Using Energy Efficiency and Demand Flexibility to Achieve State Energy Goals

Presented by Natalie Mims Frick, Berkeley Lab

Contributions by Lisa C. Schwartz, Berkeley Lab

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Midwestern state energy goals and activities

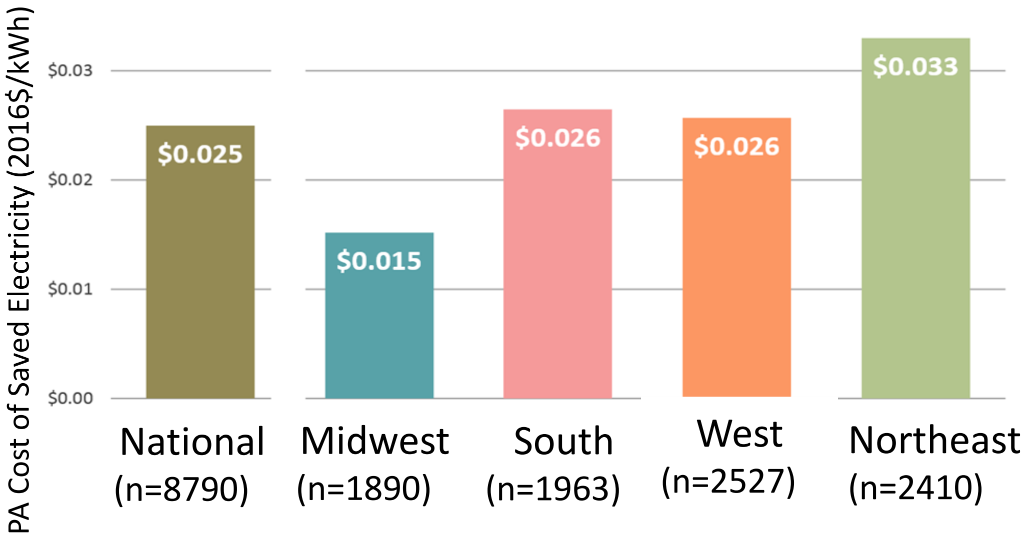
- Many states in the Midwest have established energy efficiency and renewable energy standards or goals and are considering additional provisions.
- Michigan's RPS offers a 2x multiplier for solar and several states have introduced legislation or have open dockets considering storage (next slide).
- Several Midwestern states are participating in national groups that consider the role of distributed energy resources (DERs) in electricity planning and state energy goals:
  - NARUC-NASEO Task Force on Comprehensive Electricity Planning: Minnesota, Michigan, Ohio, Indiana
  - NASEO-NARUC Grid-interactive Efficient Buildings Working Group: Wisconsin, Michigan, Minnesota, Nebraska

Midwestern states energy goals and activities*

	EE	RE	Storage
IL	ComEd- 21.5% cumulative savings by 2030; Ameren – 16% cumulative savings by 2030; Natural gas - 1.5% of sales by 2019	25% by 2026; Bill introduced for 100% RE by 2050	Nextgrid proceeding (2018) recommended action on energy storage legislation and regulation; Clean Energy Jobs Act
IN	-	*10% by 2025*	-
IA	Savings targets for each rate – regulated electric and gas utility	105 MW	-
KS	-	*20% by 2020*	-
KY	*Reduce projected 2025 consumption by 18%*	-	-
MI	1% prior year sales for electricity; 0.75% for natural gas	15% by 2021 with solar multiplier; Bill introduced for 100% RE by 2050	Open PUC docket on interconnection rules including storage
MN	Electricity and natural gas - 1.5% of retail sales annually	26.5% by 2025 (IOUs); 31.5% by 2020 (Xcel); Bill introduced for 100% RE by 2050	Dep't of Commerce +E3 conducting cost-benefit study of storage
MO	*1.9% of total annual energy; 1.0% annual peak demand*	15% by 2021	Draft PSC rules on DER analysis, including storage
NE	-	-	Bill introduced to study T&D infrastructure, including storage opportunities
ND	-	*10% by 2015*	-
OH	1% of prior three year retail sale average**	8.5% by 2026	Bill introduced to allow distribution utilities to offer customer energy services incl. storage
SD	*10% by 2015*		-
WI	1.2% annual retail revenue	10% by 2015; *100% by 2050*	

* Not intended to be comprehensive. **HB 6 amended EERS in OH, ending EE requirement 12/31/20. Sources: MEEA, DSIRE, NCSL. State goals are shown in *italics*.

Energy efficiency is a low-cost resource that can be used to meet state energy goals.



