INTERSECT 19

The New Energy Ecosystem

Assessment of Grid-Scale Energy Storage Scenarios for the Southeast

Benefits, Costs and Implications

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April 10, 2019

INTERSECT 2019
Atlanta, GA

Research Team and Collaborators

Core Team	GT Department
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External Partners	Organization
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SR SOUTHERN RESEARCH

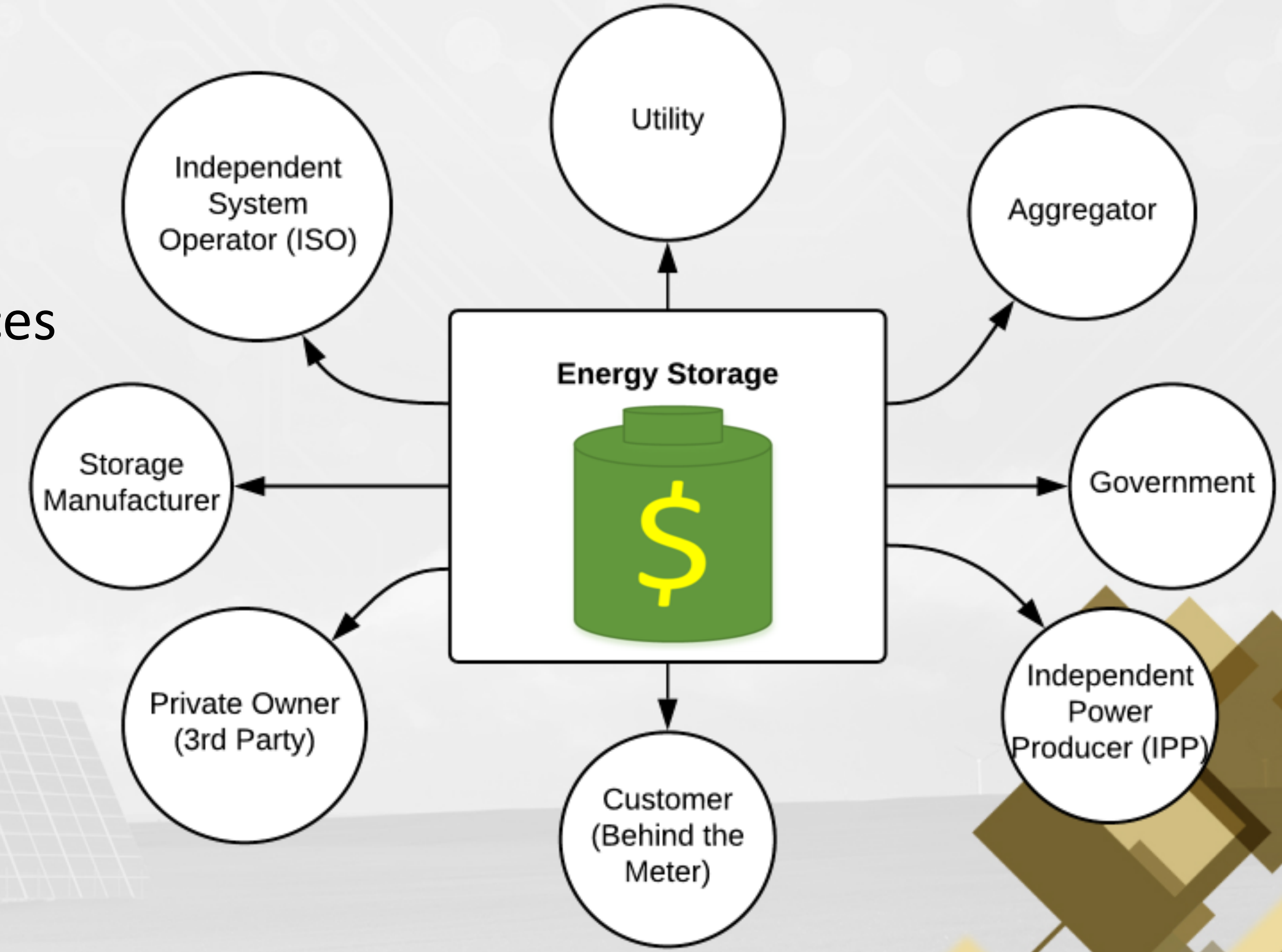
ESA Energy Storage Association

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Goal: Determine the Impact of Grid-Scale Energy Storage in the Southeast.

