U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Is It Finally Peak Energy Efficiency (But In A *Good* Way)?

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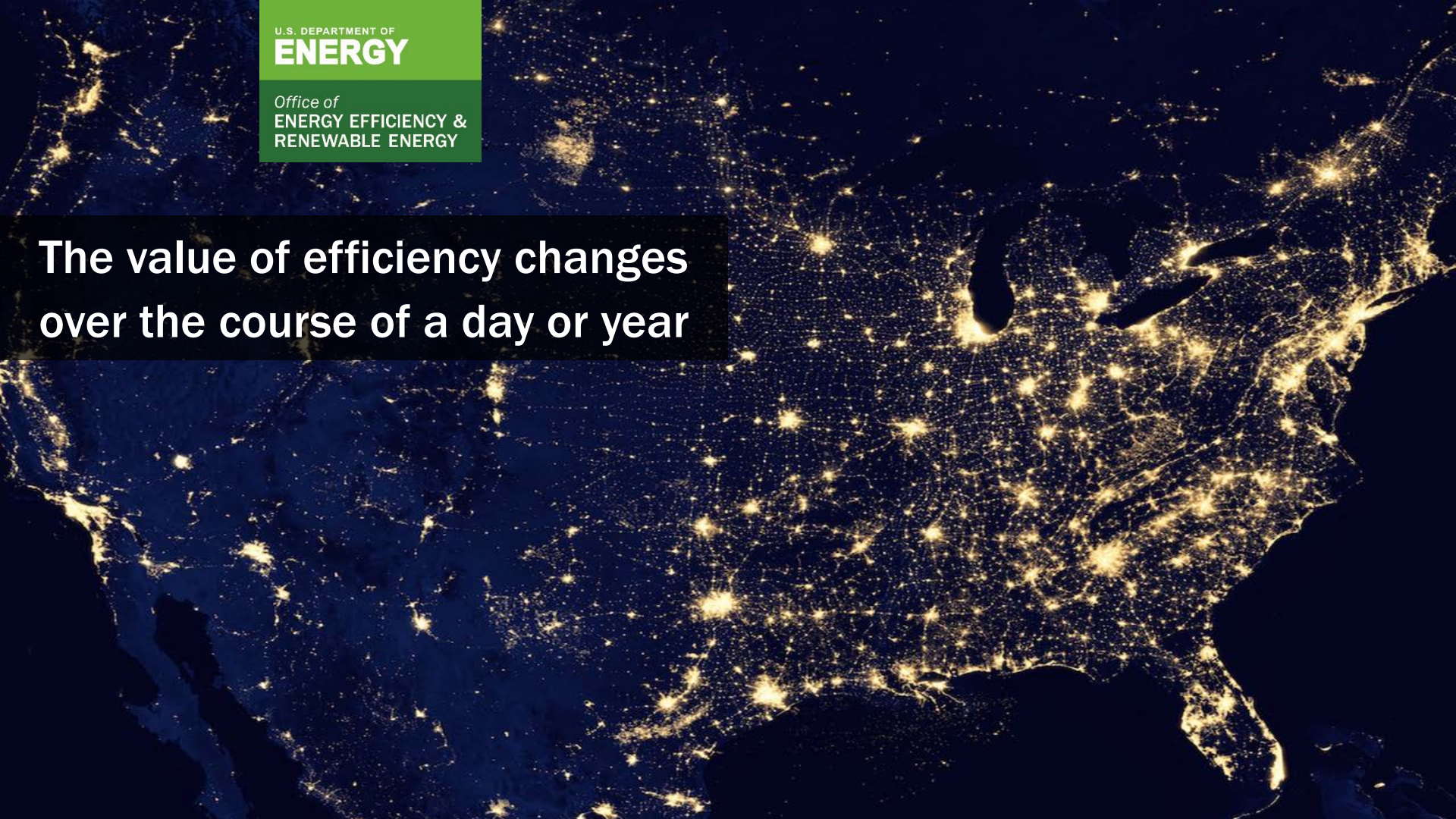
Topics to cover today

