Back-up Battery and Storage - the State of the Technology and Applications

Adapted from a presentation by:

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Energy
Storage
Association
Battery Back-up and Storage – the State of the Technology and Applications
Marissa Paslick Gillett
Vice President, External Relations
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www.energystorage.org

About the Energy Storage Association

ESA's mission is to accelerate the widespread use of competitive and reliable energy storage systems in North America. To achieve this mission, ESA educates stakeholders, advocates for public policies, accelerates market growth, and delivers direct member value.

- Established 28 years ago
- Diverse membership—vendors, developers, independent generators, utilities & other power sector stakeholders
- Federal, regional, & state policy engagement

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Energy Storage

- What is energy storage
- Current US Market state
- How storage is impacting the electric system
- Storage drivers
- Rough costs
- Potential Industrial Uses

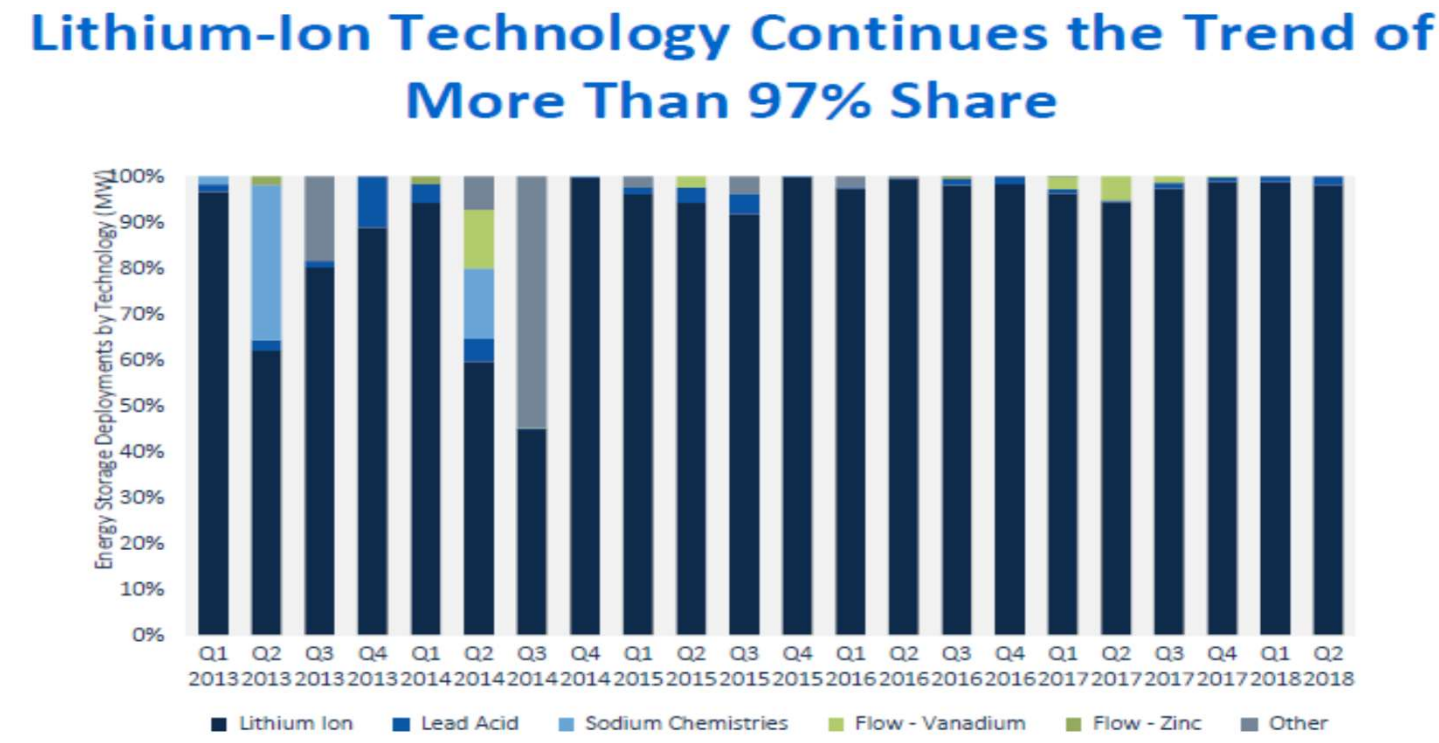
What is Energy Storage

- **Energy storage** involves converting **energy** from forms that are difficult to store to more conveniently or economically storable forms.
- Energy storage usually takes energy as it is generated and charges a storage system. The storage system can subsequently discharge energy at the time that it is needed.
- Energy storage comes in many forms:
  - Pumped hydro
  - Hot water, hot oil, steam
  - Hot solids (rocks, refractory, adobe)
  - Phase change materials
  - Fly wheels
  - Batteries

What is Energy Storage

- Battery Storage
  - Batteries store energy through reversible chemical reactions.
  - When the battery is being charged, electrical energy is being converted into chemical energy that is stored in the form of two chemicals.
  - When the battery is discharged, the two chemicals react via electrodes and an electrolyte, sending electrons (ie electric current) from one electrode, through a circuit (for use), to the other electrode.
  - When the chemicals are used up, the battery no longer functions (ie dead battery).
  - There are several types of battery systems.

