Energy Technologies Area Lawrence Berkeley National Laboratory

Michigan Public Service Commission Time Value of Energy Savings in Michigan

Tom Eckman and Natalie Mims

April 17, 2018

This work was supported by the U.S. Department of Energy’s Office of Electricity Delivery and Energy Reliability - Transmission Permitting and Technical Assistance under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231

Thanks To:
Michigan PSC
Consumers Energy Staff
DTE Staff
&
Rick Morgan

For Your Assistance and Patience

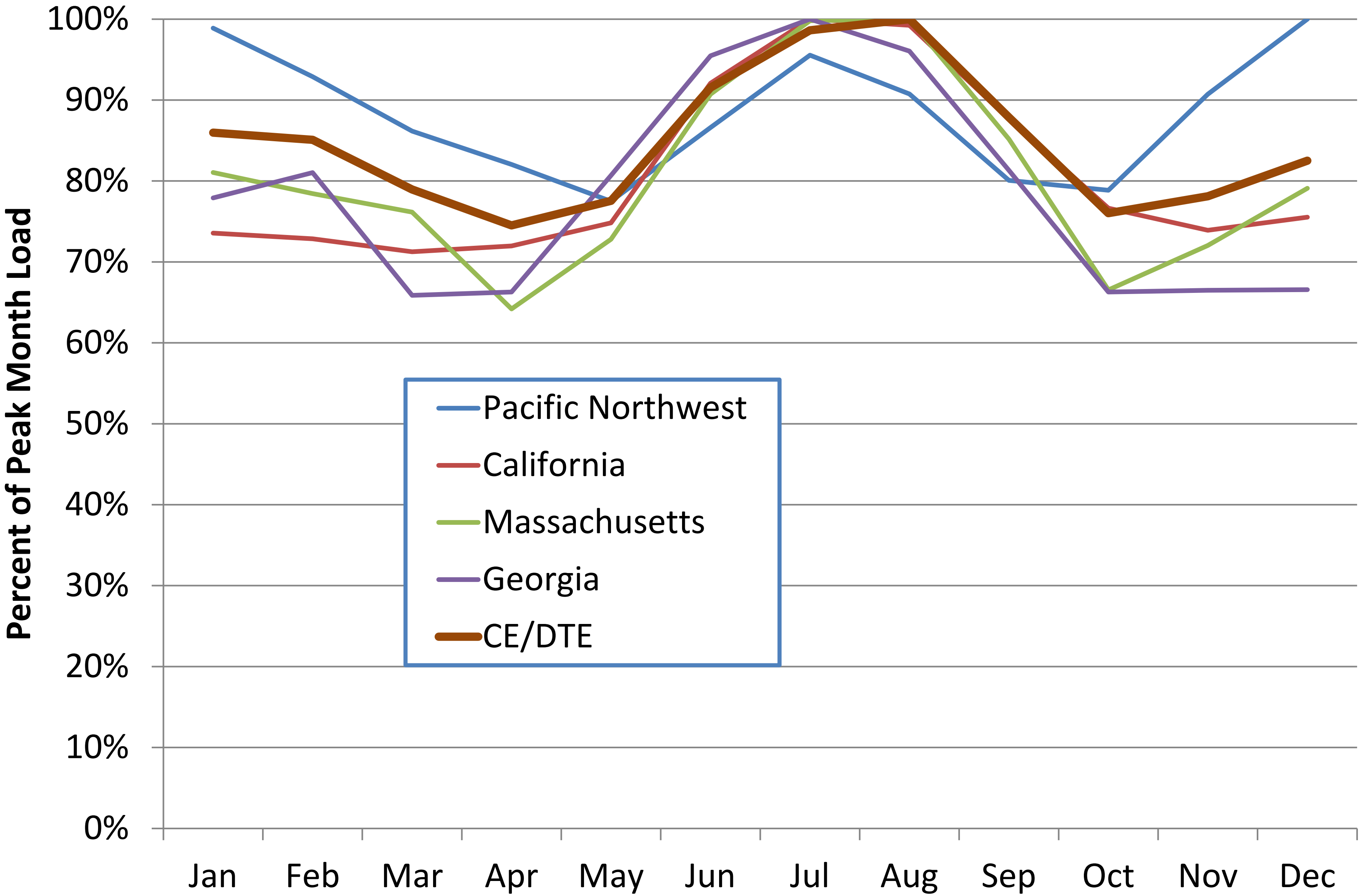
Study Approach

- Document time-varying energy (TVE) and demand impacts of five measures in Michigan
  - Exit sign (flat load shape)
  - Residential lighting
  - Residential water heating
  - Residential central air conditioning
  - Commercial lighting
- Use publicly available avoided costs and a combination of hourly avoided energy cost and coincidence factors (CF) derived from:
  - DSMore hourly load shapes and CFs derived from DSMore
  - DSMore hourly load shapes with CFs derived from Michigan Energy Measures Database (MEMD)
  - Hourly load shapes from metered data from the Pacific Northwest (PNW) or building simulation modeling
- Compare Michigan TVE results to four locations in prior study

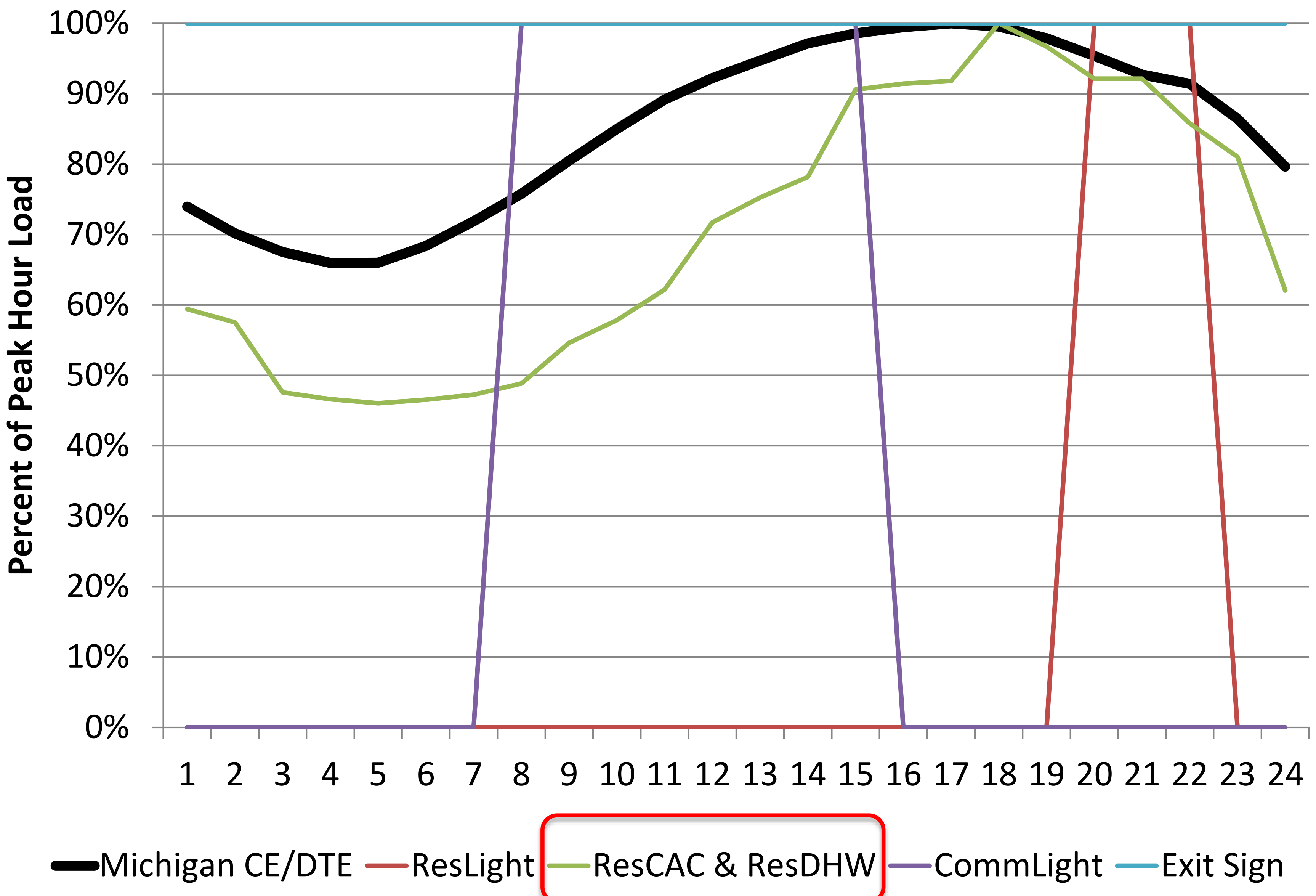
General Methodology

- Average Consumers Energy and DTE Energy system load shapes from 2014-2016 used to represent Michigan hourly load shape to determine system “peak”
- DSMore hourly energy load shapes and 15 year forecast of hourly avoided energy cost used to calculate value of energy (kWh) savings
- Coincidence factors (CF) from Michigan Energy Measures Database and avoided generation capacity, transmission and distribution deferrals, and ancillary services used to calculate capacity (kW) value of energy savings
- Hourly load shapes from Pacific Northwest metering research used to derive energy and capacity value for three end uses: residential lighting, residential water heating and commercial lighting
- Building America simulation model hourly load shapes used to derive energy and capacity value for residential air conditioning

