Load Shifting: Data and Tools for Analyzing Efficiency and Other Distributed Energy Resources

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Breakout A2: Get Ready ‘Cause its Load Shift Time
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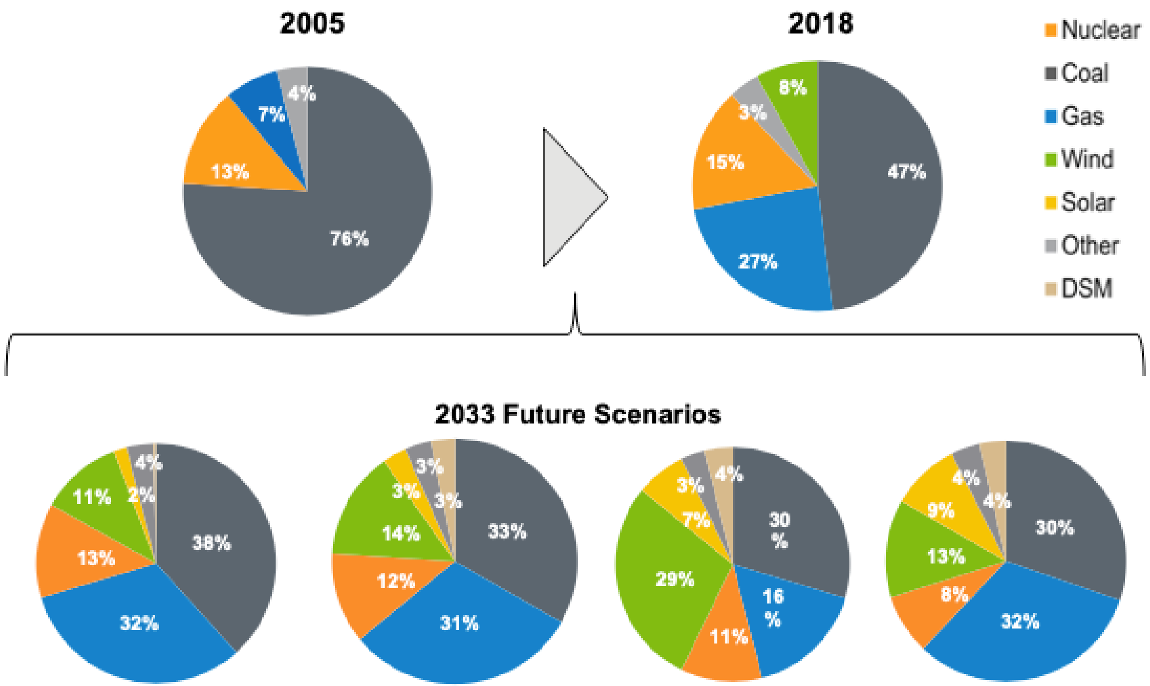


Limited Fleet Change
Stalled generation fleet changes. Limited renewables additions driven primarily by existing RPS under limited demand growth.

Continued Fleet Change
Continuation of the renewable addition and coal retirement trends of the past decade.

Accelerated Fleet Change
Renewables and demand side technologies added at a rate above historical trends. Fleet changes result in a 20% CO_2 emission reduction.[2]

Distributed & Emerging Tech
New renewable additions largely distributed and storage resources added across the region.

Source: MISO MTEP 2020

The electricity system is changing, requiring changes in grid operations and greater consideration of loads as a flexible resource.

DERs must be in the right place and operate at the right time to meet system needs.