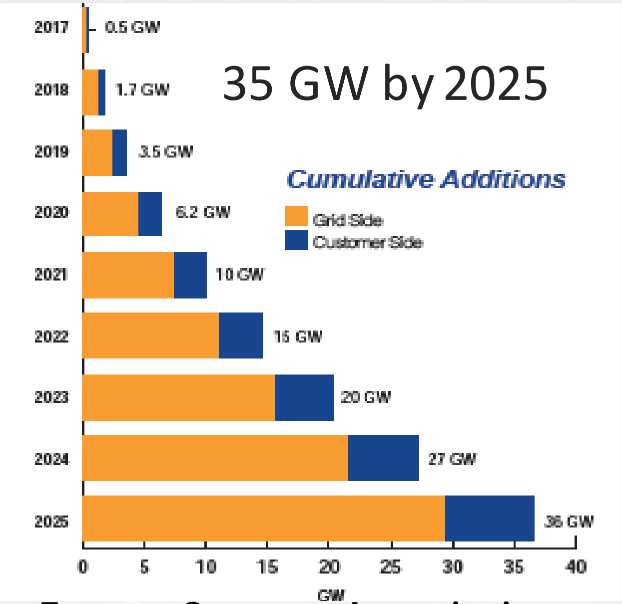
Context:

- Storage is a disruptive technology
- Enables many applications and services
- Benefits multiple stakeholders



