Buildings-to-Grid: Critical Issues for Decision Makers

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Presentation overview

- Language: Shared understanding among stakeholders
- Assessing the value of flexible solutions
- Grid challenges and opportunities
- Case studies: Three examples of flexible solutions that Grid-interactive Efficient Buildings can provide

Language: Shared understanding among stakeholders

Energy Efficiency + Demand Response

Many terms are used to describe this concept.

Grid Friendly
Shape, Shed, Shift, Shimmy
Distributed Energy Resources
Dispatchable Efficiency
Grid Citizenship
Demand Flexibility
Systems Efficiency
Integrated Demand Side Management
Grid Interactive
Virtual Power Plant
EE 2.0
Demand Response
Dynamic Efficiency
Smart
Connected

Assessing the value of flexible solutions

May Provide a Wide Range of Utility System Benefits

Examples include:

VALUE CATEGORY	POSSIBLE BENEFITS, AVOIDED COSTS
Distribution	Distribution Capacity
	Distribution O&M
	Increased Hosting Capacity
	Voltage/Power Quality
	Reliability
	Resiliency (avoided cost of interruption)
	Reduced Distribution Losses
Transmission	Transmission Capacity
	Reduced Transmission Losses
Generation	Resource Adequacy
	Renewable Integration (Flexibility)
	Energy
	Ancillary Services

What about consumer benefits?

Lower Bills

- Demand charge reduction — this is the biggest source of value in near term
- Energy charge reduction — lower energy use, including ability to shift load to lower cost periods with time of use or real-time pricing

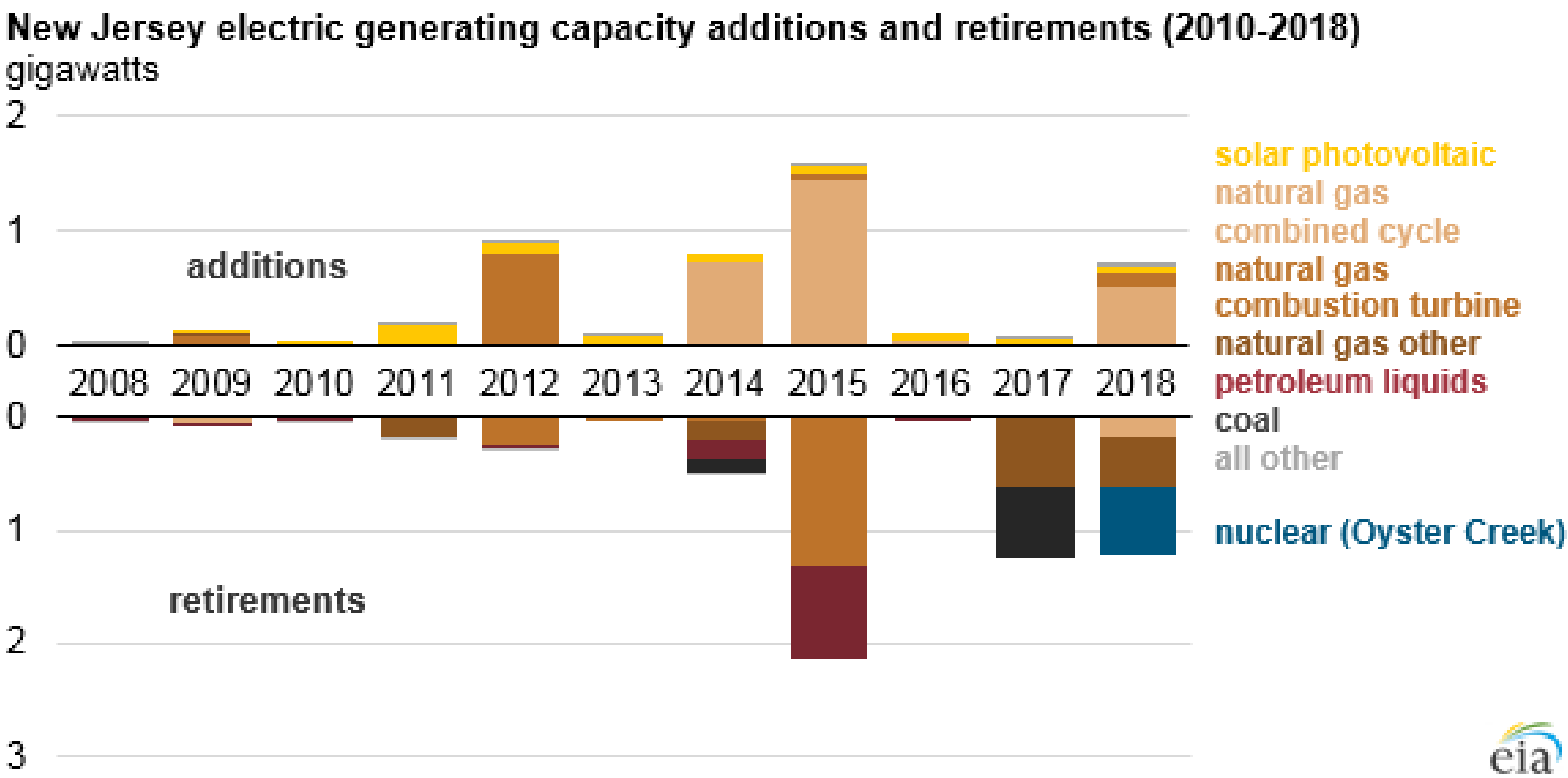
More Income

- Payment for capacity/ demand response — utility rebate or ability to participate in forward capacity market
- Payment for frequency regulation — utility rebate for providing regulation services or ability to participate in ancillary services market

Plus Non-Energy Benefits: Enhanced control, improved occupant comfort, greater reliability, more competitive choices, lower emissions

