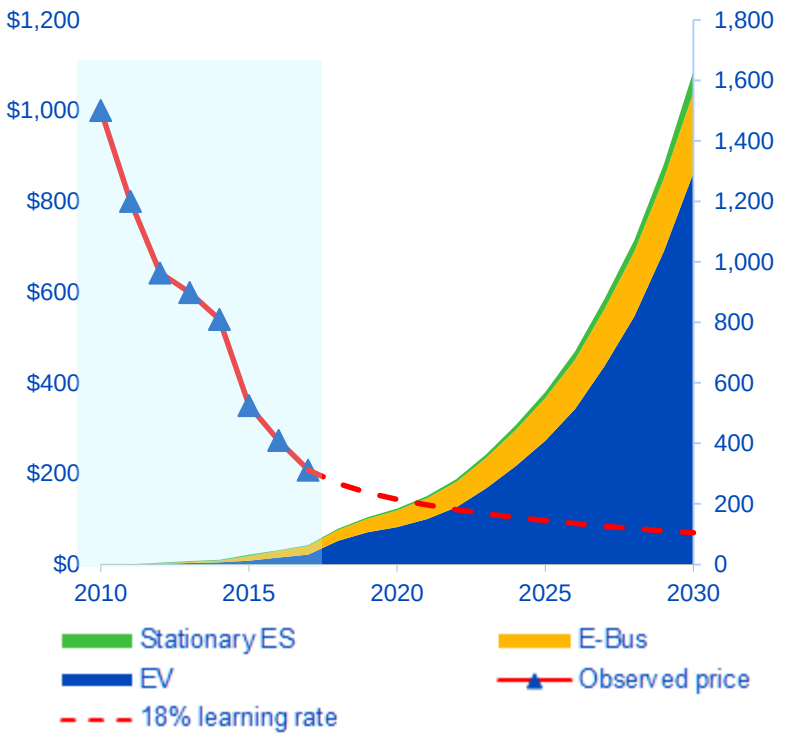
It is estimated that 8.4 GW of utility-scale storage and 2.3 GW of behind-the-meter storage will be installed through 2023, an incremental $10 B opportunity[1]

Projected Energy Storage Market (annual)



Battery Cost Curve Projections[2]



Rapid acceleration of installed storage capacity is expected over the next few years; especially paired with solar and the 30% ITC

1) Annual 2018-2023 investment in front-of-meter and C&I market; Wood Mackenzie Power & Renewables and Energy Storage Association; March 2019
2) Bloomberg New Energy Finance, "Lithium-Ion Battery Price Survey"

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The Investment Tax Credit (ITC) timeline continues to drive near and mid term investments in solar and storage

Solar / Storage Investment Tax Credit (ITC) Timeline

Start of Construction Year[1]	Commercial Operations Year							
	2017	2018	2019	2020	2021	2022	2023	2024 or Later
2023							10%	10%
2022						10%	10%	10%
2021					22%	22%	22%	10%
2020				26%	26%	26%	26%	10%
2019			30%	30%	30%	30%	30%	10%

- **Storage COD thru end of 2023 receives the 30% ITC when paired with and charged primarily by solar**
  - Stand-alone storage ITC legislation is also under consideration

Continued cost declines in both solar and storage will continue to drive investment in both through 2023 and beyond

1) The acquisition year of equipment used to satisfy the 5% “safe harbor” for incurred costs, or the year in which significant construction ("Physical Work") begins

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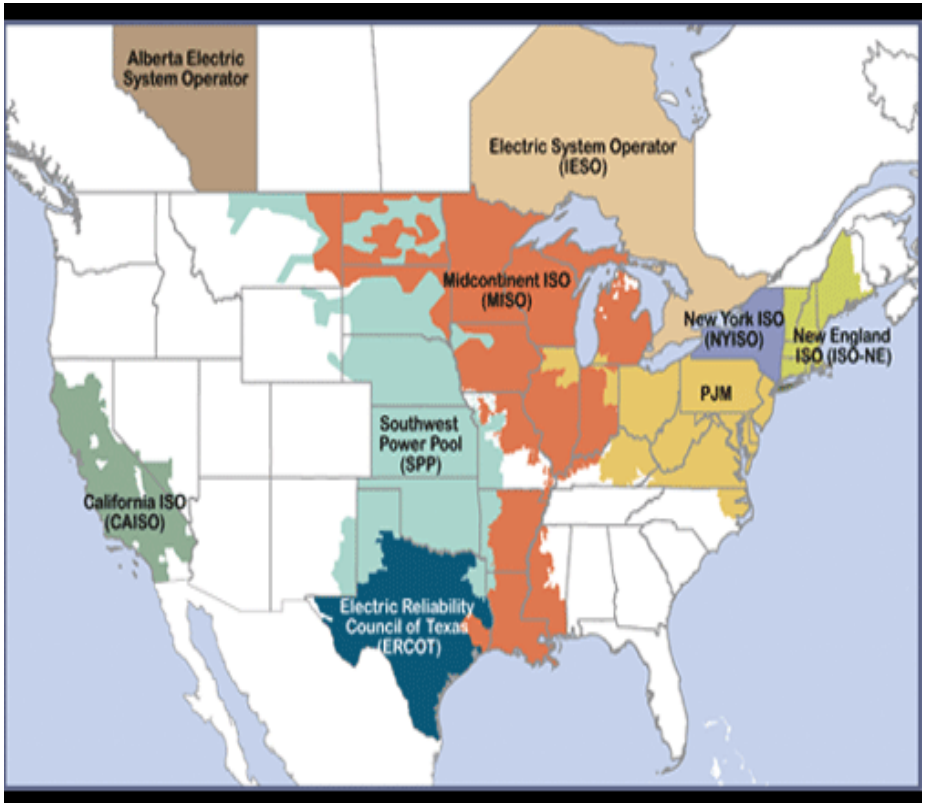
A utility's view on energy storage depends to some extent on the market environment in which they are located