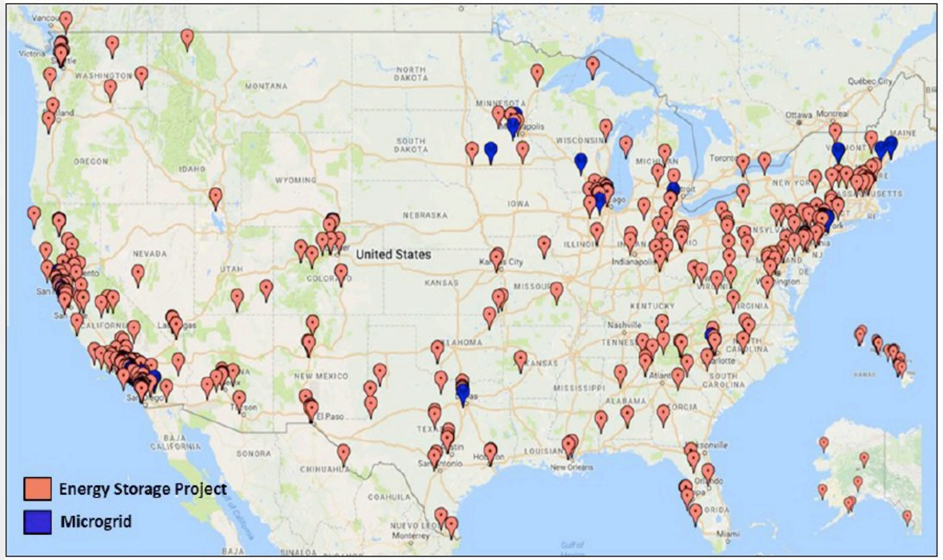
Trends for grid-scale BES

- Deployment growth



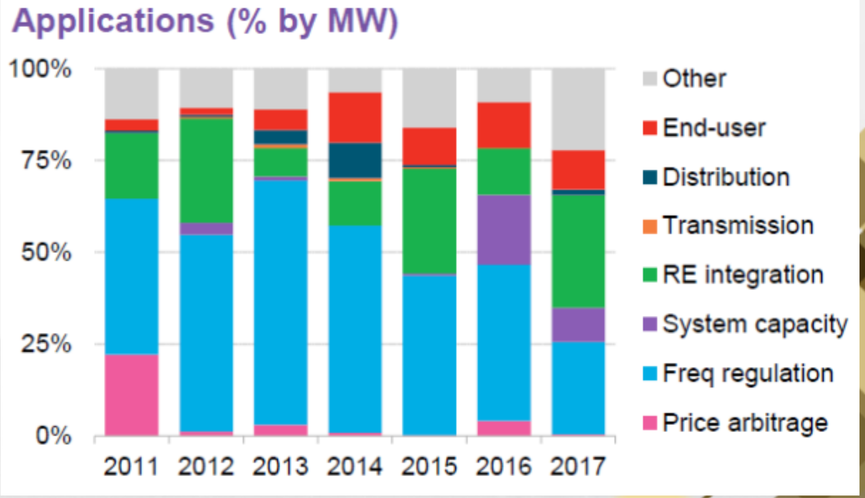
Energy Storage Association

- California & Northeast Lead in US Deployment



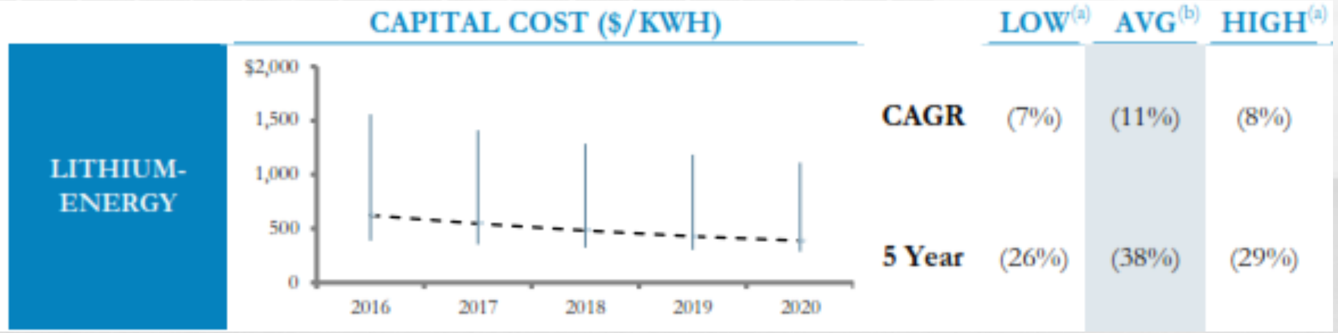
DOE Energy Storage Database

- Renewables & BTM are key use cases



Bloomberg New Energy Finance

- Capital cost decline (~40% 2015-2020)



Lazard Levelized Cost of Storage v2

Challenges

- Energy storage **cost-benefit analysis** is critical and timely.
- Existing planning models do not capture **all the value streams** of energy storage systems.
- Analysis must consider **regional characteristics** and **local energy policies**.
  - Most of the existing analyses are in market regions, e.g. PJM.
  - Southeast region has unique aspects that must be considered.