Grid challenges & opportunities

Grid challenge: Capacity needs

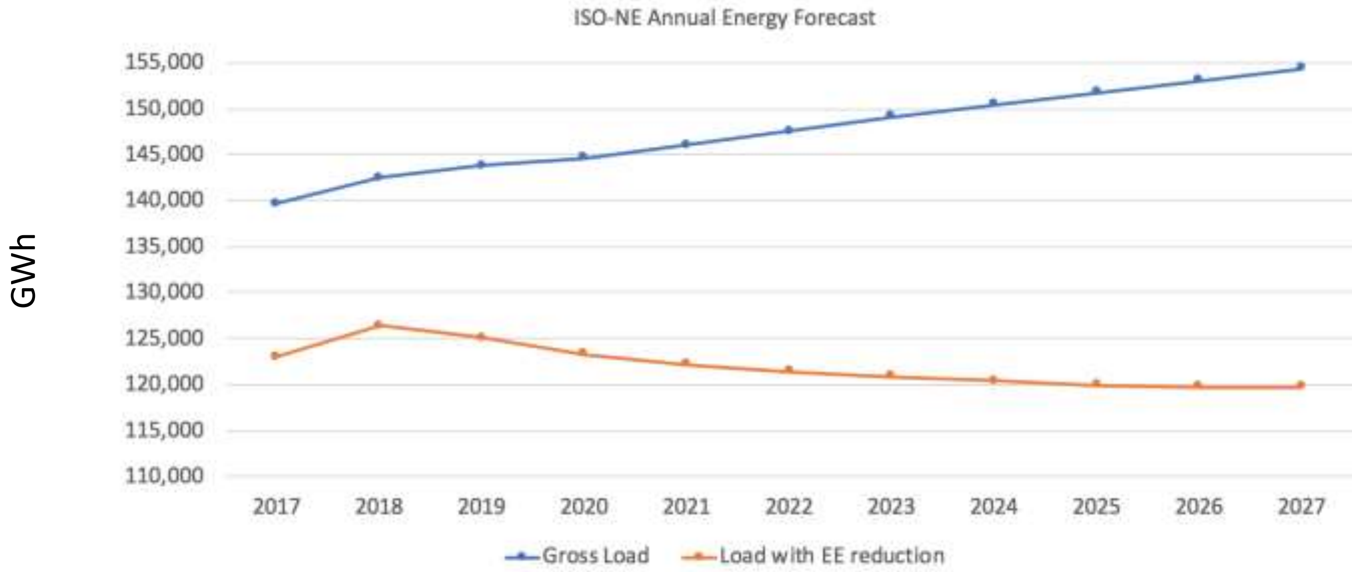


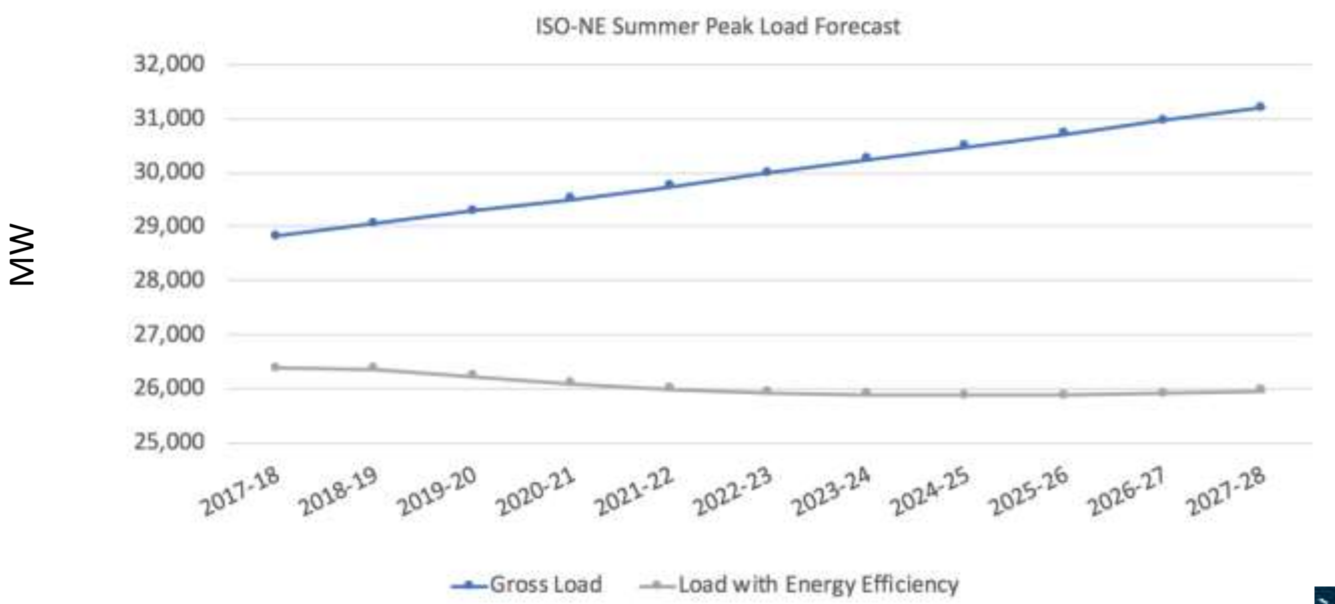
https://www.eia.gov/todayinenergy/detail.php?id=37055

Building grid service: Efficiency

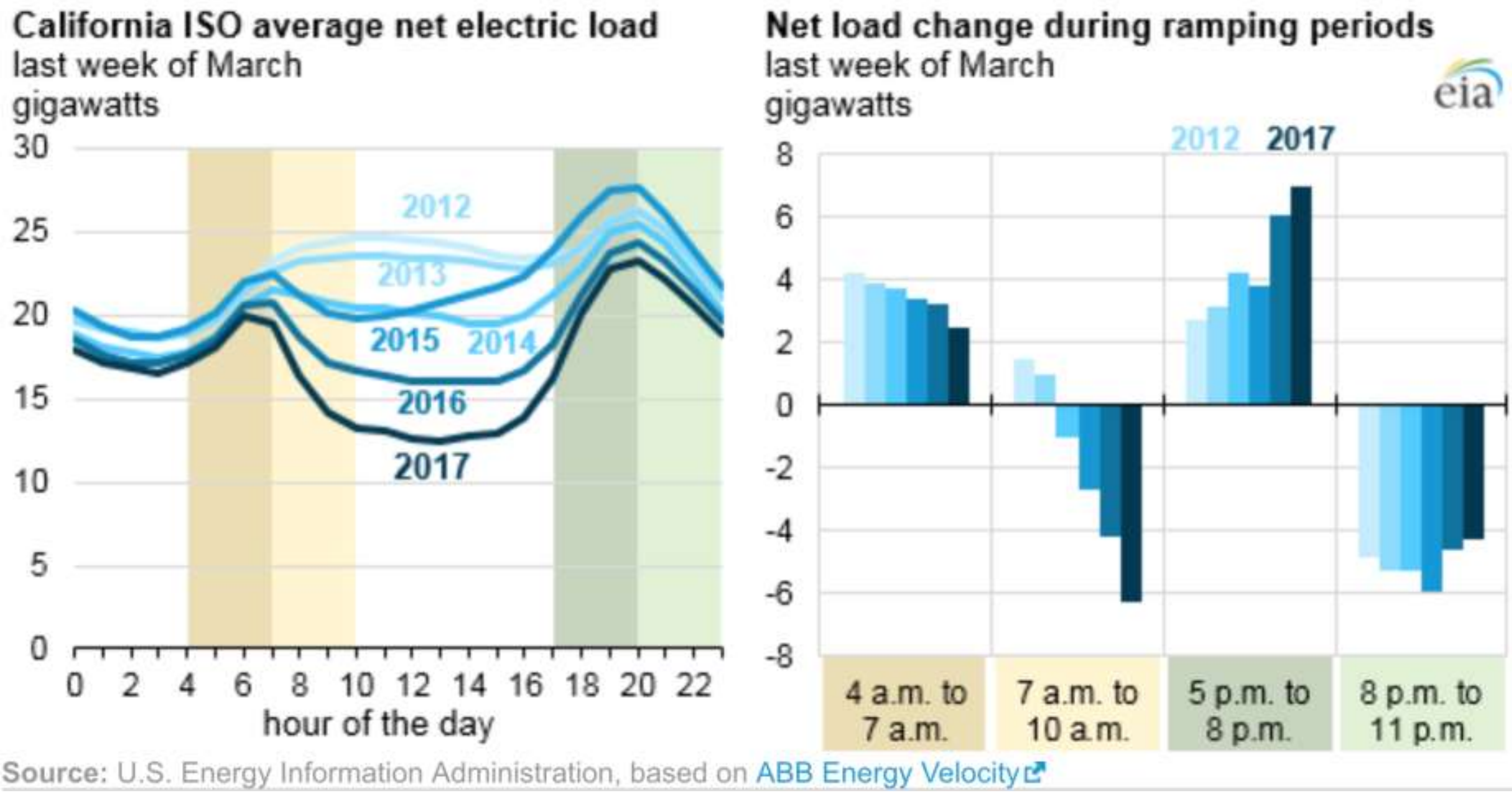
- New England's annual electricity use is expected to change by an average of -0.3% annually over the next decade.
- Regional summer peak demand under normal weather conditions is expected to change at an annual average rate of -0.18%.

Source: Berkeley Lab analysis based on [2018 ISO-NE CELT report]





Grid Challenge: Variable energy generation (1)