- ✓ **Value of efficiency change over a day or year (duh) so let's recognize that**
- ✓ **Time-sensitive valuation of efficiency (TSV-EE) supports Grid-interactive efficient buildings (and non-bldgs. for that matter) and demand flexibility**
- ✓ **TSV-EE use cases**
  - Energy efficiency program planning
  - Electricity resource planning
  - Distribution system planning
  - State programs
- ✓ **Key opportunities for TSV-EE implementation (and not just ToU rates!)**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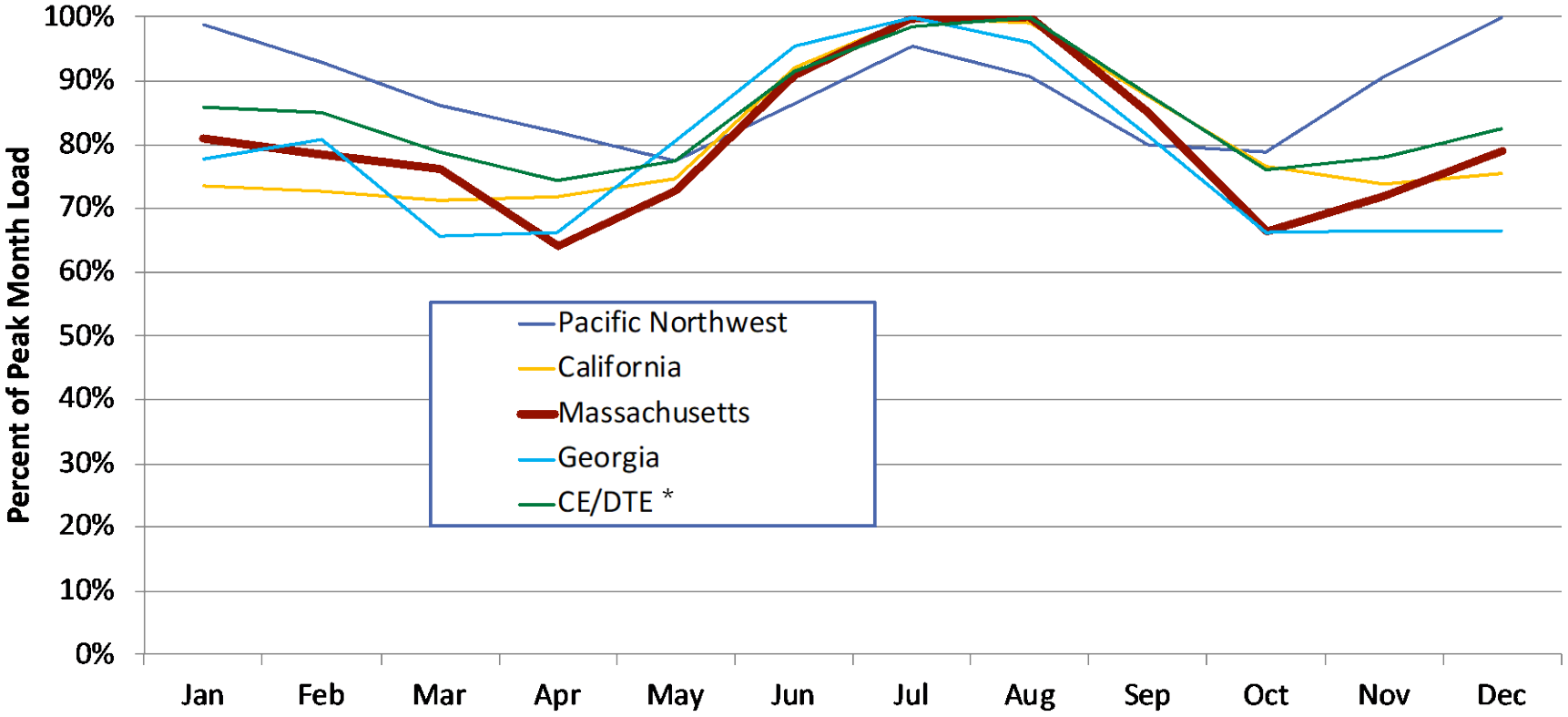
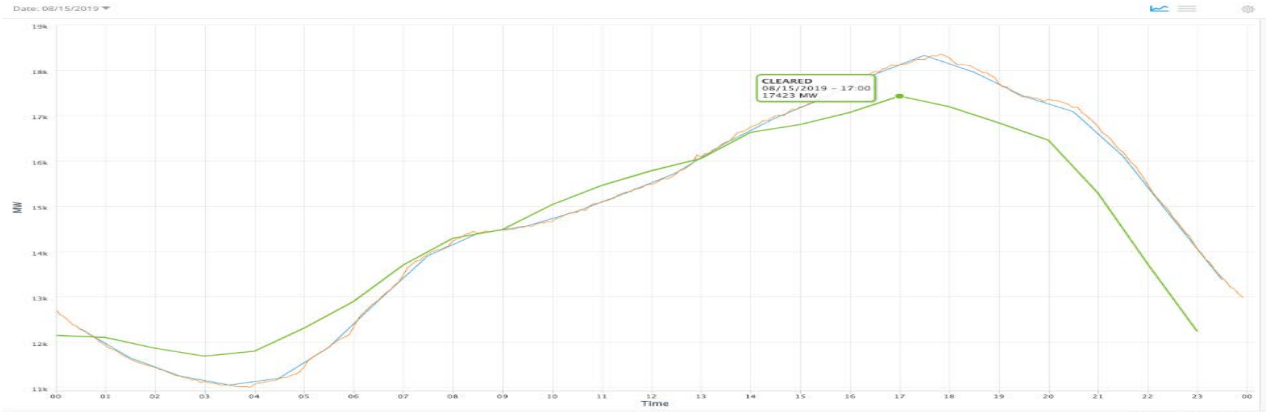
The value of efficiency changes
over the course of a day or year

