What's Next for Energy Efficiency: Grid Interaction

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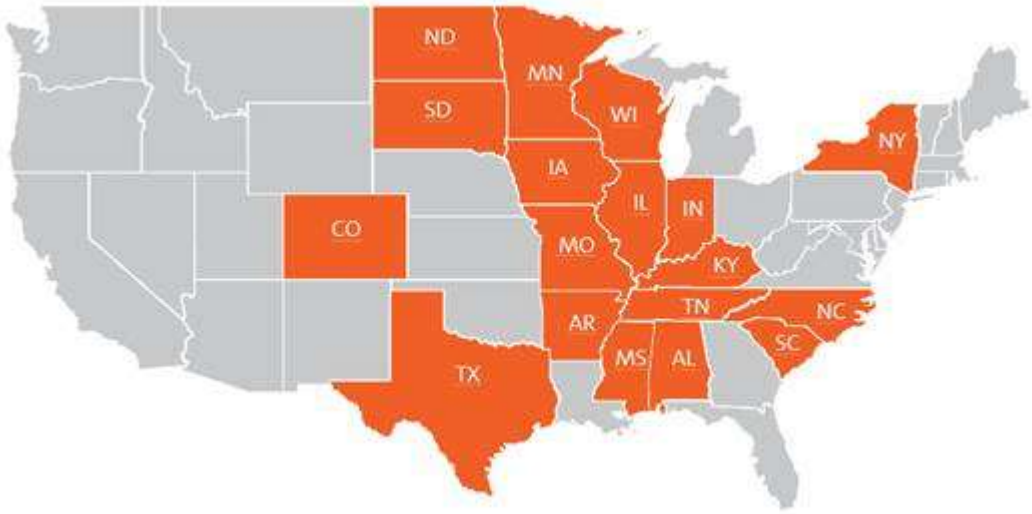
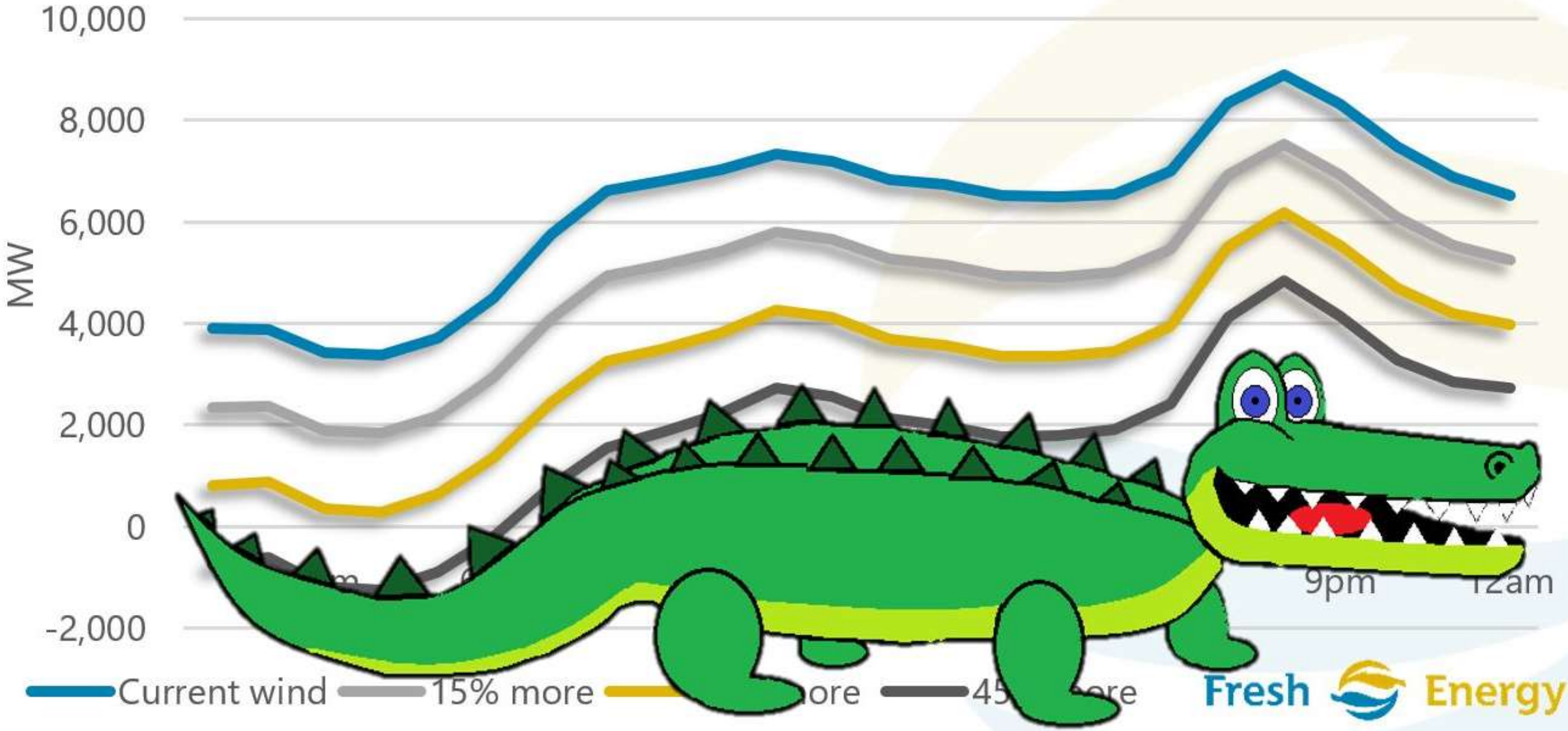
The energy practice of EYP Inc.

