

# Impacts of Distributed Storage on Electricity Markets, Utility Operations, and Customers

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# Background: ERCOT Storage Study

## The Value of Distributed Electricity Storage in Texas

Proposed Policy for Enabling Grid-Integrated Storage Investments

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## Analyzed grid-integrated storage on distribution systems across Texas

- 5,000 MW cost effective from a system-wide perspective at cost of \$350/kWh
- Total customer benefits (lower bills and improved reliability) would exceed costs
- This level of storage deployment reduces but does not eliminate need for new generation

## Found that current market and regulatory mechanisms do not enable cost-effective deployment

- Neither wholesale market participants nor T&D companies can capture all value streams offered by distributed storage

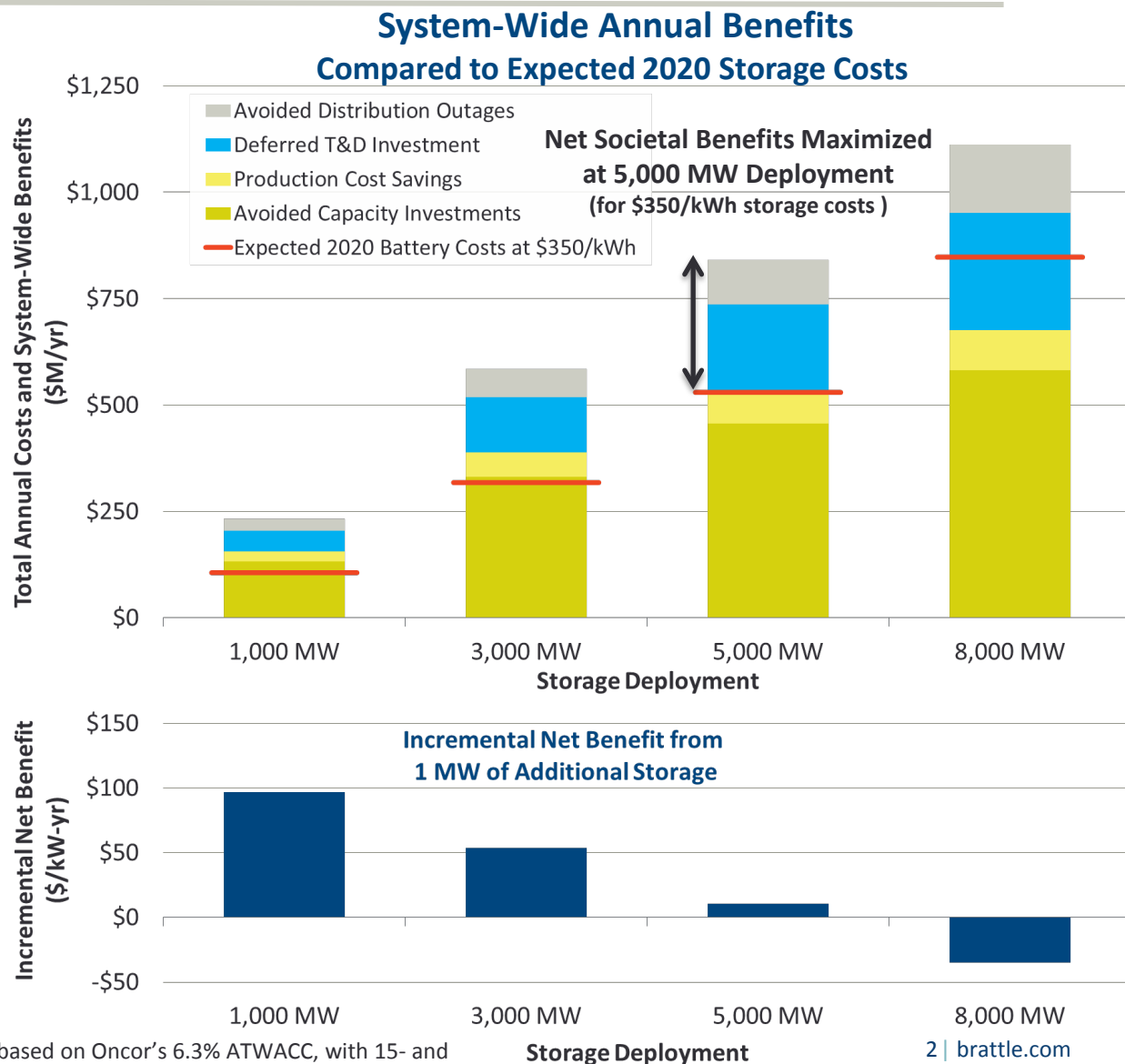
## Requires new business models and policy frameworks

