Better Buildings Residential Network Peer Exchange Call Series:

Electrification – What Does It Mean for Energy Efficiency?

December 12, 2019

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
  - **Jessica Shipley**, Regulatory Assistance Project
  - **Emily Levin**, Vermont Energy Investment Corporation
  - **Scott Blunk**, Sacramento Municipal Utility District
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- Jan. 9: Known Unknowns: Key Energy Efficiency Trends in the New Year
- Jan. 23: Going Deep – What Drives Deep Energy Retrofits?
- Feb. 13: Comfort – The Biggest Driver of Residential Energy Efficiency

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Better Buildings

U.S. DEPARTMENT OF ENERGY

Jessica Shipley
Regulatory Assistance Project

U.S. DEPARTMENT OF ENERGY

12 December 2019

Energy Efficiency and Beneficial Electrification

US DOE Better Buildings Residential Network

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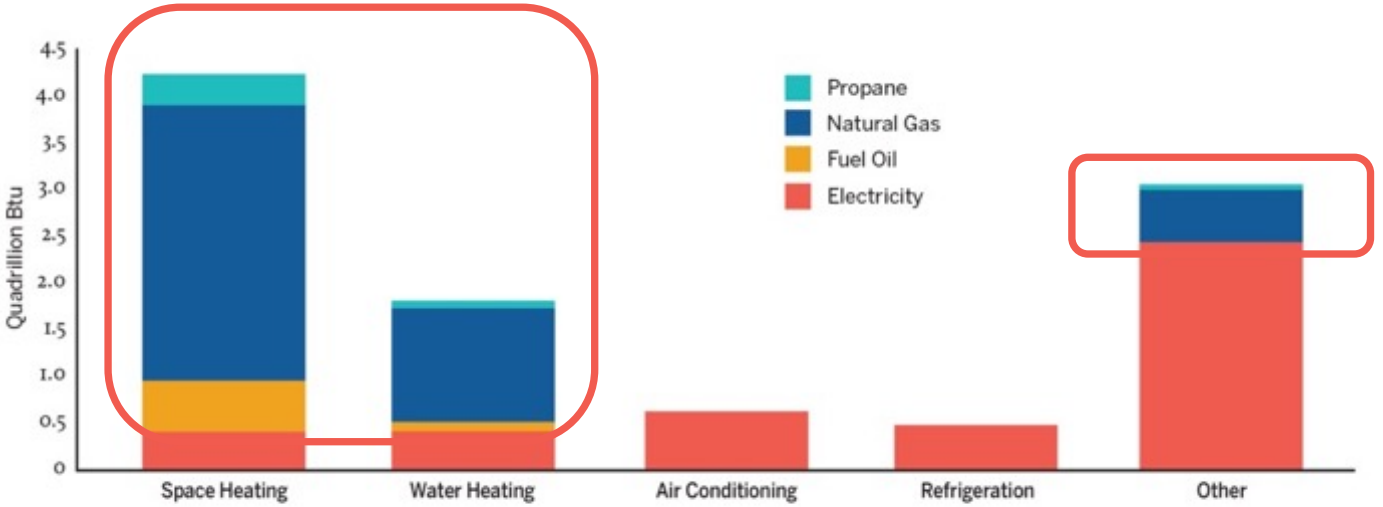
Fuel Choice – 1990

- Wind and solar were not viable economic resources
- Best heat pumps had a coefficient of performance of about 2
- Heat pump water heaters were not commonly available
- Best natural gas generating plants had about 42% conversion efficiency