What is Energy Storage



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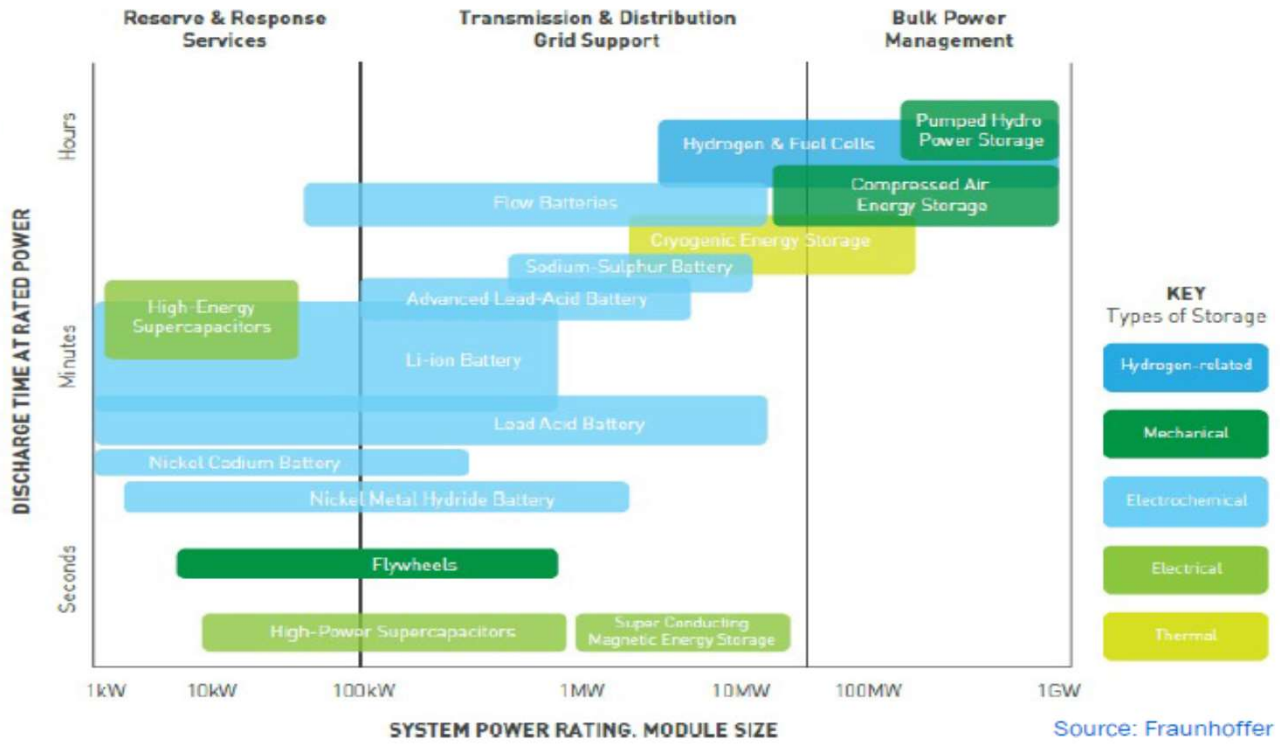
What is Energy Storage

Diverse Technologies:

- 'Energy storage' is the application of technology, not any one technology itself.
- While many different mechanisms to store energy, they all share similar performance capabilities and attributes that make ES inherently valuable.