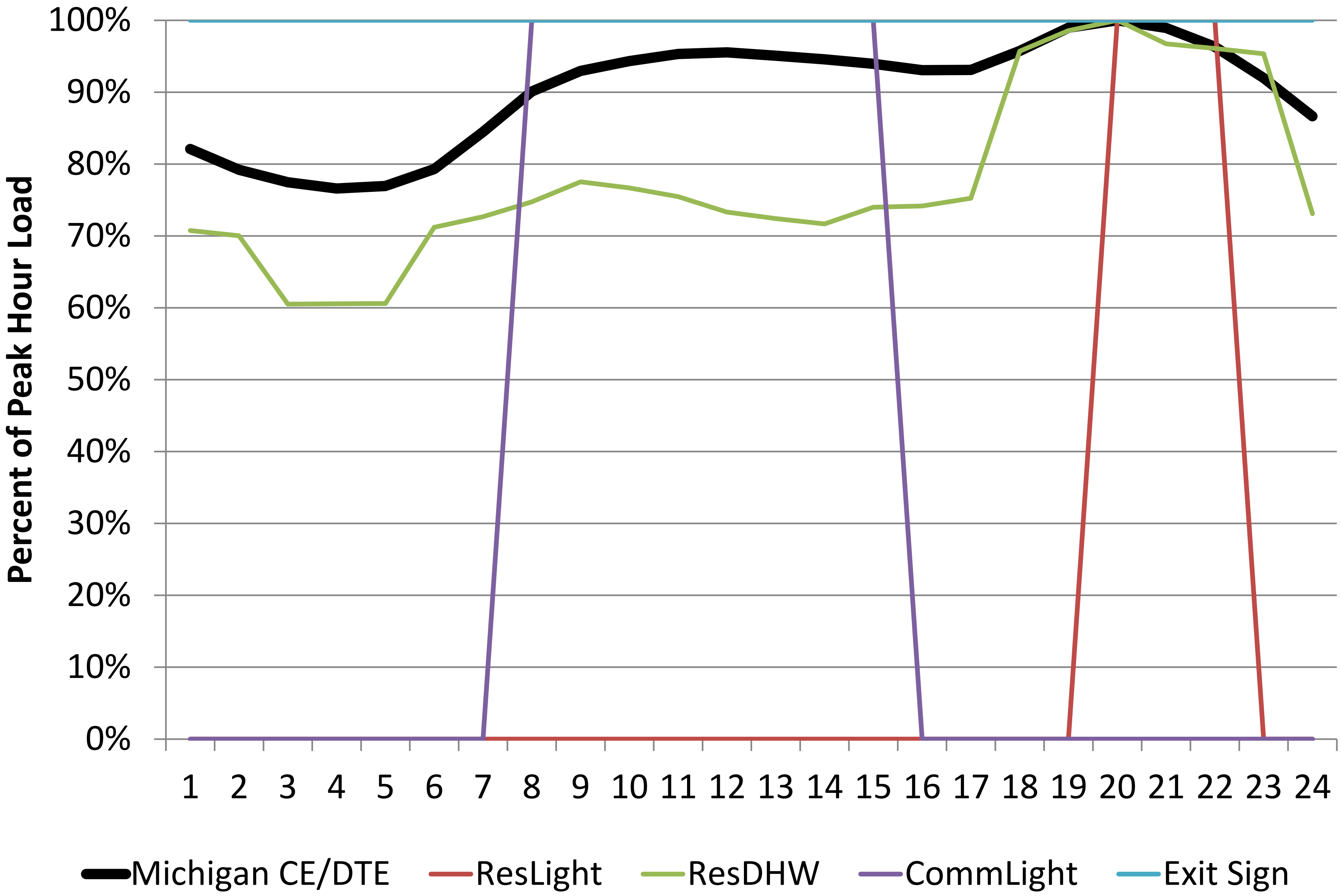
Input: Annual System Load Shapes



Input: CE/DTE Typical Summer Day System Load Shape and DSMore End-Use Load Shapes



Input: CE/DTE Typical Winter Day System Load Shape and DSMore End-Use Load Shapes



Inputs: Avoided Cost

Input Assumption	Value
Real Discount Rate*	3.88%
Expected Measure Life	15 years
Annual Savings (Normalized for all measures)	1000 kWh/yr. (1 MWh)
System Losses	7.08%
Levelized Avoided Energy Cost	Varies by load shape
Levelized Avoided Capacity Cost (2016$)	$71.50 /kW-yr.
Levelized Avoided Transmission and Distribution Cost (2016$)	$80 /kW-yr.
Levelized Avoided Ancillary Service Cost (2016$)	$3.34 /kW-yr.
Avoided CO_2 Cost	$0
Avoided Renewable Portfolio Standard Cost	$0
Avoided Demand Reduction Induced Price Effect (DRIPE)	$0
Avoided Risk	$0

Inputs: Coincident Peak Capacity Reduction

	Michigan Energy Measures Data Base (MEMD)			PNW Metered		
End Use	**Coincidence Factor**	**Maximum Non-Coincident Demand (MW)**	**Coincident Peak Load Reduction (MW/MWh)**	**Coincidence Factor**	**Maximum Non-Coincident Demand (MW)**	**Coincident Peak Load Reduction (MW/MWh)**
Residential Lighting	0.10	0.98	0.098	0.25	0.31	0.08
Residential Water Heating	0.71	0.25	0.178	0.21	0.40	0.08
Exit Sign (Flat)	1.00	0.12	0.122	1.00	0.12	0.12

