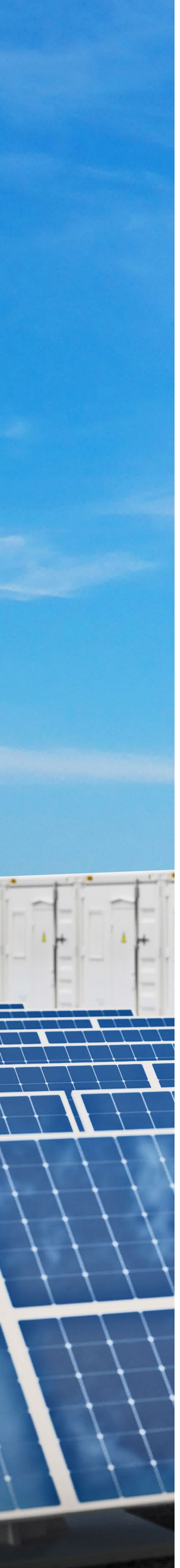

Energy Storage as a Transmission Asset

September 11, 2024

Jeremy Twitchell

LDES National Consortium Annual Workshop

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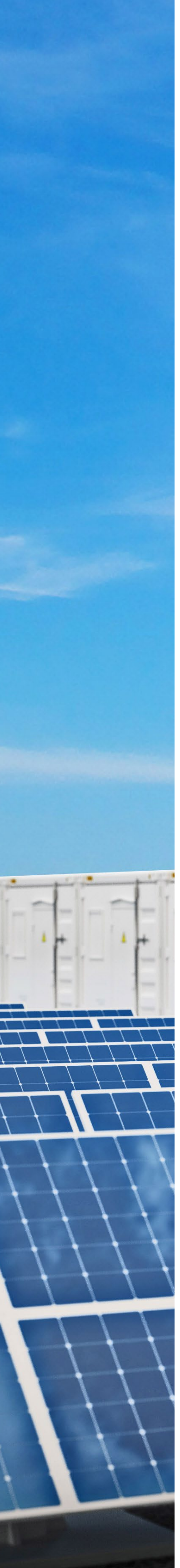
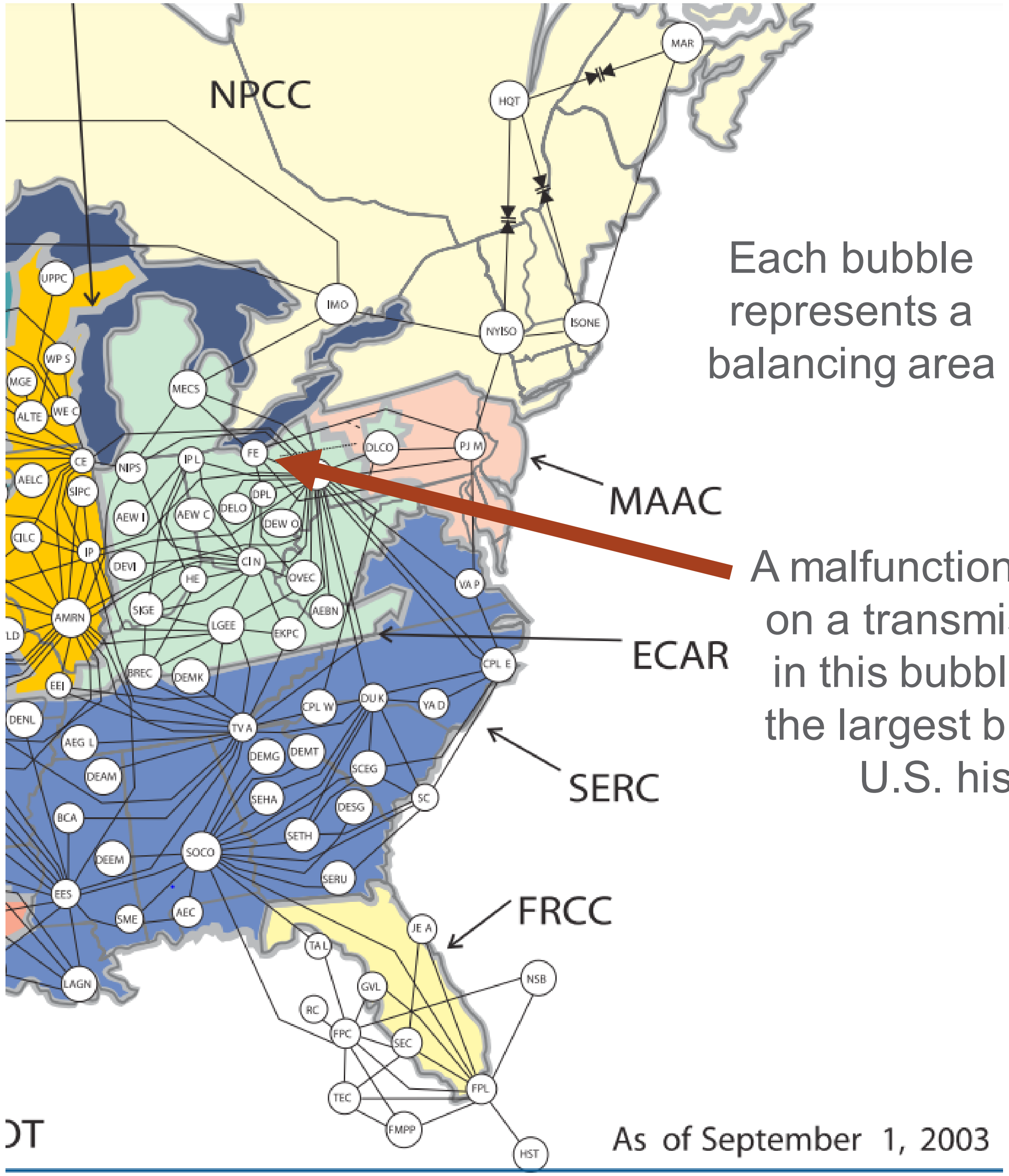