Annual system load shapes

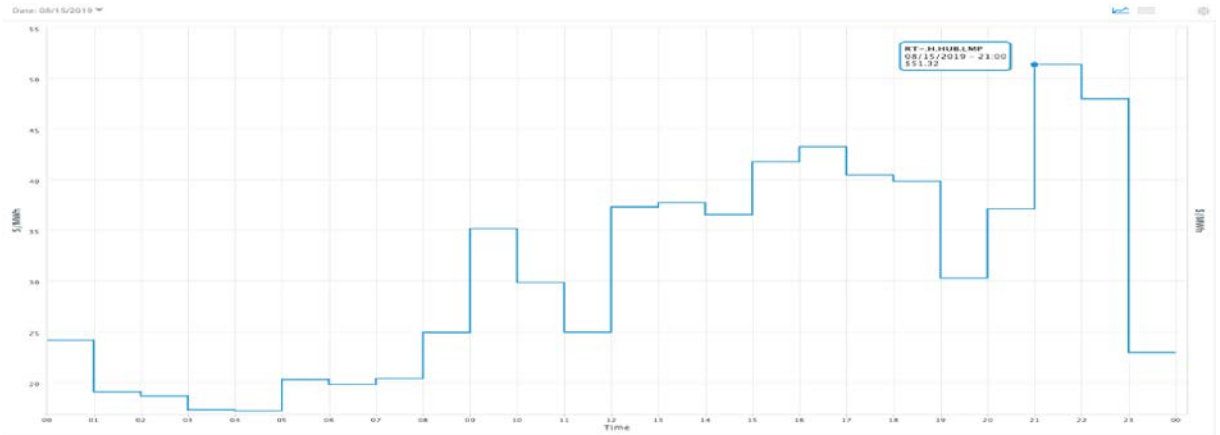


*CE/DTE is Consumers Energy and DTE Energy, utilities in Michigan

Daily load and locational marginal price in ISO-NE: August



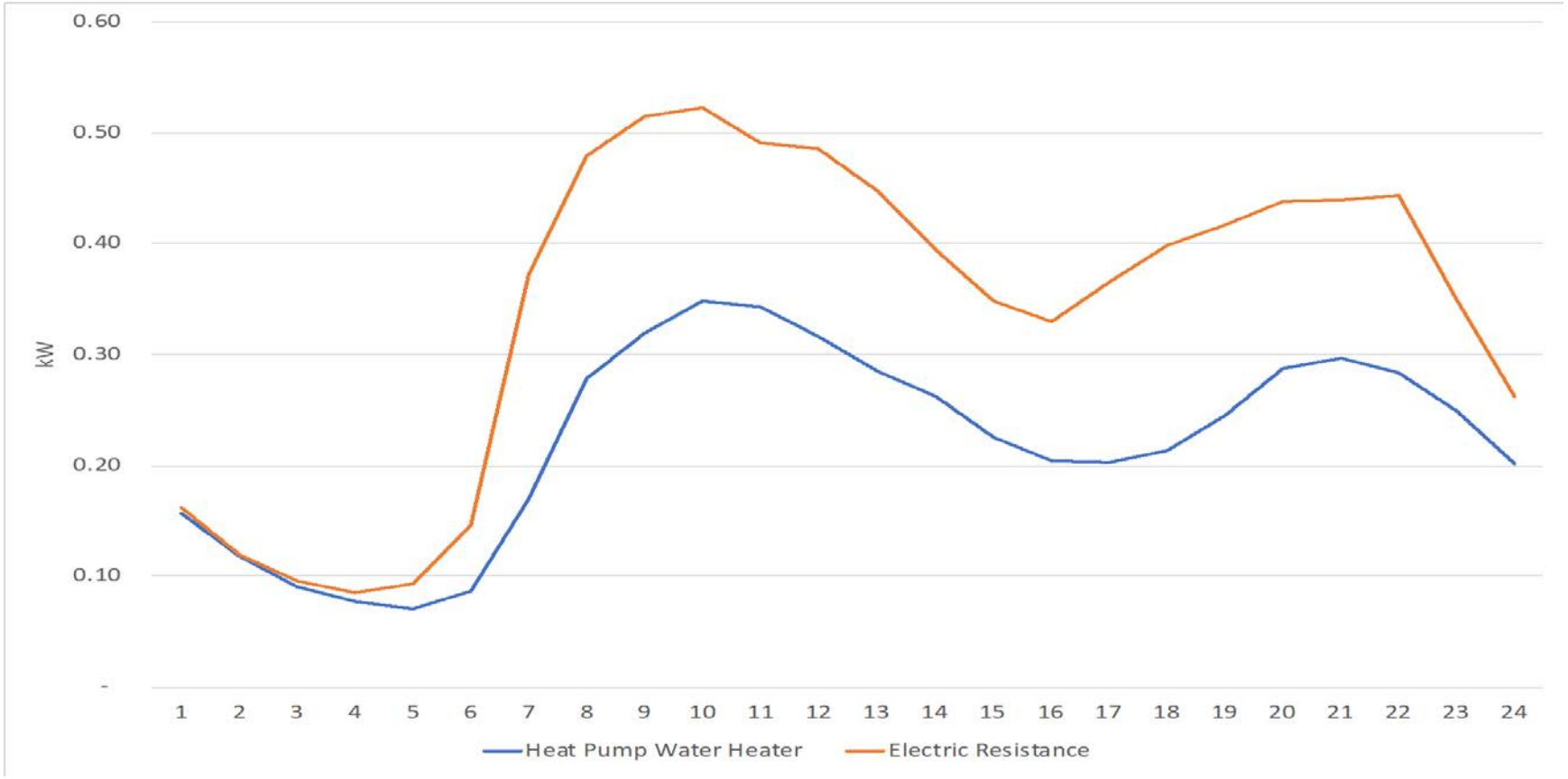
8/15/19
Cleared ISO-NE System Load @ 17:00
17,423 MW



