

October 11, 2018



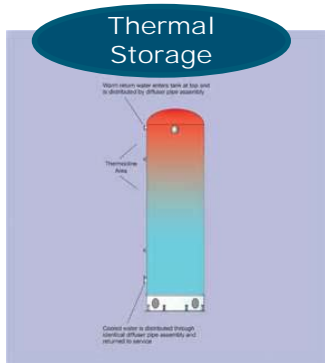
FL Public Service Workshop 50 MW Battery Program Update

Agenda

- 1) Energy Storage Background
- 2) Integrating Energy Storage into the Business
- 3) Energy Storage Use Cases

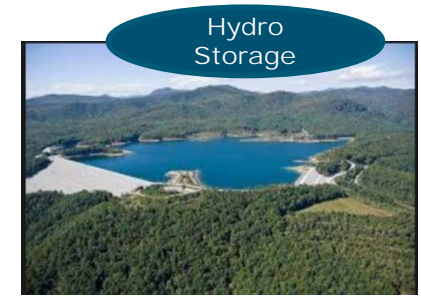
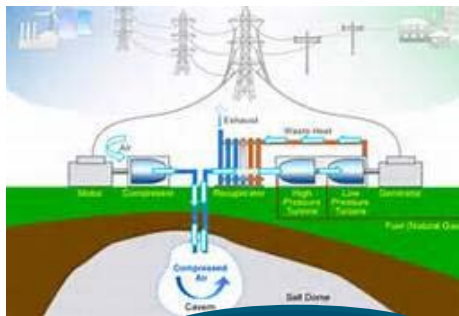
Energy Storage Background

Energy storage is accomplished by devices or physical media that store energy to perform useful operation at a later time.



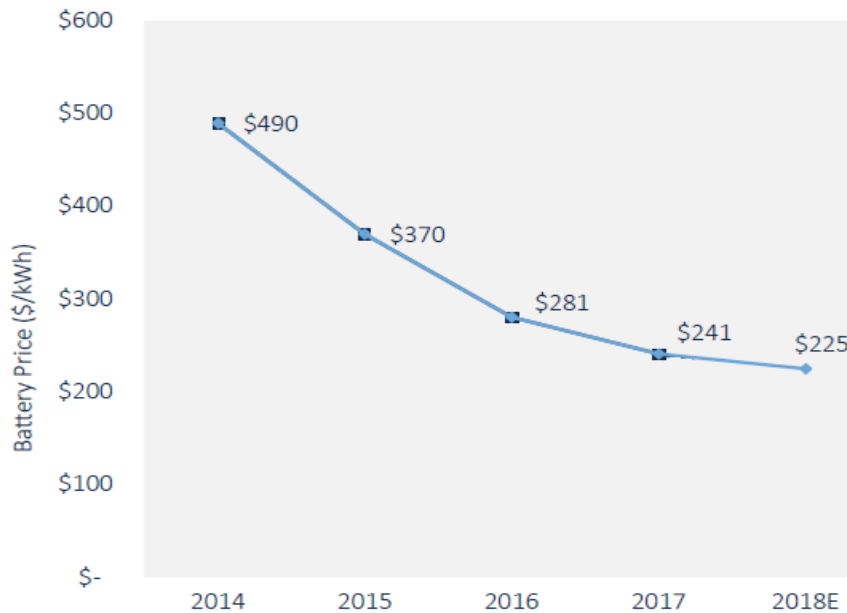
Energy Storage Will Be Transformative To The Utility

- Potential to eliminate real time need to balance generation with demand
- Enables variable generation to become mainstream
- Supports increased grid reliability and asset utilization
- Supports reliable distributed grid concepts
- Potential avoidance of future plant build for peaking needs
- Creates new customer products and services opportunities