# Societal / System-Wide Benefits

- From a system-wide societal perspective, distributed storage offers significant value streams:

1. Avoided generation investments and production costs
2. Deferred T&D investments
3. Reduced outages

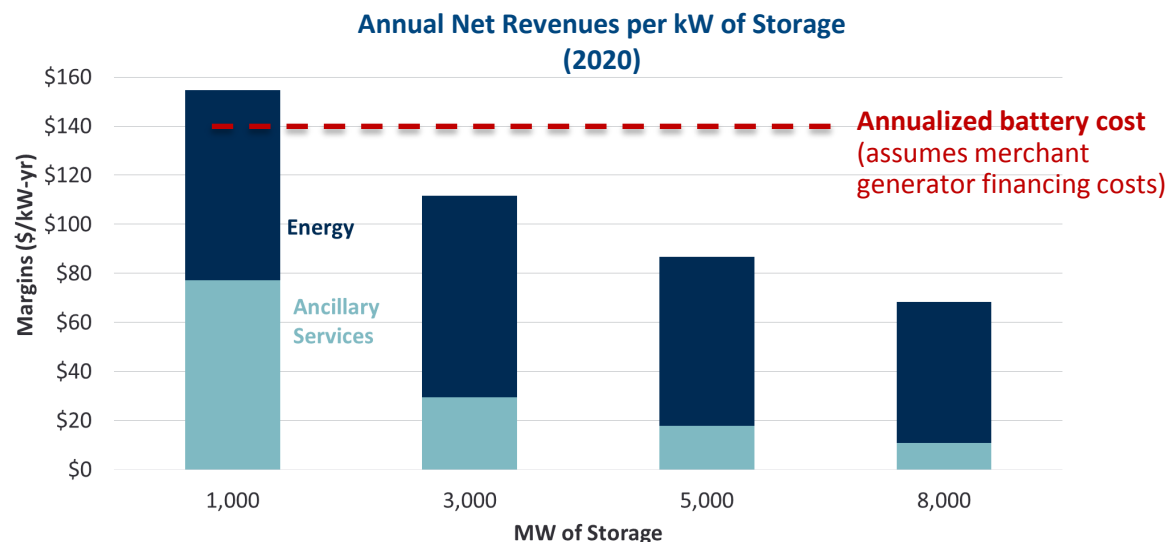
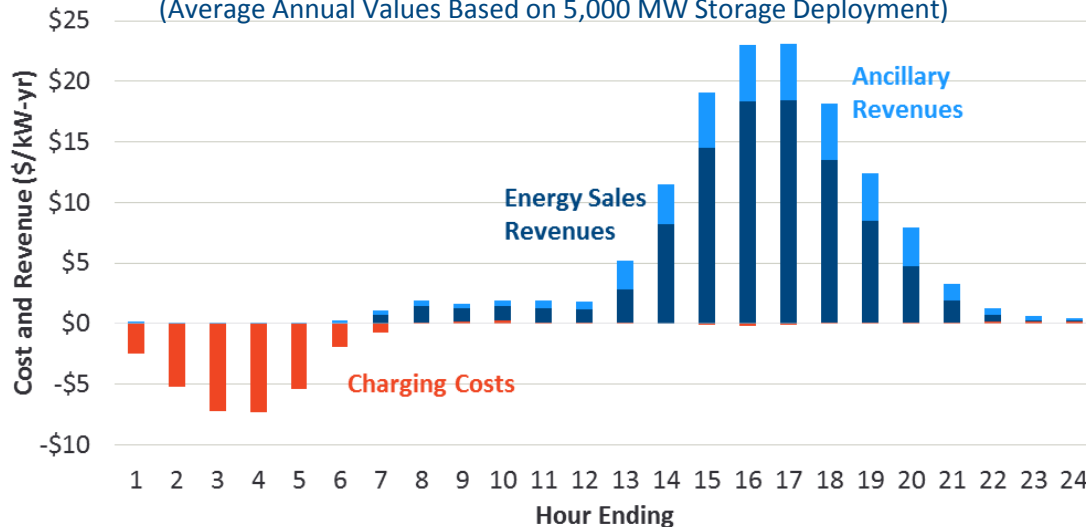
- At \$350/kWh in installed costs, the incremental value exceeds cost up to 5,000 MW



Notes: The expected 2020 battery costs are annualized based on Oncor's 6.3% ATWACC, with 15- and 30-year assumed lifetime for the battery and balance of plant respectively.