- 16 DSM programs in 18 states
- Benchmarking 12,000 buildings
- 700 New Construction or Renovation projects per year
- Average of 30% savings and 70% market penetration

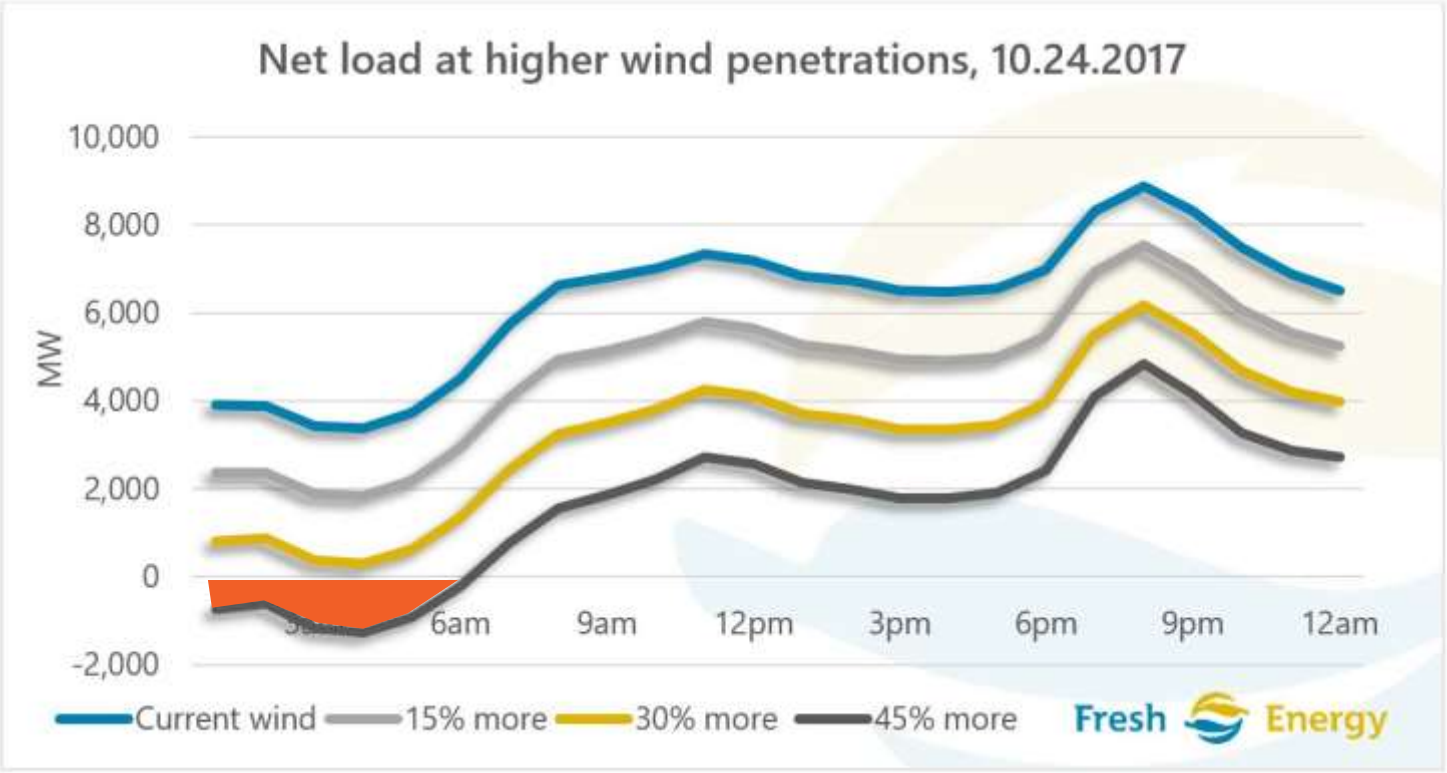


Net load at higher wind penetrations, 10.24.2017



Smiling Gator of the Upper Midwest

- Energy markets will need to adapt to zero/low marginal cost
- Lowest system costs may mean "overbuilding" wind
- Different grids will have different profiles