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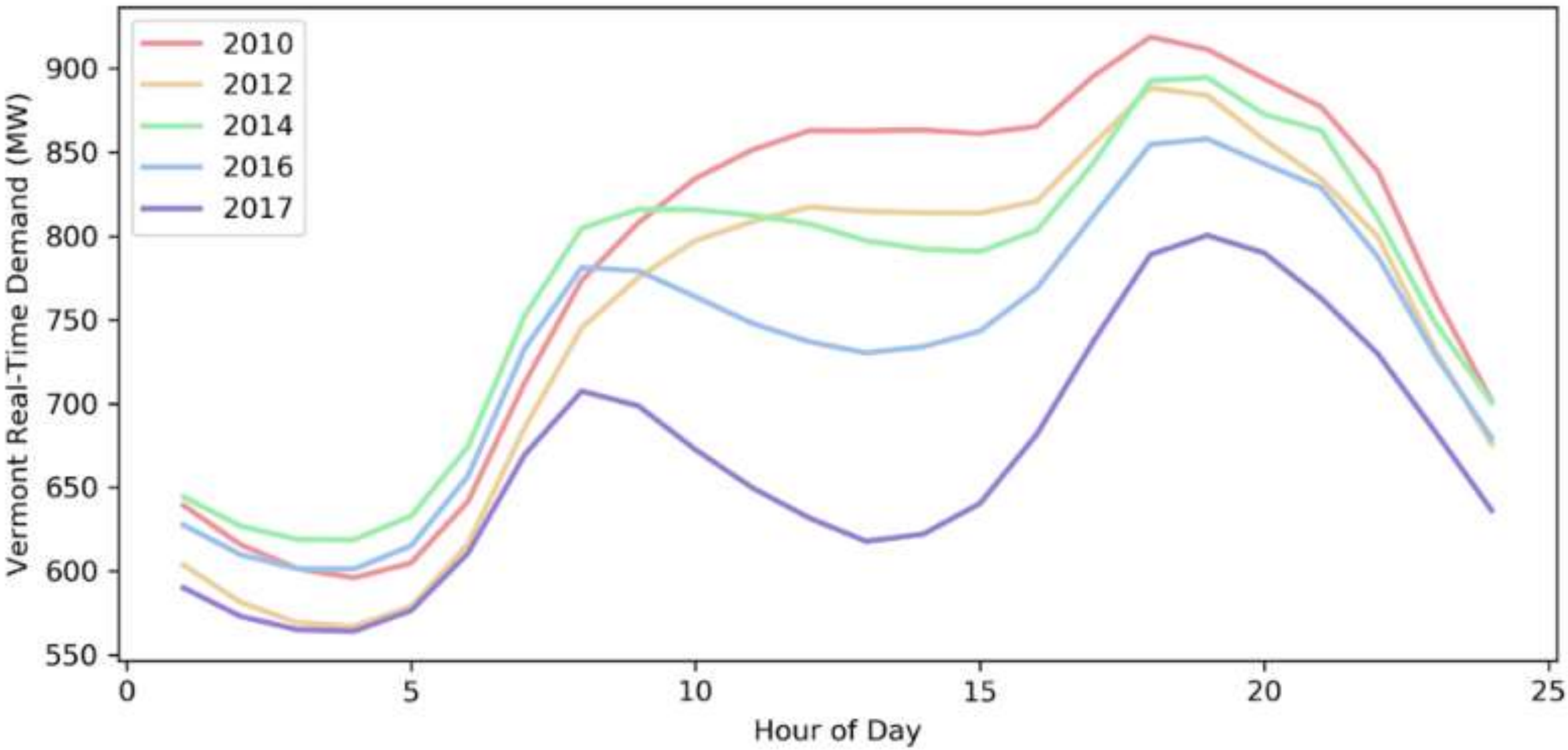
Grid Challenge: Variable energy generation (2)

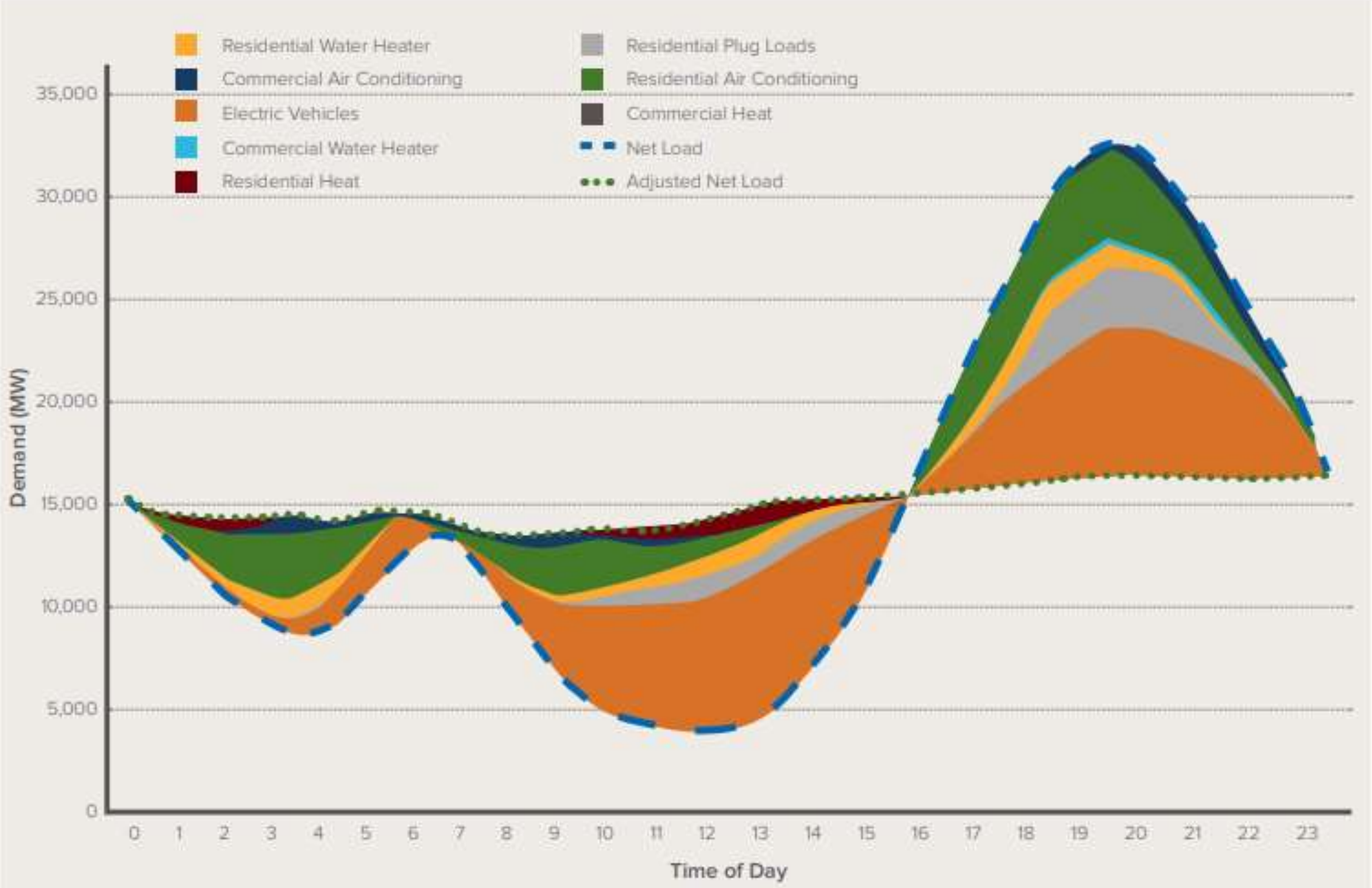
Appearance of duck curve in Vermont: 2010-2017



https://aceee.org/files/proceedings/2018/node_modules/pdfjs-dist-viewer-min/build/minified/web/viewer.html?file=../../../../../assets/attachments/0194_0286_000379.pdf#search=%22vermont%22