Inputs: Coincident Peak Capacity Reduction

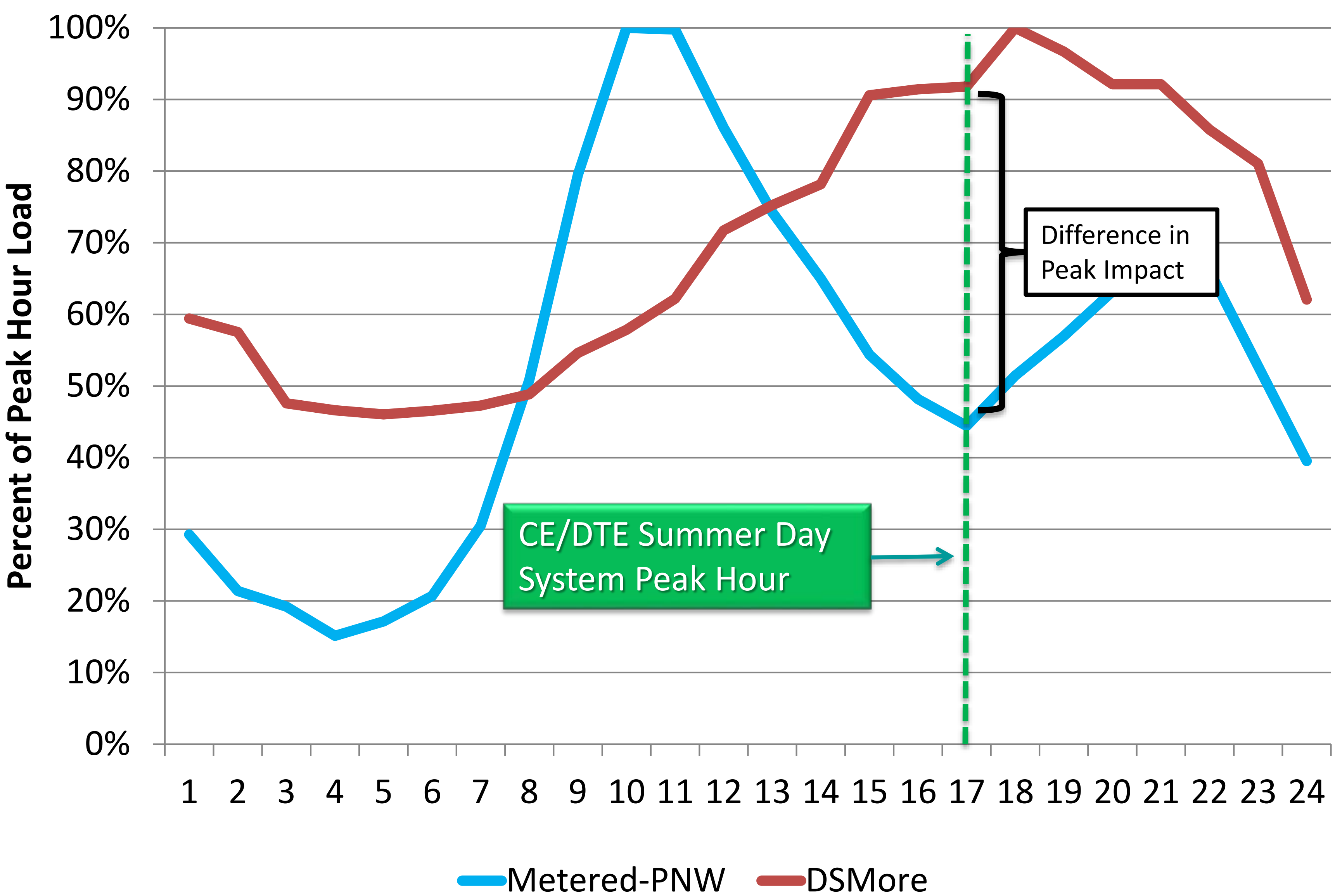
	Michigan Energy Measures Data Base (MEMD)			PNW Metered*		
End Use	**Coincidence Factor**	**Maximum Non-Coincident Demand (MW)**	**Coincident Peak Load Reduction (MW/MWh)**	**Coincidence Factor**	**Maximum Non-Coincident Demand (MW)**	**Coincident Peak Load Reduction (MW/MWh)**
Residential Central Air Conditioning	0.72	0.75	0.543			
Residential Central Air Conditioning - Lansing				0.49	7.28	3.59
Residential Central Air Conditioning - Detroit				0.53	4.41	2.35
Residential Central Air Conditioning - RBSA				0.36	2.29	0.83
Residential Central Air Conditioning - ELCAP				0.48	2.91	1.40
Commercial Office Lighting	0.49	0.37	0.180			
Commercial Office Lighting - CEC				0.76	0.29	0.22
Commercial Office Lighting - ELCAP				0.52	0.28	0.14

*Residential CAC for Lansing and Detroit derived from Building America building simulations

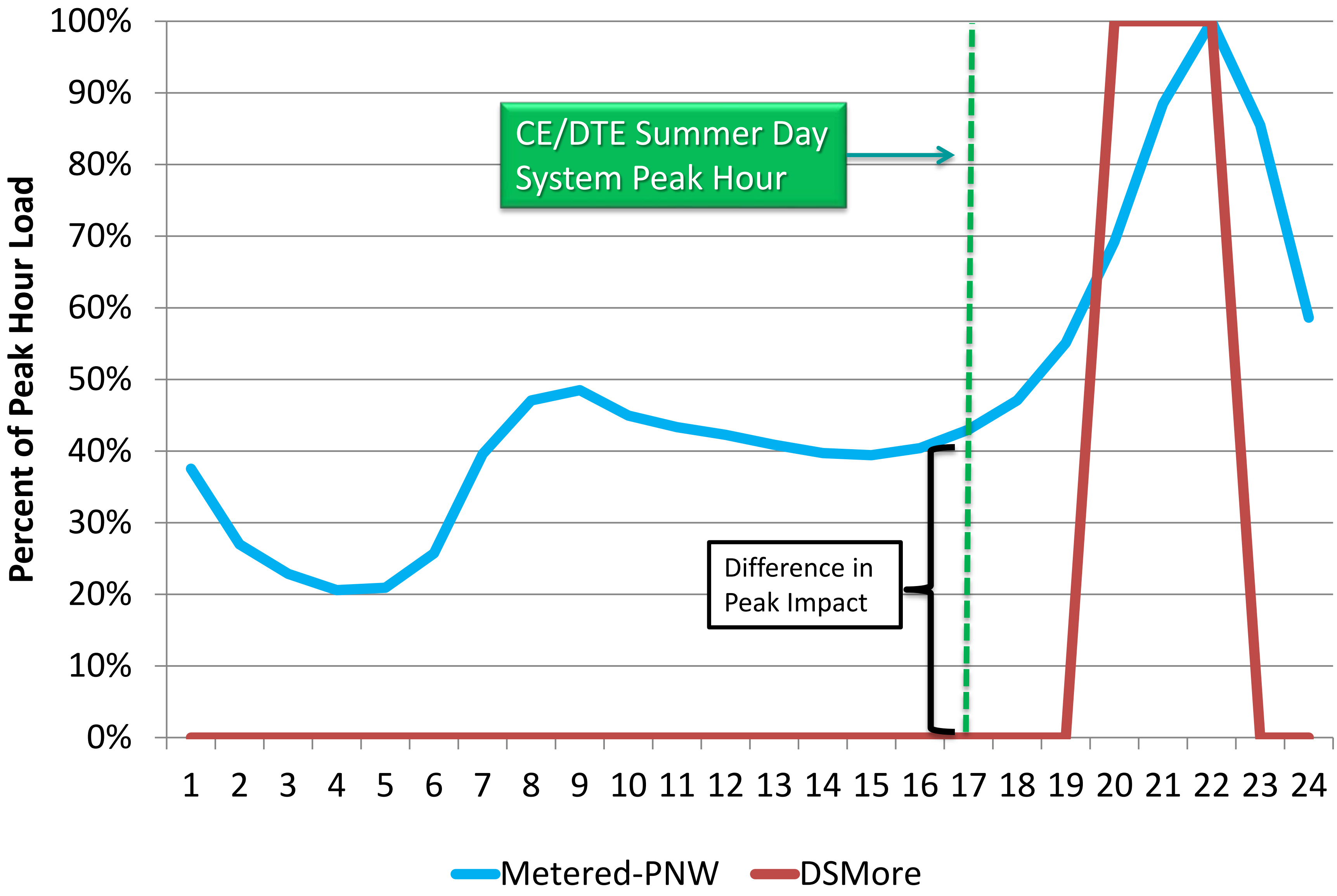
Inputs: Coincident Peak Capacity Reduction

End Use (Source of data, if applicable)	Coincidence Factor	Maximum Non-Coincident Demand (MW)	Coincident Peak Load Reduction (MW/MWh)	Source
Residential				
Lighting	0.10	0.98	0.10	Michigan Energy Measures Database
Lighting (RBSA)	0.25	0.31	0.08	Metered or Simulated Load Shapes
Water Heating	0.71	0.25	0.18	Michigan Energy Measures Database
Water Heating (RBSA)	0.21	0.40	0.08	Metered or Simulated Load Shapes
Central Air Conditioning (CAC)	0.72	0.75	0.54	Michigan Energy Measures Database
CAC – Lansing (Building America)	0.49	7.28	3.59	Metered or Simulated Load Shapes
CAC – Detroit (Building America)	0.53	4.41	2.35	
CAC – (RBSA)	0.36	2.29	0.83	
CAC – (ELCAP)	0.48	2.91	1.40	
Commercial				
Exit Sign (Flat)	1.00	0.12	0.12	Michigan Energy Measures Database
Office Lighting	0.49	0.37	0.18	
Office Lighting – California Energy Commission (CPUC)	0.76	0.29	0.22	Metered or Simulated Load Shapes
Office Lighting – (ELCAP)	0.52	0.28	0.14	