Regional Differences for Energy Storage Value

- **ISO markets can provide a variety of opportunities for storage to add value**
  - Driven by market products that leverage flexibility of storage
  - FERC Order 841 / 845
- **Non-ISO based regions with vertically integrated utility structures allow for more real-time operational flexibility**
  - Utility can determine the most valuable use of storage in real time, and dispatch as required



Energy Storage is a highly flexible resource, capable of stacking multiple applications; however there are usually two or three that drive investment decisions

Vs.

Energy Storage can do many different things, but software controls are essential to leverage this flexibility

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Energy storage applications span multiple disciplines across the grid, but use case stacking is key to unlocking the full value of energy storage

Energy Storage Applications

Generation → **Transmission** → **Distribution** → **Customer**

Energy Storage

Applications

Renewable Ramping	Frequency Regulation	Peak Shaving	Demand Charge Management
Renewable Smoothing	Voltage Support	Congestion Relief	Solar Self Consumption
Renewable Curtailment Reduction	Load Following	Power Quality	Demand Response
Renewable Capacity Firming	Spinning Reserve	T&D Deferral	UPS, Power Quality
Resource Adequacy/ Reserve Capacity			Energy Time Shifting
Renewable Time Shifting / Arbitrage			

- Short Duration Applications
- Medium Duration Applications
- Long Duration Applications

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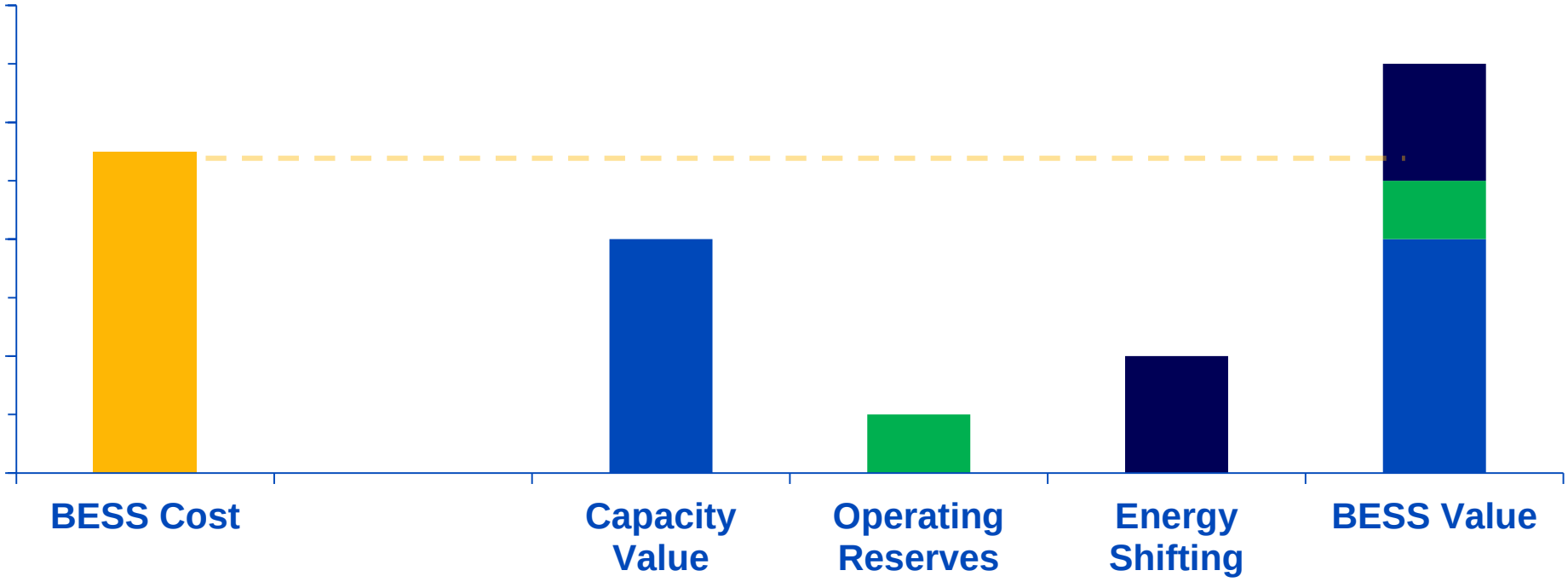
The value streams provided by energy storage may be dependent on location (ISO), as well as an entities views on long term market pricing and products

Cost vs Benefits: Breaking down the Value Stack



Total value from storage is a blend of several benefit streams, but long term value is uncertain in some cases and not always driven by economics

While capacity degrades over time with most battery technologies, adding additional batteries periodically during the useful life is a common practice

Select Factors Impacting Battery Degradation

Number of Cycles	Number of times the battery is charged and discharged (e.g. 255 annual cycles = 1 full cycle per day on all non-holiday weekdays)
Depth of Discharge	How deep is the battery charged and discharged between 0% and 100%
Idle Time & Rest SOC	How often is the battery idle; battery also degrades in idle state (also known as “calendar degradation”); resting State of Charge (SOC) when idle is a factor
Chemistry	Different combinations of anode, cathode and electrolyte material have varying degradation profiles

The modular design of most battery storage systems allows augmentation over time with minimal down time

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