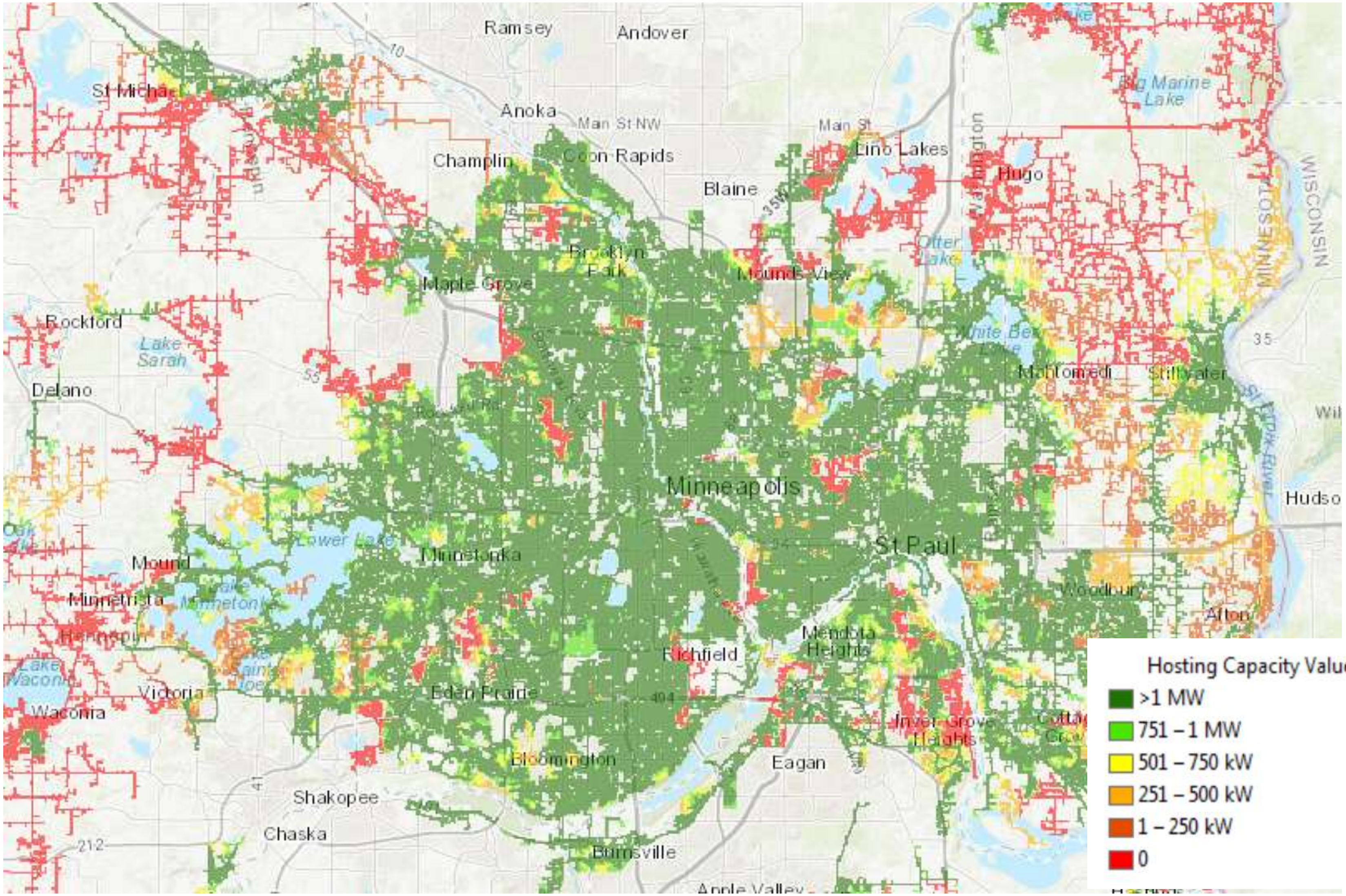
Building grid service: Demand flexibility

Texas 2050 – Net load and changes from demand flexibility for an average day



https://www.rmi.org/wp-content/uploads/2018/02/Insight_Brief_Demand_Flexibility_2018.pdf

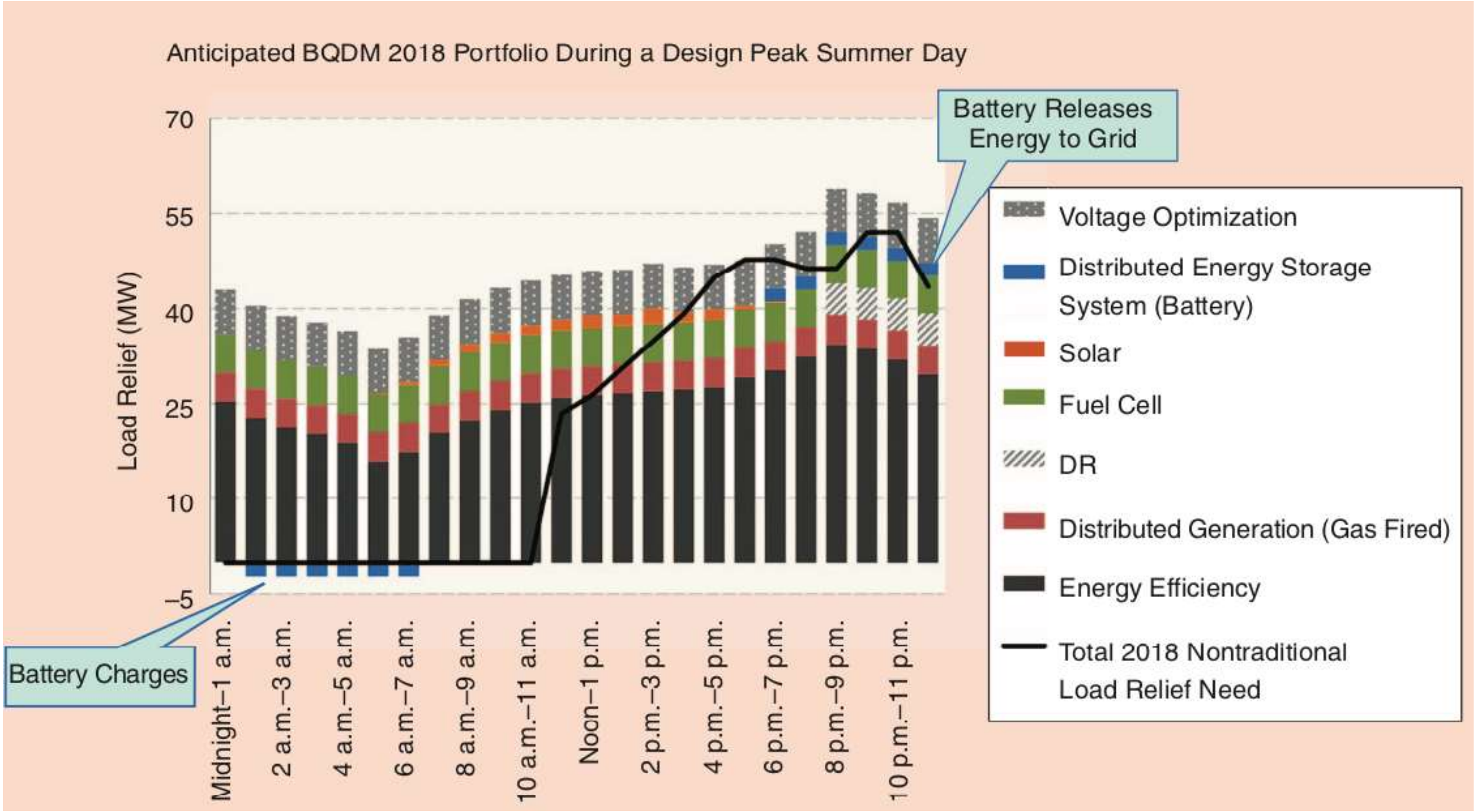
Grid challenge: Distribution system constraints



https://www.xcelenergy.com/working_with_us/how_to_interconnect/hosting_capacity_map

Building grid service: Non-wires alternatives

ConEd's Brooklyn-Queens Demand Management NWA project relies heavily on energy efficiency to provide load relief, together with demand response and other DERs



https://ieeexplore.ieee.org/document/7866936?reload=true

Case studies

Case studies of flexible solutions for buildings

- Case Study #1: PacifiCorp/Rocky Mountain Power
  - Challenge: Least-cost capacity and energy procurement by investor-owned utility
  - Solution: Optimize EE/DR in resource mix
  - Solution: EE/DR to reduce load
- Case Study #2: Consumers Energy
  - Challenge: Distribution system constraint
  - Solution: EE/DR non-wires alternatives
- Case Study #3: PJM
  - Challenge: Least-cost capacity and energy procurement by regional transmission operator
  - Solution: Allow EE/DR to participate in market