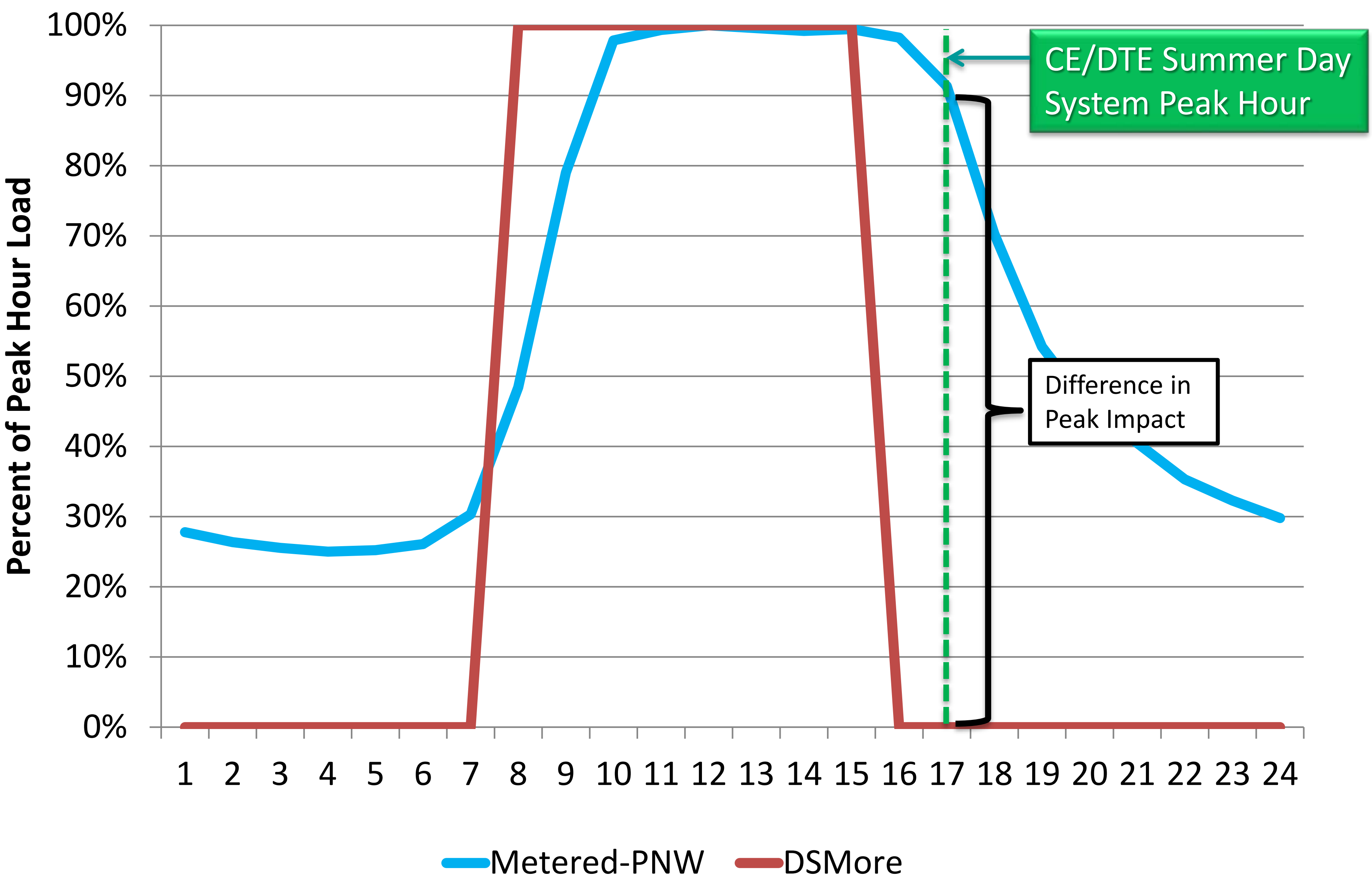
DSMore Typical Summer Day Load Shapes Compared to Metered Residential Water Heating End-Use Load Shapes



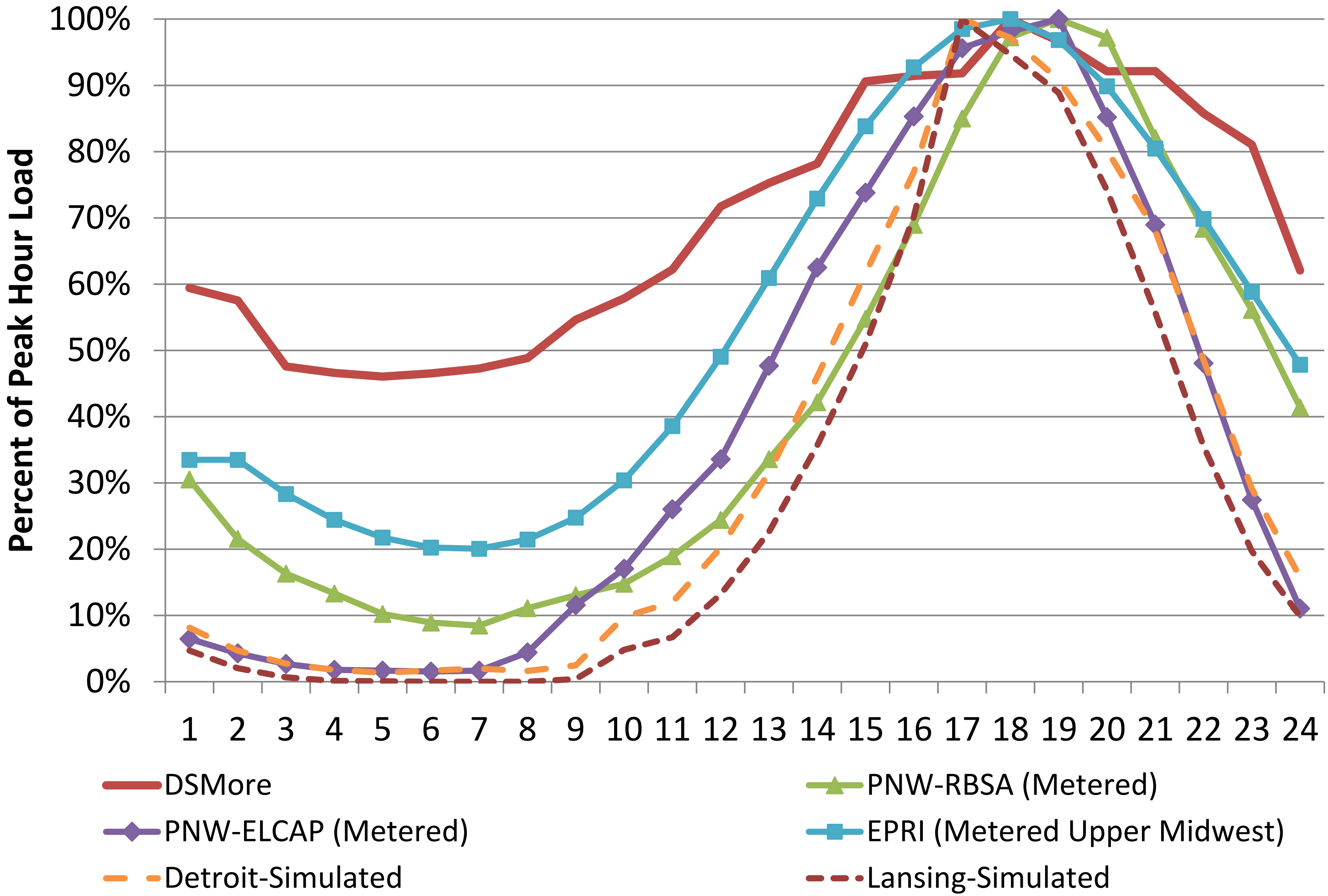
DSMore Typical Summer Day Load Shapes Compared to Metered Residential Lighting End-Use Load Shapes