Source: Fraunhoffer

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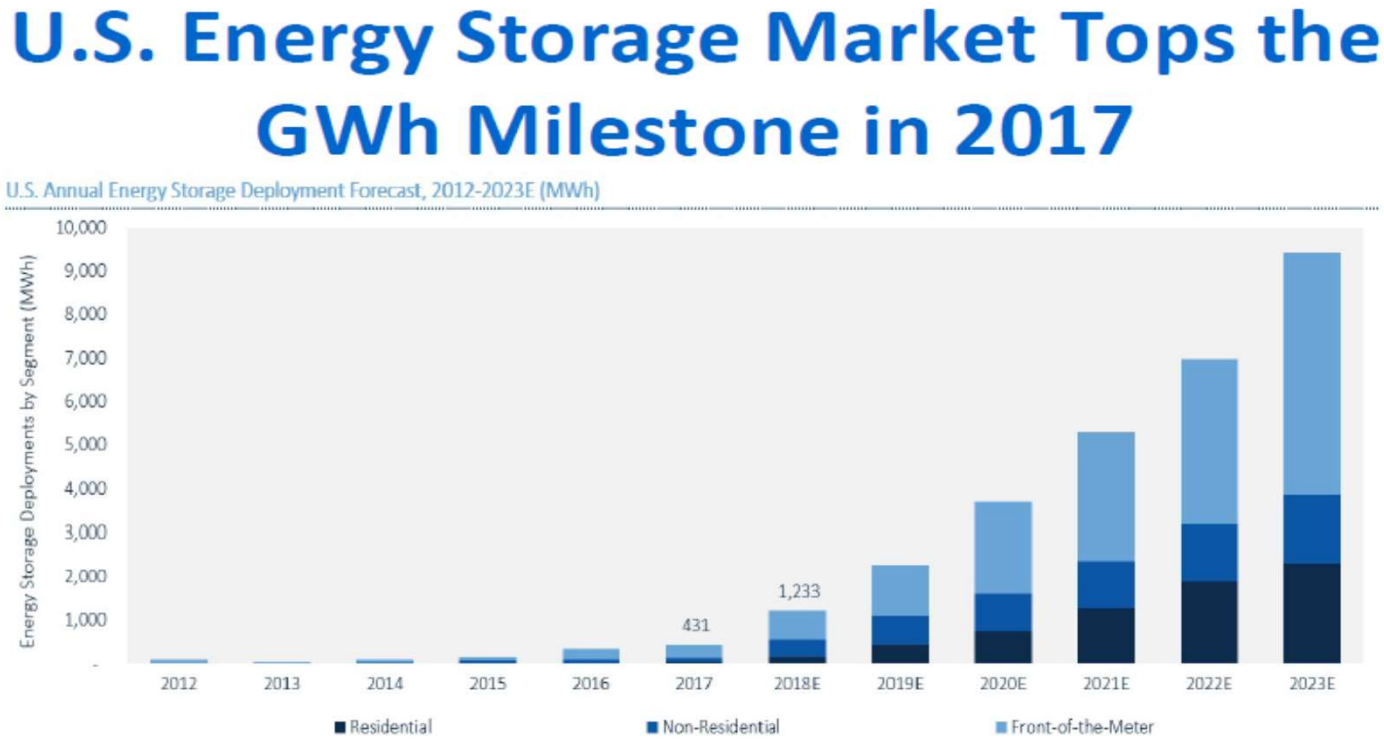
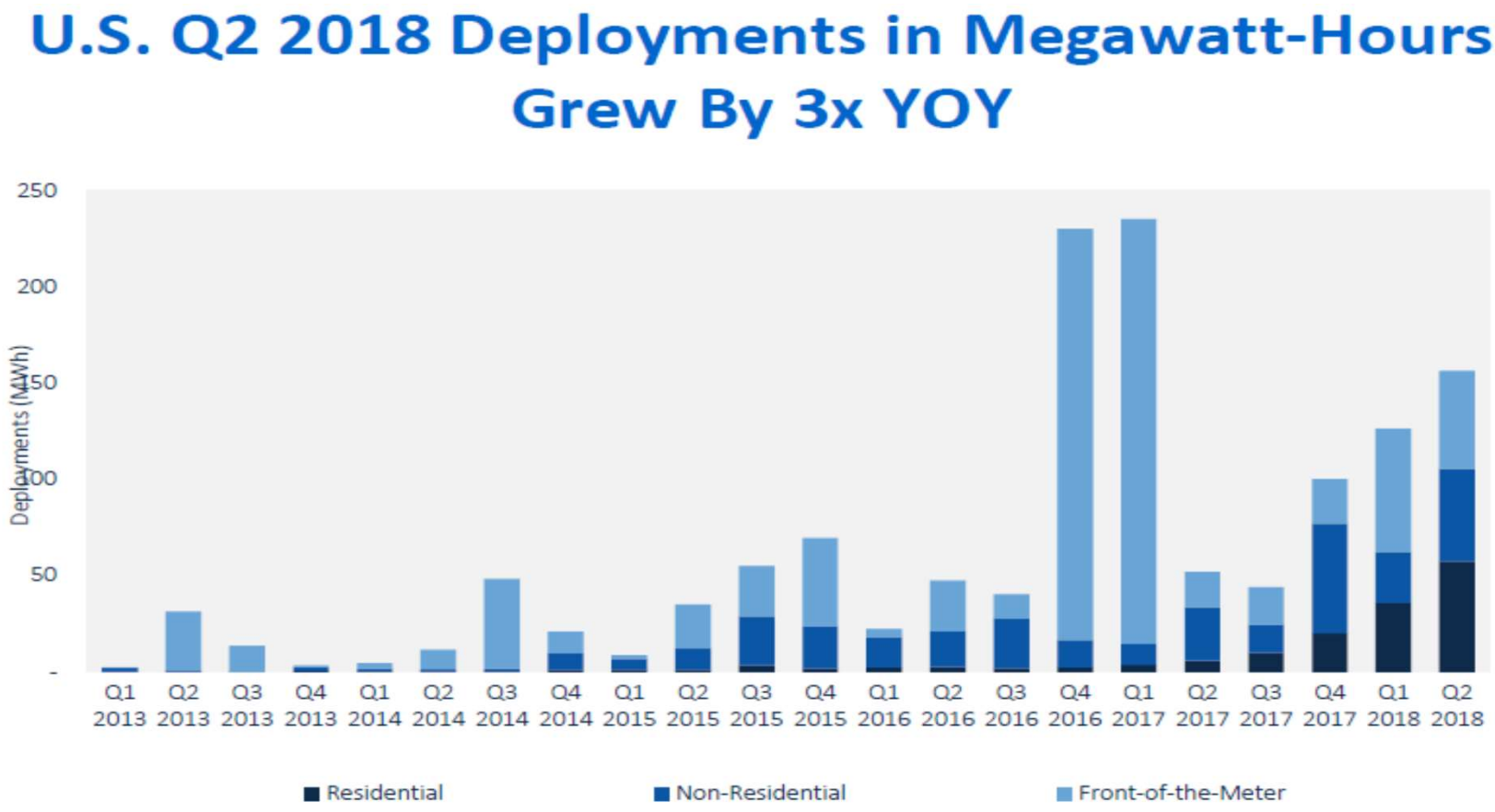
Current US Market Status