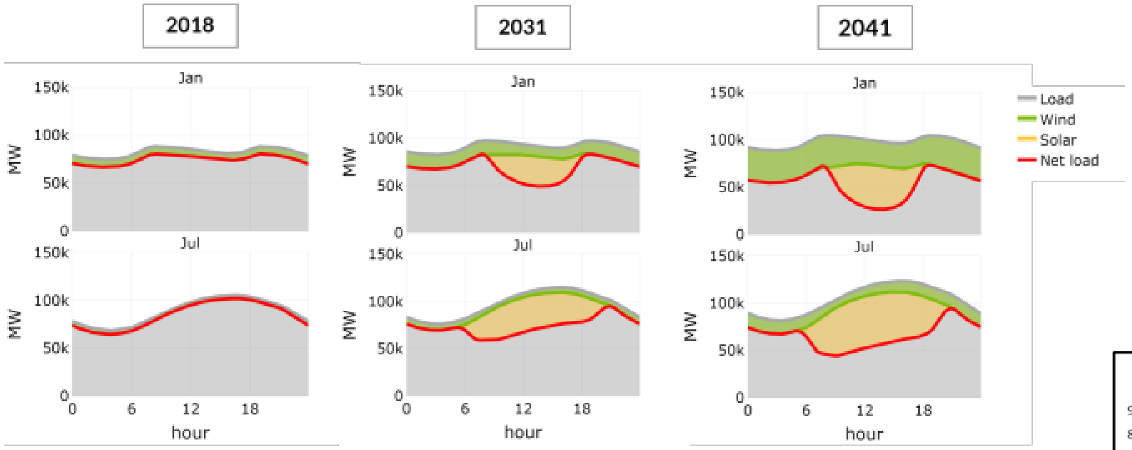
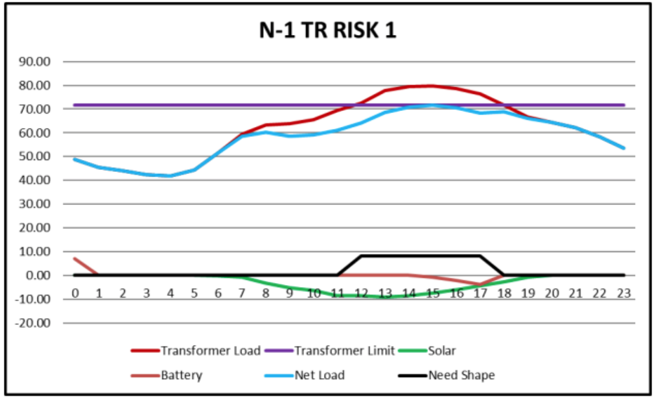


Figure 19: Monthly averages of diurnal net load components for January and July

DERs must operate at the ***right time*** to ensure they will relieve the identified constraint and provide generation or load reduction during the *peak day.*

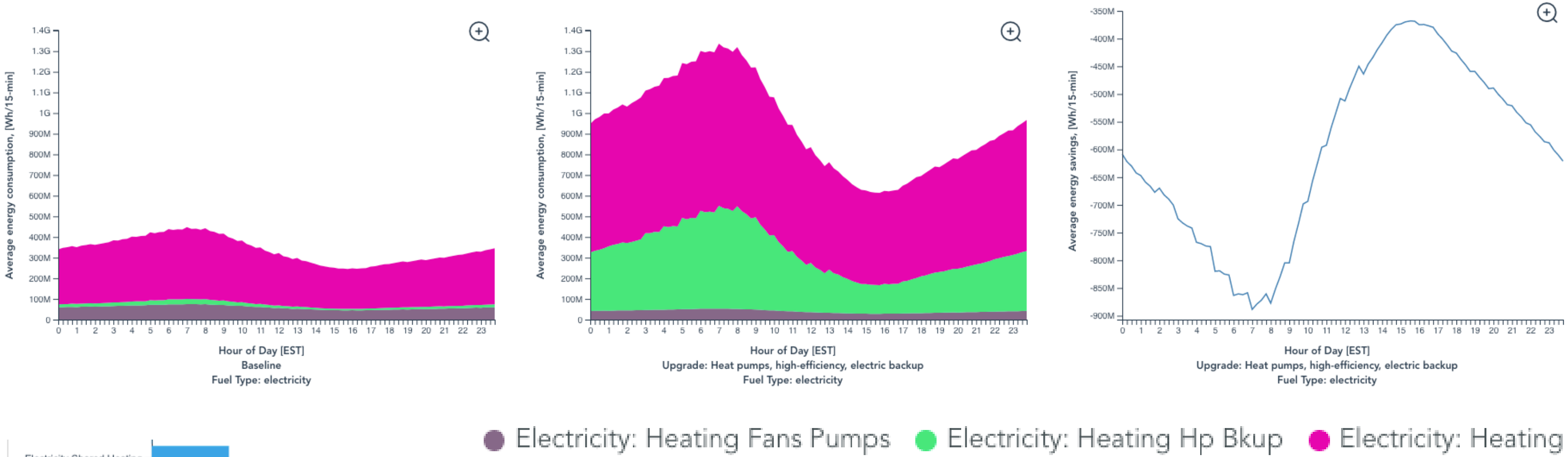


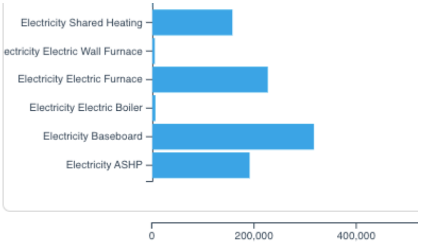
Value of DERs for the distribution system ***depends on location***.