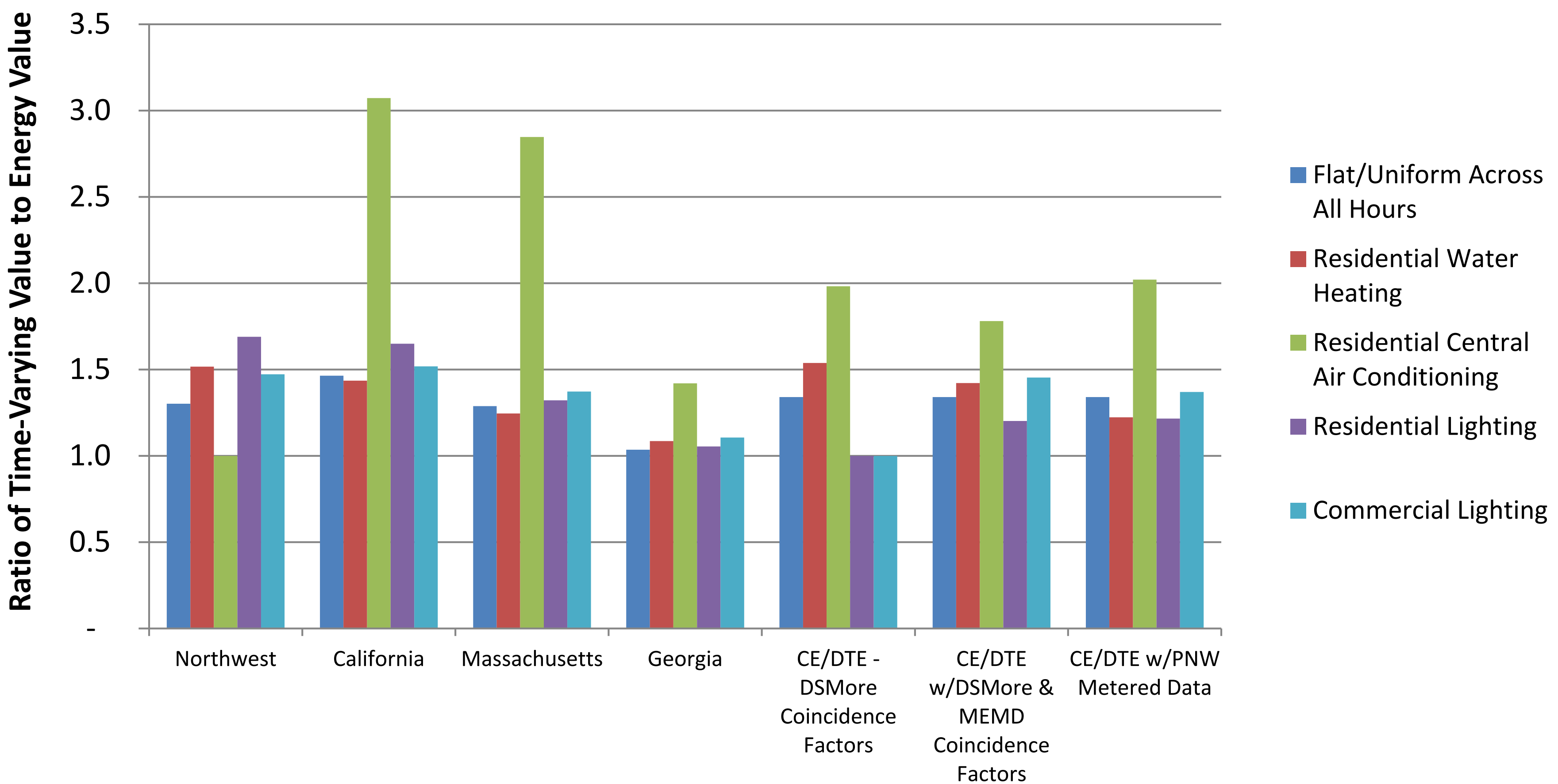
DSMore Typical Summer Day Load Shapes Compared to Metered Commercial Lighting End-Use Load Shapes



DSMore Typical Summer Day Load Shapes Compared to Simulated Residential Central AC End-Use Load Shapes

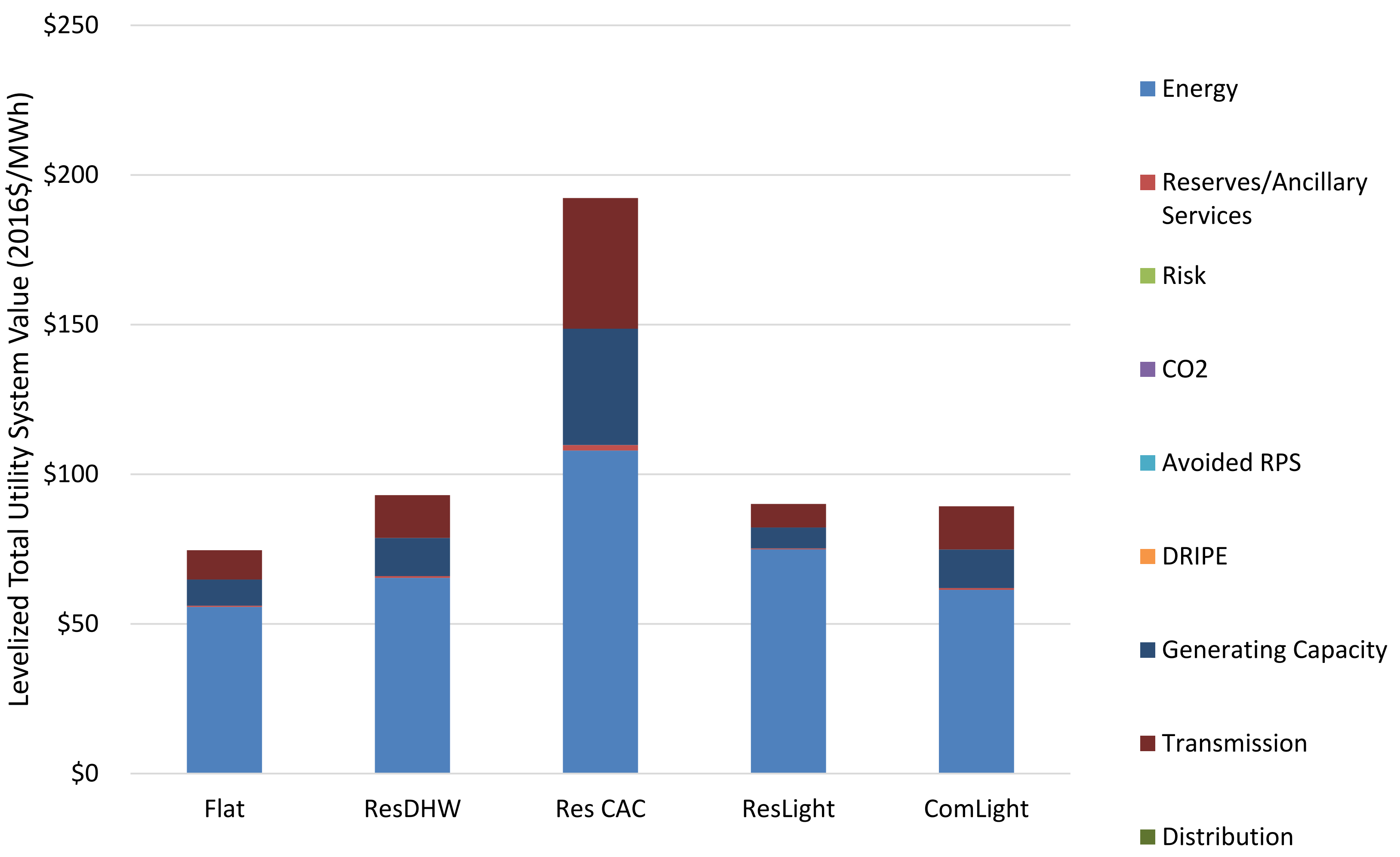


Results: Total Utility System Value of Savings Compared to Only Their Energy Value