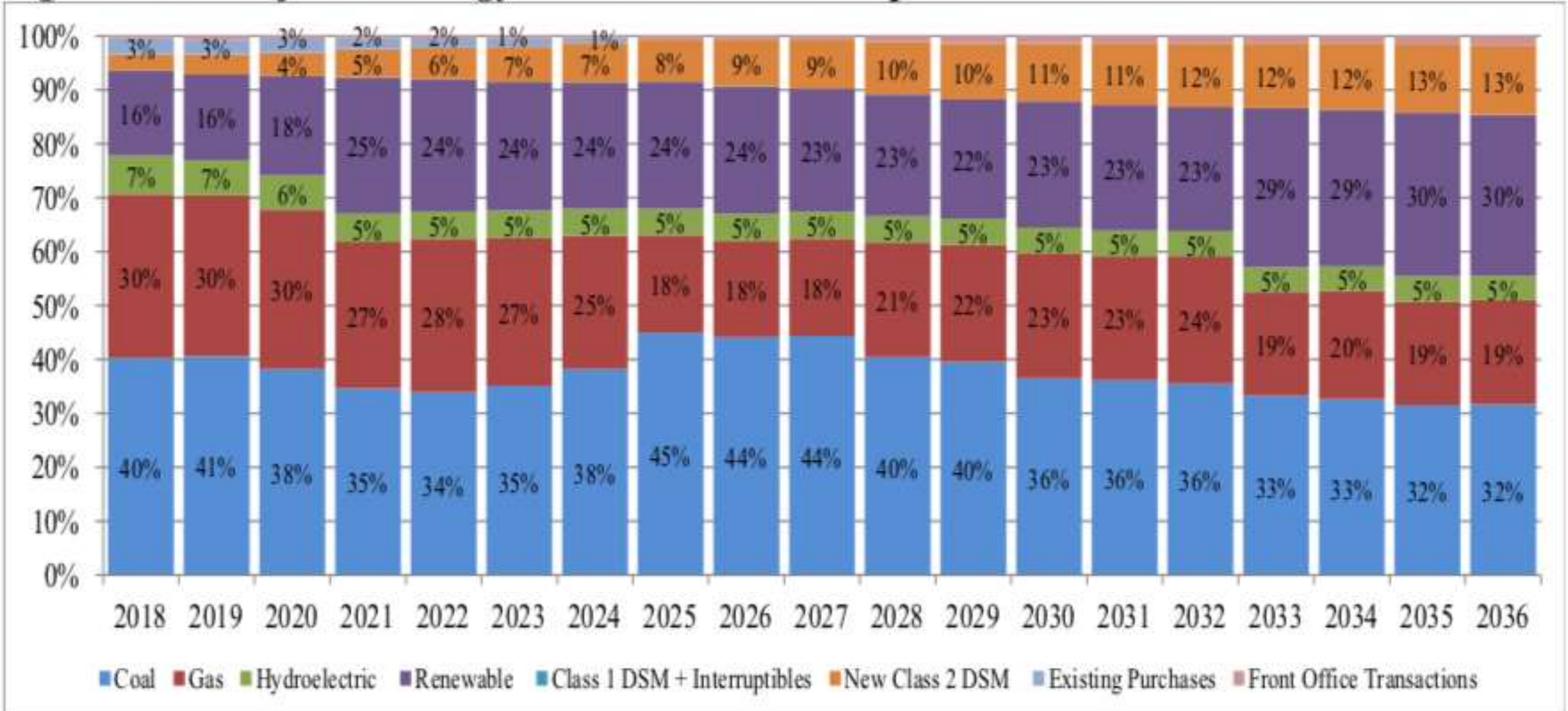
Case Study #1: PacifiCorp

Challenge: Least-cost Capacity and Energy Procurement

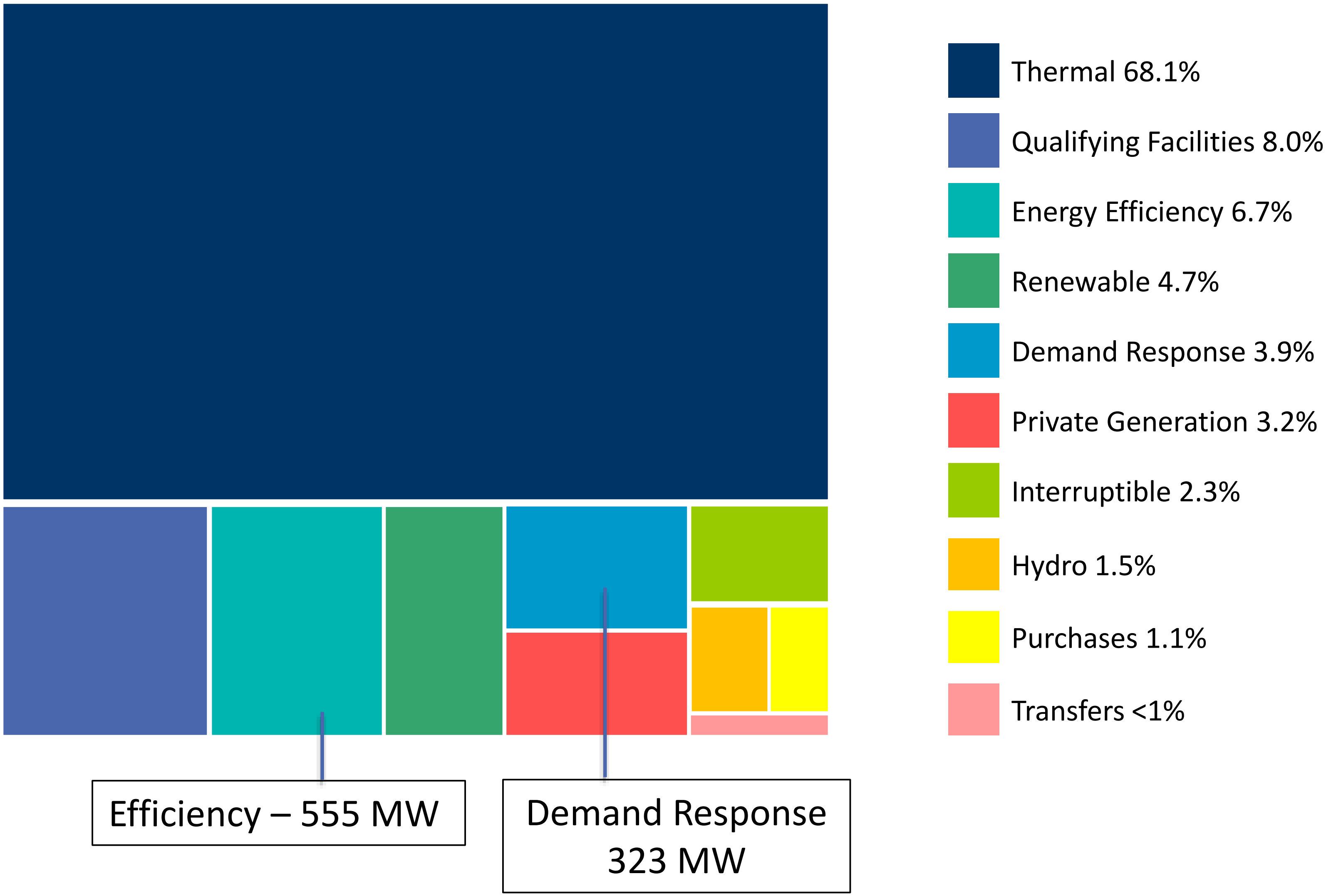
- PacifiCorp is an investor-owned utility that operates in six states (UT, OR, WY, WA, ID, CA).
- PacifiCorp conducts integrated resource planning (IRP) to determine how to meet its forecasted electricity system energy and capacity needs at the lowest cost.
- Energy efficiency is modeled as a resource through the use of efficiency supply curves which are inputs to the capacity expansion model, with all other resources.
- The utility modeled supply curves for nine types of demand response in its 2017 IRP update.

PacifiCorp 2017 IRP Update: Projected Energy Mix

Figure 8.3 – Projected Energy Mix with 2017 IRP Update Preferred Portfolio Resources