# Wholesale Market Operations and Value

Storage Charging Costs and Revenues for Energy Arbitrage and Ancillary Services  
(Average Annual Values Based on 5,000 MW Storage Deployment)

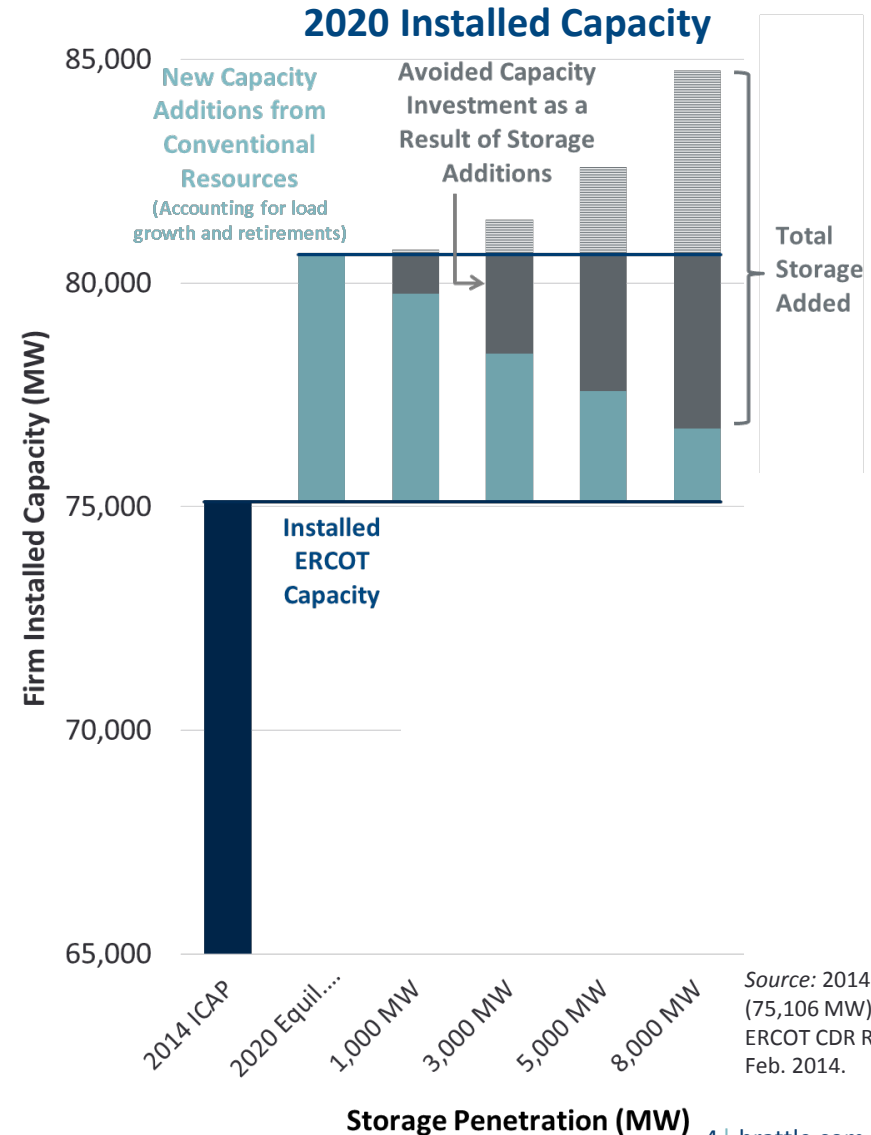


- Even at the low \$350/kWh projected installed battery costs, the wholesale market value of storage (without capturing T&D and reliability benefits) is limited to support merchant investments at a meaningful scale
  - Particularly true if capital costs were to exceed the 8% ATWACC assumed for merchant generators
- At less than 1,000 MW, providing ancillary services accounts for the majority of the wholesale market revenues