- Value may be associated with a distribution substation, individual feeder, section of feeder, or a combination of these components.
- Avoided distribution costs vary by area. DERs must be targeted to capture the highest value.

Sources: MISO Regional Resource Assessment 2022, Xcel MN 2022 IDP

Efficiency and demand flexibility will impact existing and new load shapes.





End-Use Load Profile and Savings Shape Reports

[Market Needs, Use Cases and Data Gaps](#)

[Methodology and Results of Model Calibration, Validation and Uncertainty Quantification](#)

[Practical Guidance on Accessing and Using the Data](#)

[End-Use Savings Shapes: Residential Round 1](#)

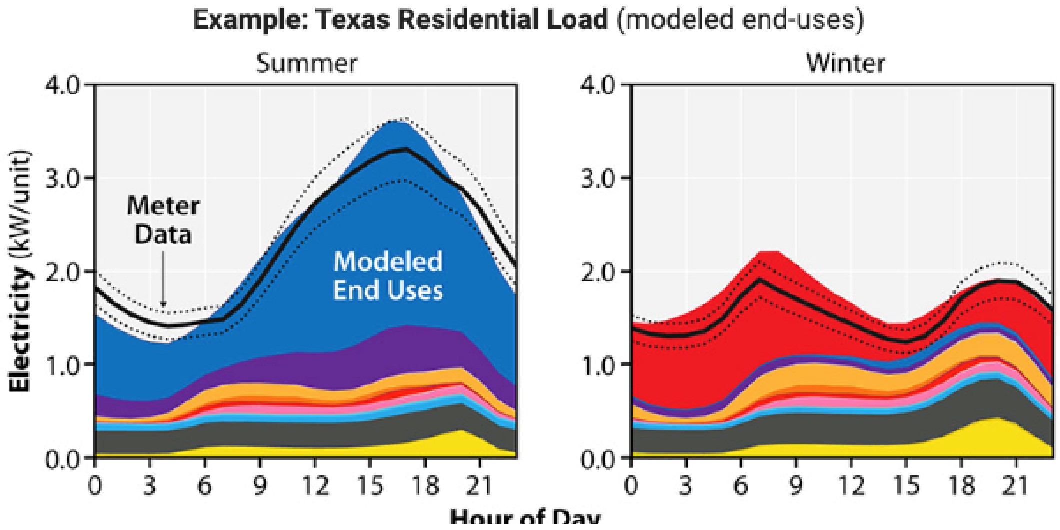
Access all datasets on the project website https://www.nrel.gov/buildings/end-use-load-profiles.html

Foundational Dataset of ~1 Million End-Use Load Profiles for the U.S. Residential and Commercial Building Stock

ComStock ResStock

Building stock models calibrated through 70+ model updates, supported by data:

- Electric load data from 11 utilities and 2.3 million meters
- 15 end-use metering datasets



- The end-use load profile dataset is the output of approximately 900,000 (550,000 ResStock plus 350,000 ComStock) building energy models.
- The output of each building energy model is 1 year of energy consumption in 15-minute intervals, separated into end-use categories.
- Simulation results, building characteristics, energy models are available

Source [NREL]

Practical Guidance on Accessing and Using End-Use Load Profiles

- Accessing the End-Use Load Profiles and Savings Shapes
- Considerations and Limitations
- Use Cases

Use Case	Application of End-Use Load Profiles
Integrated resource planning	Develop load forecast or energy efficiency supply curves
Long-term load forecasting	Analyze the impact of particular equipment adoption scenarios statewide, across a utility area, or a smaller geographic area; improve baseline building energy consumption assumptions
Transmission planning	Disaggregate the load into components that behave differently during and after a fault
Distribution system planning	Analyze the value of solar and wind as well as different types of energy efficiency based on the location and timing of the generation or savings
Electrification planning	Understand how electrification could affect annual electricity consumption and how the increase in consumption could be spread across hours of the year
Demand-side management	Use as an input to cost-benefit analysis to understand the time-value of energy efficiency; in potential assessments to understand the available amount and timing of energy efficiency (e.g., improving baseline building energy consumption assumptions); and in program design
Bill impacts and rate design	Estimate how electricity bills may increase or decrease with adoption of DERs or switching to a new time-based electricity rate for individual buildings with realistic load profiles, and aggregations of buildings