Acknowledgment

The work described in this presentation was funded by the Energy Storage Office within the U.S. Department of Energy, Office of Electricity, and the Water Power Technologies Office.

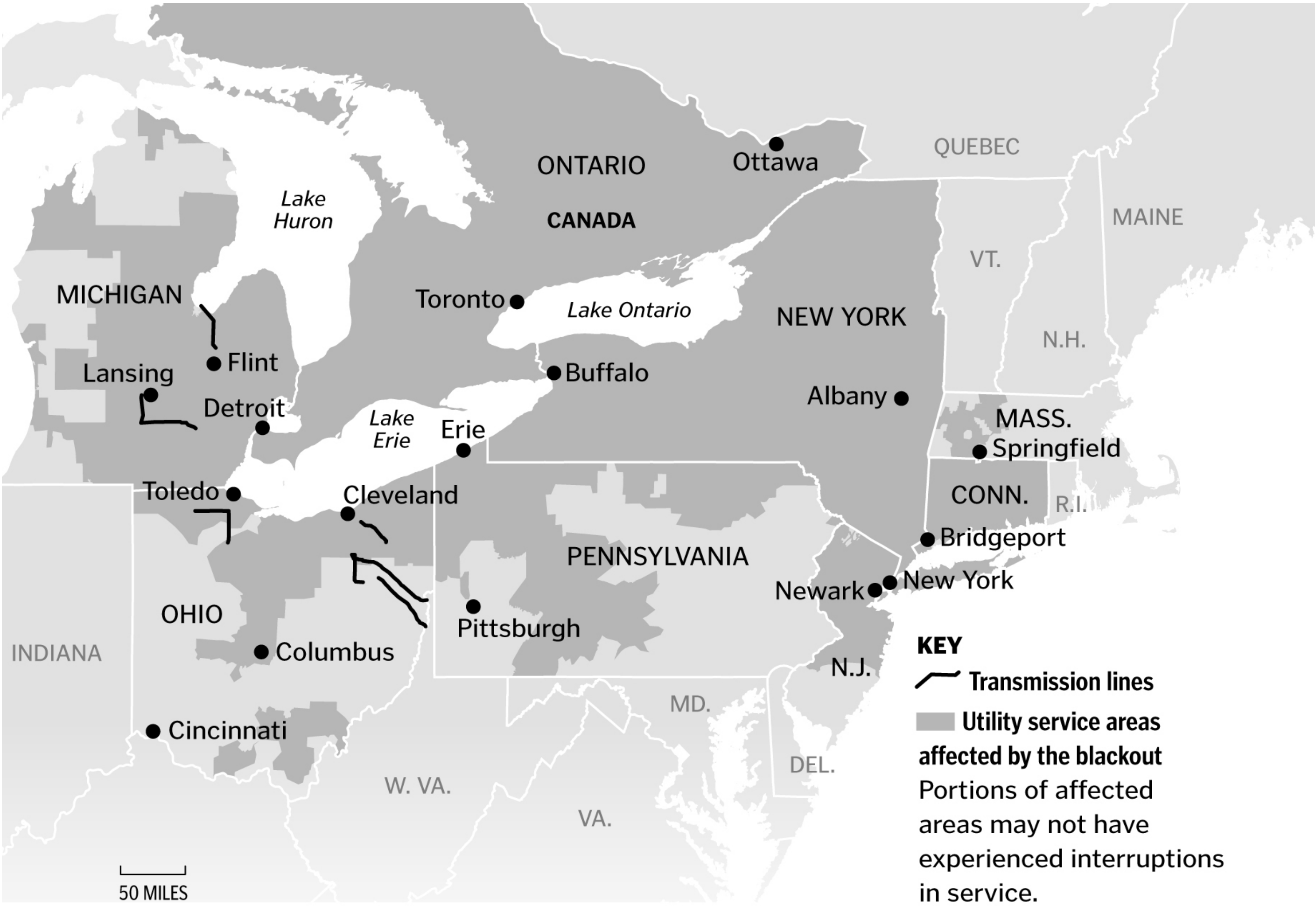
Our story begins in 2003



U.S. Department of Energy

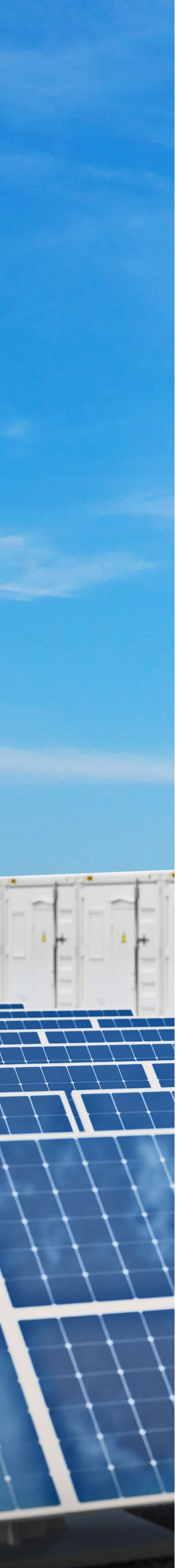
Each bubble represents a balancing area

A malfunctioning switch on a transmission line in this bubble caused the largest blackout in U.S. history:



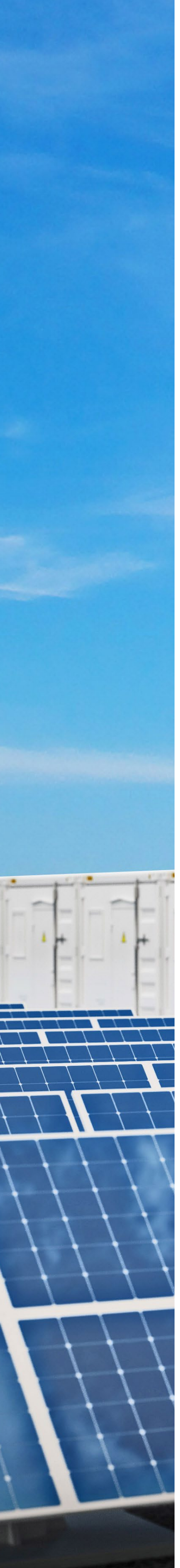
Boston Globe

Key Takeaway: This outage was not caused by any external factors. A piece of hardware malfunctioned and no one recognized what had happened until it was too late.