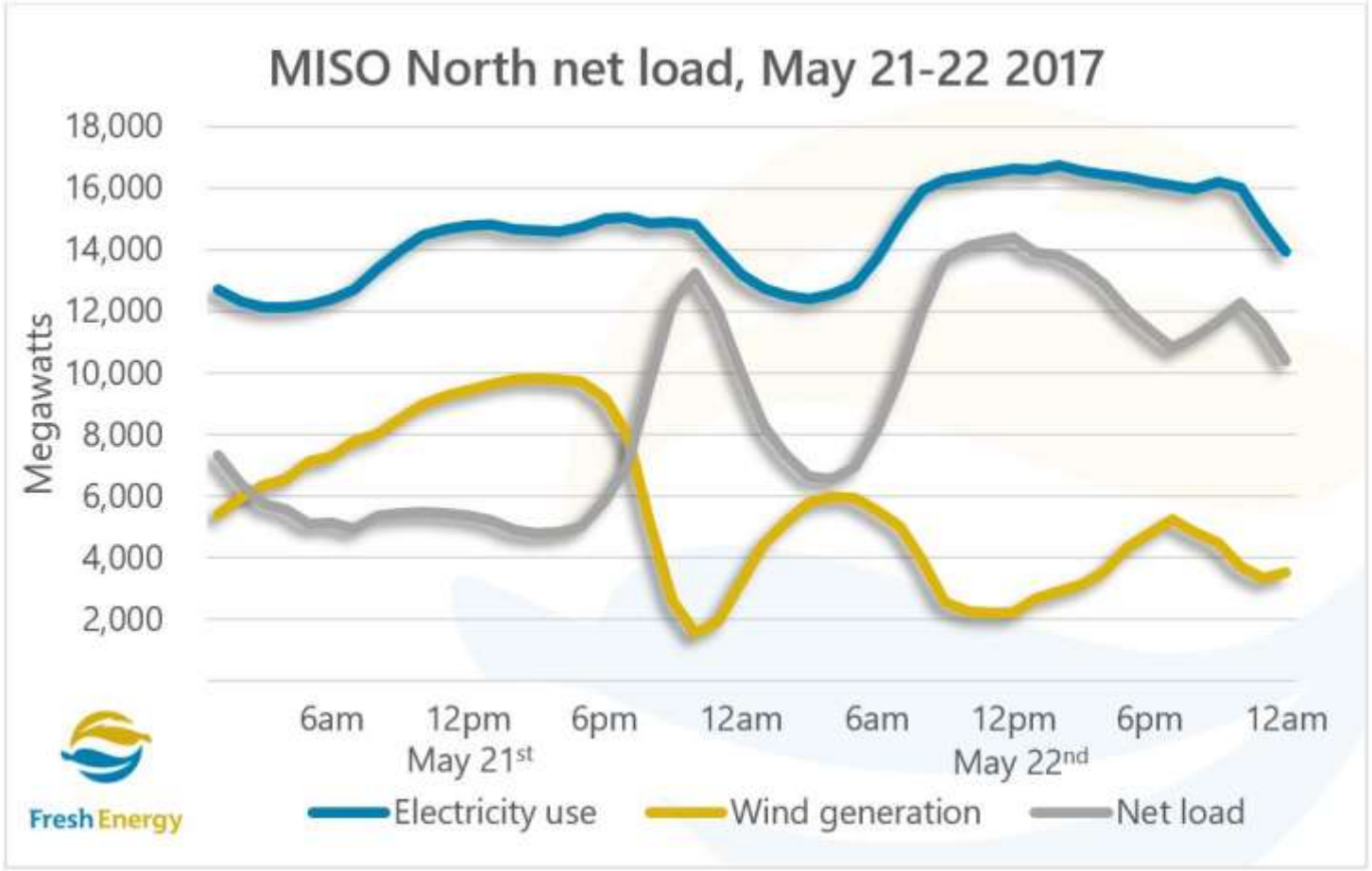


"Nothing is either good nor bad, but ~~thinking~~ costs and environmental impacts makes it so"

Hamlet

Net Load Example

- Spinning reserve is expensive, you are paying for something you might need
- Some building loads may be able to be shifted
- Wind generation shifts may be less consistent than solar



Four Ways for Buildings to Respond to Generation

- **Shape** captures DR that reshapes customer load profiles through price response or on behavioral campaigns—"load-modifying DR"—with advance notice of months to days.
- **Shift** represents DR that encourages the movement of energy consumption from times of high demand to times of day when there is a surplus of renewable generation. Shift could smooth net load ramps associated with daily patterns of solar energy generation.
- **Shed** describes loads that can be curtailed to provide peak capacity and support the system in emergency or contingency events—at the statewide level, in local areas of high load, and on the distribution system, with a range in dispatch advance notice times.
- **Shimmy** describes loads that can be curtailed to provide peak capacity and support the system in emergency or contingency events—at the statewide level, in local areas of high load, and on the distribution system, with a range in dispatch advance notice times.

Source: LBNL's 2025 California Demand Response Potential Study

Shaping Load Profiles

Xcel Energy's Time Value of Energy Efficiency Study

Context

- Since 1993
- Commercial buildings 20,000 sf +
- Program includes
  - Free energy analysis
  - Design team incentive
  - Owner incentive
- 2017 Program size
  - 117 participants
  - 56,895,120 kWh saved
  - 12,328 kW saved
  - 1,124,910 therms saved

Xcel Energy's Time Value of Energy Efficiency Study

Drivers

- Economic value of DSM is changing due to decarbonizing system
  - Loss of fuel savings
  - Less environmental benefits
- Currently at 58% carbon free, going to 75% by 2025
- Wanted to see if DSM could help shape the load