Options to Access the End-Use Load Profiles: Contents of the Dataset

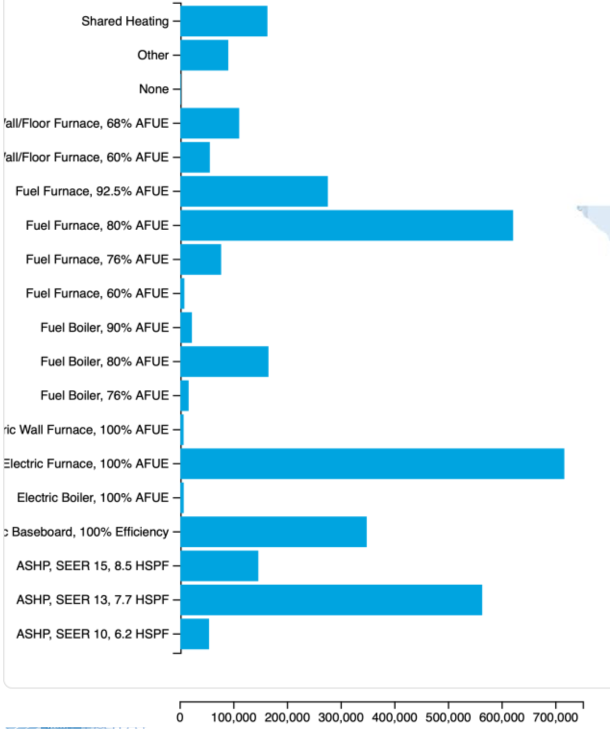
	Commercial	Residential
Models Run (per weather year and upgrade)	350,000 buildings	550,000 dwelling units
Representing	64% of U.S. commercial floor area per CBECS	137 million U.S. homes Excludes AK, HI, territories
Building Types	14	5
End Uses	19	49
Upgrades	Coming soon	10 packages
Weather years	TMY (typical meteorological year), AMY 2018 (actual meteorological year)	TMY, AMY 2012, AMY 2018

Source: EULP webinar

Three Strengths of ResStock and ComStock End-use Load Profiles

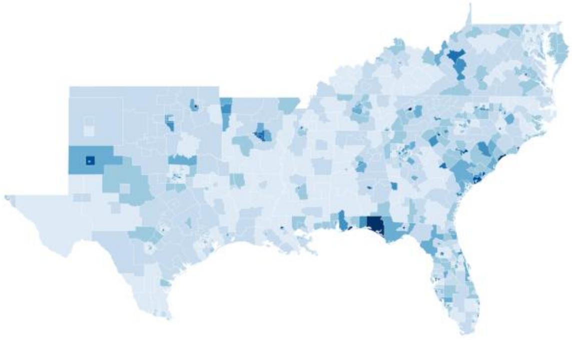
Building stock

Residential heating systems in Virginia



Source: EULP webinar

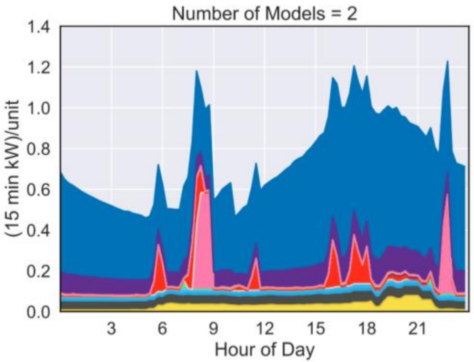
Geographic granularity

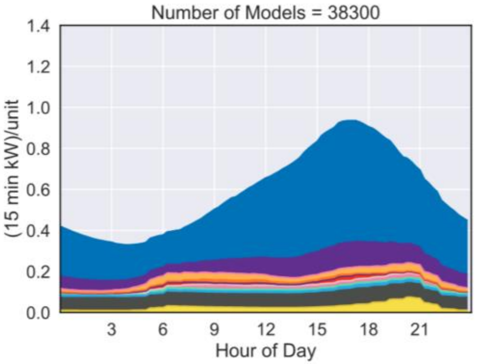


Example of Public Use Microdata Area* (PUMA) resolution:
~200k people; ~2,400 in U.S.

* https://www.census.gov/programs-surveys/geography/guidance/geo-areas/pumas.html

Behavioral diversity





Wilson et al. 2022 Figure 368 (subset)

Overview of the Access Options

ResStock and ComStock

- Web viewer
  - Annual and timeseries graphs
  - 15-minute end-use consumption for a custom set of buildings
  - Compare baseline and efficiency upgrades (ResStock only for now)

OpenEI Data Lake

- Aggregate files
  - 15-minute end-use consumption by building type and geography (e.g. state, county)

- Individual buildings
  - 15-minute end-use consumption for individual buildings and dwelling units
  - Building energy model files

Time-Sensitive Value Calculator

- The Time-Sensitive Value Calculator (Calculator) — coupled with publicly available national data — allows users to assess the hourly value of measures throughout the United States using a consistent approach.