8/15/19
Hourly LMP @ 21:00
$51.32/MWh

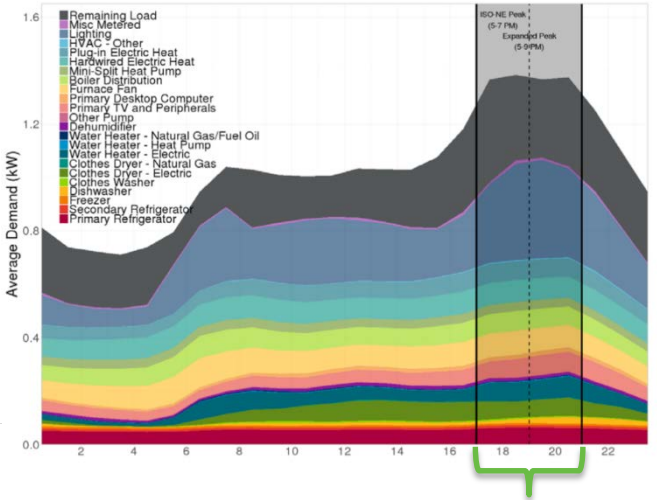
Source: ISO-NE

Water heating load shapes

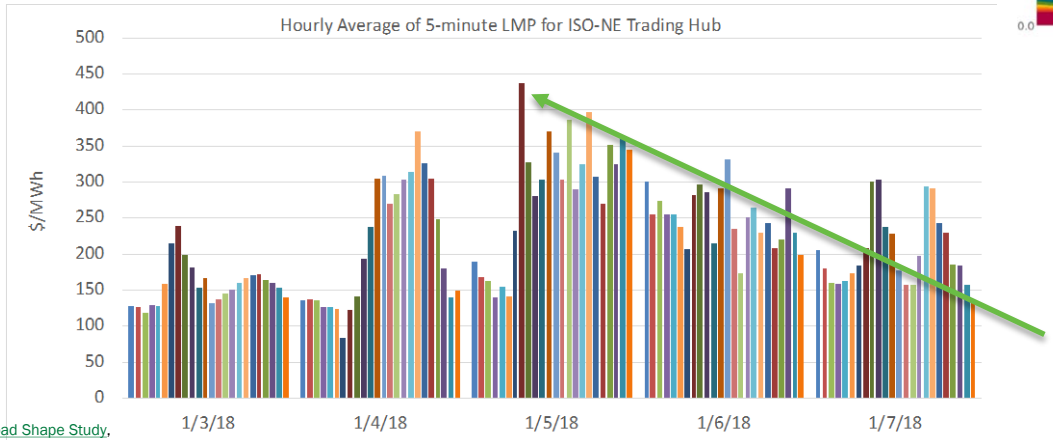


The anticipated grid need and value may not occur as planned

TSV-EE considers *when* energy efficiency occurs and the *economic value* of the energy or demand savings to the electricity system at that time.



ISO-NE winter peak period 5-7 pm (extended peak 5-9 pm)



Friday January 5, 2018
Hour ending 7 (6-7am) $436.80/MWh

Sources: Navigant MA Baseline Load Shape Study, LBNL analysis using ISO-NE 2018 LMP data

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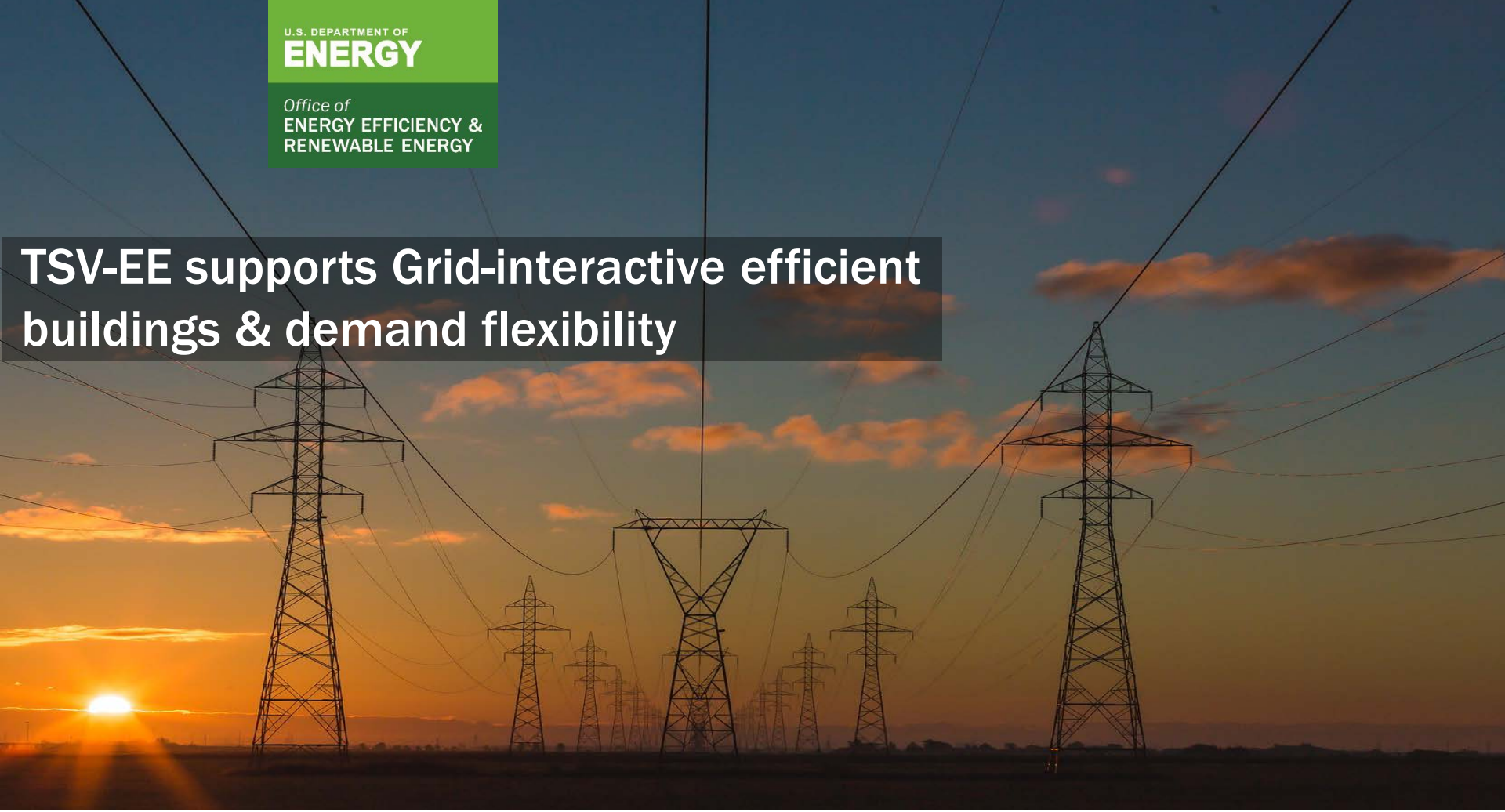
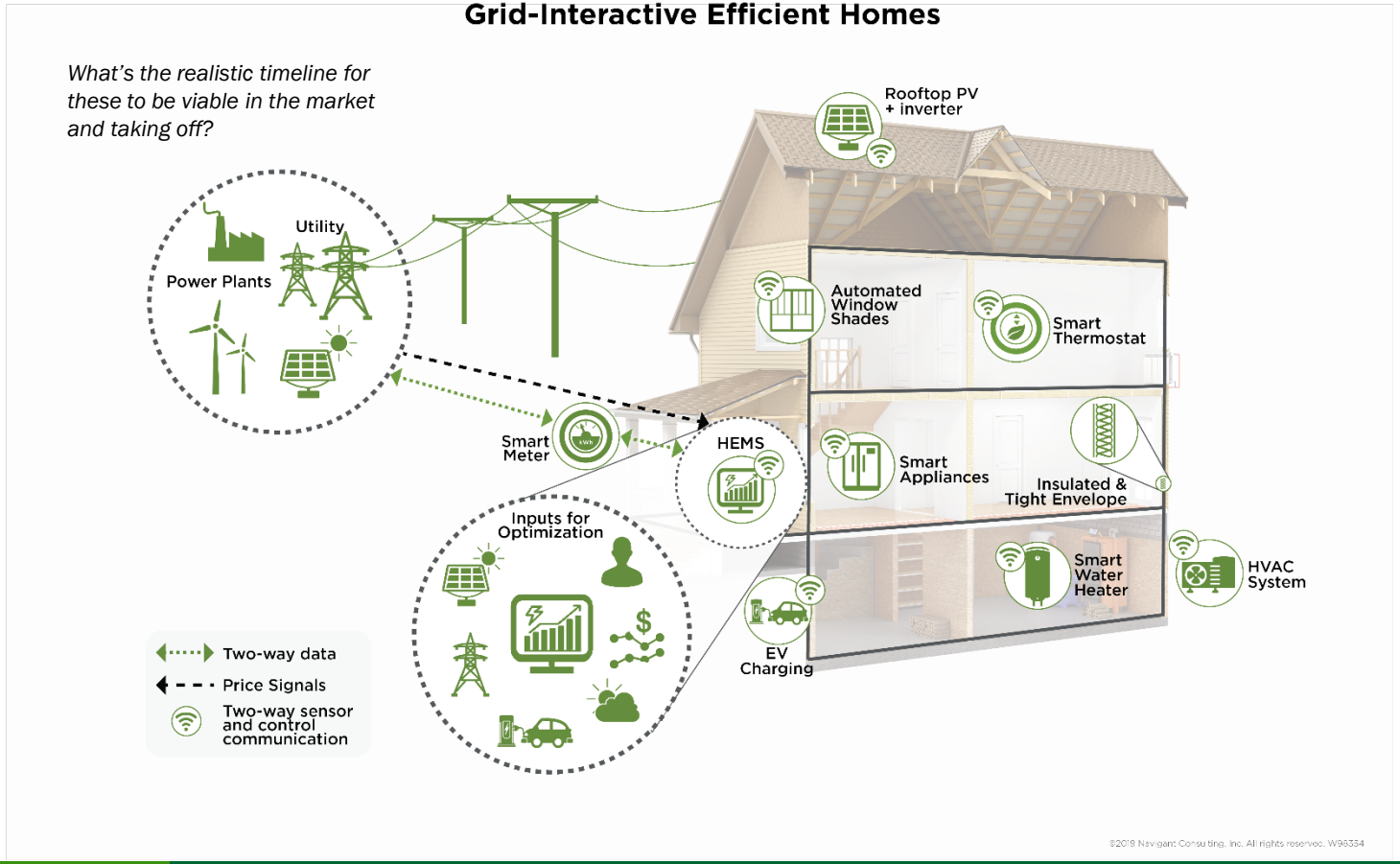
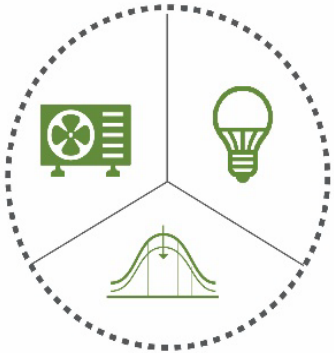
TSV-EE supports Grid-interactive efficient buildings & demand flexibility