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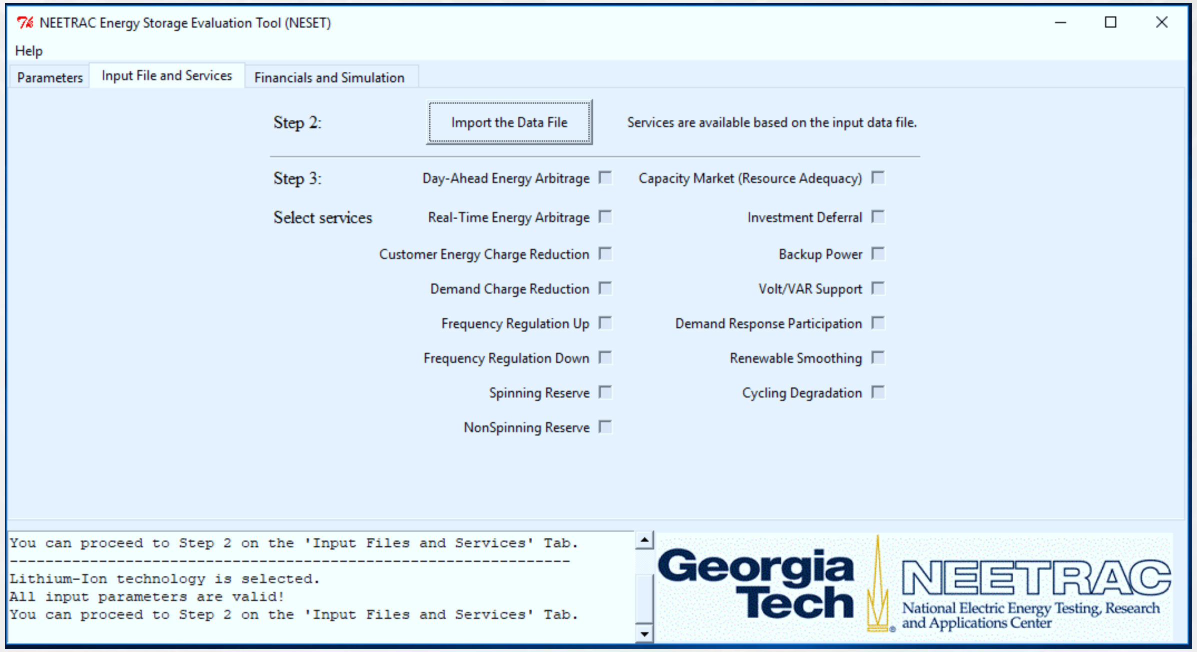
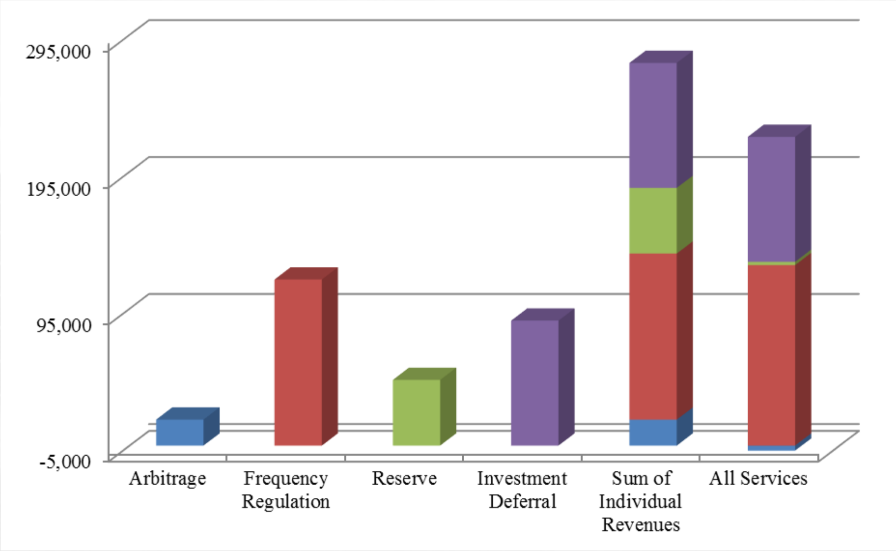
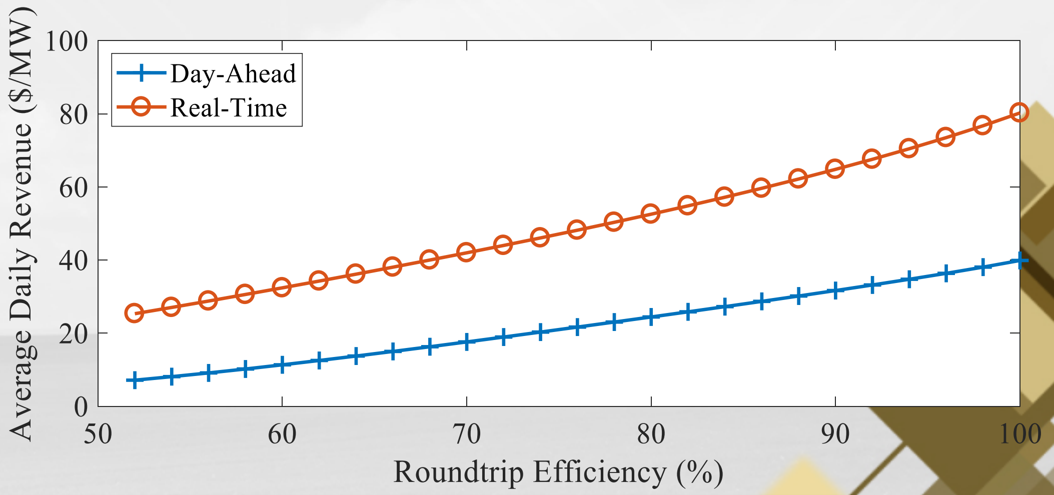
Previous Work