- The Calculator is a publicly-available, free tool that estimates the value of measures using hourly electricity system cost estimates.

- The Calculator takes hourly profiles of up to six measures and monetizes their value for five hourly value streams and one annual value stream, producing outputs in tabular and graphical formats.

- The Calculator was designed for public utility commissions, state energy offices, utilities and stakeholders to estimate the value of measures under future electricity system conditions.

Calculator Features

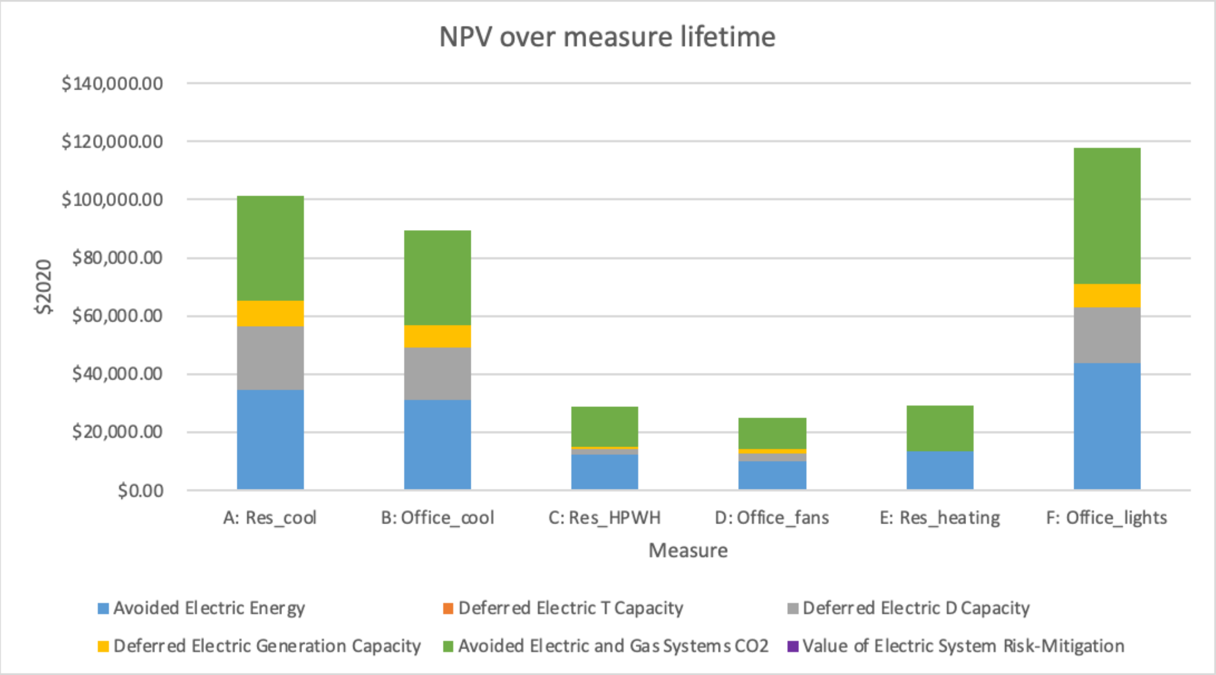
- At a high level, the Calculator monetizes one year of a measure shape by multiplying each hour's demand by the corresponding hour's cost from each hourly value stream and then applying the annual factors. It does this for each of the eight analysis years chosen by the user and then estimates the net present value (NPV) of the total value of each measure over its lifetime.

- Users can select years with different generation mixes and avoided costs to compare the value of measures in diverse resource portfolios. Users can also include or exclude avoided cost values to compare the value of a measure with and without inputs (e.g., avoided cost of carbon).

- The Calculator can create a variety of results. We focus on two of them here, and in the user manual.