The average cost to utilities to save a kilowatt-hour (kWh) in the United States is 2.5 cents and is less – 1.5 cents – in the Midwest.

Source: LBNL Cost of Saving Electricity

New England Avoided Energy Supply Cost

Avoided RPS Costs by State, 2018$/MWh

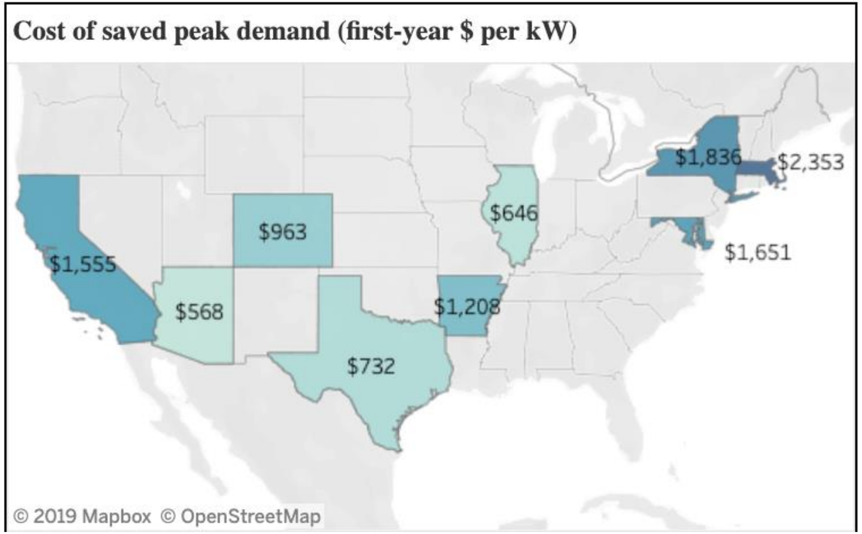
	CT	ME	MA	NH	NJ	VT
Class 1/New	$2.82	$0.21	$1.72	$1.51	$2.39	$0.53
MA CES	NA	NA	$0.45	NA	NA	NA
All Other Classes	$0.94	$0.31	$1.44	$3.43	$0.03	$1.46
Total	$3.76	$0.51	$3.61	$4.94	$2.42	$1.99

Source: AESC 2018

Energy efficiency reduces the cost of compliance with renewable portfolio standards (RPS) (or other state energy goals) by reducing total load.

Energy efficiency also can reduce peak demand.

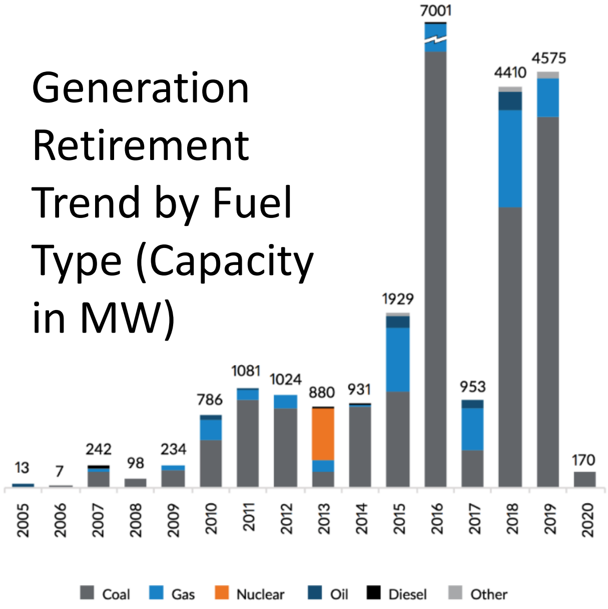
State	Savings-Weighted PA CSPD (2017$/kW)	Savings-Weighted PA CSE (2017$/kWh)
Arizona	568	0.013
Illinois	646	0.020
Texas	732	0.021
Colorado	963	0.020
Arkansas	1,208	0.030
California	1,555	0.036
Maryland	1,651	0.036
New York	1,836	0.025
Massachusetts	2,353	0.039
All Nine States (average)	**1,483**	**0.029**



Source: LBNL [Peak Demand Impacts of Efficiency]

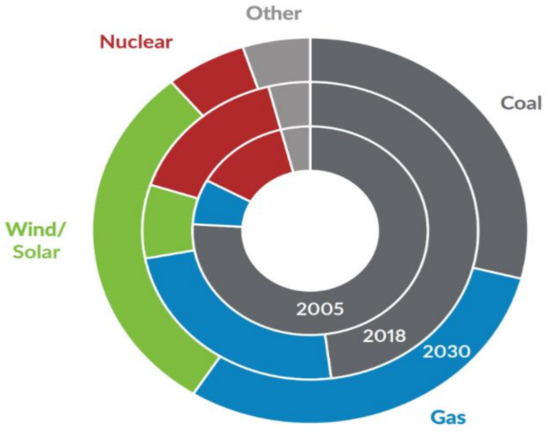
The electricity mix is changing and requires changes in grid operations.