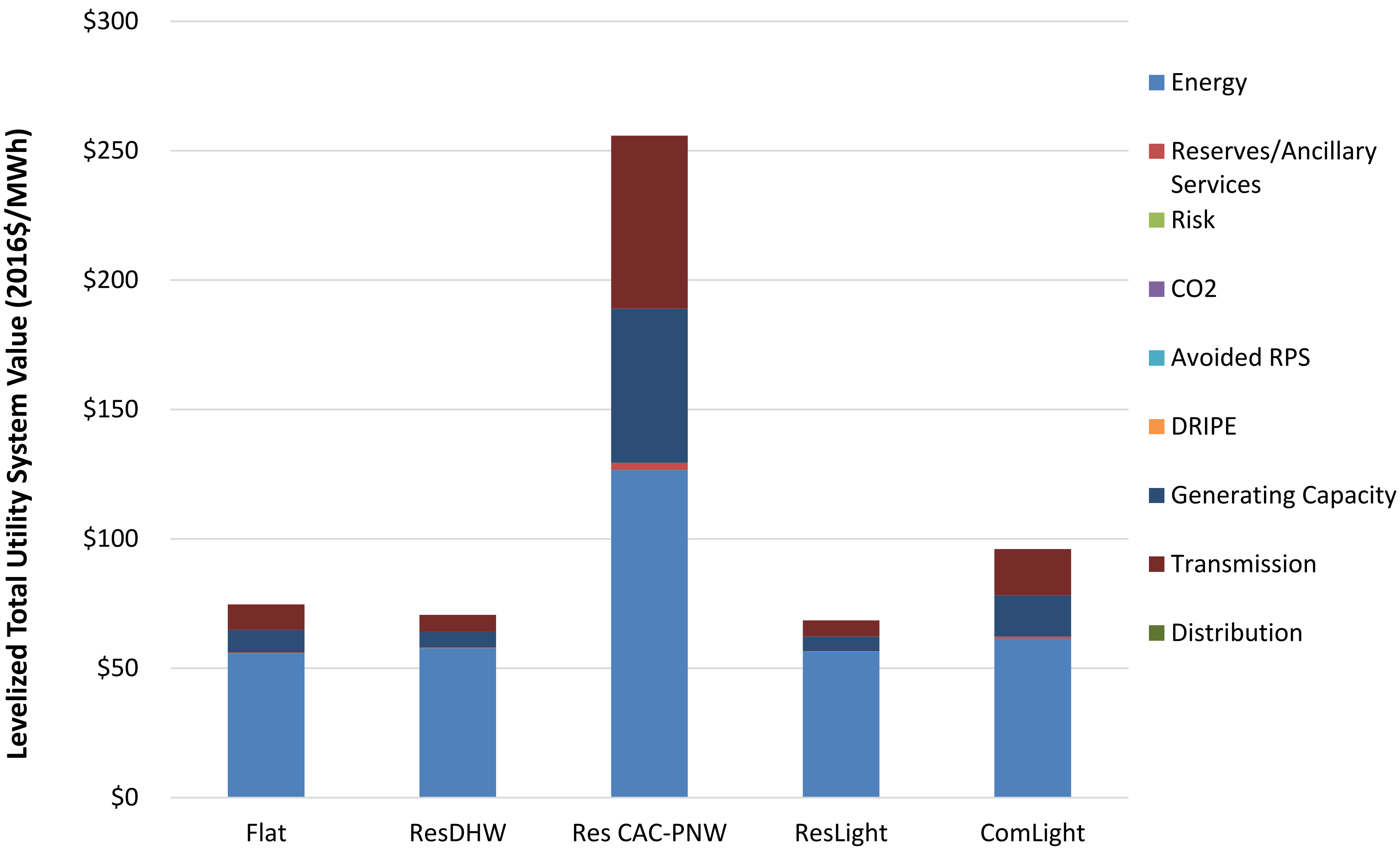
Notes: The flat load shape is an exit sign. Energy value includes: energy, risk, carbon dioxide emissions, avoided RPS and DRIPE, as applicable. Total time-varying value includes all energy values and capacity, transmission, distribution and spinning reserves. Ratios are calculated by dividing total time-varying values by energy-only values.

Results: Total Value
DSMore Load Shapes and MEMD Coincidence Factors



Note: Avoided Transmission cost also include avoided cost of distribution

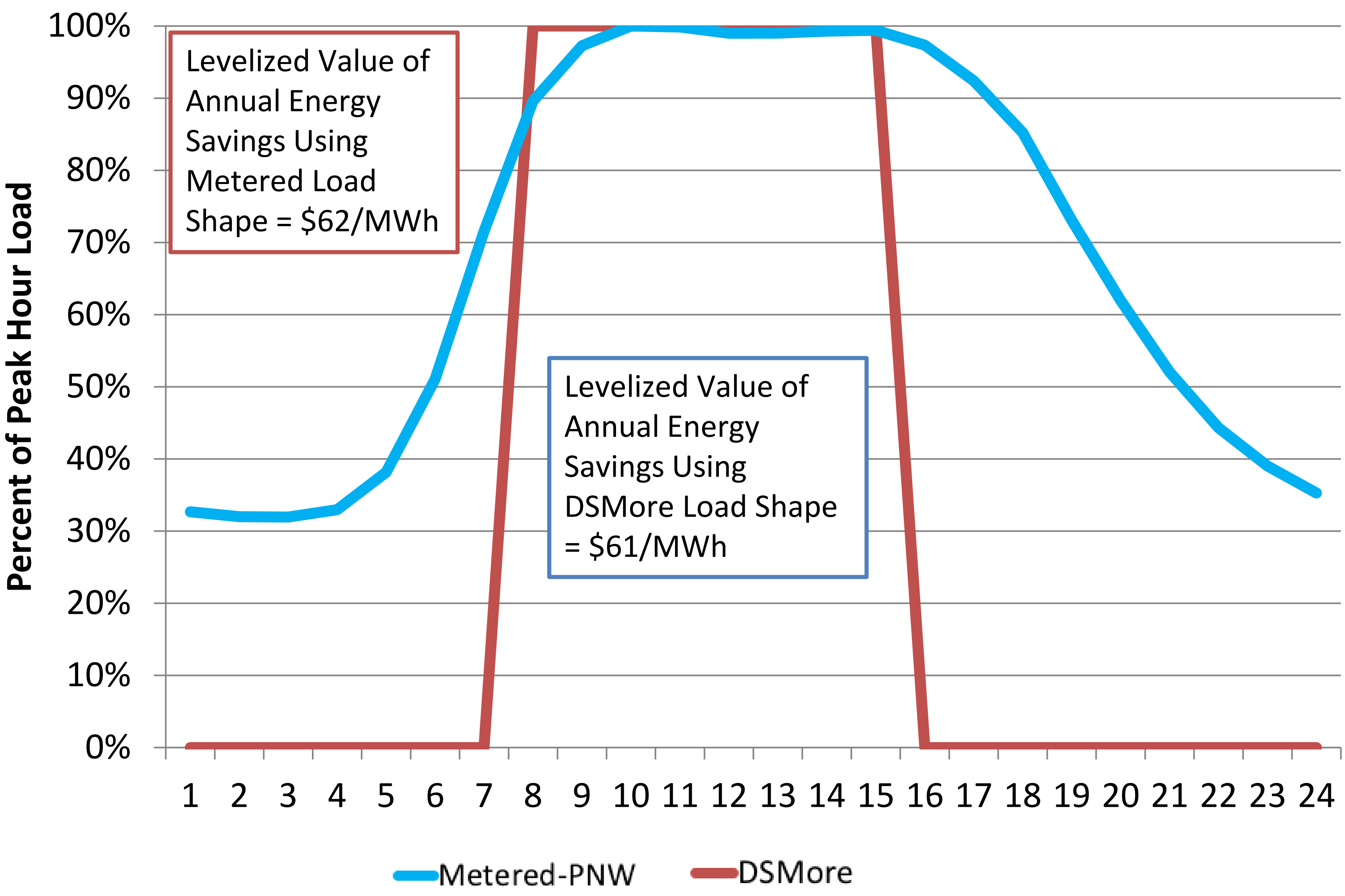
Results: Total Value
Metered Load Shapes and Coincidence Factors