Rocky Mountain Power (UT, WY, ID) Summer 2027 Capacity Mix

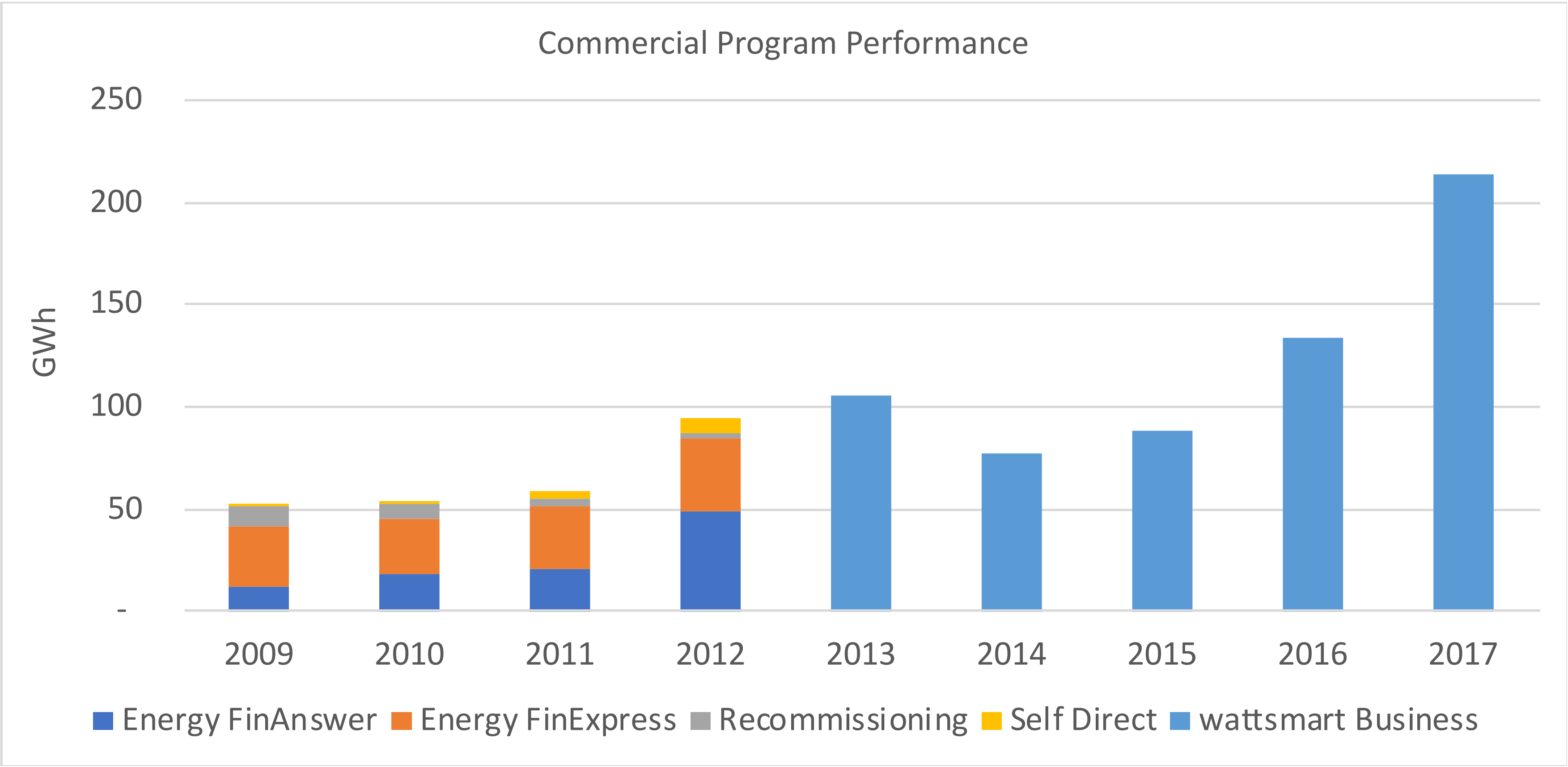


Rocky Mountain Power (UT, WY, ID) Winter 2027 Capacity Mix

Efficiency – 363 MW

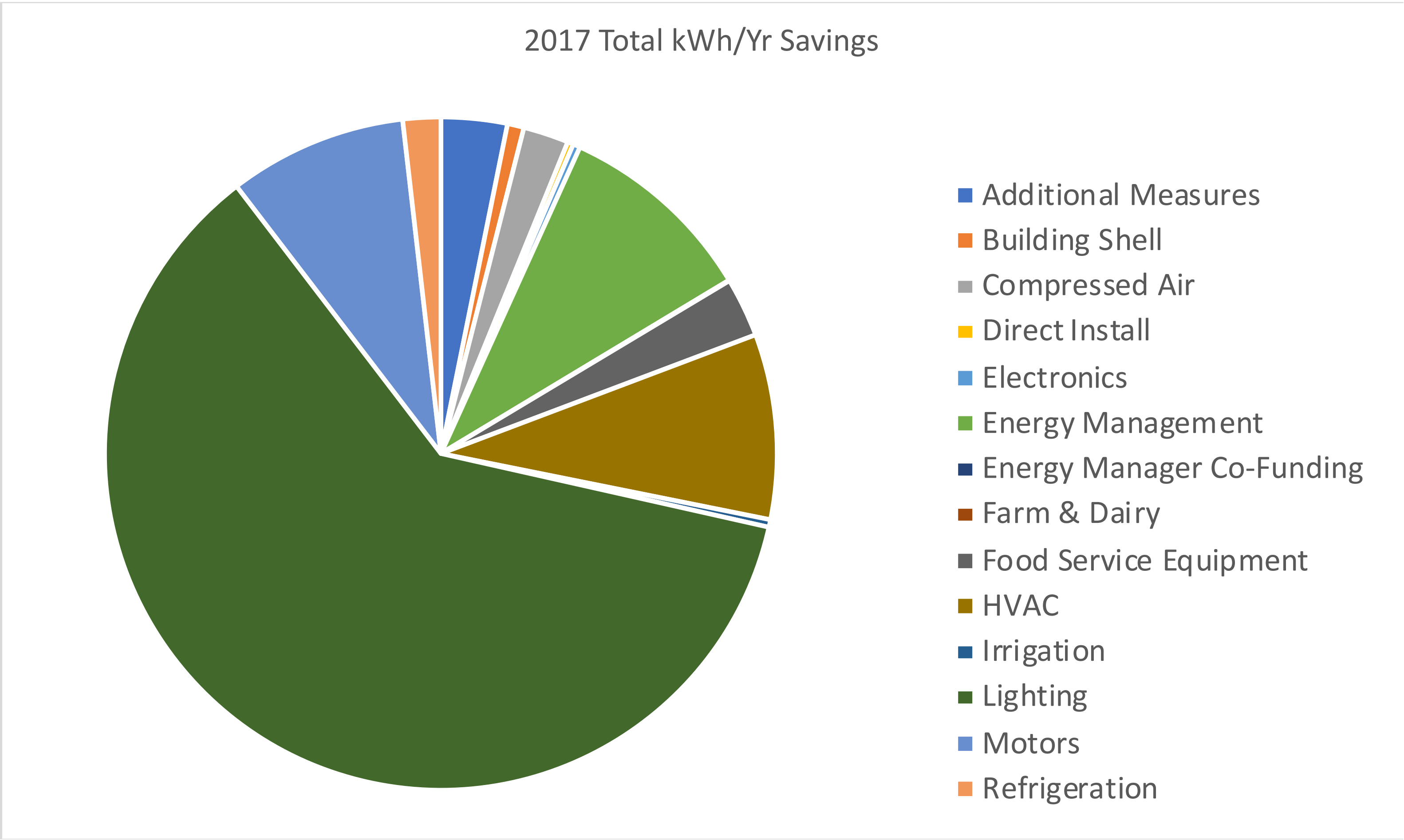
Demand Response
0 MW

Utah commercial energy efficiency programs (1)



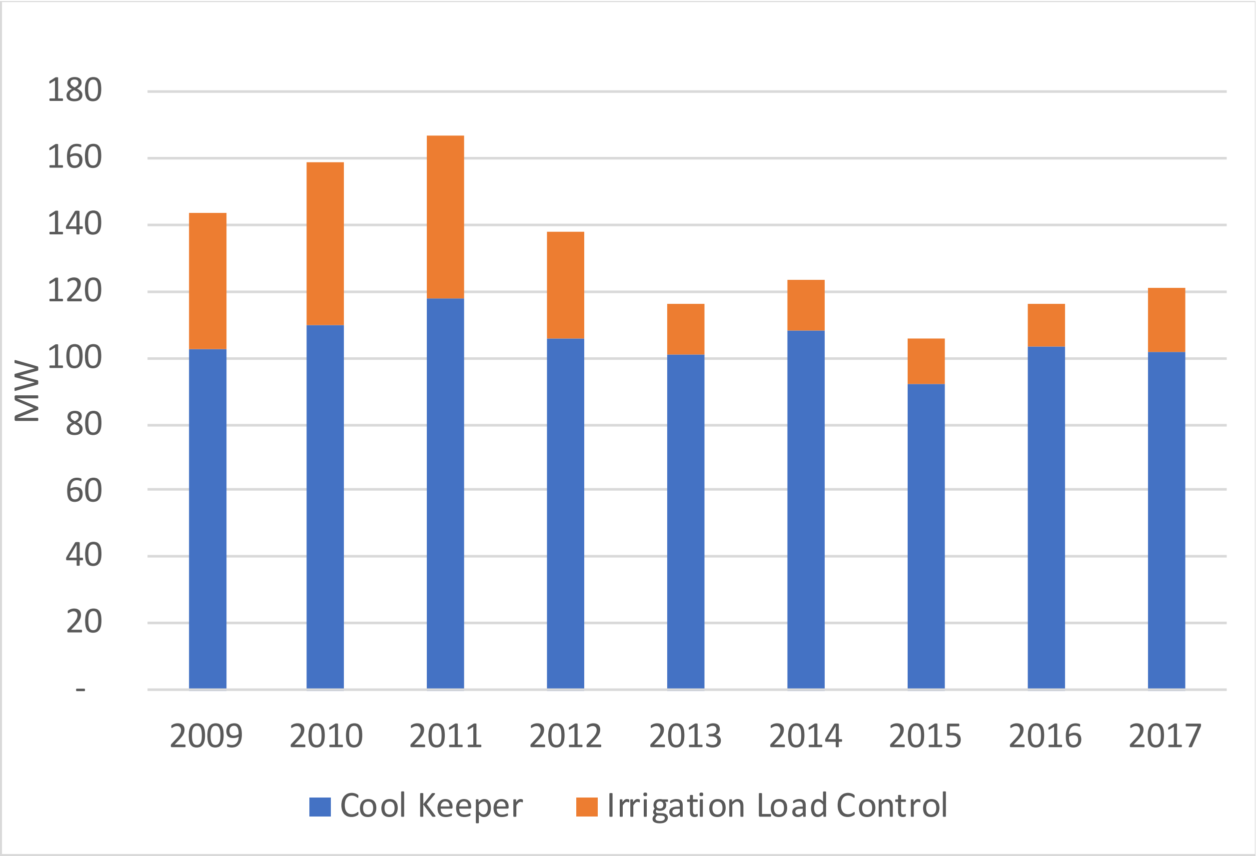
Utah commercial energy efficiency programs (2)