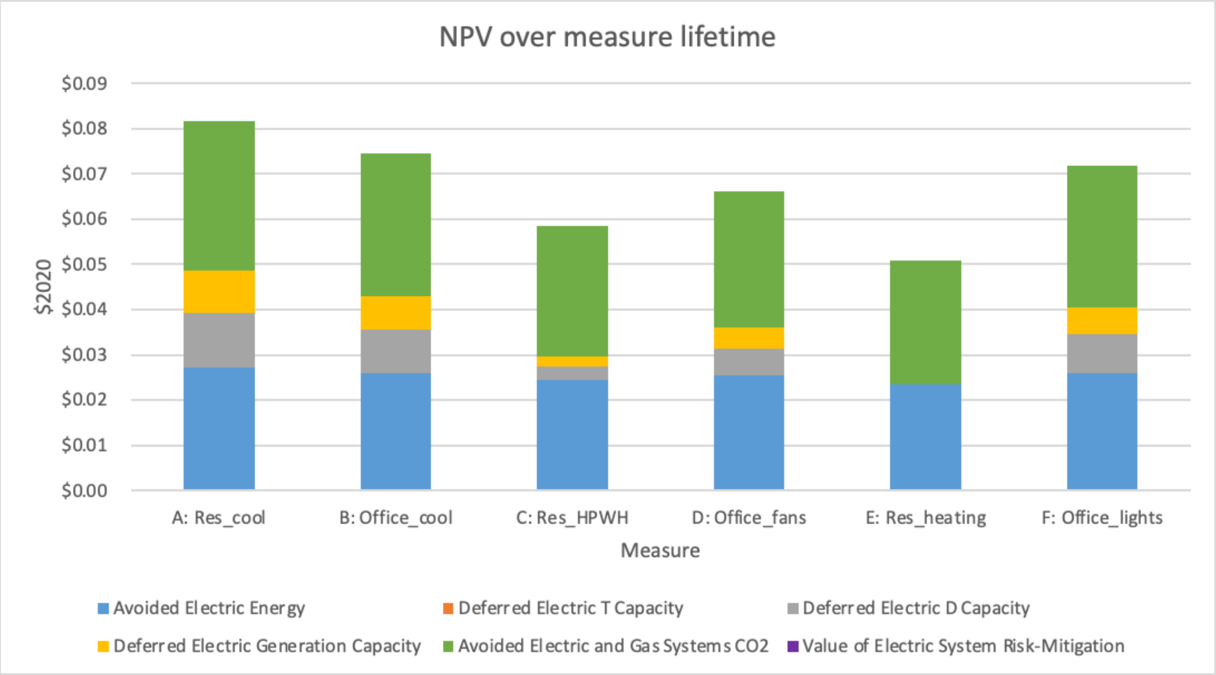
  1. Comparison of the value of savings from different measure shapes and impact, taking into consideration the life of the measure – *Shape+*
  2. Comparison of the value of savings from different measure shapes by isolating the timing of the measure impact – *Shape Only*

Example of Shape+ Analysis



Measure	Savings (kWh/year)	Measure lifetime (years)
A: Residential cooling	100,000	17
B: Office cooling	100,000	15
C: Residential heat pump water heater	50,000	13
D: Office fans	50,000	9
E: Residential heating	50,000	17
F: Office lights	150,000	15

Example of Shape Only Analysis

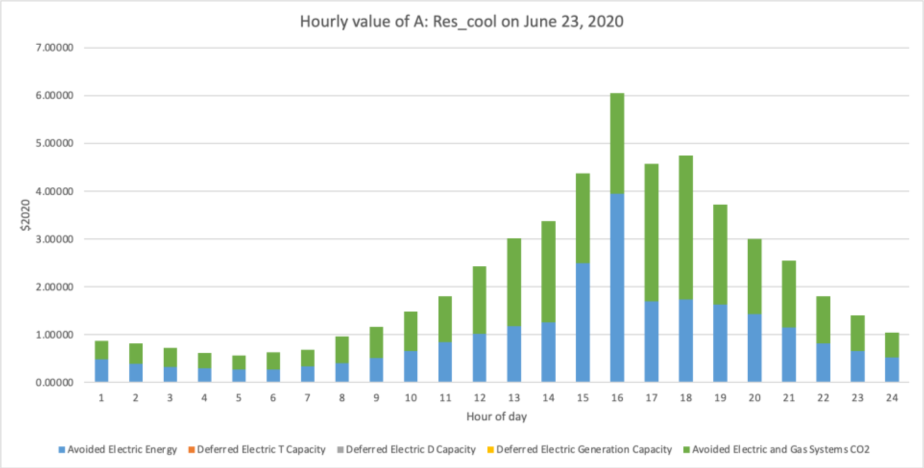


Measure	Savings (kWh/year)	Measure lifetime (years)
A: Residential cooling	1	1
B: Office cooling	1	1
C: Residential heat pump water heater	1	1
D: Office fans	1	1
E: Residential heating	1	1
F: Office lights	1	1