- Identifying more than 20 services
- Service evaluation methodologies, revenue analysis, stacking
- Storage evaluation tool: NESET







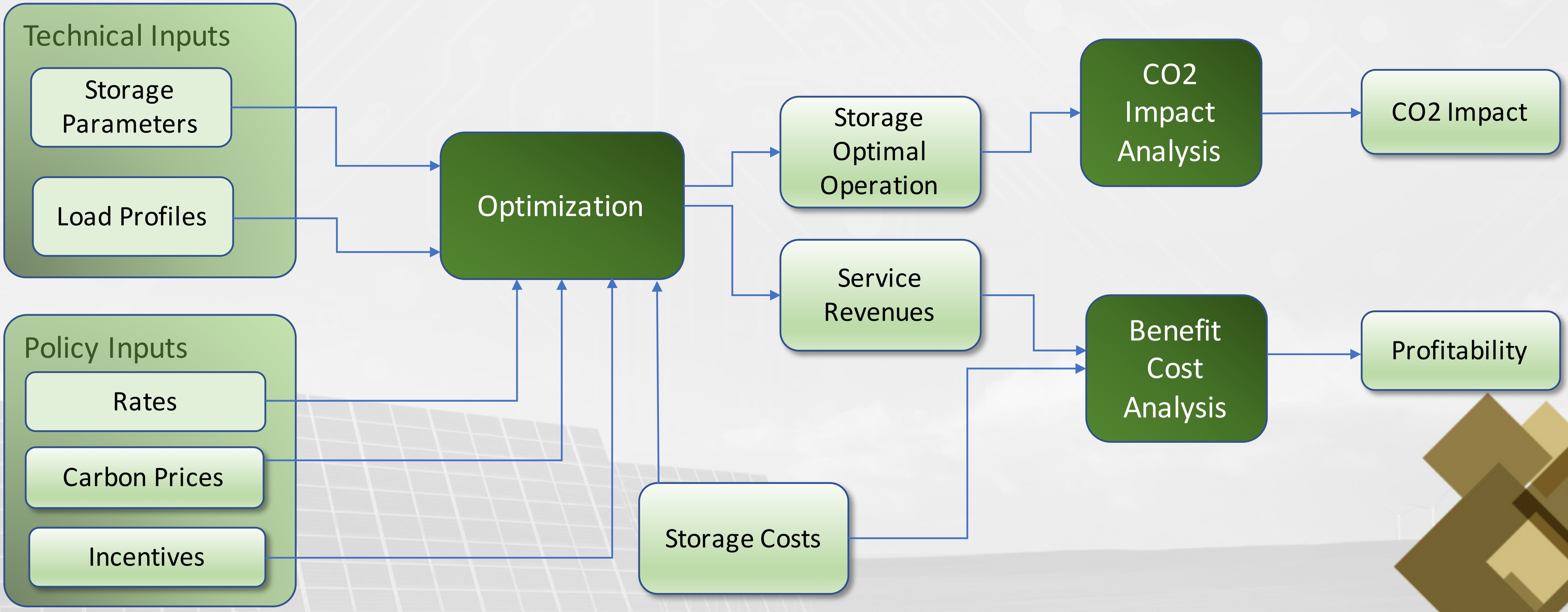
Core Questions

- What are the **key scenarios** for energy storage deployment in the **Southeast**?
- What are the **system-level impacts**, e.g. **economics**, **reliability, resiliency**, **CO_2 emissions**?
- How can advanced **optimization** methods be used to identify **all the benefits** of energy storage?
- How can **energy policies** influence the **value** of energy storage scenarios and their **deployment**?