Note: Avoided Transmission cost also include avoided cost of distribution

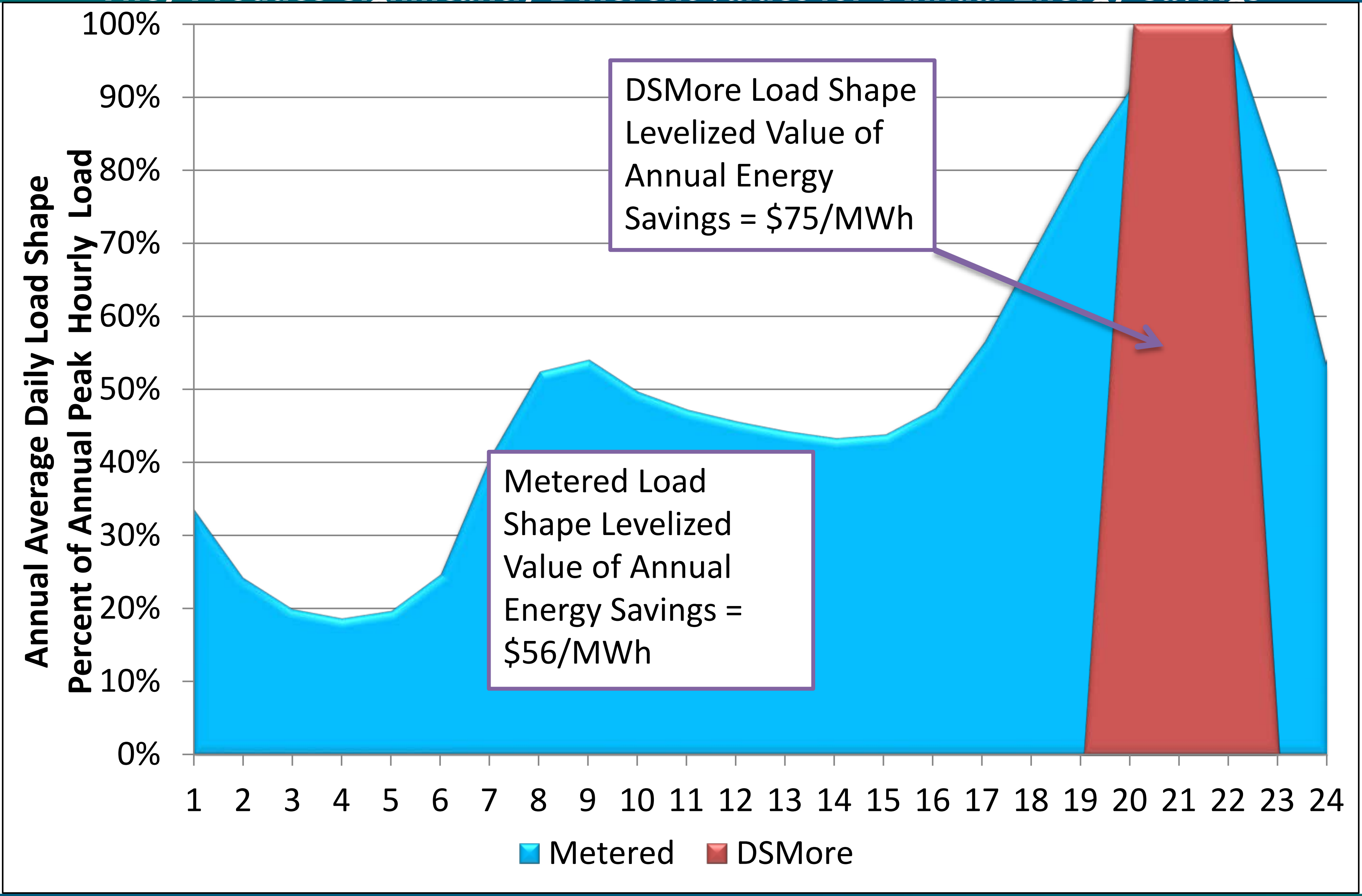
Why Accurate Load Shapes Matter

Example: When DSMore and Metered Commercial End-Use Load Shapes Agree, Both Produce Equivalent Values for Annual Energy Savings



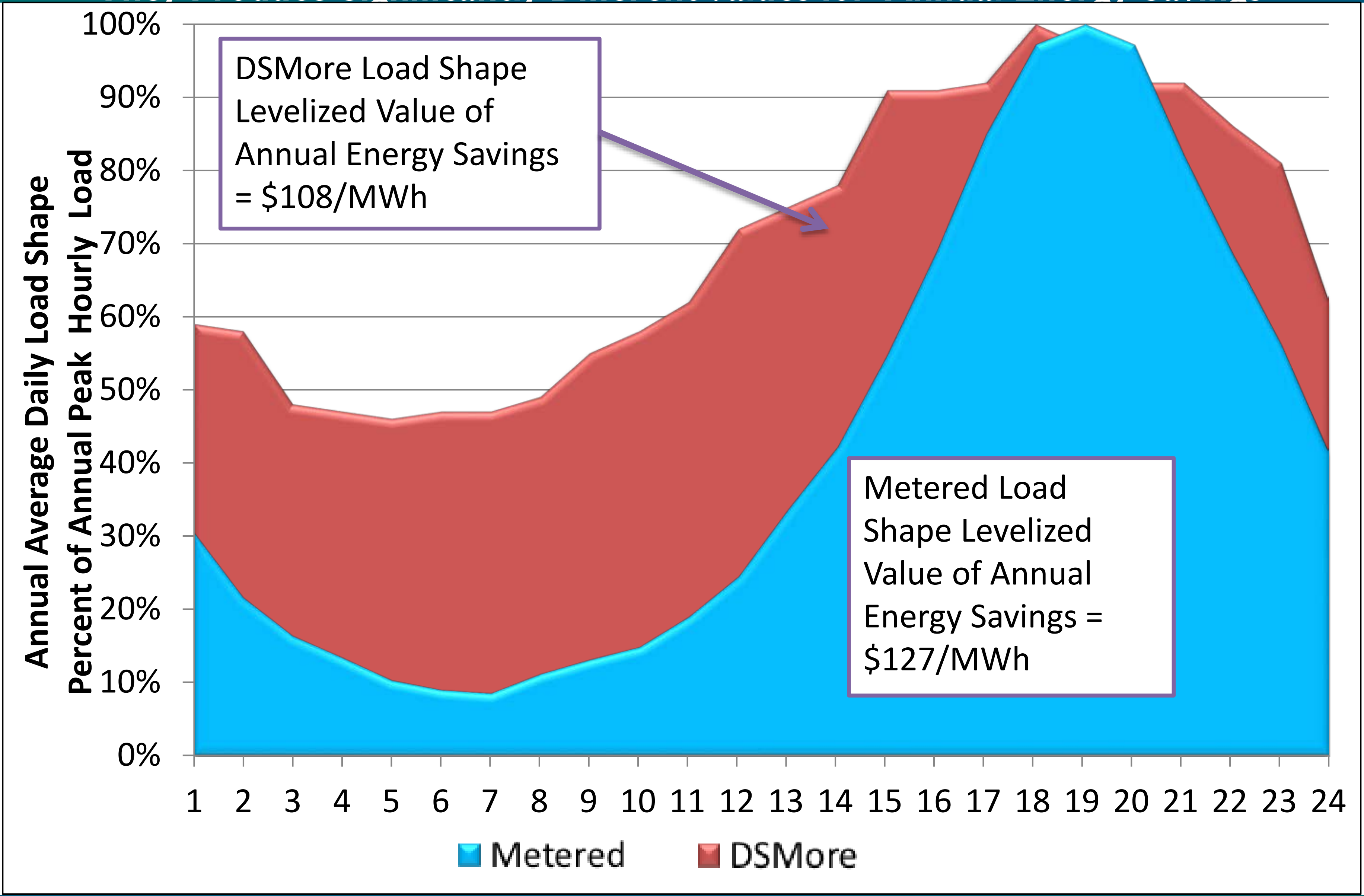
Why Accurate Load Shapes Matter

When DSMore and Metered Load Shapes Residential Lighting Disagree, They Produce Significantly Different Values for Annual Energy Savings