Source: GTM Research / ESA U.S. Energy Storage Monitor

Current US Market Status



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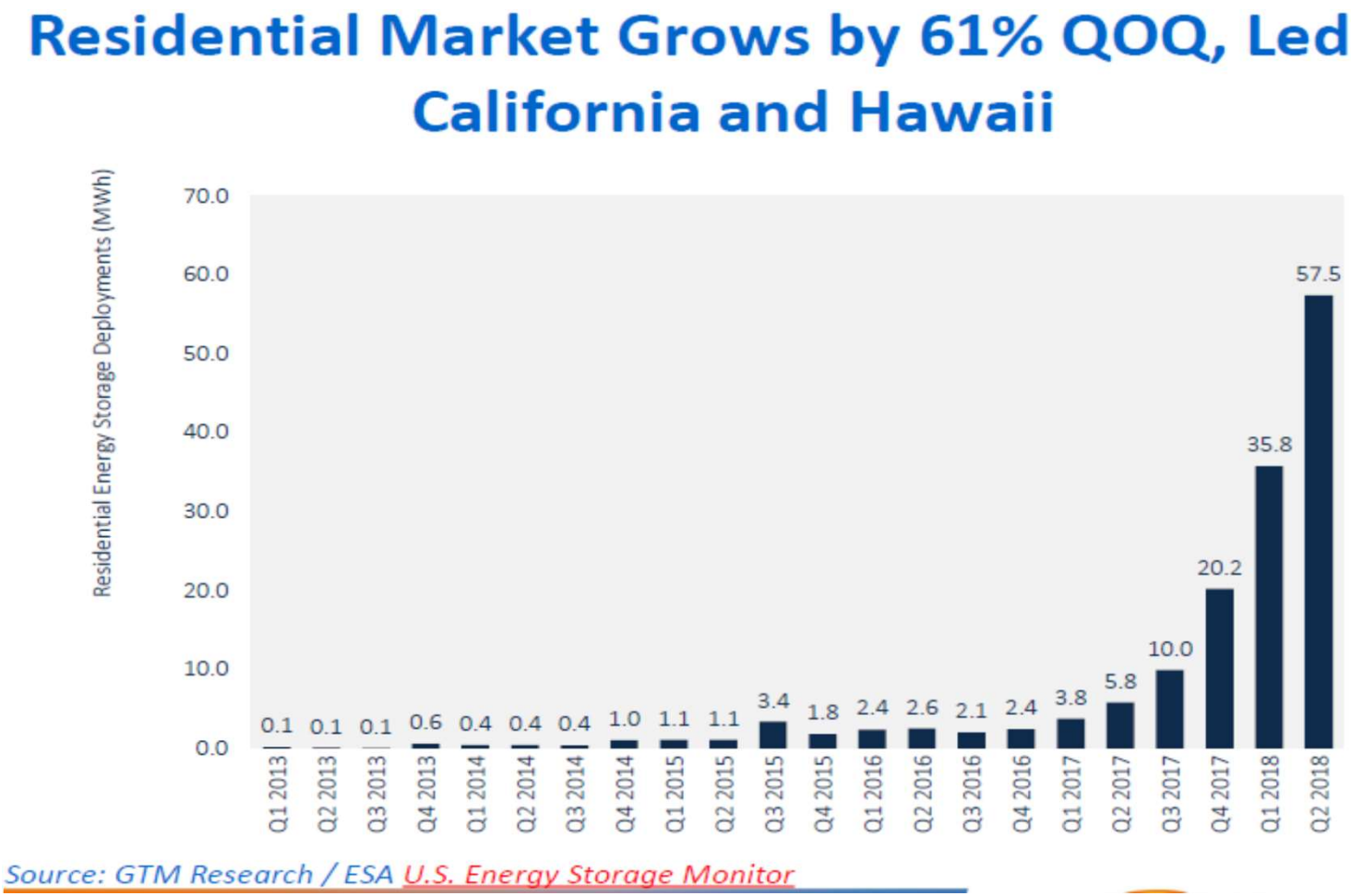
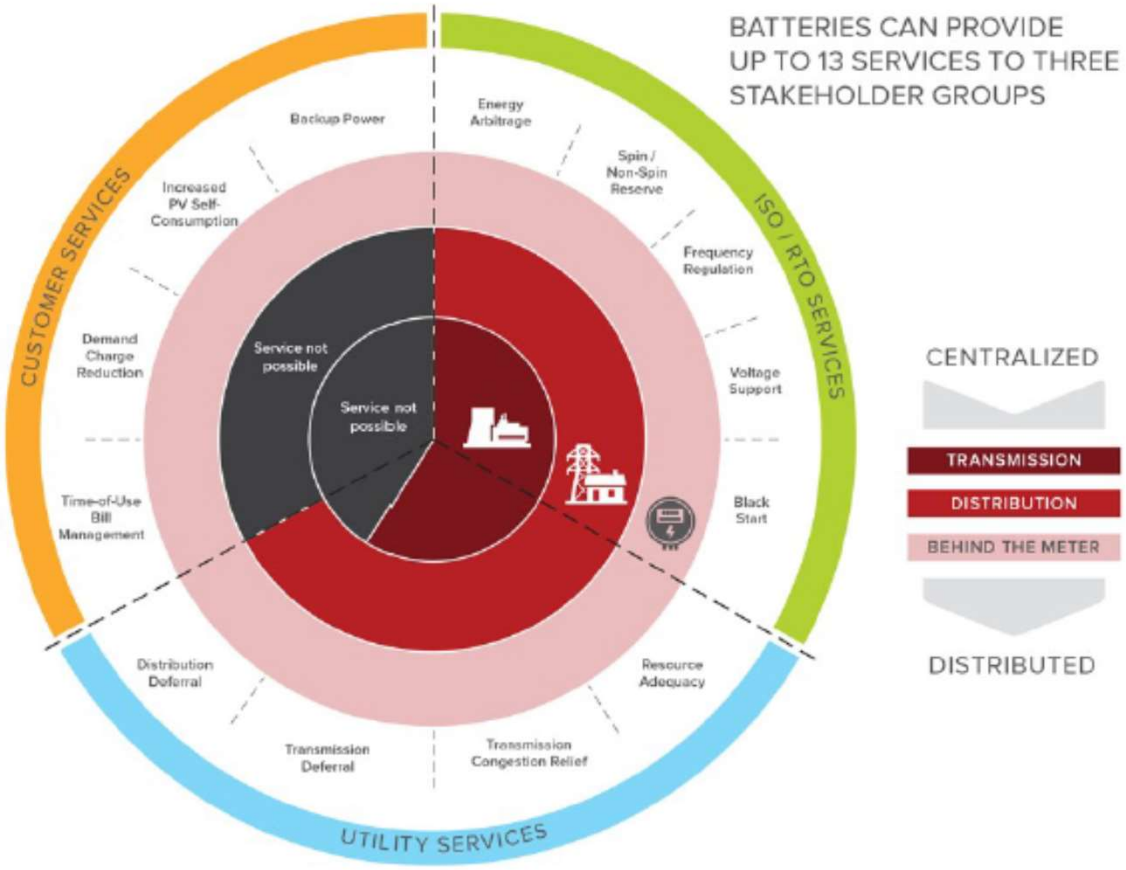