Key Scenarios

- Scenario #1: Behind-the-meter (BTM) energy storage, owned and operated by the customer
- Scenario #2: Customer-sited and owned energy storage, operated jointly by customer and the utility
- Scenario #3: Utility owned and operated energy storage

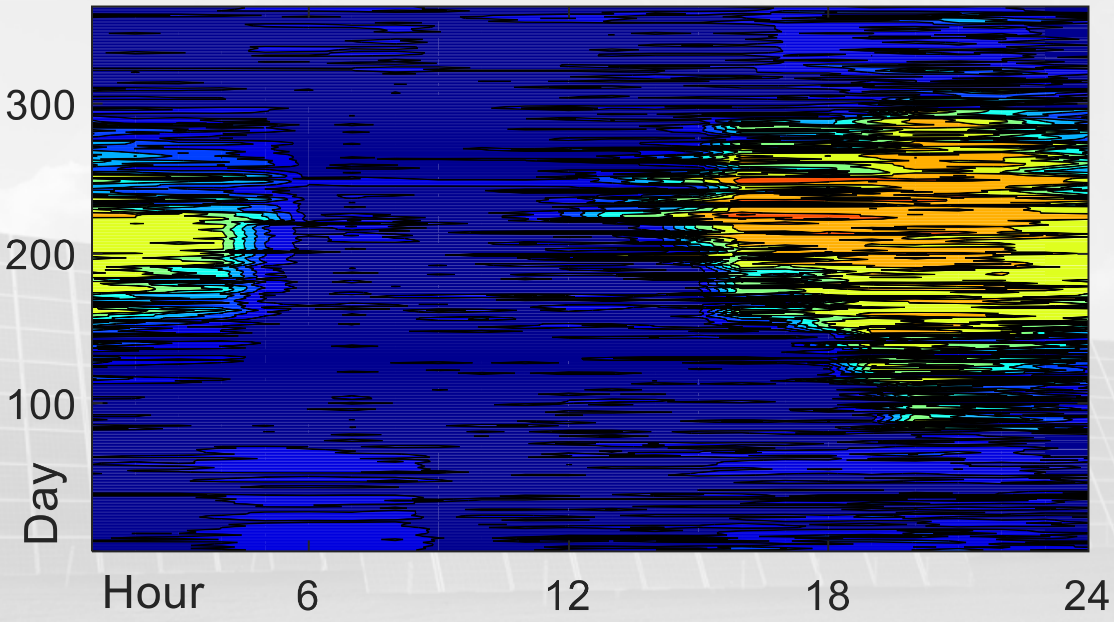
Developed Workflow

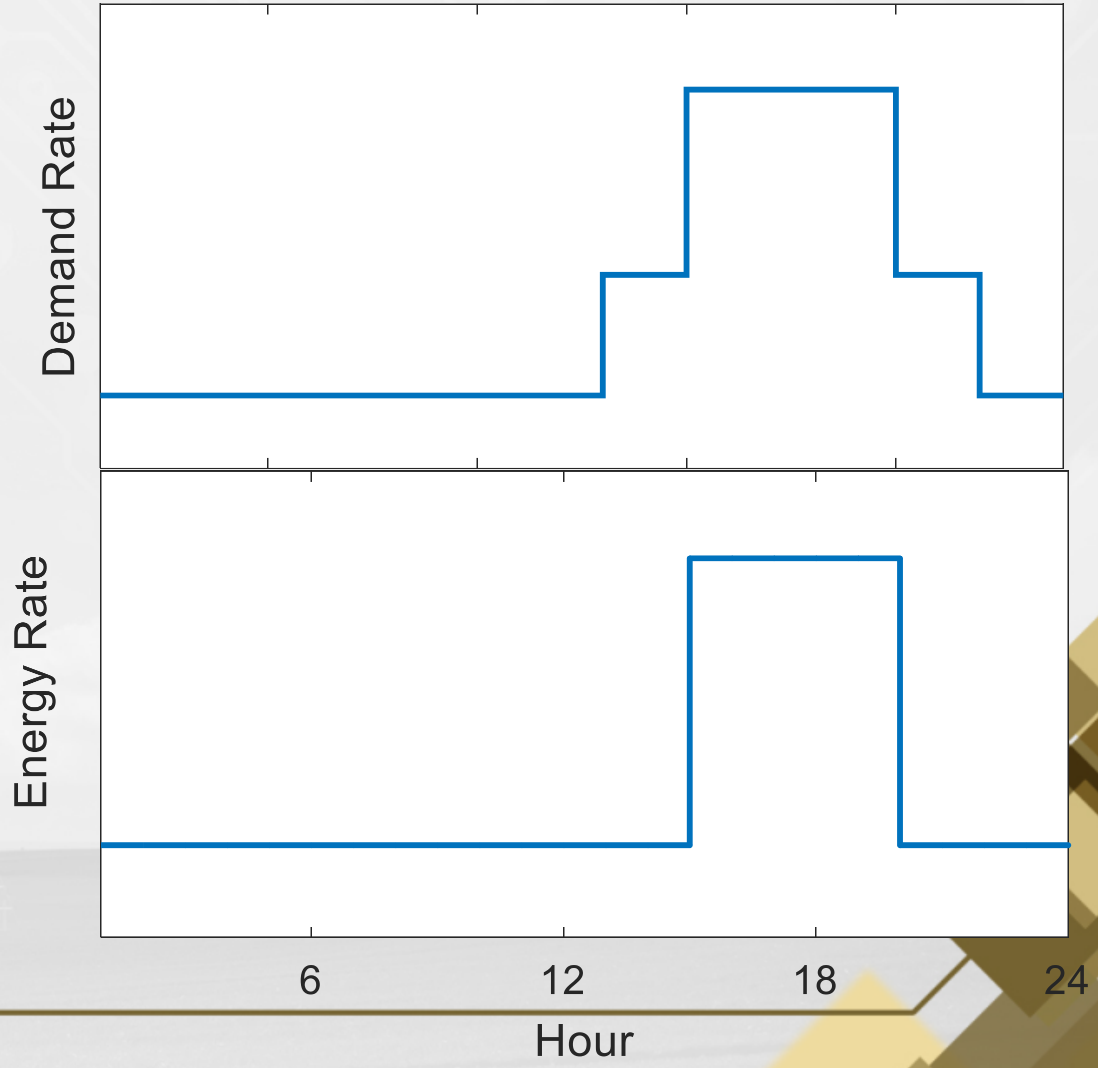


Illustrative Example: Data Preparation