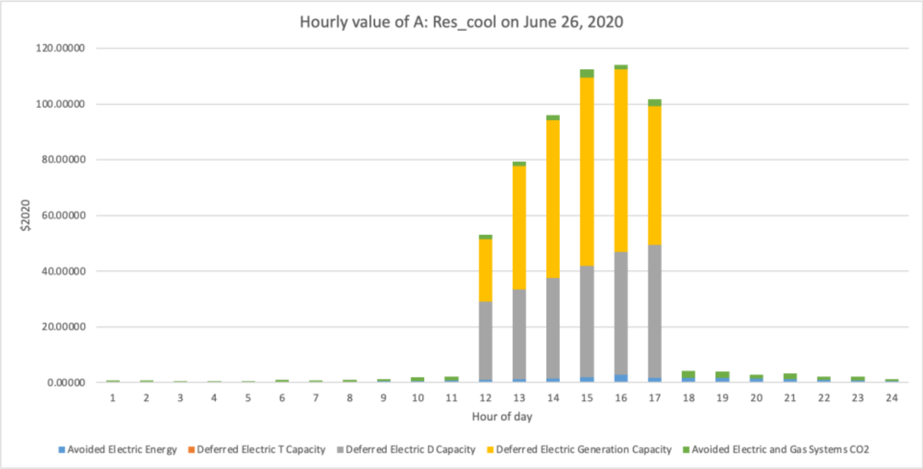
Calculator Demo Results – Savings for a Specific Date

Savings for a specific day/month/year	
	Start
Year	2020
Month	June
Day	23
Measure	A: Res_cool

Refresh this chart



Results are also provided in a table format



Calculator Demo Results – Hourly System Shape for a Specific Day

Shapes for a specific day/month/year		
	Start	End
Year	2030	
Month	November	
Day	24	