Generation Retirement Trend by Fuel Type (Capacity in MW)

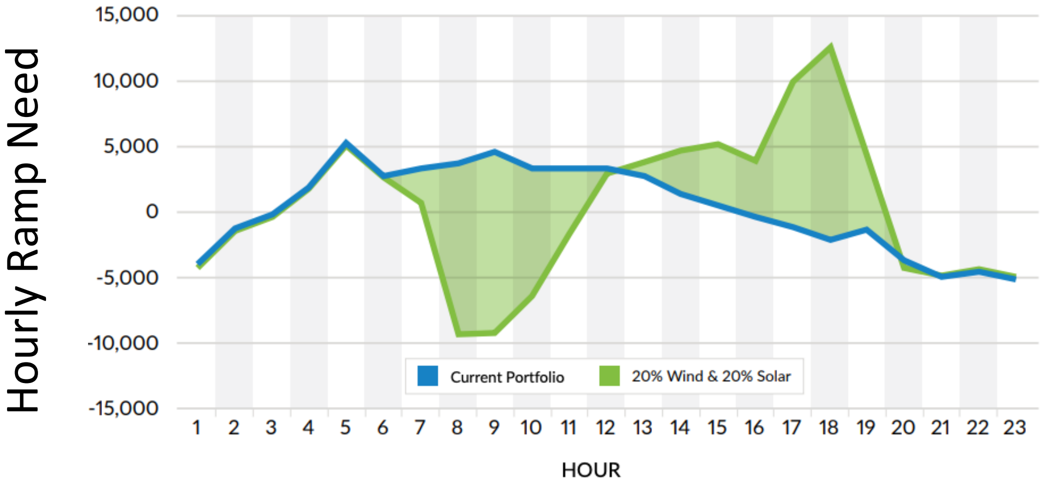


MISO Energy Mix Transition from 2005 to 2018 to 2030

Notes: based on utility announcements and state IRPs. Chart reflects ratio of generation.