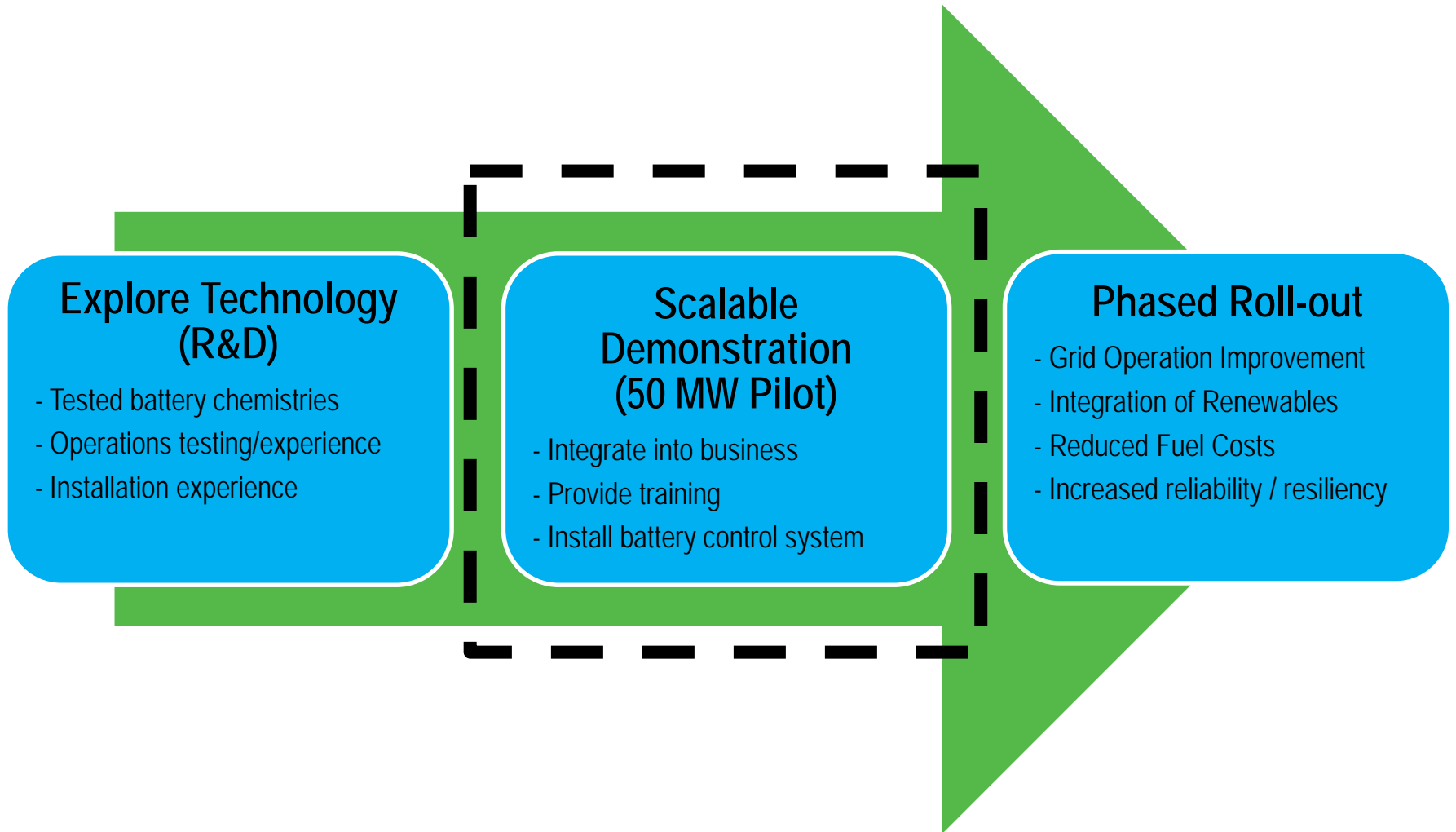
Energy Storage Background

- Li-ion will dominate in next 10 years
- Non-lithium still in developmental stages
- Costs continue to come down at a rapid pace
- Expect 'breakthrough' press releases to be common
- 295 MW deployed in 2017 in U.S. Expected to grow to 2,500 MW in 2022 (GTM)