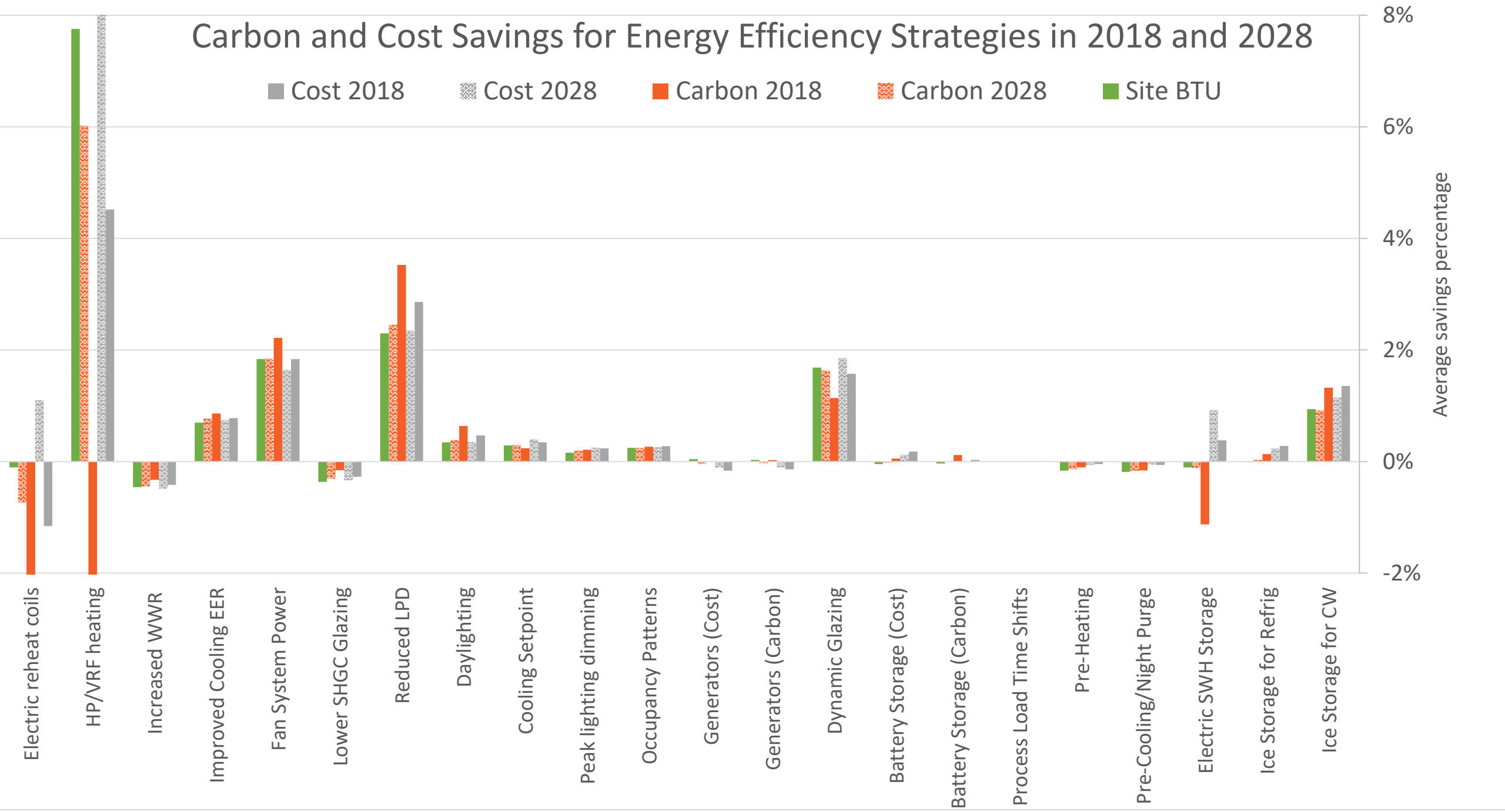
Plan	Spend (Million $)	GWh of Savings	Societal Net Benefits (Million $)	System Net Benefits (Million $)
2010-2012	$84	473.6	$285.4	$262.8
2013-2016	$90	507.3	$251.5	$175.2
2017-2019	$95	433.9	$128.5	$64.1
2020-2022	$95	433.9	$107.5	$40.7

Time Value of Energy Efficiency Methodology

- Analyzed impacts on 10 DSM projects
  - 2018 marginal cost and carbon
  - 2028 marginal cost and carbon
- Analyzed 20 potential strategies

- Ice Storage for Chilled Water
- Ice Storage for Refrigeration
- Electric SWH Storage
- Pre-Cooling/Night Purge
- Pre-Heating
- Process Load Timing Shifts
- Battery Storage (Carbon)
- Battery Storage (Cost)
- Dynamic Glazing
- Standby Generators (Carbon)
- Standby Generators (Cost)
- Occupancy Pattern Shifts

- Lighting 20% dim at peak times
- Cooling Setpoint temperature Change
- Daylighting
- Reduced Overall LPD
- Lower SHGC Glazing
- Fan System Power Reduction
- Improved Cooling Efficiencies
- Increased WWR
- Replace Heating With Heat Pumps/VRF
- Replace Reheat Coils with Electric Resistance



Hourly Profile with Ice Storage

Shaping Consumption to Match Renewable Generation

Closing Thoughts

- Building stock turns over slowly about 2% per year
- Shape and shift may require different mechanical systems, hard to retrofit
- Buildings could potentially take excess generation and reduce load during high net load times
- System peak kW and kWh based programs do not have enough nuance

Thank You

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