2017 commercial energy efficiency savings by measure category



See "Additional Slides" for programs for residential customers

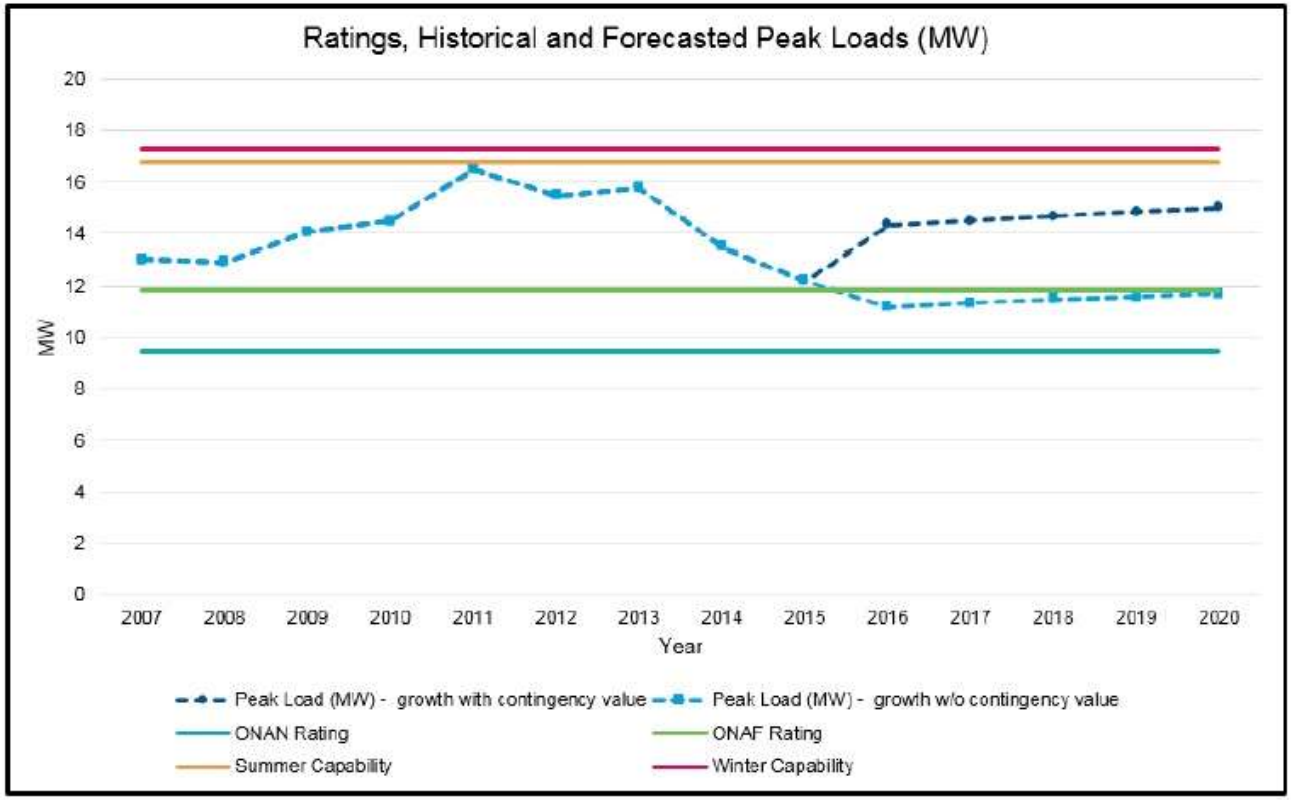
Utah demand response programs



Program	Description
Cool Keeper	Residential A/C two-way direct load control program that cycles compressor on and off for periods in each hour. Administered by GoodCents and Eaton.
Irrigation Load Control	12 pm – 8 pm M-F, two-way dispatchable load control system administered by EnerNoc. Pay-for-performance structure with limited number of opt-outs of events.

Case Study #2: Consumers Energy (MI) Challenge: Substation Capacity Constraint

- Screening criteria for NWA pilot
  - Distribution system upgrade driven by load growth
  - Deferrable cost of at least $1 million
  - System need at least 2 to 3 years out



Swartz Creek Substation Load

Source: Mark Luoma and Steve Fine, Consumers Energy, "Non-Wires Alternatives Lessons and Insights from the Front Lines," presentation for Peak Load Management Association

Energy Savers Club for Targeted Load Relief

- Swartz Creek substation transformer peak loadings: 92%, 94%, 80%, 79%, and 85%, respectively from 2012 through 2016
  - Need for capacity upgrade was not immediate
  - Allowed time to test NWAs
- Energy Savers Club pilot program to reduce energy load on substation
  - Tests role that intentional targeting of EE and DR programs to specific capacity-constrained geographies can play in managing load and deferring capacity-related investments
  - Investigates EE and DR as potential lower-cost solutions
  - Relies heavily on existing EE and DR programs
- Uniquely branded marketing campaign within target area (suburban/rural) to connect customers to existing programs
  - Energy efficiency – Marketing EE programs to commercial and industrial customers
  - Demand response - Marketing two types of time-varying rates and an AC cycling program to residential customers
- Started discussions on the possibility of piloting in another location in 2019

Sources: *Consumers Energy's Electric Distribution Infrastructure Investment Plan (2018-22)*, March 1, 2018; personal communication with Mark Luoma, Consumers Energy, Oct. 15, 2018