Grid-interactive Efficient Buildings (GEBs)



Characteristics of GEBs

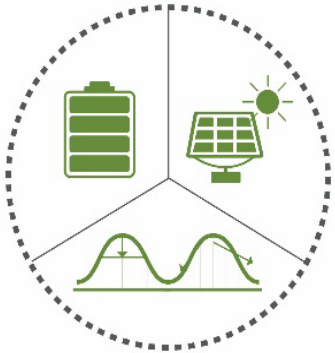


EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure

CONNECTED

Two-way communication with flexible technologies, the grid, and occupants



FLEXIBLE

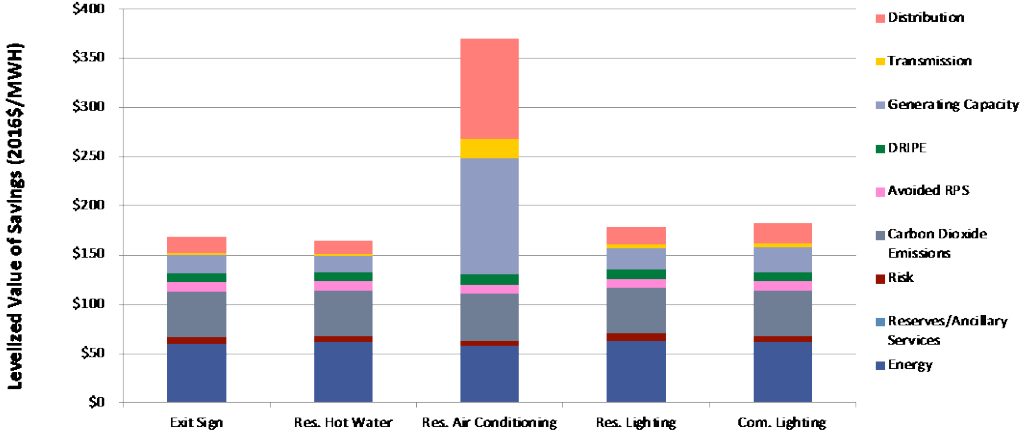
Flexible loads and distributed generation/storage can be used to reduce, shift, or modulate energy use