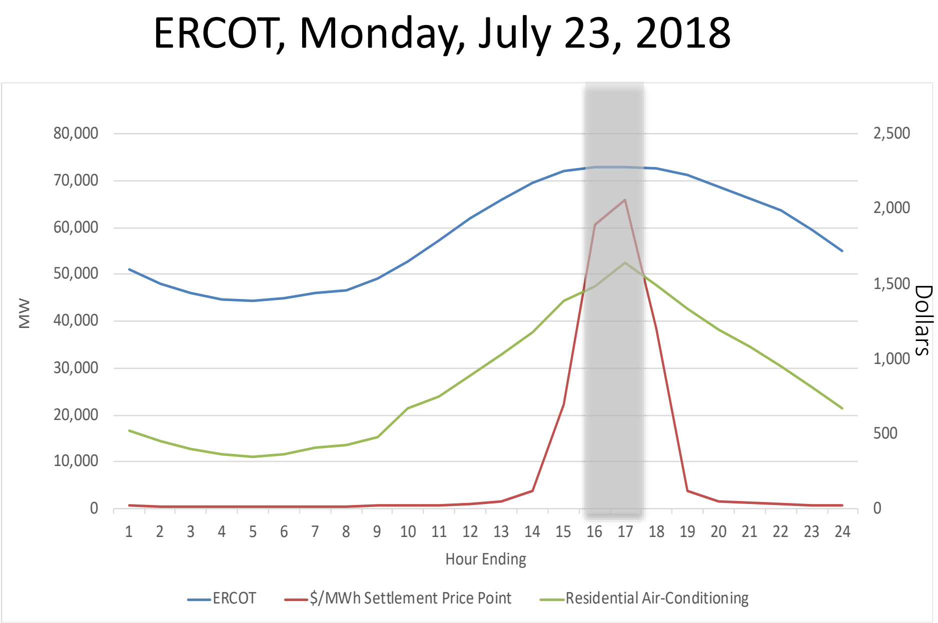


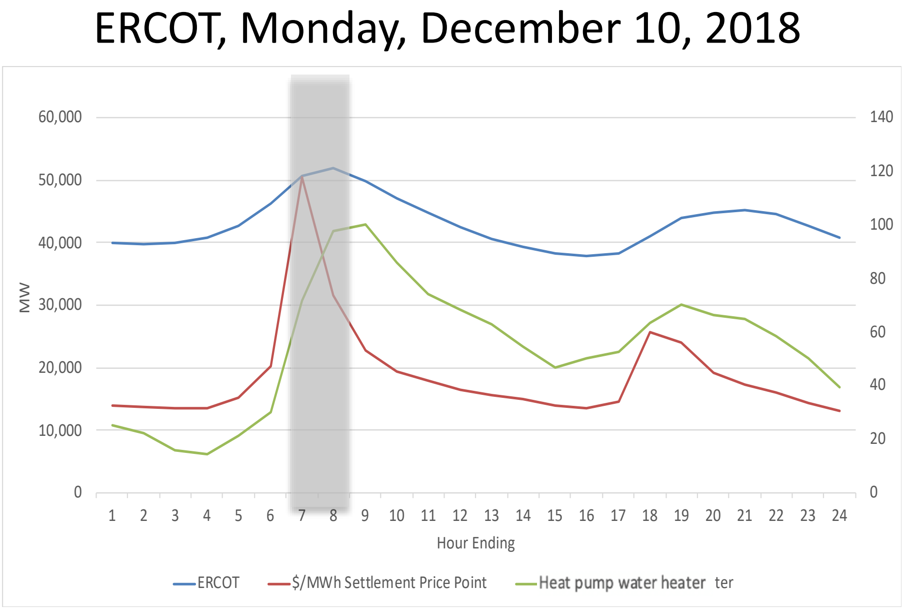
The evolving portfolio requires increased and more dynamic ramp capabilities.



Sources: MISO, MISO

When energy savings occur is increasingly important (1)





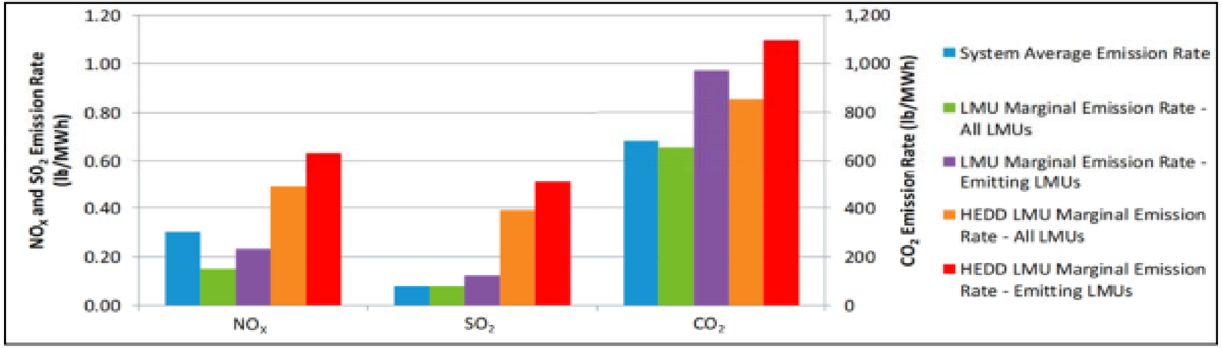
Time-sensitive value of energy efficiency (TSV-EE) considers *when* energy efficiency occurs and the *economic value* of the energy or demand savings to the electricity system at that time.

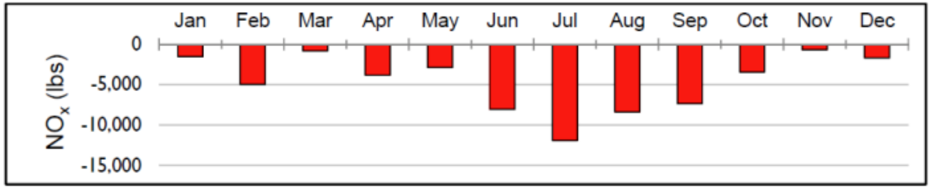
Source: ERCOT system, ERCOT price, Texas air-conditioning load shape

When energy savings occur is increasingly important (2)

Comparison of 2017 ISO New England Emissions Rates (ISO-NE 2019)

- LMU: Locational marginal unit
- All LMUs: includes all LMUs identified by the locational marginal price
- Emitting LMUs: excludes all non-emitting units with no associated air emissions (e.g., hydro, nuclear, solar)
- HEDD: High electric demand day