What changed after 2003

- The North American Electric Reliability Corporation (NERC), which had previously been an industry association that developed voluntary grid reliability standards, was empowered to enact and enforce binding reliability standards.
- NERC’s transmission planning standard, TPL-001-5, is a complex document that applies to all transmission-owning entities in the U.S.
- Contingency planning is a primary function of transmission planning
  - Planners engage in extensive “what-if” analyses: what happens if a particular transmission line or generator is disrupted? (N-1 scenarios)
  - TPL-001-5 prescribes the reliability metrics that the system must meet during a contingency; if those metrics are not met, planners must identify the investments necessary to meet them
  - Storage can provide contingency services such as regulating power flows, providing voltage, and mitigating outages



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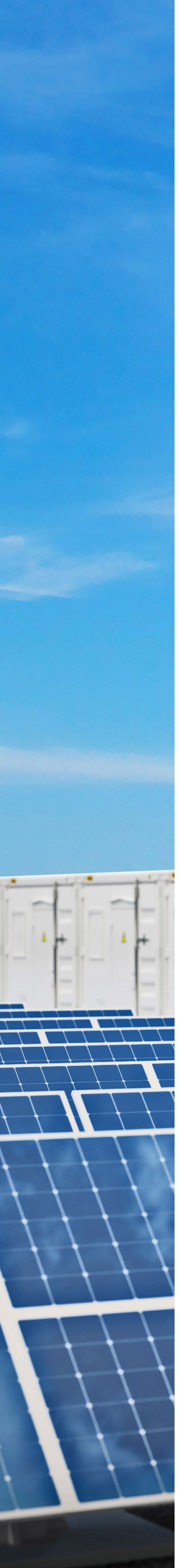
Storage as Transmission – Policy Background