SMART

Computing, data analytics, and machine learning supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences

TSV-EE and GEB

TSV-EE is one component of considering the value of grid-interactive efficient buildings



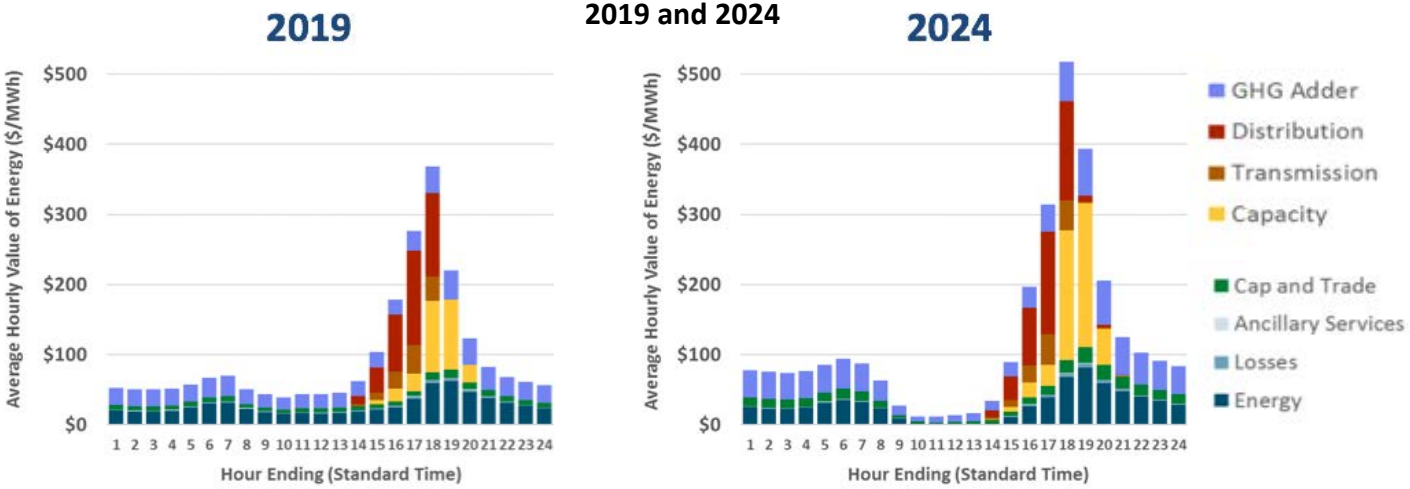
Benefit	Utility System	Building Owners/Occupants	Externalities
Reduced operation & maintenance costs	✓	-	-
Reduced generation capacity costs	✓	-	-
Reduced energy costs	✓	-	-
Reduced T&D costs	✓	-	-
Reduced T&D losses	✓	-	-
Reduced ancillary services costs	✓	-	-
Increased resilience	✓	✓	✓
Increased DER integration	✓	✓	-
Improved power quality	-	✓	-
Reduced owner/occupant utility bills	-	✓	-
Increased owner/occupant satisfaction	-	✓	-
Increased owner/occupant flexibility and choice	-	✓	-
Environmental benefits	-	-	✓

- **Demand Flexibility: The capability provided by DERs to *reduce*, shed, shift or modulate electricity**
- **TSV-EE quantifies the value of providing savings when grid services are needed**

How are utilities using the time-sensitive value of efficiency?

Benefit-cost analysis: CPUC Avoided Cost Calculator

California Avoided Cost Calculator Output for Climate Zone 4 (hot and dry)
2019 and 2024



The stacked bar charts are comprised of components of publicly available avoided costs in California. This chart was made by E3 for the California Public Utilities Commission.

Methodology: The avoided cost model is used to forecast long-term marginal costs to evaluate the cost-effectiveness of distributed energy resources such as energy efficiency, distributed generation, storage and demand response. The model uses annual hourly energy savings and electricity price forecasts.