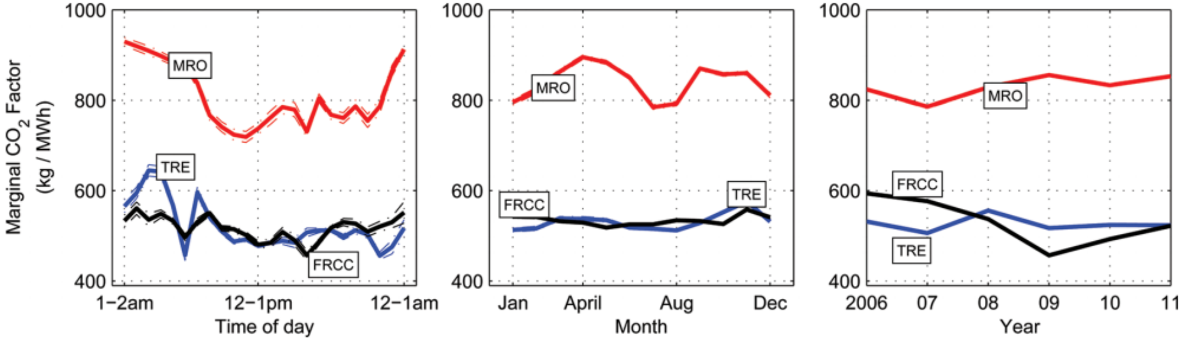




Monthly NOx Reductions in 2015 from Renewables in Clark County, NV (EPA 2018)

Marginal Emissions Factors for the U.S. Electricity System (Siler-Evans, Azevendo and Morgan 2012)

- MRO: Midwest
- TRE: Texas
- FRCC: Florida



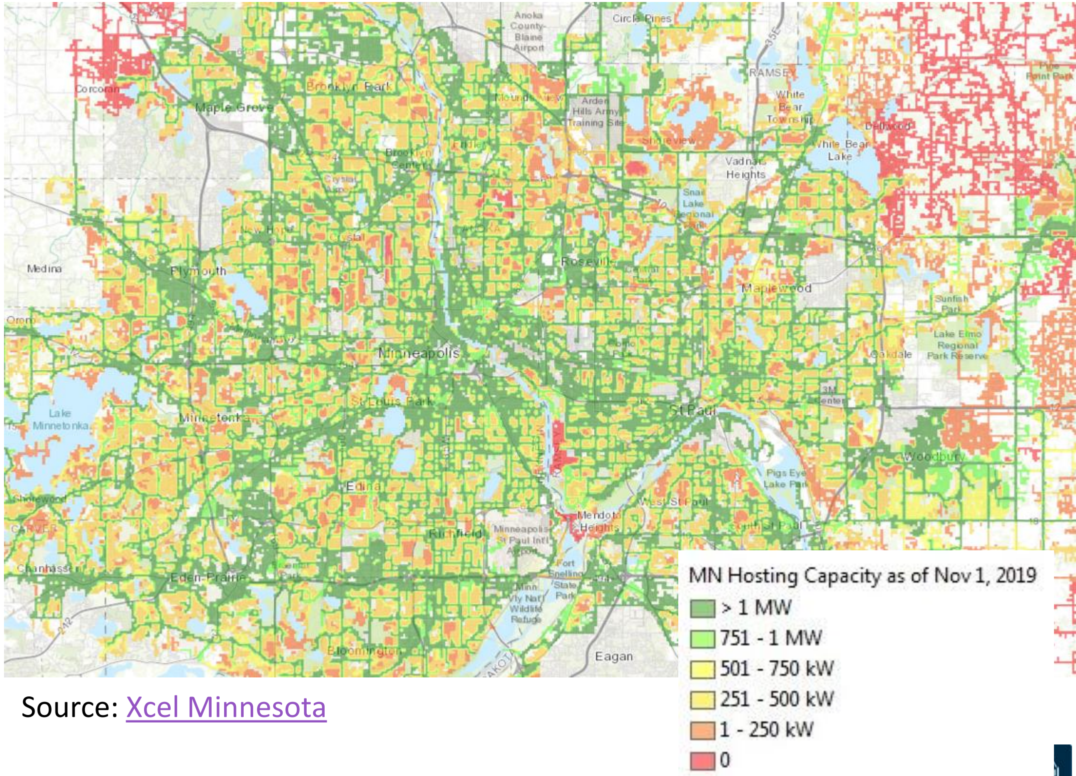
Where efficiency and demand flexibility occur are increasingly important

Demand flexibility is the capability of DERs to adjust demand profiles across different timescales.