How storage is impacting the electric system



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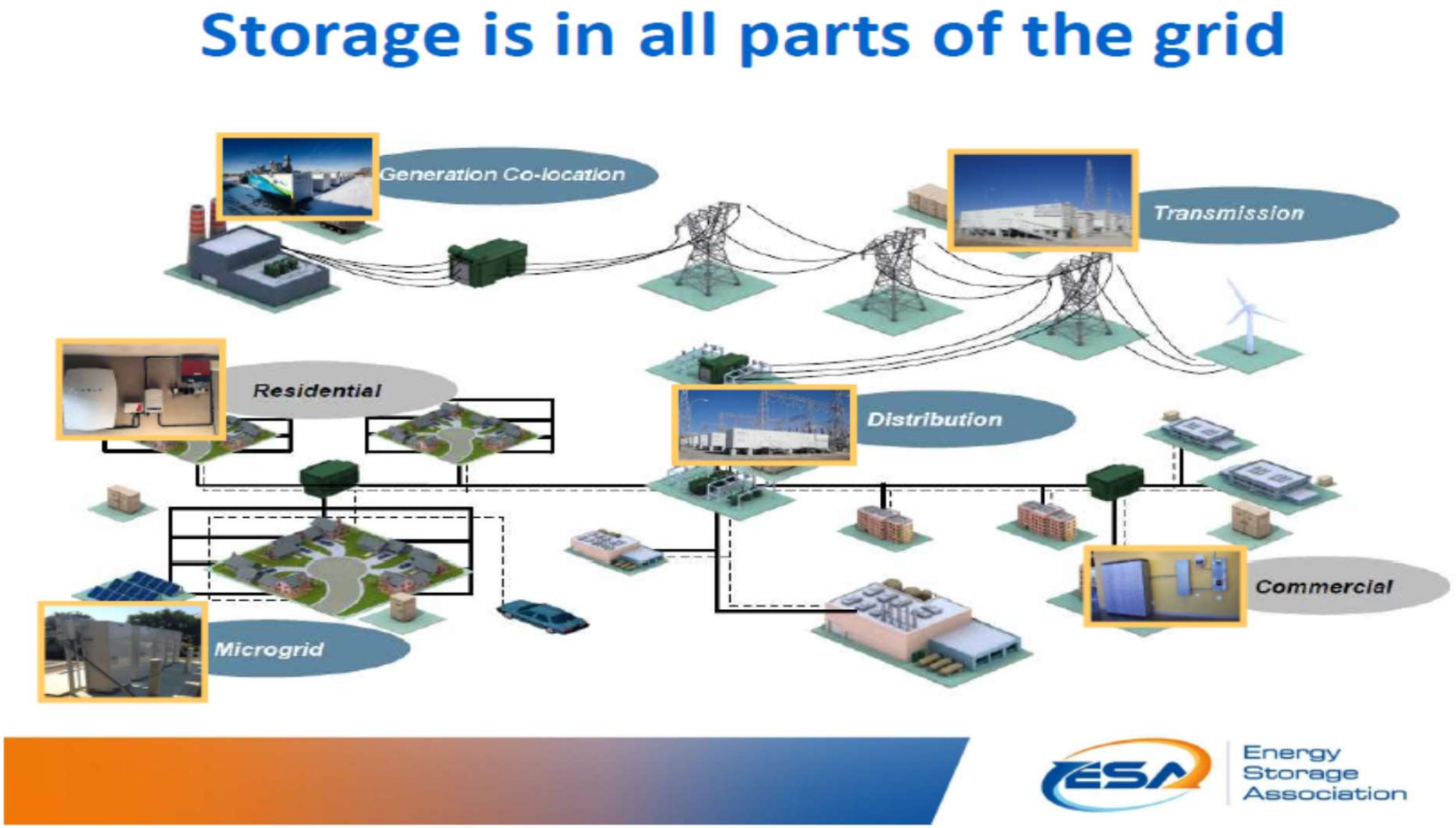


How storage is impacting the electric system

Market Drivers

Market Drivers

- Emergency Power
  - In every power plant, there is a battery system that kicks in immediately upon loss of power. Critical components run on battery power until the emergency generator can be started up and brought up to power.
  - In an nuclear plant, the emergency diesel must come online within 30 seconds. In a fossil plant, the timing is more like a few minutes.
- Black Start
  - Particularly for large systems, a battery is needed to engage the starting motor for start up.
- Backup Power
  - For critical situations, equipment, site specific requirements.

Market Drivers

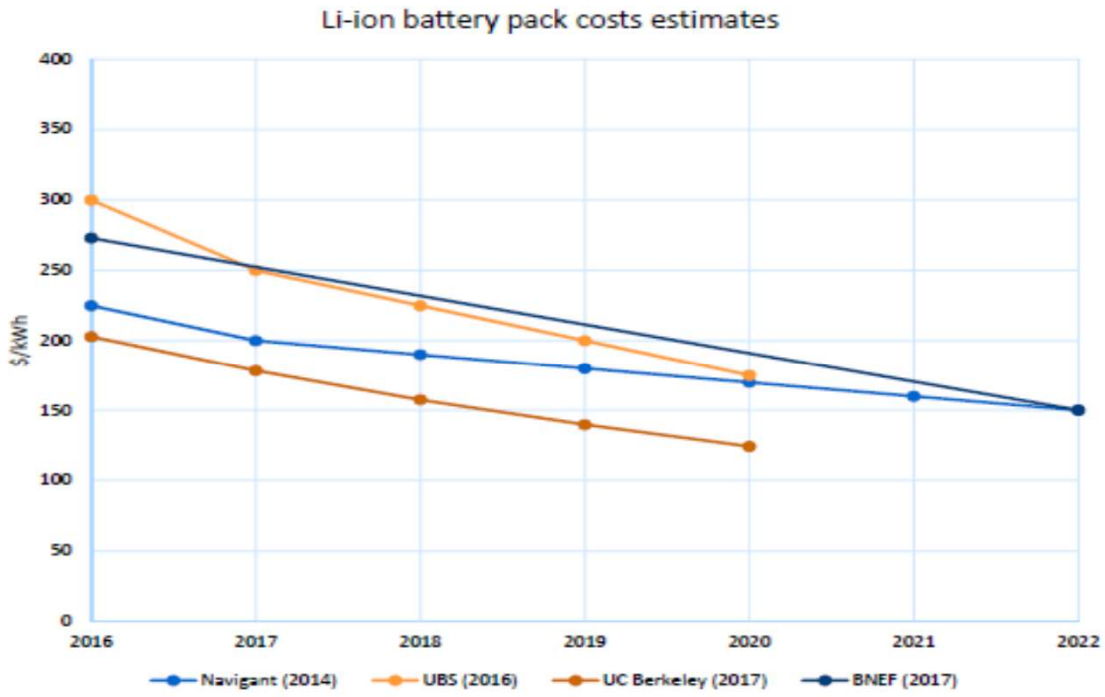
- Renewable integration
- Transmission and Distribution upgrade deferral
- Power quality
  - Frequency regulation
  - Voltage support
  - Reserves
- Improved efficiency of nonrenewable sources (e.g., coal, nuclear)
- Off-grid applications