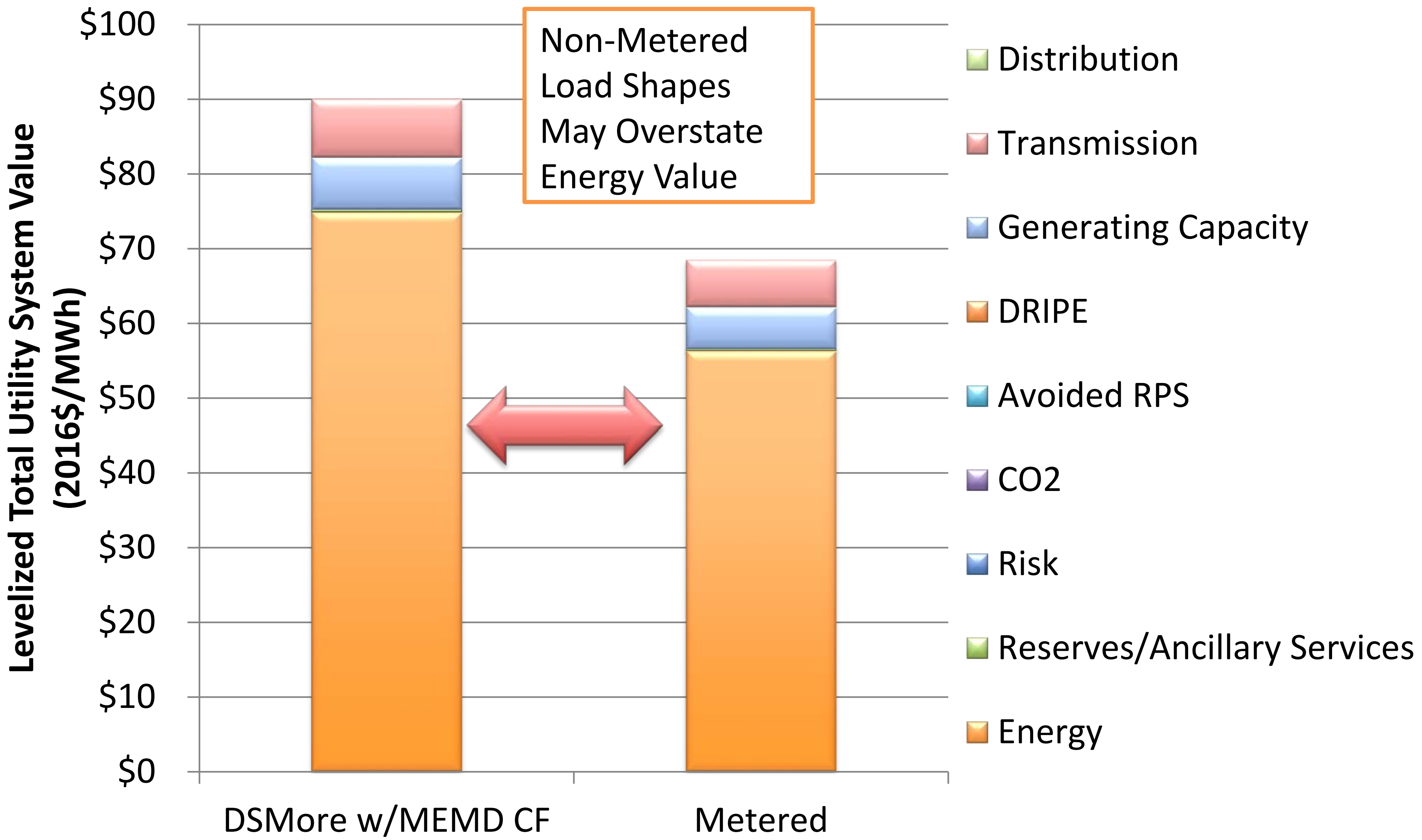
Why Accurate Load Shapes Matter

When DSMore and Metered Load Shapes Residential Air Conditioning Disagree, They Produce Significantly Different Values for Annual Energy Savings

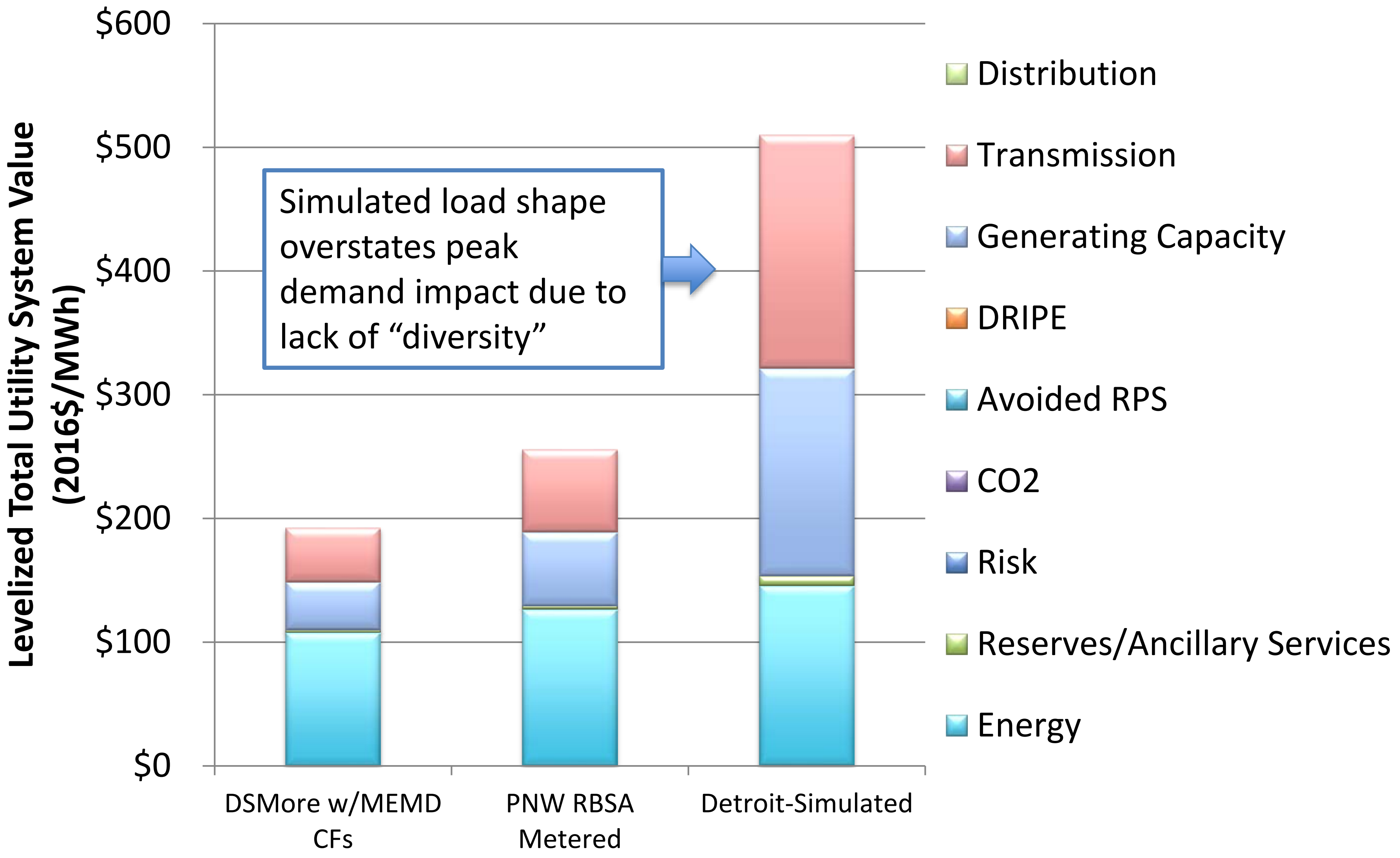


Why Accurate Load Shapes Matter

Example: Valuing Residential Lighting Annual Energy Savings



Why Accurate Load Shapes Matter
Example - Valuing Residential Central AC Capacity Savings



Conclusions (I)

- Overall, the ratio of the <u>total</u> utility system value of energy savings to their <u>energy-related</u> value in Michigan aligns with other states with similar system load shapes.
- End-use load shape research that is specific to Michigan would enable more accurate analysis of the time-varying value of efficiency.
- Until such time that statistically representative, metered data on end-use load shapes in Michigan are available, data from regions with similar energy consumption characteristics should be considered for adoption (e.g., we used Pacific Northwest end-use load shapes in our analysis because they are based on metered data and are very similar to the end-use load shapes for some measures from the Electric Power Research Institute (EPRI) End Use Load Shape Library that are applicable to Michigan).

Conclusions (2)

- Use of current DSMore load shapes to determine both energy and peak savings may overstate the value of residential water heating savings and understate the value of residential air-conditioning savings.
- Lack of statistically representative metered end-use load shape data for Michigan limits the ability to confidently characterize the time-varying value of energy efficiency savings, especially for weather-sensitive measures such as residential air-conditioning.
- Investigating alternative data sources for the analysis, we found that substitution of simulated end-use load shapes may not accurately represent the hourly distribution of energy use unless the data reflects diversity of occupant behavior.

Conclusions (3)

- Investigation of all value streams for energy efficiency in Michigan will help avoid undervaluing this resource. For the purpose of this analysis, we assumed that there is no value for DRIPE or avoided fuel price risk, air emissions, and RPS compliance costs.
- Prior analysis by Berkeley Lab (Mims et al. 2017) found that in states where avoided cost includes a value for the risk mitigation benefits of energy efficiency, the total value of savings increased by 3-5 percent, depending on load shape. Including DRIPE also increased the value of savings by about 5 percent. For those jurisdictions which include a value for reduced carbon dioxide emissions, the total value of energy savings increased significantly — 6-13 percent in California, 13-28 percent in Massachusetts, and 32-52 percent in the Pacific Northwest.

Technical Brief Available At: http://eta-publications.lbl.gov/sites/default/files/lbnl_tve_michigan_20180402_final.pdf

Natalie Mims

namims@lbl.gov

510-486-7584

Tom Eckman

teckman49@gmail.com

503-803-5047

Lisa Schwartz

lcschwartz@lbl.gov

510-486-6315

Visit our website at: http://emp.lbl.gov/
Click here to join the LBNL Electricity Markets and Policy Group mailing list and stay up to date on our publications, webinars and other events. Follow the Electricity Markets & Policy Group on Twitter @BerkeleyLabEMP