Source: GTM Research

Energy Storage @ Duke Energy – Past, Present, Future



Integrating Energy Storage into the Business – Value Streams

| Example use cases | Description |
|-------------------|---|
| Generation | ✓ Renewables Firming Mitigate the variability of renewables |
| | ✓ Clipped Energy Capture Enable greater energy capture for solar |
| | ✓ Steady Ramp-rate Smooth ramps from renewable intermittency |
| | ✓ Peaker Planning Defer investment in peaker plants |
| | ✓ Voltage Regulation Manage system voltage in short-term |
| | ✓ Energy Arbitrage Charge and discharge when economical |
| Grid | ✓ T&D Deferral Defer T&D investments |
| | ✓ Islanding Enable grid segments to autonomously operate for long duration outages |
| Customer | ✓ Customer Demand Help minimize demand charges |
| | ✓ Back-up Power Increase reliability during short outages |

Lithium-ion is the dominant technology

The cost of lithium-ion batteries is declining steadily

Mature technology in electric vehicles

Project capacities are increasing, enabling learning efficiencies

Next-gen technologies are more nascent

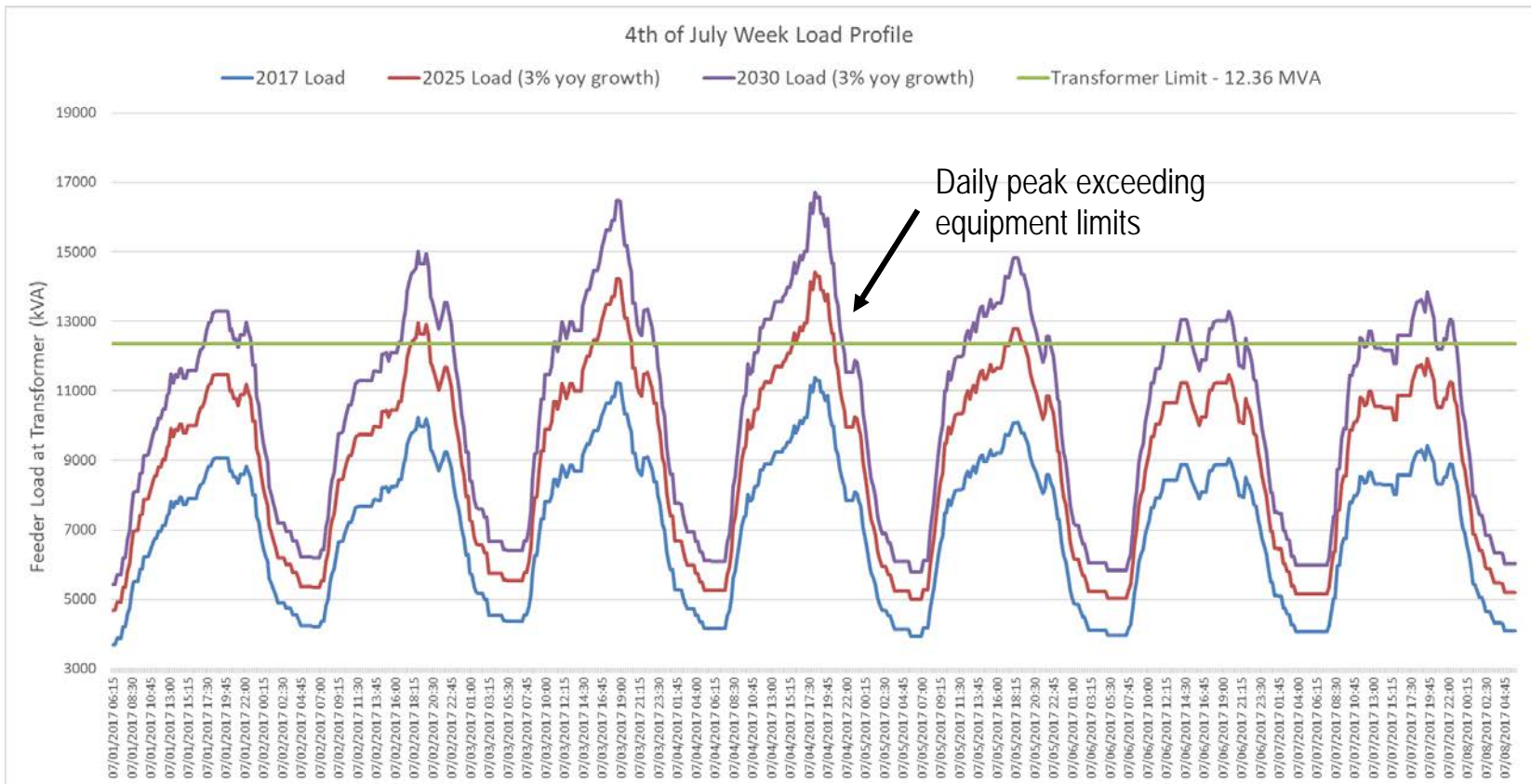
Pumped hydro storage projects require regulatory push, large up-front investment