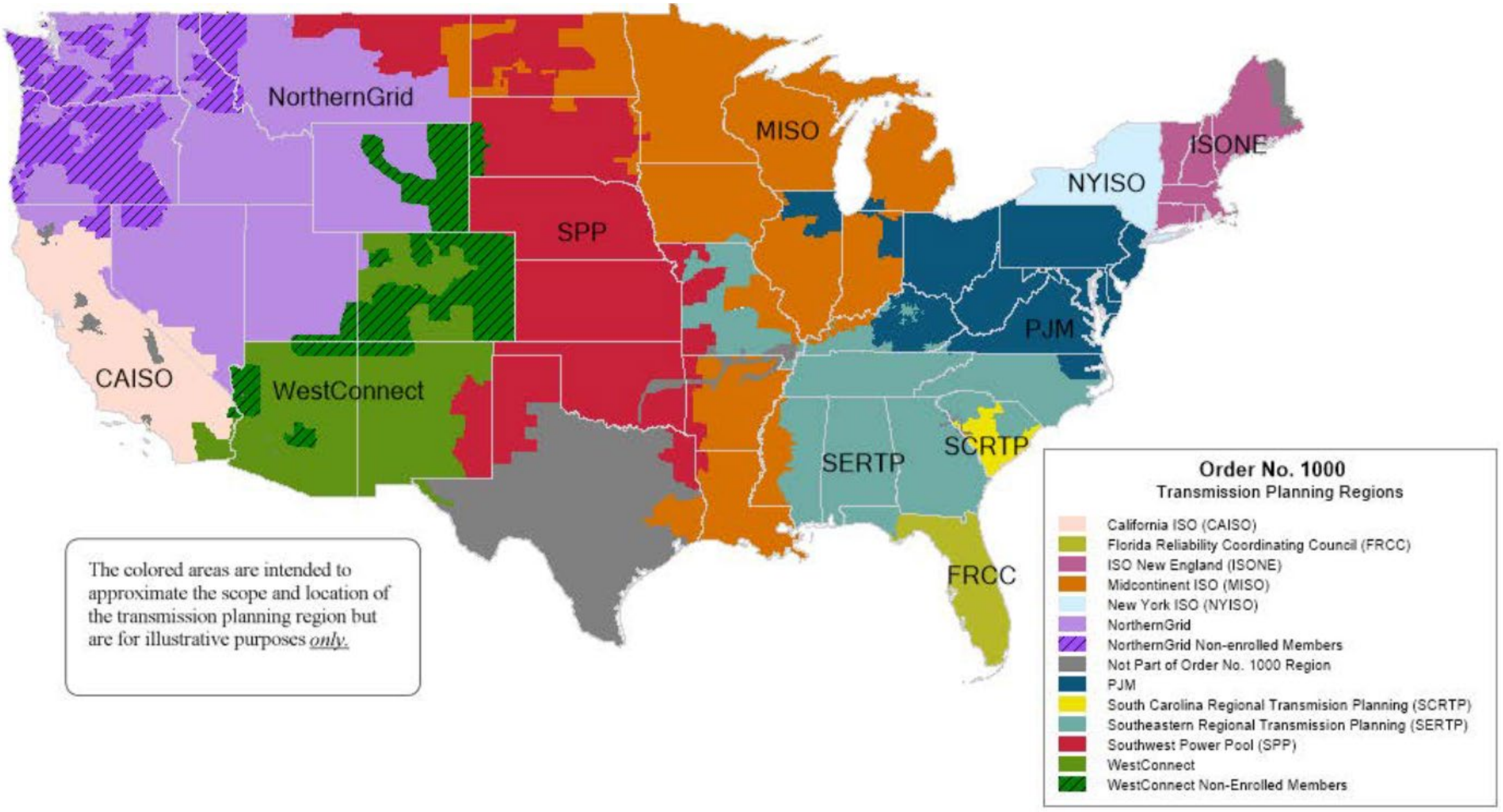
- **Energy Policy Act of 2005:** Defines energy storage as an "advanced transmission technology," which "increases the capacity, efficiency, or reliability of an existing or new transmission facility"
- **Nevada Hydro Order (2008):** FERC rejects proposal for a pumped storage hydropower to be built and turned over to the California ISO (CAISO) to be operated as a generation or transmission asset at CAISO's discretion in exchange for a regulated rate of return, because
  - It would compromise CAISO's independence and
  - It didn't present a unique use of the storage facility that would justify regulated compensation
- **Western Grid Order (2010):** FERC approves proposal for a network of batteries to provide voltage and thermal overload support in CAISO and receive a regulated rate of return (though they weren't built)
- **Dual-use Policy Statement (2017):** FERC clarifies previous orders and expresses support for allowing storage to be a regulated transmission asset and, when not needed for transmission service, to participate in energy markets and earn market revenue
  - Key objective: Reduce system costs by sharing market revenue with customers
  - FERC invited ISOs to develop enabling tariffs, but none have yet done so