- Scenario 1: BTM Storage
- Objective: Customer Bill Charge Reduction (Energy + Demand)

Annual load profile of a sample customer





Illustrative Example: Problem Formulation

- Scenario 1: BTM Storage
- Objective: Customer Bill Charge Reduction

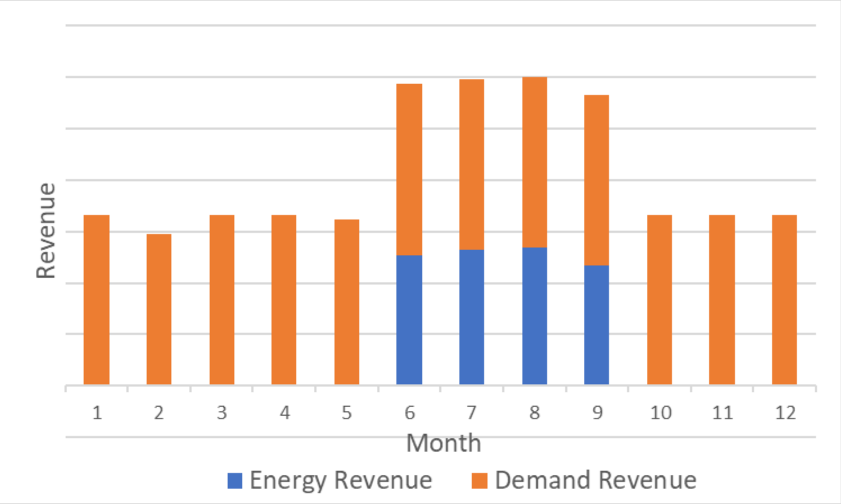
$$Benefit = \underset{P^{net}, P^{\max}}{\text{minimize}} \sum_t \pi_t^{ene} E_t^{net} + \pi^{dem} P^{\max}$$