Note: Li-ion cannot currently address islanding use case because islanding requires duration of 4+ hours

Source: Cleantechica; Energy Storage Journal; R&D Magazine; Battery University; Energy Storage Report; MIT; Greentech Media; DOE Global Energy Storage Database; Company press releases

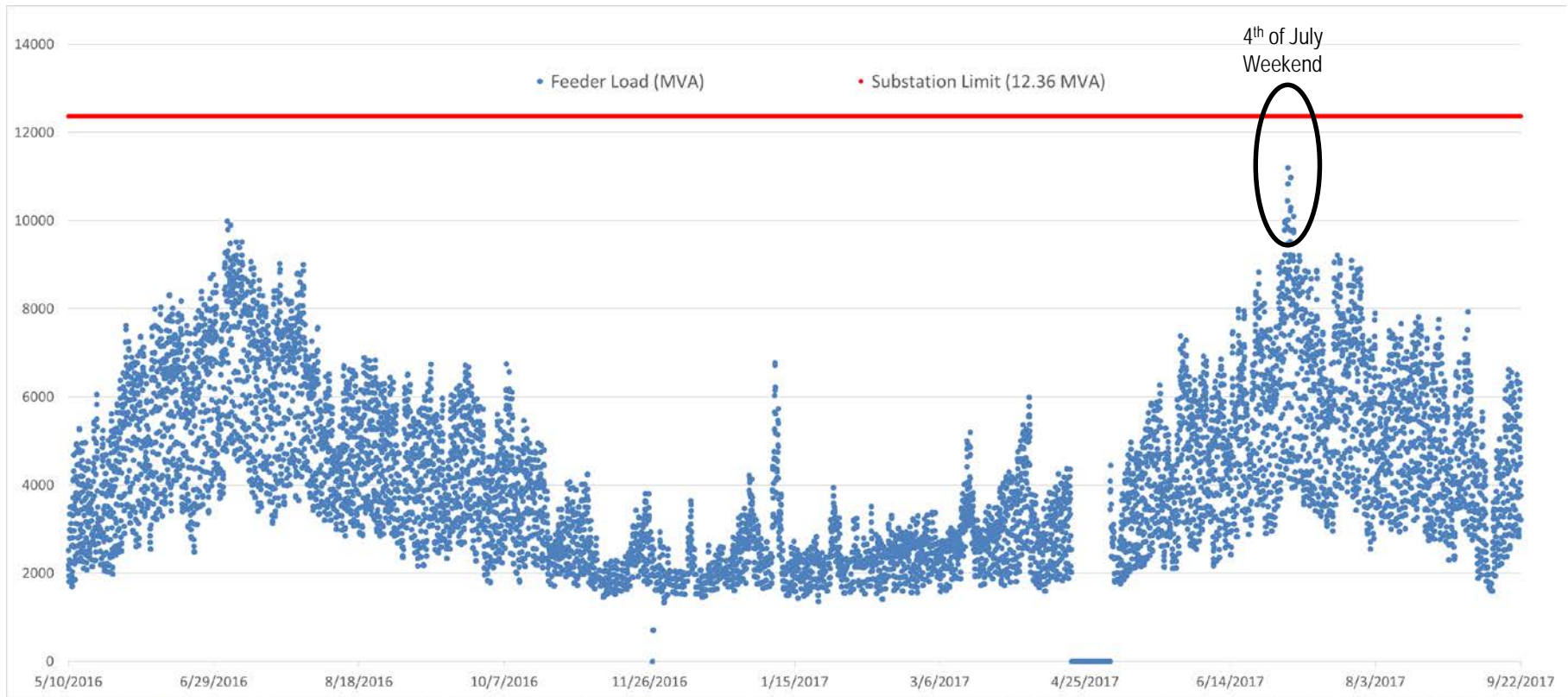
Use Case #1: Distribution Investment Deferral/Elimination