Rough Costs

- Why is Storage Valuation Difficult?
  - Location/Jurisdiction
  - Market area, e.g., California ISO
  - Vertically integrated utility
  - Transmission and distribution deferral is very location specific
  - Many applications require a combination of technical and financial analysis
  - Dynamic simulations (requires an accurate system model)
  - Production cost modeling (requires an accurate system model)
  - Difficult to break out current cost of services, especially for vertically integrated utilities
  - Identifying alternatives can be difficult
  - Many storage technologies are not “off-the-shelf”, proven technology (e.g., O&M costs, warranty????)
  - Storage is expensive.

Rough Costs

Battery costs to continue rapid decline



Recent reference points

- Chevy Bolt (2017): ~$200/kWh battery pack
- Tesla (2016): $190/kWh battery pack

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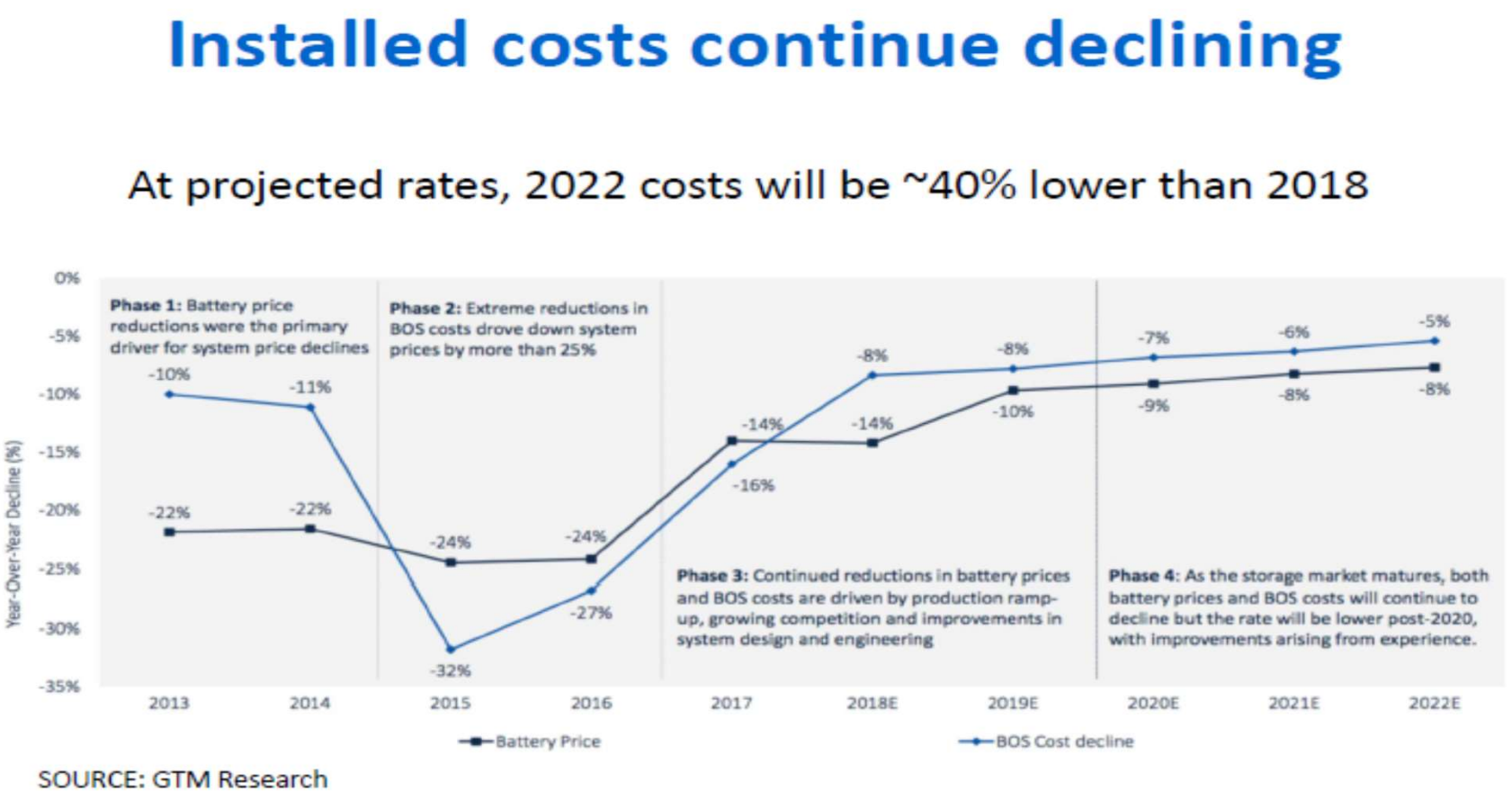
Rough Costs



SOURCE: GTM Research

Rough Costs

- Note that battery costs are given in $/kwhr of capacity (not operation).
- Balance of system (BOS) costs include inverters, safety devices, grid connections, meters, instrumentation, controls, and labor, etc.
- BOS costs are in the neighborhood of $1,000 – 1,200/Kw.
- Roof top solar runs about $7,000 – 9,000/Kw(peak).
- Capacity factors for roof top solar in the northeast are about 11%.
- The panels degrade by 1%/yr.
- Li-ion batteries degrade whether used or not.
- Li-ion batteries are intolerant of deep discharge (ie battery ruined).