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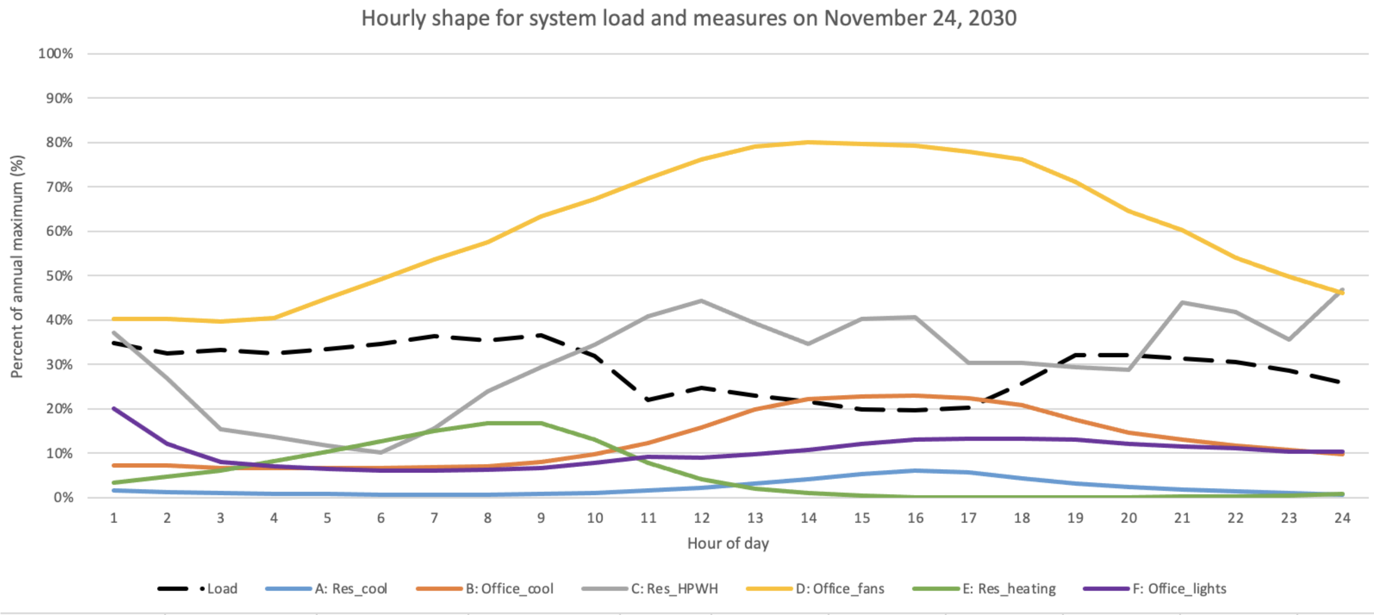
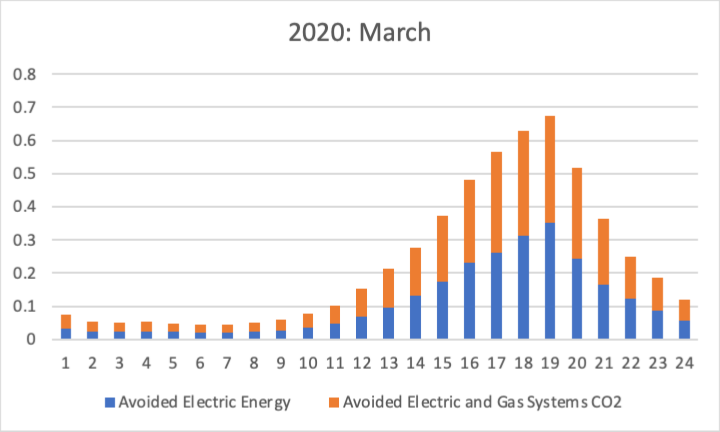
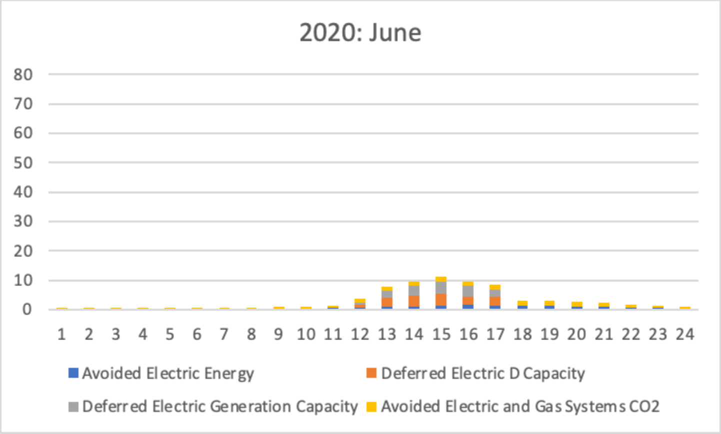
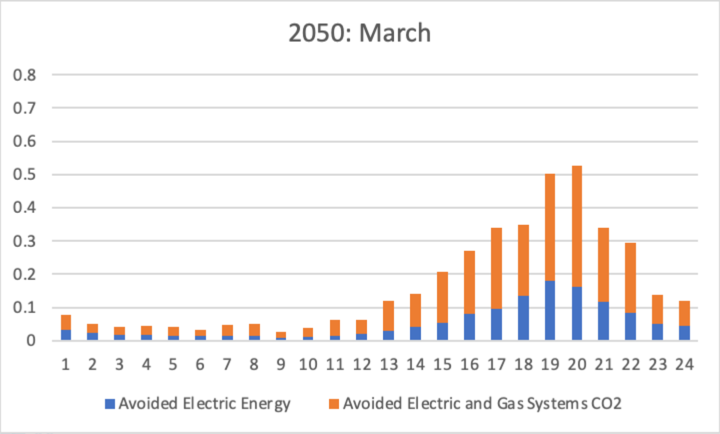
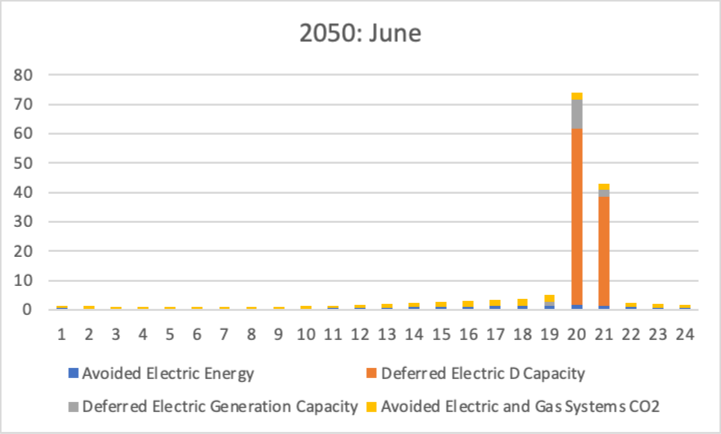


Use Case: Texas Residential Cooling Value Over Time









Select Berkeley Lab Resources

- Berkeley Lab's Time and Locational Sensitive Value website links to publications on the topics.
- NREL's End Use Load Profile website
- NREL's residential end-use load profiles and savings shapes are here.
- NREL's commercial end-use load profiles are here.
- Download the Time-Sensitive Value Calculator here; see the Notes section of the webpage for step-by-step instructions on how to use it. We are in the process of updating it so ***please let us know if you have suggestions for improvements.***
- Our report *Practical Guidance on Accessing and Using the Data* is available for download. The webinar and slides are also available.
- Materials from our End Use Load Profile technical advisory group are available here. Prior reports are available at the links below.
  - *Market Needs, Use Cases and Data Gaps*
  - *Methodology and Results of Model Calibration, Validation and Uncertainty Quantification*

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For more information

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