# Impact on Wholesale Market and Generators

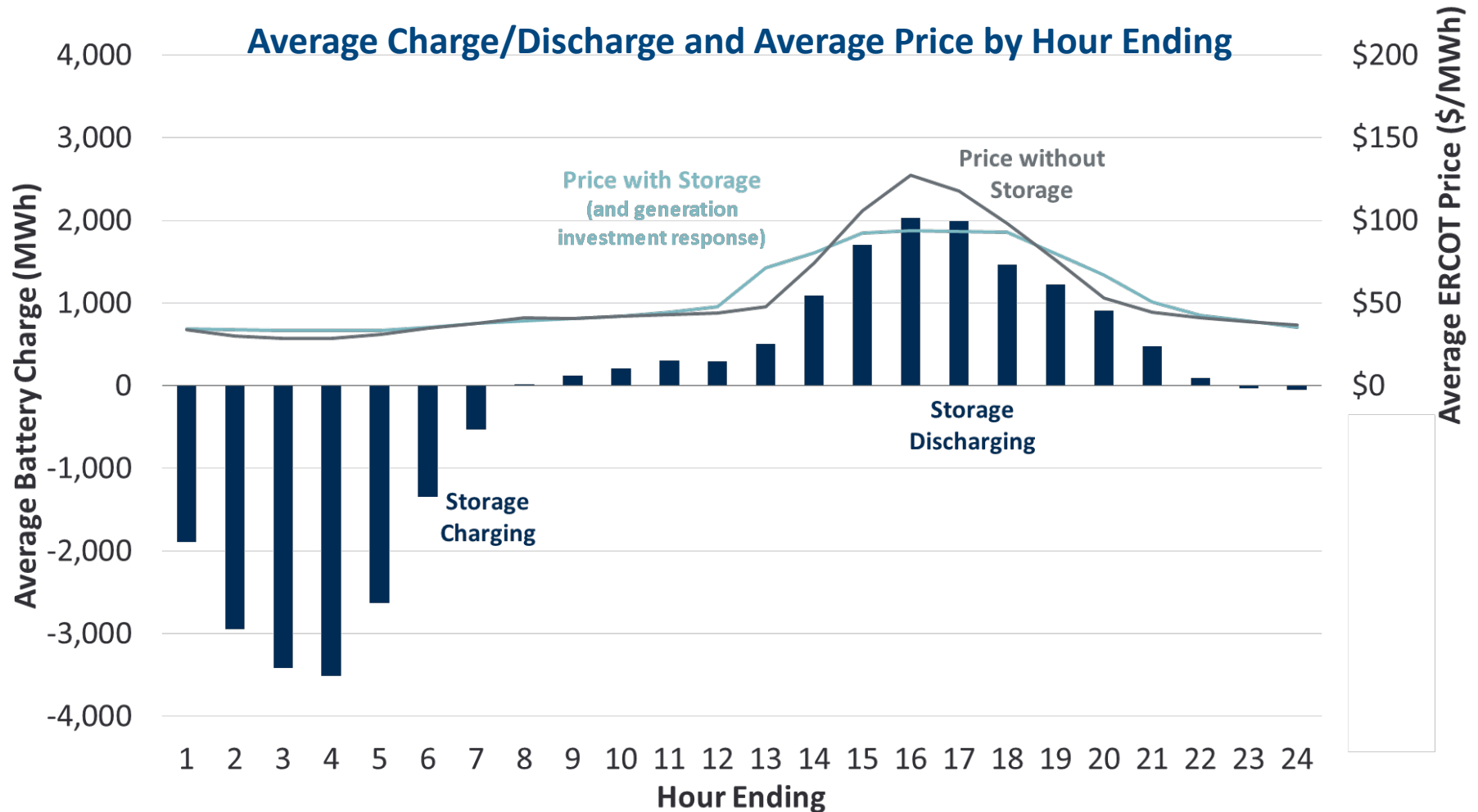
## Simulating Generation Investment Response

- Simulated ERCOT's energy-only market in 2020:
  - With full ORDC curve
  - With 2011 and 2012 weather years to arrive at realistic distribution of CC margins
- Evaluated the likely investment response by conventional generation if storage is added to the ERCOT system
- Yields reserve margin consistent with a market outcome
  - 5,000 MW of storage results in 3,100 MW of reduced generation investment (or increased retirements)