Rough Costs

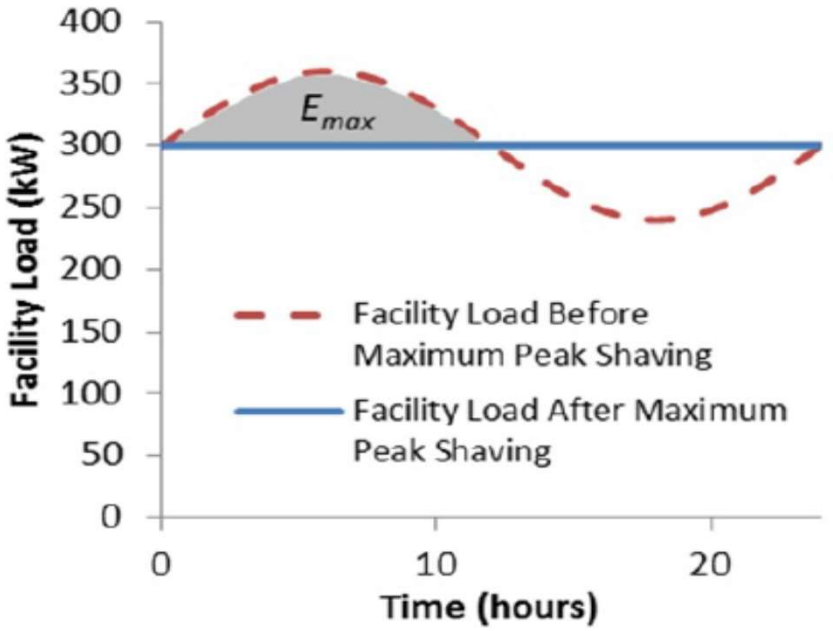
- For a 5 Kw roof top installation, the capital cost will be in the range of $40,000.
- Two 5 Kw batteries, each with 4 hours duration, will provide 40 kwhrs of energy when there is no generation.
- For a home with a 4 Kw peak and 2.5 Kw average (with 1.5 Kw draw at night), the 40 Kwhrs will last about 16 hours. That might be enough to get through the night in the winter time.
- The battery cost will be $8,000. The installation cost will be another $10 – 12,000.
- The total cost would be about $60,000. The total generation would be about 5,000 Kwhrs/yr. The system, including the batteries, cannot produce more than that. With a 20 year life (batteries don't last that long), the amortization is $3,000/yr (no interest or ROI). The COE at that rate would be 60 cents/Kwhr (no subsidies).

Rough Costs

- The prior analysis is very rough.
- The northeast is not the best place for roof top solar.
- The real point is that batteries alone are not the total solution to renewable energy generation.
- Location is important.
- System energy use is important.
- Federal, state, and local subsidies and requirements will drive the demand at current costs.
  - In Massachusetts, the total value of subsidies is over 75% of the total installed costs. Electric prices are high in that region.

Potential Industrial Uses

- Reduction in demand charges (behind the meter).
- Large potential savings for industrial customers.



Potential Industrial Uses

- Typically, demand charges persist for 12 months. Consequently, one brief increase in demand (say in the summer) causes a charge at the peak level for the next 12 months, or until a new peak is reached, in which case a new 12 month peak charge is started.
- Most commercial and industrial facilities are subject to demand charges. Of course, the actual charge is dependent upon the particular rate plan for the facility. There are about 18,200 rate structures in the US. Thus, benefits tend to be very site specific.
- Time of use pricing is another impact on facilities. The ability to move demand to off peak pricing periods can be another means of savings afforded by battery use.

Potential Industrial Uses

- In addition to back up power and emergency power, batteries can help support cogeneration or microgrid projects, particularly where island capability is desired.
- For certain industries, resiliency is particularly important. Recent storms have demonstrated the kinds of damage and power interruption that can occur. Battery power for critical components can help mitigate some of these issues.
- Detailed studies will likely be required to figure out the amount of storage and the types of back up that will be needed.

Summary

- Energy storage has been around for a long time. However, gross large scale applications have been limited.
- Battery development has reached a stage where certain applications are starting to make some sense.
- As costs have come down, more applications are becoming economical.
- Batteries alone, will not be the complete economic answer to variable output renewable energy.
- Benefits will be very site specific.
- Typically, systems studies will be necessary.