Hosting capacity is the amount of DERs (e.g., solar) that can be interconnected without adversely impacting power quality or reliability under existing control and protection systems and without infrastructure upgrades.

This map indicates areas where only limited (orange) or no (red) solar can be installed without infrastructure upgrades or additional demand flexibility.

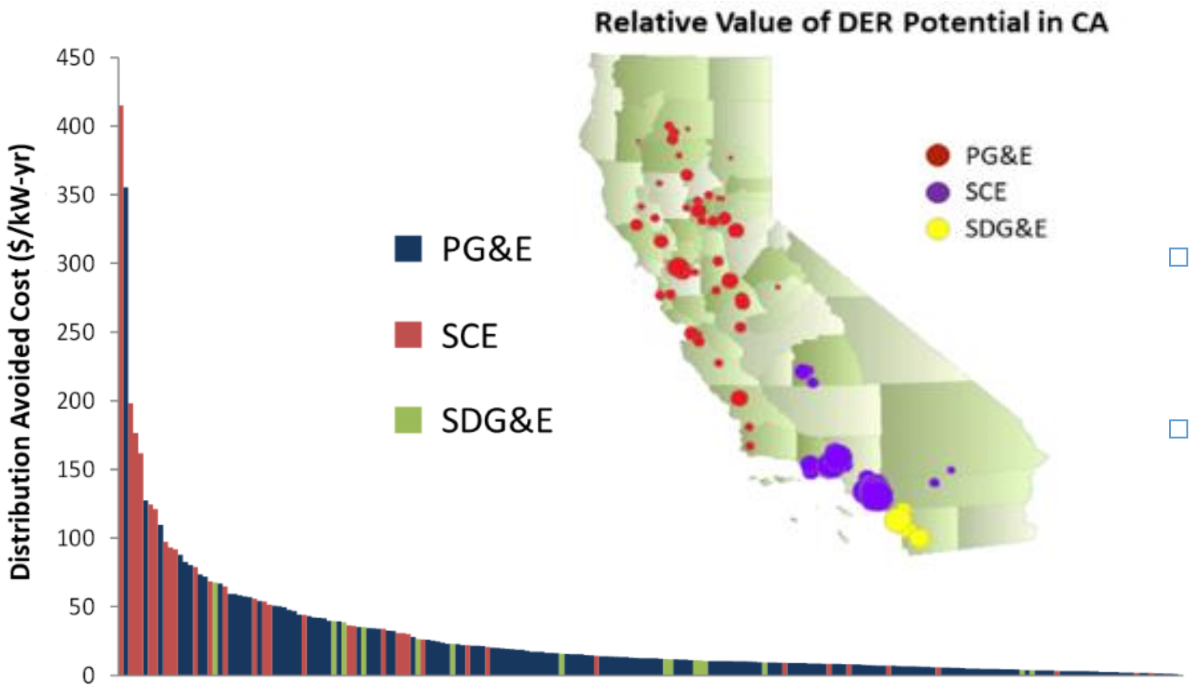
Minneapolis Hosting Capacity Map



Source: [Xcel Minnesota]

Where efficiency occurs impacts resource value.

- The 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.
- 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.

E3 study for California using utility distribution planning information

Efficiency and demand response can be used to defer distribution system upgrades.

Consumers Energy: Energy Savers Club

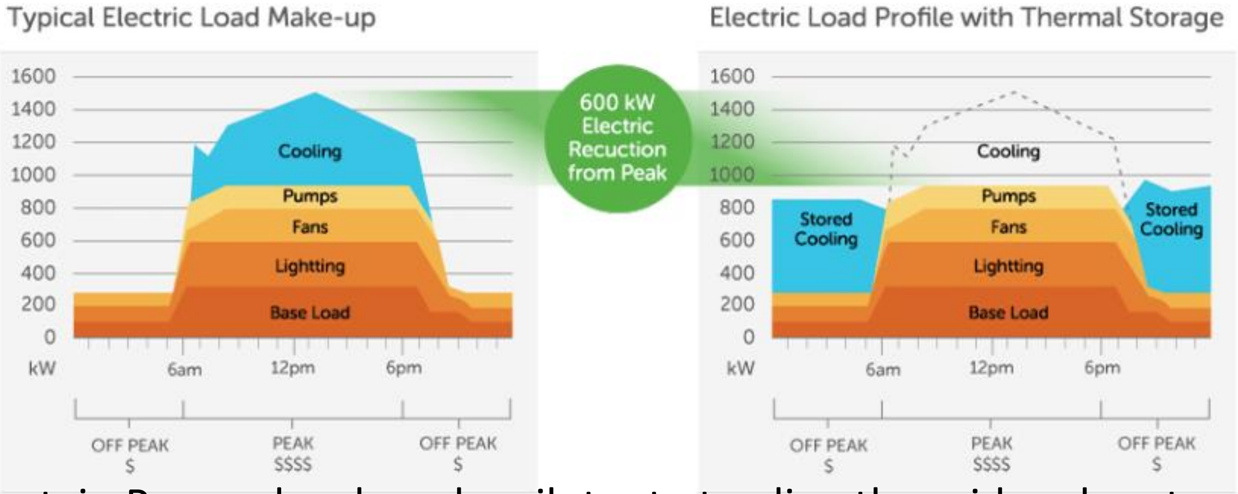
- Swartz Creek substation transformer peak loadings: 92%, 94%, 80%, 79%, and 85%, respectively from 2012 through 2016
  - Need for capacity upgrade was not immediate
  - Allowed time to test NWAs
- Energy Savers Club pilot program to reduce energy load on substation
  - Tests role that intentional targeting 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
- In 2018, the Energy Savers Club had ~500 residential and business customers registered. The program saved 110 kW at the substation and 223 kW throughout the zip code.
- Consumers Energy and NRDC collaborated on a second pilot in 2019.