Fuel Choice Today

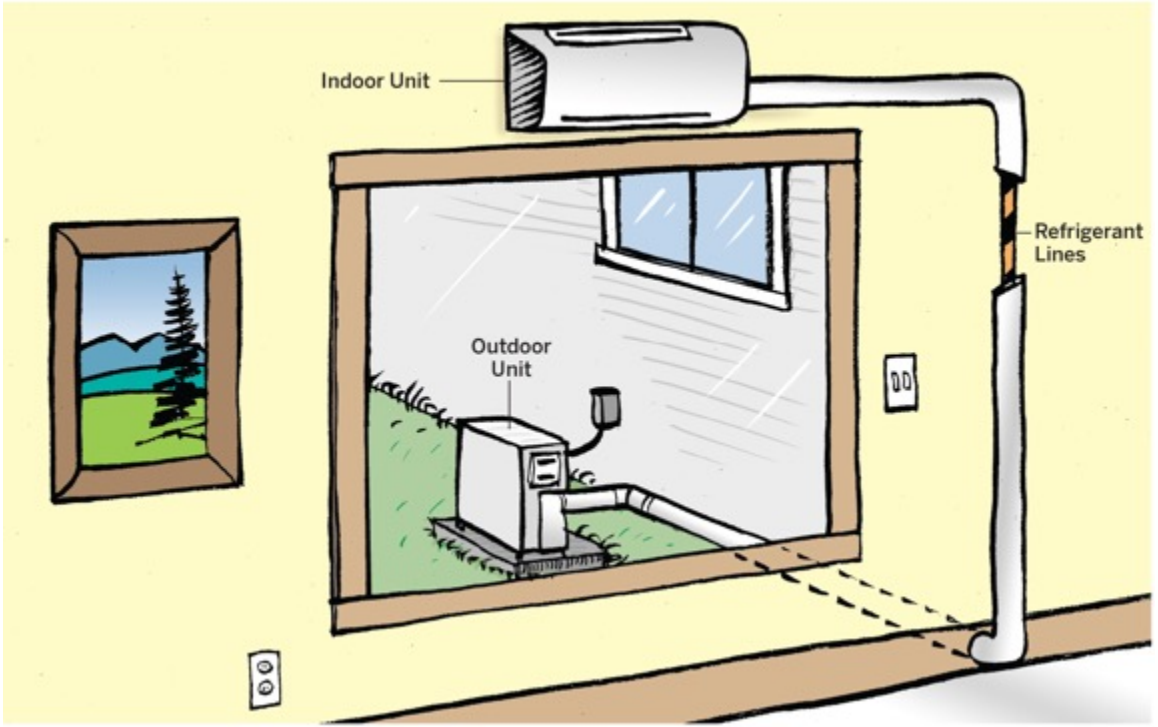
- Wind and solar 2 - 3 ¢/kWh
- Heat Pump COPs are better
- New gas generation is as much as 62% efficient,
- Modern technology enables load control

What's The Opportunity?



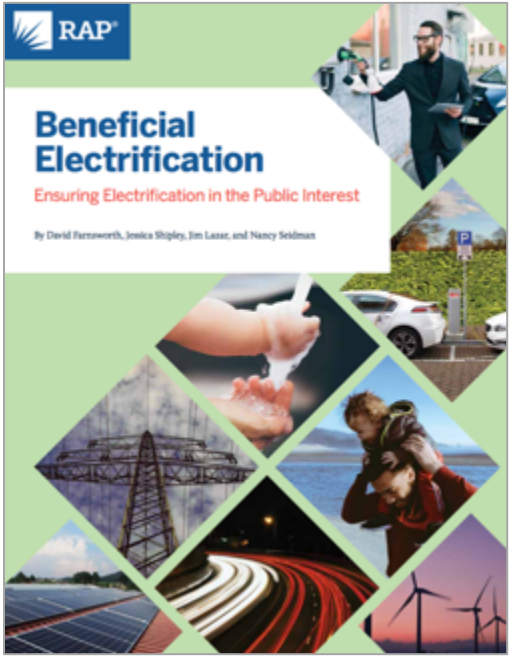
Source: Steinberg, D., Bielen, D., Eichman, J., Eurek, K., Logan, J., Mai, T., et al. (2017). *Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization*, using data from Energy Information Administration 2009 Residential Energy Consumption Survey.

Innovative & Efficient End Uses – Electrification Is Underway



Beneficial Electrification: Ensuring Electrification in the Public Interest

- 6 principles to ensure beneficial to consumers, environment, grid
- Papers for EVs, water heating, and space heating



https://www.raponline.org/BE

Electric Space Heating Technologies We Looked At

- Air-source heat pumps
  - Ducted or ductless
  - Standard and cold-climate
- Air-source heat pumps with back-up or storage heating ("dual fuel")
- Ground-source heat pumps
- Electric resistance heating with storage

Electric resistance heater photo: Steffes Corp.