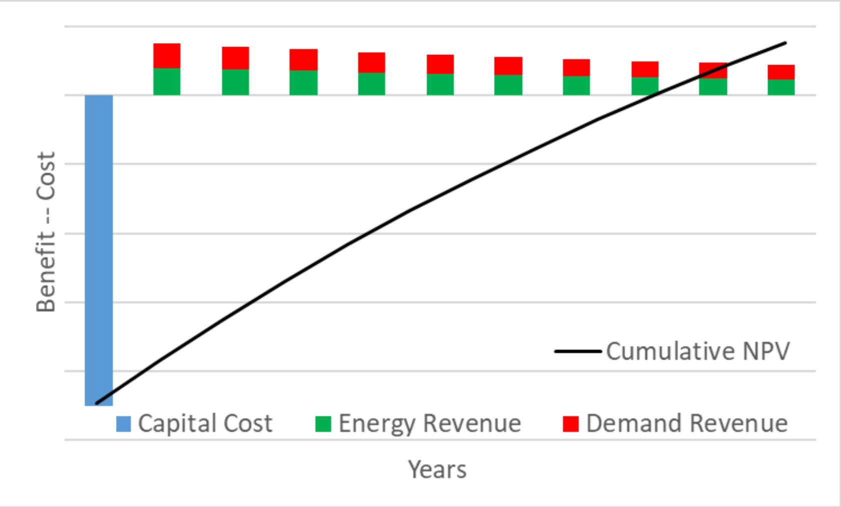
$$Cost = Capital$$

$$NPV(Y = PojectLife) = \sum_{year}^{Y} \frac{Benefit_{year} - Cost_{year}}{(1+r)^{year}}$$

$$Profitable\ if: \ NPV > 0$$

$$Payback\ \ Period = y\ ; NPV(y) = 0$$





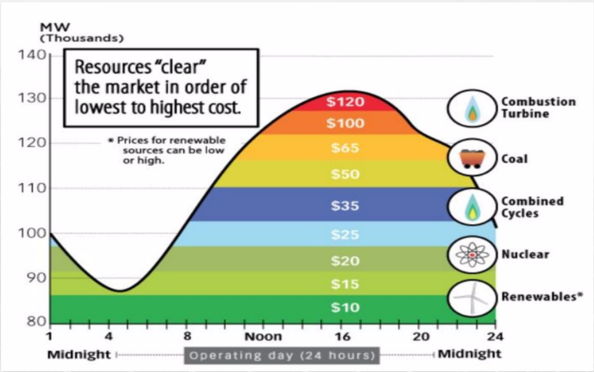
Carbon Pricing and Emissions Implications

- Profitability and CO2 impact will both be considered in the optimization algorithm
- Objective is to quantify potential co-benefits of storage in reducing CO2, and avoid unintended adverse effects

INPUT DATA
Demand
Generation
Customer Rates
Marginal Prices
Fuel/CO2 properties
Others

Data Sources: DOE/EIA, EPA, FERC

Notional Hourly Dispatch



Graphic Source: Northbridge Energy Partners, P. Kelly-Detwiler

Energy Storage Optimization Algorithms

Societal Impacts

- CO2 emissions
- Air Quality
- Reliability
- Resilience

Next Steps

- Finalizing the methodology, assumptions and input data
- Simulating the three energy storage scenarios
- Preparing preliminary and final reports and presentation

Date	Description
04/31/2019	Methodology, assumptions and input data
05/31/2019	Behind-the-Meter ESS simulations
08/31/2019	Customer-Sited and jointly operated ESS simulations
11/30/2019	Utility scale ESS simulations
12/31/2019	Final report and presentation

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Publications

1. S. Vejdan and S. Grijalva, "Maximizing the revenue of energy storage participants in day-ahead and real-time markets," *IEEE Clemson University Power Systems Conference 2018*, Charleston, SC.
2. S. Vejdan and S. Grijalva, "The value of real-time energy arbitrage with energy storage systems," *IEEE PES General Meeting 2018*, Portland, OR.
3. S. Vejdan and S. Grijalva, "The analysis of multiple revenue streams for privately-owned energy storage systems," *IEEE Power and Energy Conference at Illinois 2018*, Urbana, IL.
4. S. Vejdan and S. Grijalva, "The expected revenue of energy storage from energy arbitrage service based on realistic market data statistics," *IEEE Texas Power and Energy Conference 2018*, College Station, TX.
5. J. Deboever, S. Grijalva, "Energy Storage Dispatch under Different Ownership and Control Models," in *IEEE PES General Meeting*, Chicago, IL, July 16-20, 2017.
6. J. Deboever, S. Grijalva, "Optimal Scheduling of Large-Scale Price-Maker Energy Storage", *IEEE Power and Energy Conference at Illinois*, Champaign, IL, Feb18-20, 2016.

Thank You

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