FERC

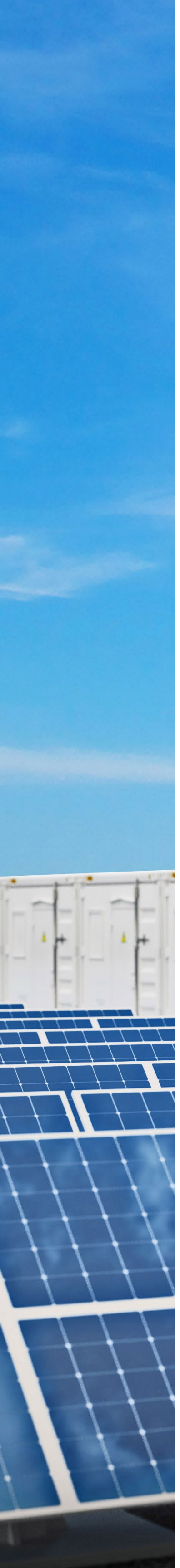


Storage as Transmission – Policy Background

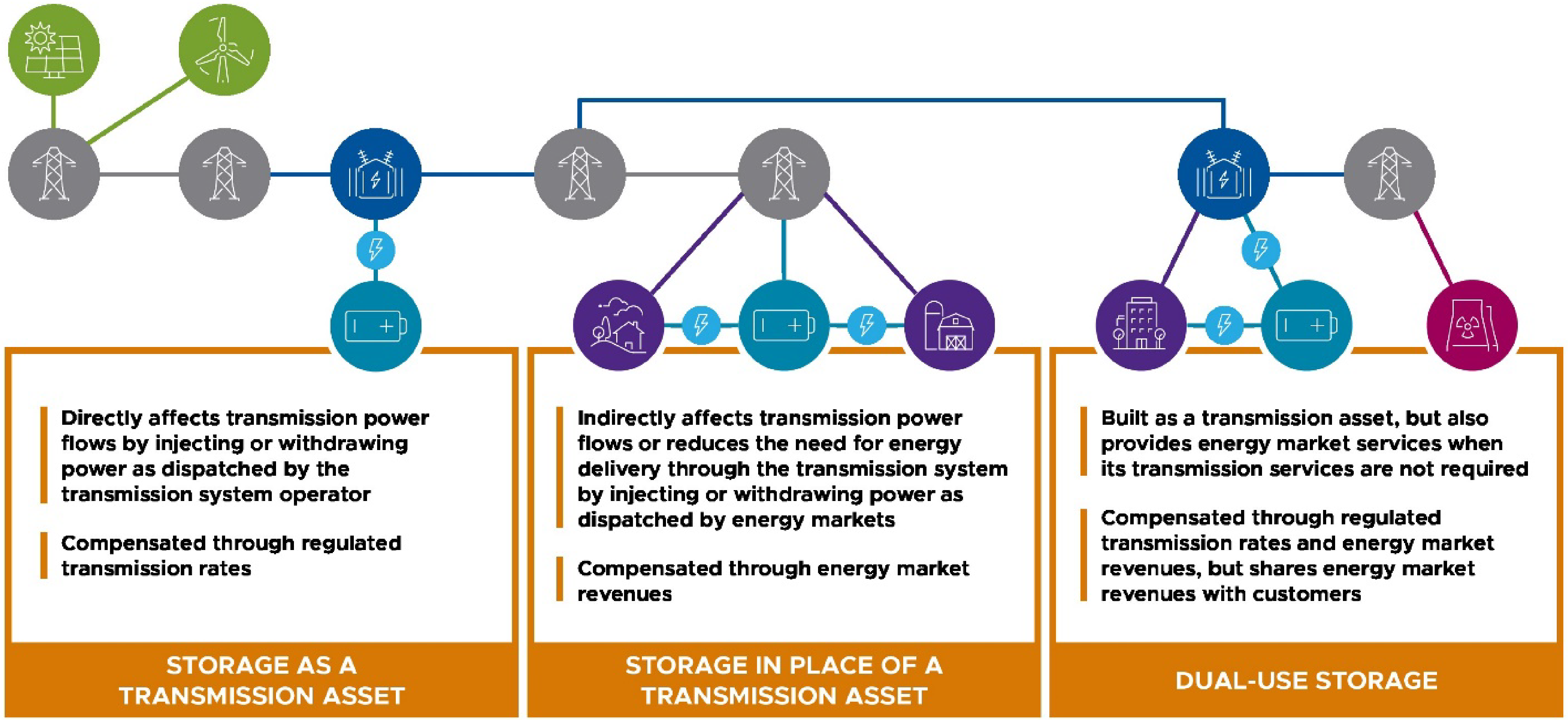
- **FERC Order 890 (2007)**
  - Transmission owners must conduct transparent transmission planning processes
- **FERC Order 1000 (2011)**
  - Requires coordinated, regional transmission planning
  - Non-transmission alternatives must be considered
- **FERC Order 784 (2013)**
  - Created Account 351: Energy Storage Equipment—Transmission



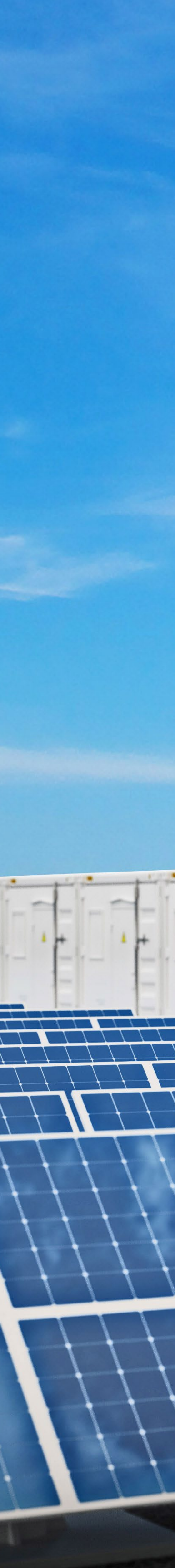
FERC



Storage use cases on the transmission system



- In the U.S., energy regulation is a federalist system (transmission is the federal government, generation and distribution are state governments)
- This structure creates rigid rules about how storage, which can provide service in all three functions, can interact with the transmission system