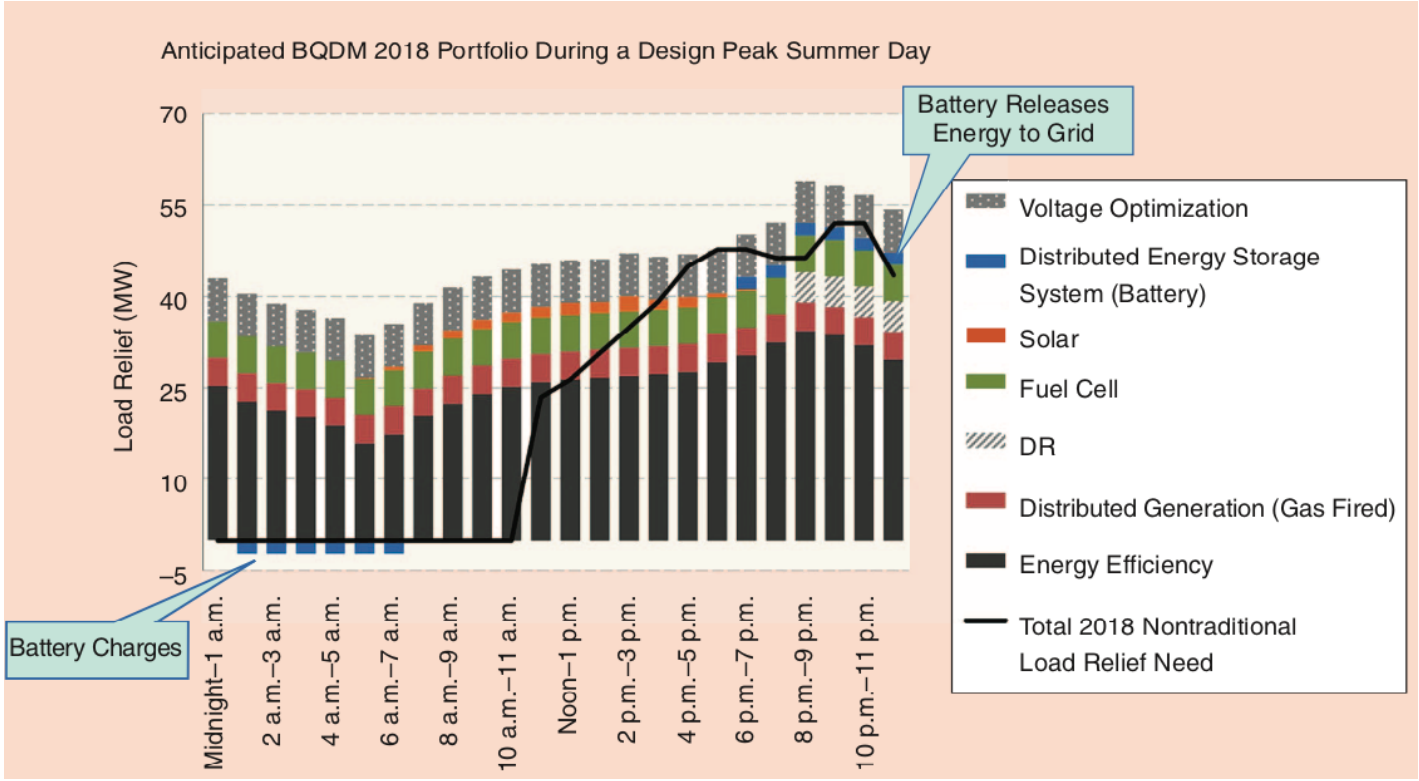
Energy efficiency program design: Oncor

Select Incentives for Oncor 2019 Commercial Standard Offer Program

Description	Measure Life	$/kW for On Peak Demand Reduction	$/kWh for Annual Energy Reduction
Air Cooled Chiller	25	$387.81	$0.125
LED	15	$209.21	$0.057
Energy Star Commercial Dishwasher	11	$193.11	$0.054
Hot Food Holding Cabinet	12	$164.21	$0.041
Zero Energy Doors for Refrigerated Cases	12	$123.16	$0.025
Lodging Guest Room Occupancy Sensors	10	$86.51	$0.022
Refrigeration Evaporator Fan Controls	16	$49.57	$0.010
Vending Machine Controls	5	$20.64	$0.021
Pre-Rinse Spray Valves (Food Service)	5	$12.38	$0.004

Methodology: Several utilities in Texas, including Oncor, provide energy efficiency program incentives for both energy and peak demand savings. Peak demand reductions are calculated for each utility using methodologies described in the statewide technical reference manual.

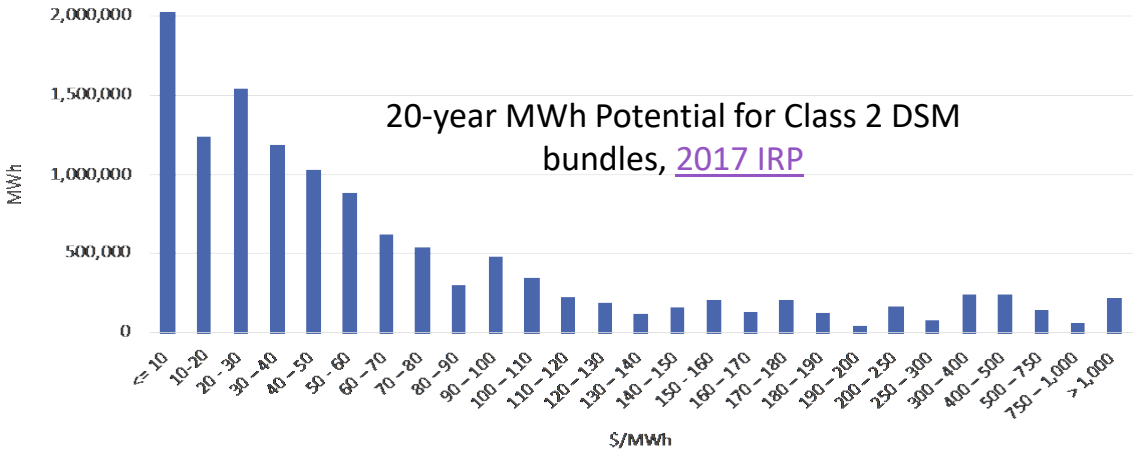
Non-wires alternative: Brooklyn Queens demand management