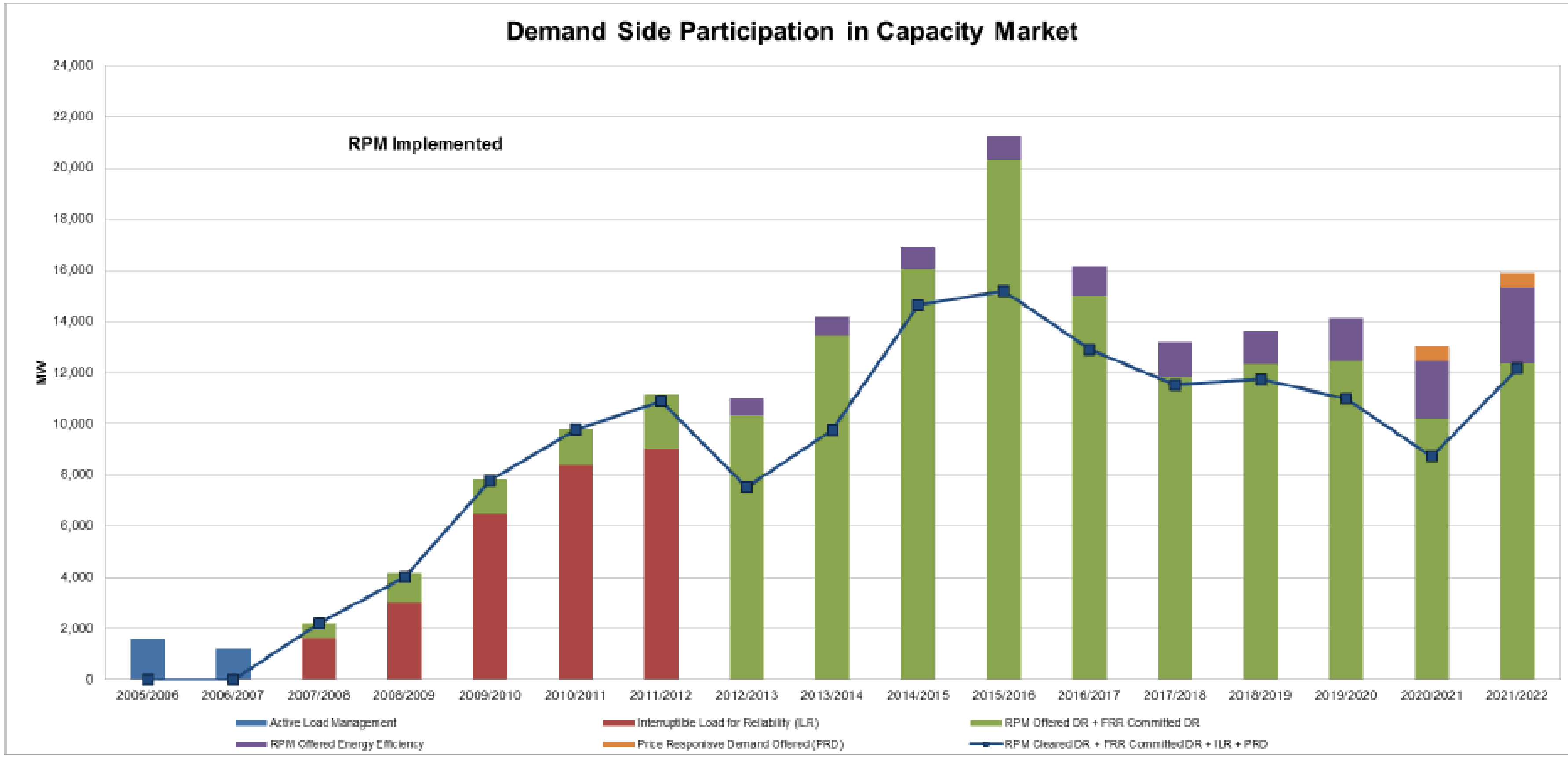
Case Study #3: PJM

Challenge: Least-cost Capacity and Energy Procurement

- Aggregators, utilities and large customers are the direct market participants.
- Performance in the capacity market is measured by amount of savings in peak load hours (summer afternoons).
- Penalties are assessed for any lack of performance compared with amount of savings that was promised to the market.
- Market participants can trade out of, or increase obligations, in subsequent Incremental Auctions that occur closer to the delivery year. Prices are almost always lower than Base Residual Auction (BRA) price.
- In PJM, energy efficiency measures can only participate for 4 years from date of installation. This treatment may undervalue investment in efficiency.

PJM slides by Doug Hurley, Synapse Energy Economics, Inc., for Berkeley Lab

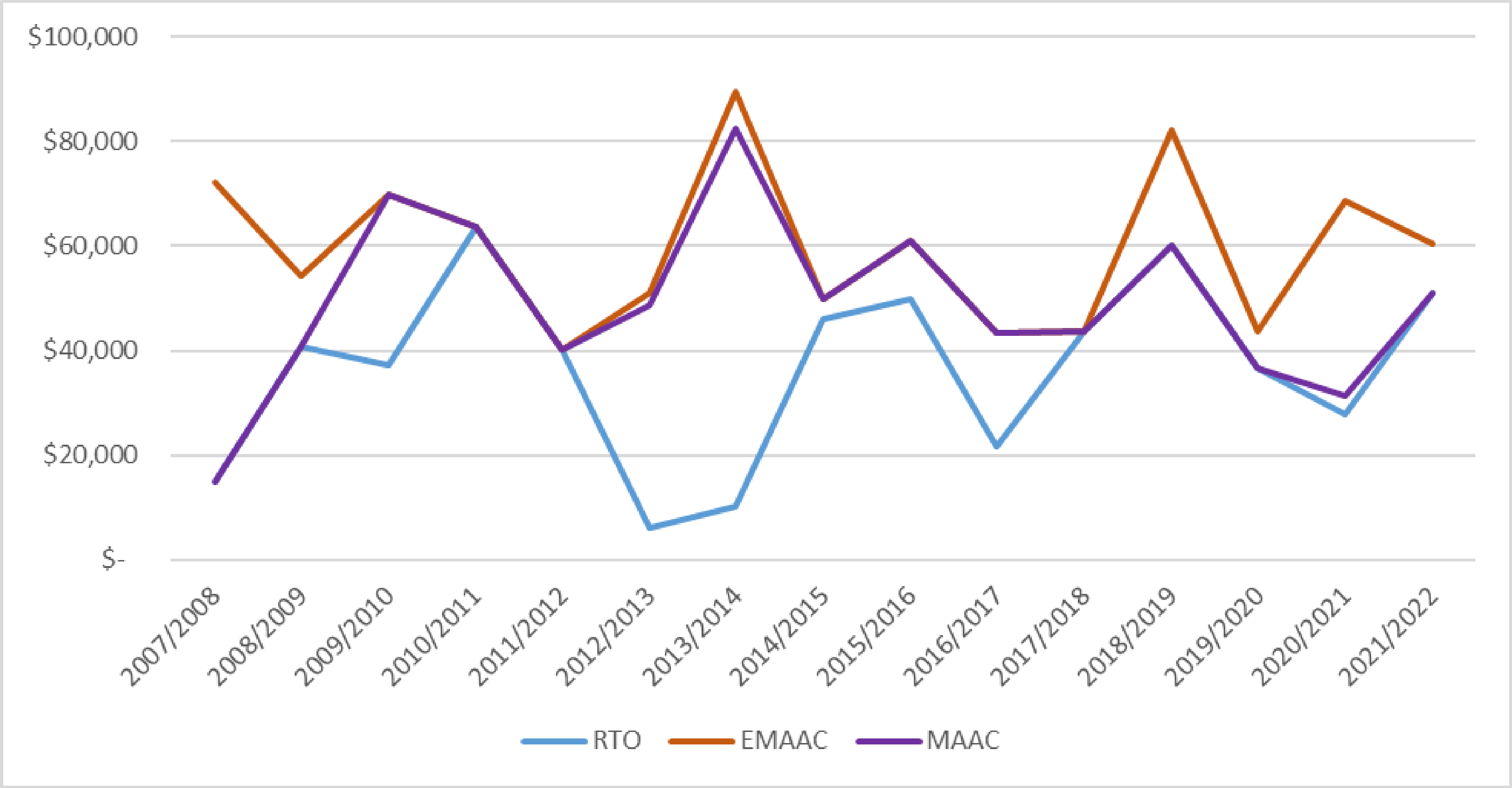
EE and DR in PJM's Reliability Pricing Model (RPM)



- Various types of DR over time. EE first eligible in 2012/2013
  - Max percent of total capacity cleared was in 2014/2015, at 10%
  - In most recent auction EE+DR = 8.5% of total

Source: PJM 2021-2022 BRA Results Report, Figure 1 and Table 6

Annual RPM Revenue for 1 MW Resource



- Varies over time and location based upon overall market conditions
- In general, more valuable in constrained areas (e.g., NJ, MD, DE, Eastern PA)

Source: PJM 2021-2022 Base Residual Auction Results Report. Figure 2. Clearing price translated into annual revenue amount.

Additional Resources

- Time-and locational-varying value of energy efficiency
  - Links to Berkeley Lab publications on integrated distributed energy resources analysis, distribution system planning, and time-varying value of efficiency
- No Time to Lose: Recent research on the time-sensitive value of electric energy efficiency
  - Link to November 2018 webinar on the time-sensitive value of efficiency.
- Technical assistance to states
  - Topics include efficiency, grid modernization, utility regulation & business models, electricity system planning and more
- Electricity Markets and Policy Group research
  - Topics include demand response and smart grid, electric system planning, electricity reliability, energy efficiency, renewable energy, technical assistance and utility regulation & business models

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