# Impact on Wholesale Market and Generators

## Charging/Discharging Impact on Price

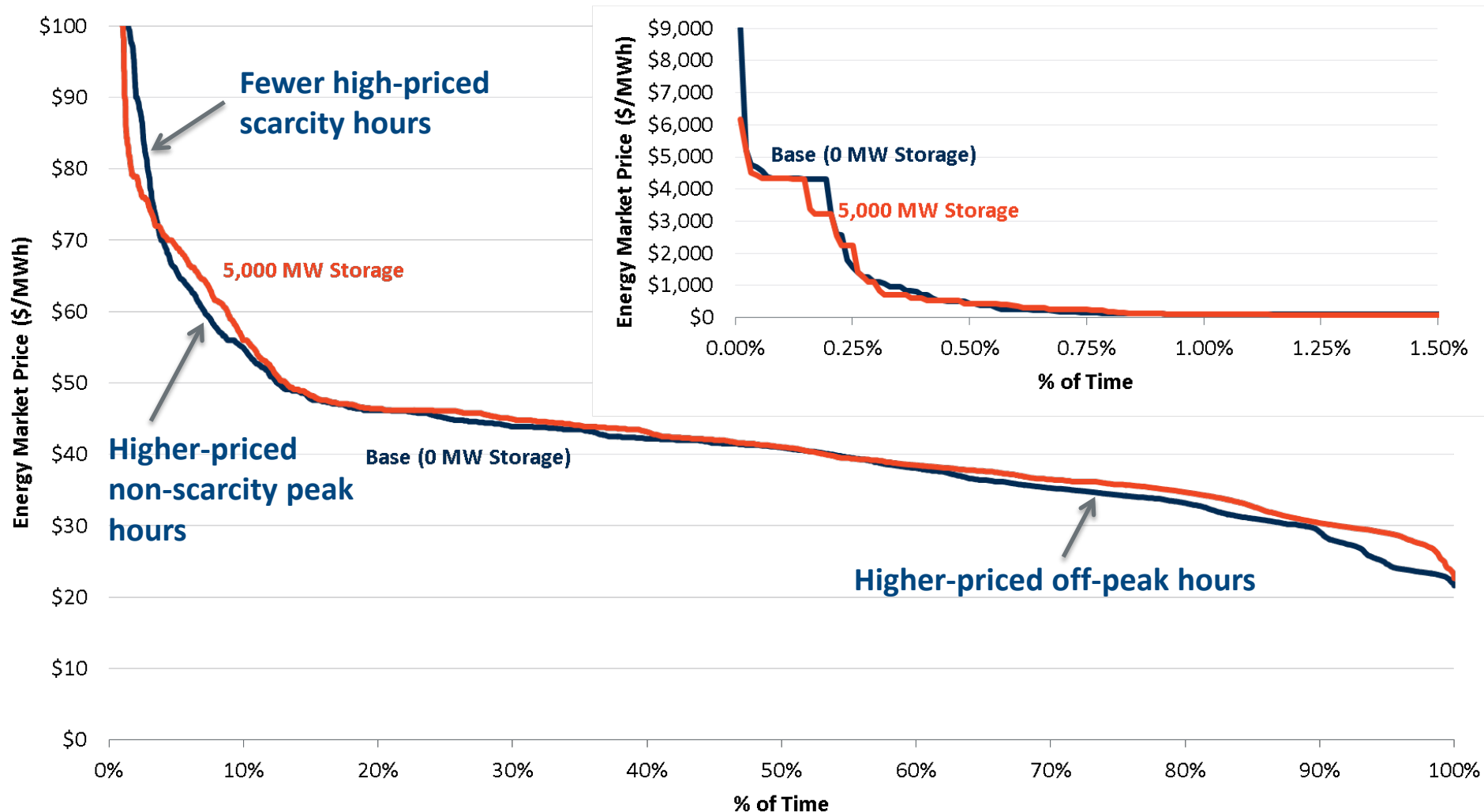


### Notes:

Price with storage reflects 3,068 MW of less generation investment compared to the price without storage  
Results represent the weighted average of the 2011 and 2012 weather year results