Sources: *Consumers Energy's Electric Distribution Infrastructure Investment Plan (2018-22)*, March 1, 2018; Consumers Energy's 2018 Energy Waste Reduction Annual Report , May 31, 2019.

Efficiency, demand flexibility and rate design can be used to align grid and customer benefits.

Efficiency Vermont, Green Mountain Power and Dynamic Organics

Brattleboro Retreat Flexible Load Management



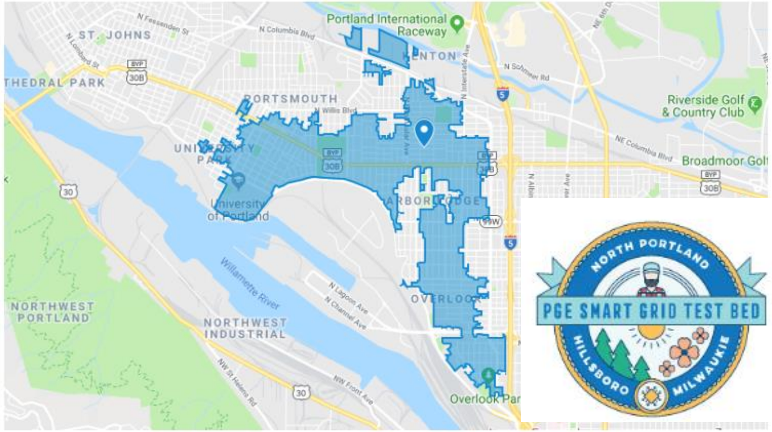
- Green Mountain Power developed a pilot rate to align the grid and customer benefits from flexible load management.
- Created a financial incentive to utilize the ice storage system to reduce peak use, in a way that would be more beneficial than simply shutting down ice production.
- Conducting 10 additional pilots based on Brattleboro Retreat project

Source: Efficiency Vermont

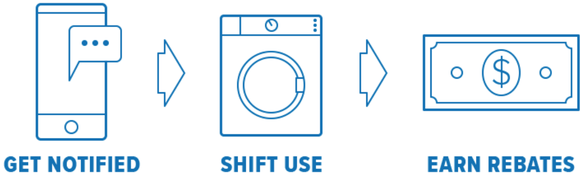
Efficiency and demand flexibility can be used to meet capacity needs.

PGE Smart Grid Test Bed

- Demand flexibility during peak events
- Systemwide, targeting 69 MW of demand flexibility in summer and 77 MW in winter to fill a 2021 capacity gap identified in Integrated Resource Plan
- Residential customers
  - Tstats, direct load control, battery storage, heat pump water heaters, EV chargers
  - Testing value propositions
  - Peak time rebate
- Small and medium businesses
  - Direct installation of smart thermostats; plans to add EV charging and storage
  - Coordinating with Energy Trust of Oregon on efficiency and solar incentives



Focusing on neighborhoods served by 3 distribution substations



Efficiency and demand flexibility can help achieve state energy goals.