Problem: A radial feeder is experiencing very sharp load growth during the July 4th weekend. The peak load is approaching the substation transformer operational limit. Instead of upgrading the substation and feeder, energy storage can be used to serve the peak load. Storage remains useful for other services the remainder of the year, where the upgrades would not be providing value.

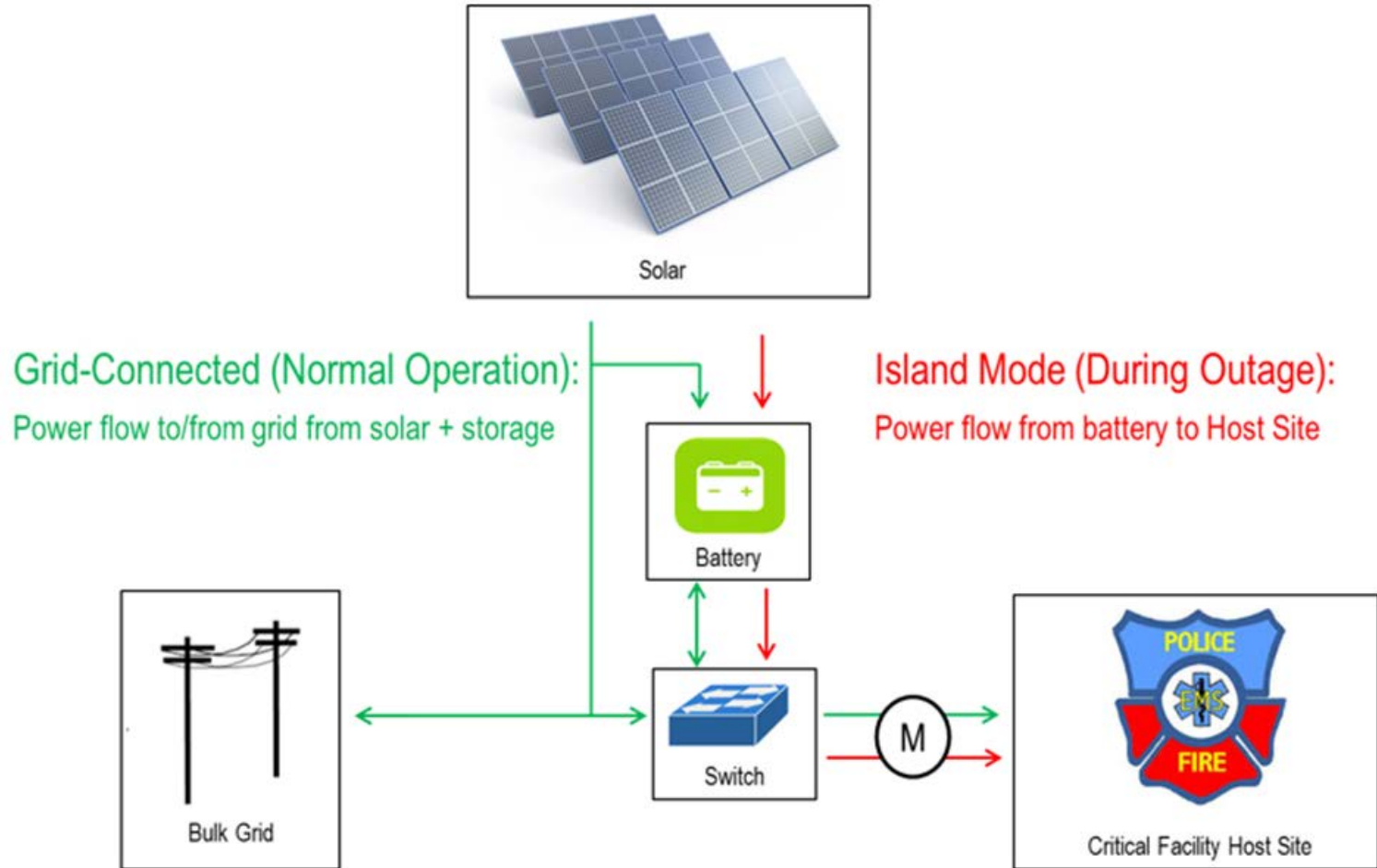


Use Case #1: Distribution Investment Deferral/Elimination

Annual view – Energy Storage can be used to serve other functions the remainder of they year.



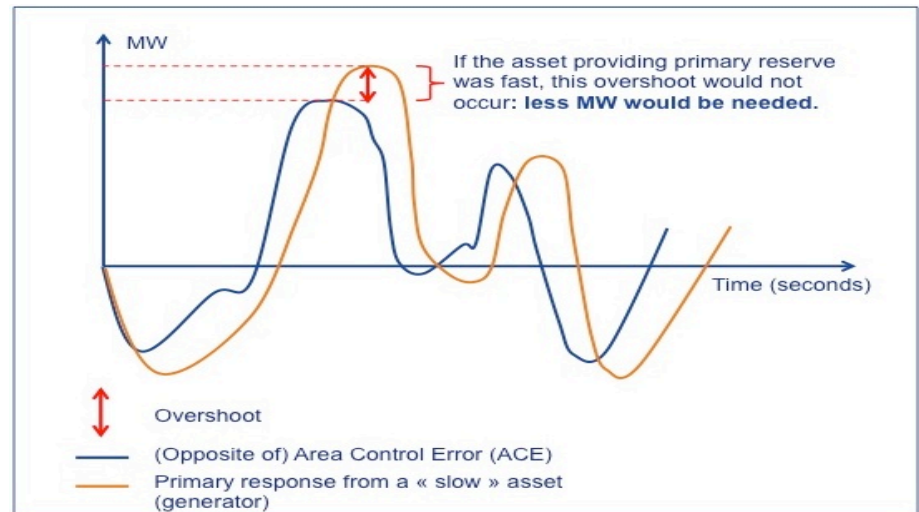
Use Case #2: Critical Facility Backup Power



Use Case #3: Storage tied to Solar

Adding storage to solar can offer many benefits:

- **Intermittency** - Batteries can offer fast-acting response to deal with fluctuations in solar output which can cause issues with frequency to our system
- **Ramp Rate** – As solar production drops off towards the end of the day, fast ramping resources are needed to meet system load
- **Energy Shifting** – Energy storage can be used to shift energy production from intermittent resources such as solar to peak times (preventing future solar curtailment)
- **Increase PV Capacity** – Energy storage can be used to capture solar PV energy that is clipped by inverters due to local interconnection limits. This allows utilities to increase the amount of solar PV that would otherwise be sent to the grid.



Energy Storage Summary

- Energy Storage is fast reaching the tipping point for adoption
- As battery costs continue to decrease, valuable use cases will increase
- Business cases will be developed with stacked benefits across T, D and G
 - Continued focus around strengthening our planning tools and processes will ensure storage values are captured appropriately across T, D and G
- Duke Energy is preparing, as the FL grid operator, to use energy storage in many functions to maximize value to FL customers