# Impact on Wholesale Market and Generators

## Price Duration Curve with/without Storage



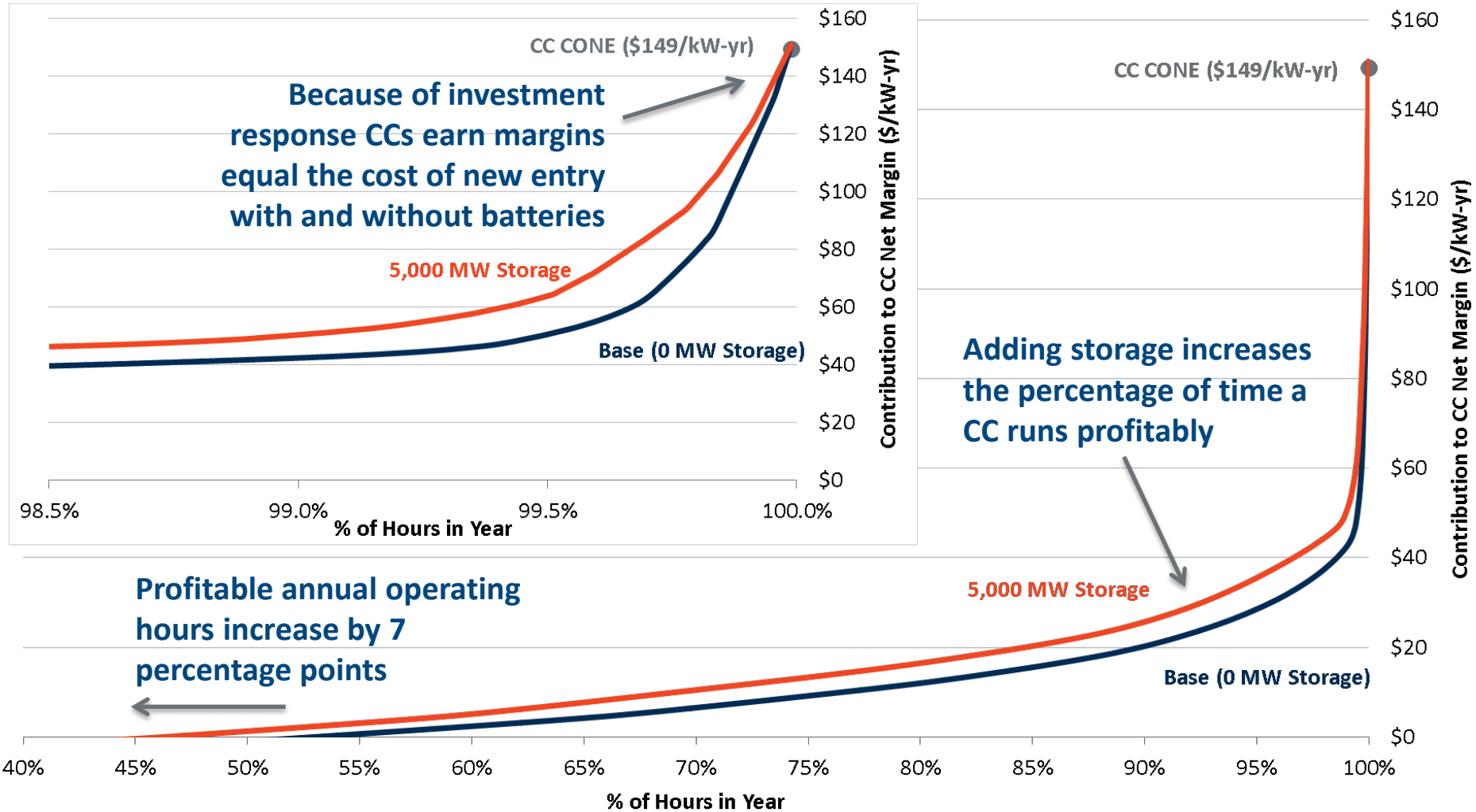
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# Impact on Wholesale Market and Generators