- In addition to being efficient, achieving state energy goals may mean that buildings (and other loads) also must be flexible. Energy efficiency and demand flexibility can work together to achieve state energy goals at least cost and meet changing grid needs.
- Energy efficiency is a low-cost resource that can be installed when and where grid needs occur.
- Strategies states can consider to achieve their energy goals include:
  - Encourage efficiency measures that use smart controls, leverage building energy management systems, and enable demand response (e.g., smart programmable thermostats, grid-interactive water heaters, demand response-enabled variable frequency drives).
  - Consider when and where energy efficiency and demand flexibility are needed and identify measure mixes that can provide those grid needs.
  - Identify and consider all costs and benefits from energy efficiency and other DERs in planning to ensure selection of the least-cost, least-risk resource mix.

Key Actions States (and Local Governments) Can Take to Advance Demand Flexibility	Gov. Office	PUC	SEO	Other Agencies*	City/County	Utilities	RTO/ISO	Bldg. Owners**
1. Gather Information and Identify Opportunities								
Consider how demand flexibility can support goals	●	●	●	●	●	●	●	●
Inventory options and select opportunities for early action	●	●	●	●	●	●	●	●
Participate in pilot projects and share best practices		●	●	●	●	●		●
2. Develop and Implement Strategies in Integrate Demand Flexibility								
Develop a roadmap to advance demand flexibility	●	●	●	●	●	●	●	●
Develop mechanisms to allow building owners, operators, and occupants to earn compensation for providing grid services		●	●			●	●	●
Conduct outreach and education about opportunities and benefits		●	●	●	●	●	●	●
3. Accelerate Adoption								
Assess and remove barriers to advancing demand flexibility in buildings for grid services	●	●	●	●	●	●	●	●
Update economic valuation methods for DERs as energy assets for utility programs, plans and procurements		●				●		●
Establish practices for robust and cost-effective assessments of demand flexibility performance for utility programs and electricity markets		●	●	●	●	●	●	●
Regularly assess and report on progress	●	●	●	●	●	●	●	●

*For example, state departments of general services, codes, environment, economic development, and transportation, and financing authorities.

**Opportunities for owners and operators of privately owned buildings to support state and local activities.

Select LBNL Resources

- State and Local Energy Efficiency Action Network (SEE Action Network). *Grid-Interactive Efficient Buildings: An Introduction for State and Local Governments.* Prepared by L. Schwartz and G. Leventis, Lawrence Berkeley National Laboratory. Forthcoming.
- SEE Action Network. *Determining Utility System Value of Demand Flexibility From Grid-Interactive Efficient Buildings.* Prepared by T. Eckman, L. Schwartz, and G. Leventis, Lawrence Berkeley National Laboratory. Forthcoming.
- SEE Action Network. *Retrospectively Assessing Demand Flexibility Performance of Grid-Interactive Efficient Buildings.* Prepared by S. Schiller, S. Murphy, and L Schwartz, Lawrence Berkeley National Laboratory. Forthcoming.
- T. Woolf, B. Havumaki, D. Bhandari, M. Whited, and L. Schwartz. *Benefit-Cost Analysis for Utility-Facing Grid Modernization Investments.* Lawrence Berkeley National Laboratory. Forthcoming.
- Satchwell, A., P. Cappers, J. Deason, S. Forrester, N. Frick, B. Gerke, and M.A. Piette. *A Conceptual Framework to Describe Energy Efficiency and Demand Response Interactions.* Lawrence Berkeley National Laboratory. Forthcoming.
- Developing and Evaluating Metrics for Demand Flexibility in Buildings: Comparing Simulations and Field Data. Forthcoming.
- Time and locational sensitive value of efficiency
  - Reports: Time-Sensitive Value of Efficiency: Use Cases in Electricity Sector Planning and Programs (2019); Time-varying value of electric energy efficiency (2017); Time-varying value of energy efficiency in Michigan (2018); Locational Value of Distributed Energy Resources. Forthcoming
- End-Use Load Profiles for the U.S. Building Stock - U.S. DOE Building Technologies Office 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.
  - End-Use Load Profiles of the U.S. Building Stock: Market Needs, Use Cases and Data Gaps; End-Use Load Profile Inventory
- Schwartz, L., I. Hoffman, S. Schiller, S. Murphy, and G.Leventis. Cost of Saving Electricity Through Efficiency Programs Funded by Customers of Publicly Owned Utilities: 2012–2017. 2019.
- Schiller, S., I. Hoffman, S. Murphy, G. Leventis and L. Schwartz. 2019. Cost of saving natural gas through efficiency programs funded by utility customers: 2012-2017. Forthcoming
- Peak Demand Impacts from Electricity Efficiency Programs
- Energy Efficiency in Electricity Resource Planning. Forthcoming.

Natalie Mims Frick
nfrick@lbl.gov
510-486-7584

Lisa Schwartz
lcschwartz@lbl.gov
510-486-6315

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