Storage as Transmission Use Cases

- Storage would directly affect power flows on the system
- Dispatched by the grid operator in a contingency event
- Compensated through regulated transmission rates

Thermal Overload

- If a large transmission line is disrupted, power flows may be redirected over lines that cannot handle them, causing them to overheat
- **Storage can absorb excess power flows and prevent them from overloading other lines**

Reactive Power

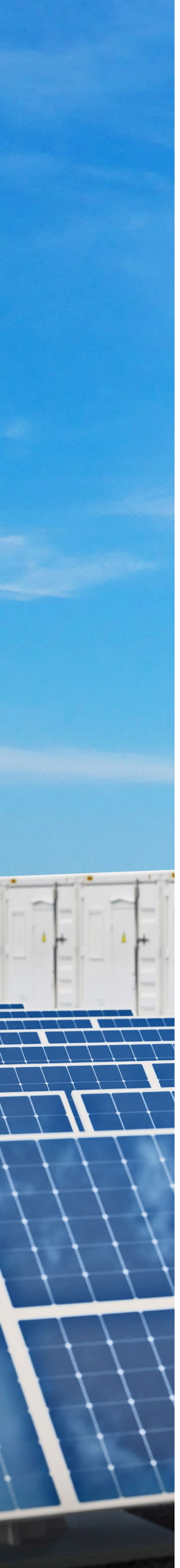
- Reactive power is the energy that supports the back-and-forth flow of alternating current electricity; the loss of a generator may result in inadequate reactive power in a region
- **Storage can provide reactive power through an inverter**

Voltage

- Electricity transmission requires high voltages, but if a large generator or power line loses service, there may inadequate voltage on remaining lines
- **Storage can maintain voltage in contingency situations or improve it on long-distance transmission lines**

Outage Mitigation

- Some contingencies may result in customers losing service, or grid operators may have to actively cut service to customers to rebalance the grid after a contingency event
- **Storage can maintain service to customers that would otherwise be cut off in a contingency**



Storage in place of Transmission Use Cases

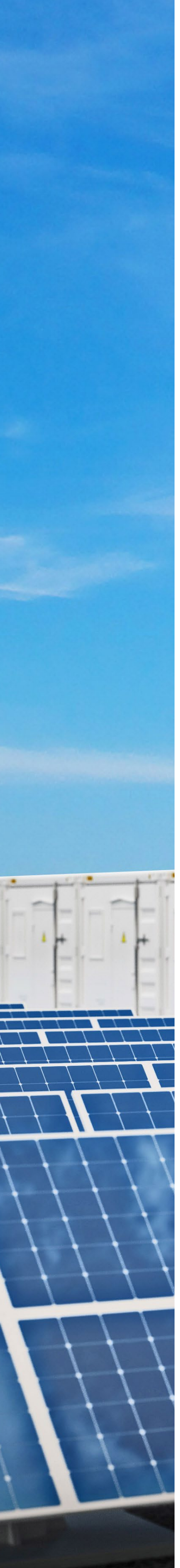
- Storage would <u>indirectly</u> affect power flows on the system
- Dispatched by market operator
- Compensated through competitive energy markets

Peak Management

- When peak demand in an area outgrows the capacity of the transmission lines that serve, additional transmission lines may be required
- **Storage can be used to meet excess demand, delaying or eliminating additional lines**

Congestion Relief

- Inadequate transmission connection to low-cost resources may force reliance on higher-cost resources
- **Storage can capture low-cost generation during low-demand periods and use it during high-demand periods**



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Thank you

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