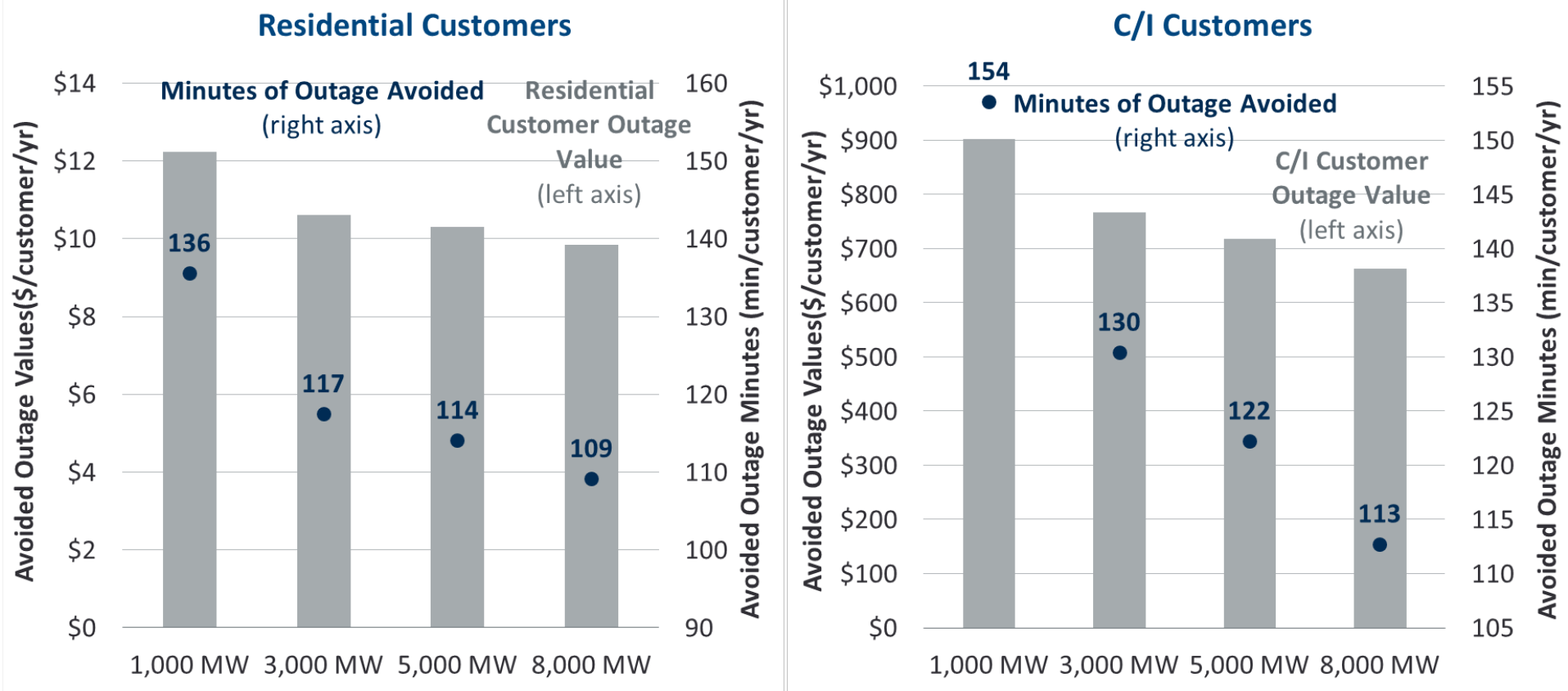
## CC Energy Margins with/without Storage



**Notes:**  
 Margins calculated based on the representative CC unit (Jack County) used for determining the equilibrium reserve margin.  
 Results represent the weighted average of the 2011 and 2012 weather year results