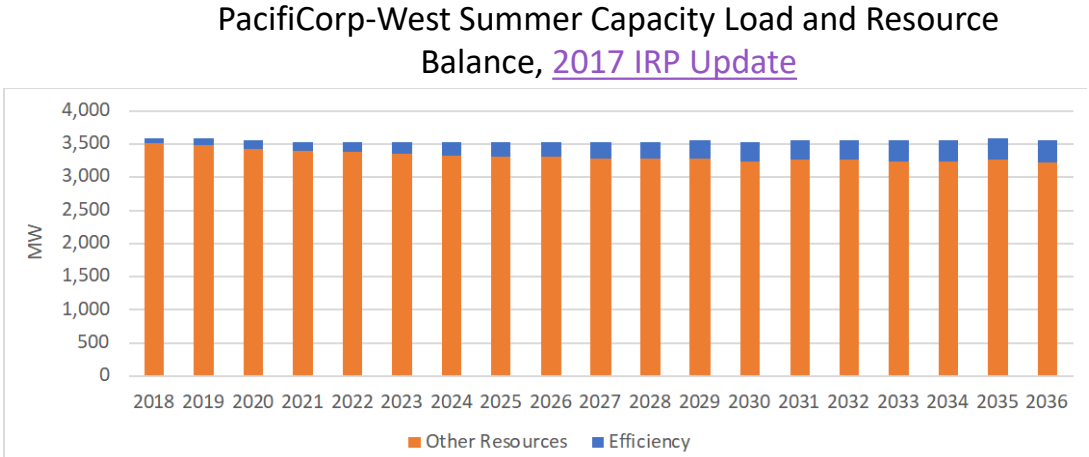


Source: https://ieeexplore.ieee.org/document/7866936?reload=true ConEd 2018

Integrated resource planning: PacifiCorp

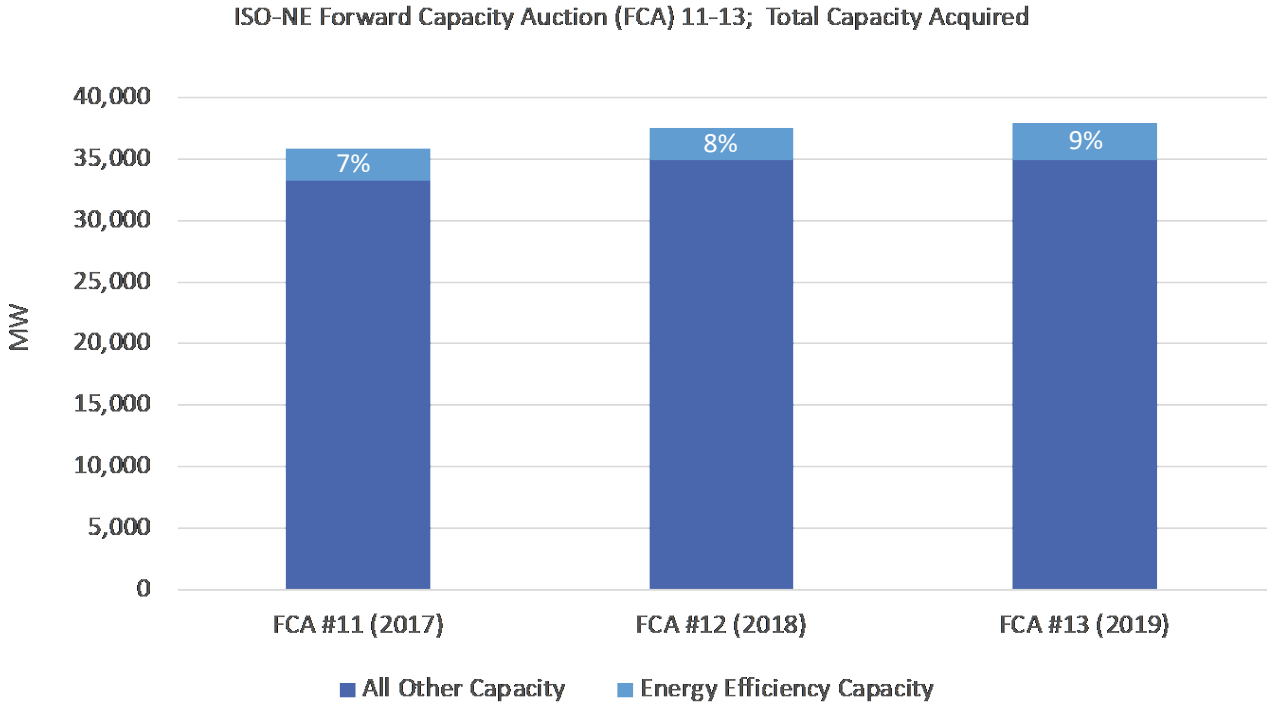
TSV-EE Methodology: PacifiCorp creates energy efficiency cost curves using annual hourly (8,760) load shapes, which are inputs to the IRP capacity expansion model with all other resources. Allowing efficiency to compete with all other resources creates a reliable portfolio at least cost.





Capacity markets: ISO-NE

On-Peak Resources Performance Hours



Methodology: Energy efficiency may participate in ISO-NE's Forward Capacity Market by bidding resources that produce demand reductions during designated hours for both summer and winter seasons.

Source: FCA #11, FCA #12, FCA #13

Select LBNL Resources

- Time and locational sensitive value of efficiency
  - Time-Sensitive Value of Efficiency: Use Cases in Electricity Sector Planning and Programs (forthcoming)
  - Time-varying value of electric energy efficiency (2017)
  - Time-varying value of energy efficiency in Michigan (2018)
  - No Time to Lose: Recent research on the time-sensitive value of efficiency (webinar)
- End-Use Load Profiles for the U.S. Building Stock
  - Building Technologies Office (BTO) funded project that is a multi-lab collaboration to create end-use load profiles representing all major end uses, building types, and climate regions in the U.S. building stock.
- Electricity Markets and Policy energy efficiency research
- Locational Value of Distributed Energy Resources (forthcoming)
- Peak Demand Impacts from Electricity Efficiency Programs (forthcoming)
- Energy Efficiency in Electricity Resource Planning (forthcoming)

TSV-EE Opportunities

- Electric system-related state & local gov't activities can benefit from TSVing
  - Building benchmarking & reporting
  - Air pollutant emissions factors
  - Energy efficiency resource standards (and RPSs too)
  - Building energy codes
  - State building fleet energy management and upgrades
- Use of TSV-EE in electricity system planning could be expanded
  - Utility or program administrator incentives and rebates
  - Bulk system and distribution system planning
- Other areas of governmental, utility activity
  - Consumer outreach, state tax incentives
  - Building energy modeling
  - Research & development programs
  - Research & analysis

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www.energy.gov/eere/buildings/GEB

https://emp.lbl.gov/projects/time-value-efficiency