# Consumer Outage Reductions of Grid Integrated Storage

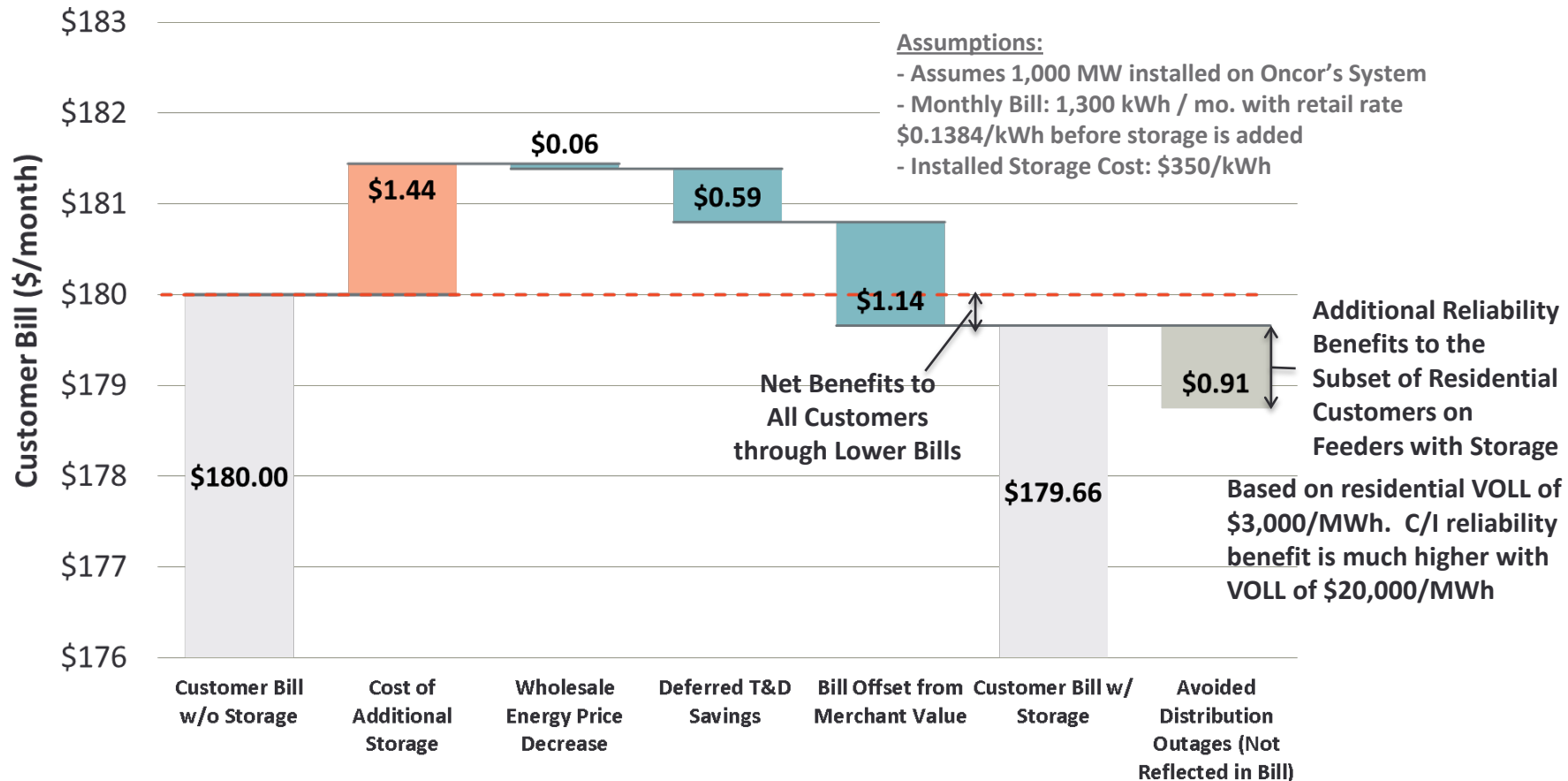


## Sources and Notes:

Results are for distributed 3 hour storage capability. Based on our analysis of five years of Oncor outage data, with the storage deployed throughout ERCOT. The average duration of outages avoided declines with storage deployment because early installations are targeted to the feeders that could benefit the most from outage prevention. Residential value is based on a standard residential consumer using 1,300 kWh/month and a VOLL of \$3,000/MWh. C/I value is based on an average customer size of 12,700 kWh/month and a VOLL of \$20,000/MWh.

# Consumer Bill Impacts – Utility Implementation

## Impact on Typical Residential Bill in 2020 for 3,000 MW of Storage ERCOT-wide



*Notes:* We assume that Oncor installs 1,000 MW out of 3,000 MW of storage deployed on an ERCOT-wide basis, with storage costs and wholesale-market proceeds reflecting the same proportion of installations. Oncor customers realize deferred transmission and distribution investment benefits based on the 1,000 MW installed on Oncor's system. The avoided distribution outage value shown is for a typical residential customer on a feeder with storage. Customers not located on a feeder with storage would not realize these reliability benefits.

# Proposed Regulatory Framework for Texas

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- Targeted distribution-level deployment and operations needed to allow the utility to realize reliability, T&D, and wholesale market benefits
- Utility-based deployment can simultaneously capture these benefits without regulated utilities transacting in competitive wholesale markets
  - Wires companies would auction off wholesale market participation to unregulated entities who would then bid the storage assets into the markets
  - Auction proceeds used to offset regulated storage costs, thereby reducing customer costs
  - Commission would evaluate and approve storage deployment plan only if beneficial from a net customer cost perspective (e.g., based on experience from limited initial deployment)
- Framework allows wires companies to make investments in electricity storage and recover investment costs through regulated rates as long as:
  - A significant fraction of the value of these storage assets is associated with reliability and T&D benefits that are not captured through wholesale market participation
  - The incremental reliability and T&D benefits are expected to exceed net customer costs by a sufficient margin
- Approach solves the barriers created by fragmented value streams that will otherwise lead to under-investment in electric energy storage

# Contact Information

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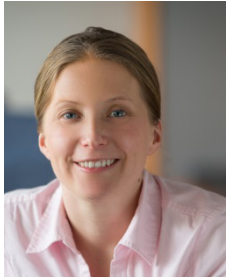
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