Beneficial Electrification (BE) - Three Conditions

1. Saves Customers Money Over Long-Term

2. Reduces Environmental Impacts

3. Enables Better Grid Management

Consumer Economics: Key Factors

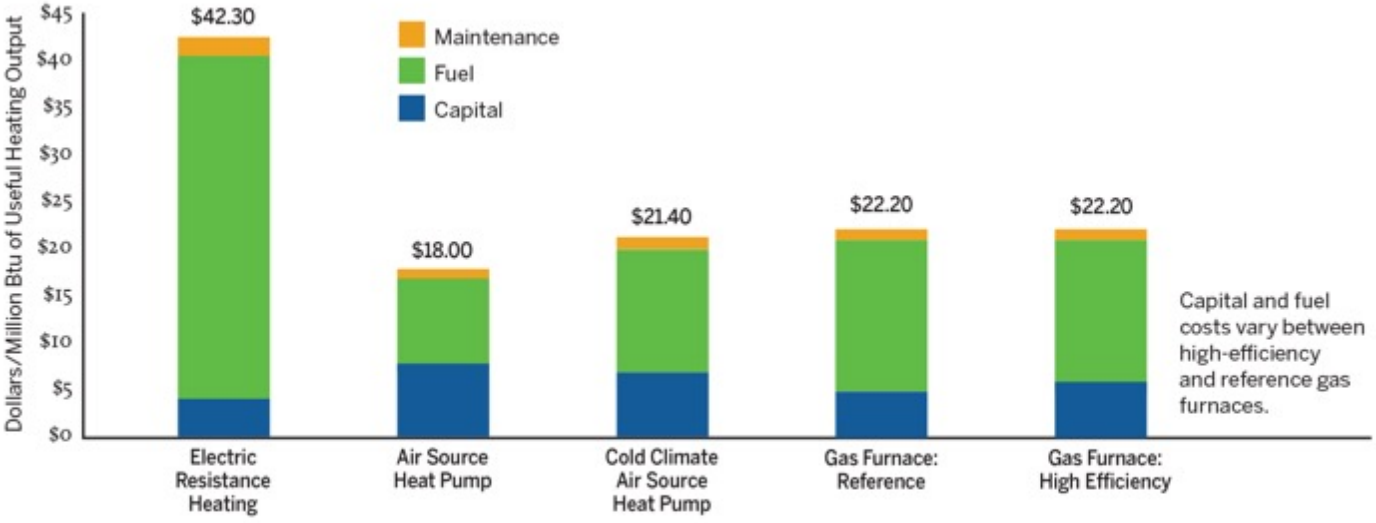
- Efficiency of space heating options
- Building type and its thermal efficiency
- Space cooling desired?
- Incremental cost of installation
- Cost of fuel

Current Economics of Converting Existing Oil Furnaces to Air Source Heat Pumps

Annual Fuel Cost Savings (or Loss) by Switching to Air Source Heat Pump From Oil Furnace

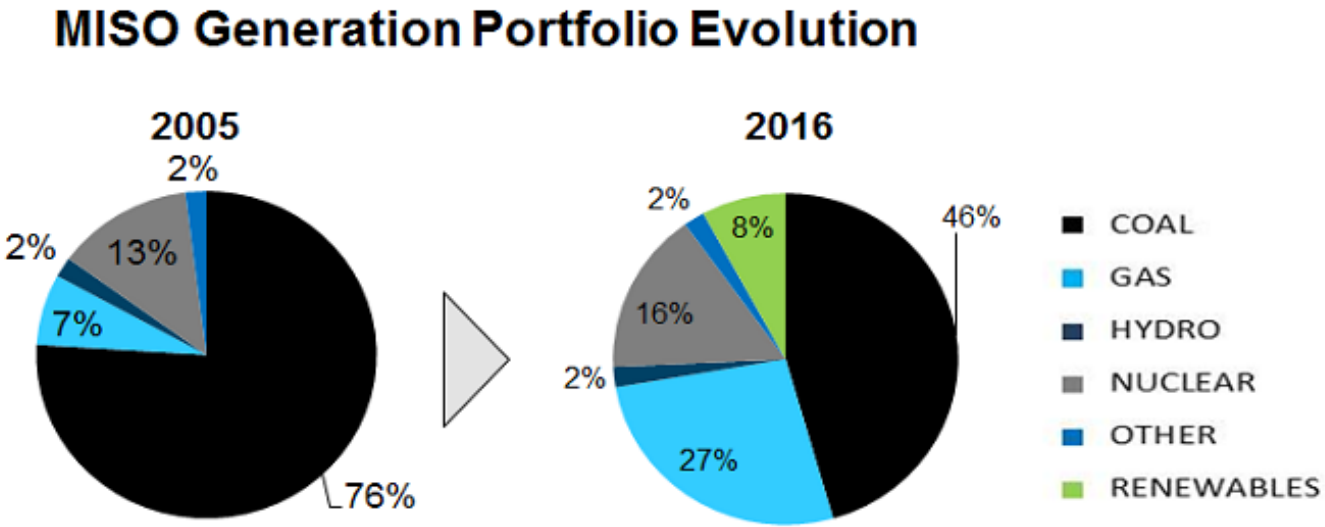
Source: Compiled with data from American Council for an Energy-Efficient Economy and US Energy Information Administration.

Future Economics of Converting Existing Gas Furnaces to Air Source Heat Pumps



Source: Jadun, P., McMillan, C., Steinberg, D., Muratori, M., Vimmerstedt, L., and Mai, T. (2017). *Electrification Futures Study: End-use Electric Technology Cost and Performance Projections Through 2050*

Emissions Impacts:
The Power Sector Fuel Mix Is Changing



http://www.misomatters.org/2017/03/3-electricity-industry-issues-we-are-watching-in-2017/

Emissions

Oil Furnace

513 gallons oil/year

22 lb CO_2/Gallon

11,300 lb CO_2/year

Heat Pump (ENERGY STAR®)

Emissions

Oil Furnace

513 gallons oil/year

22 lb CO_2/Gallon

11,300 lb CO_2/year

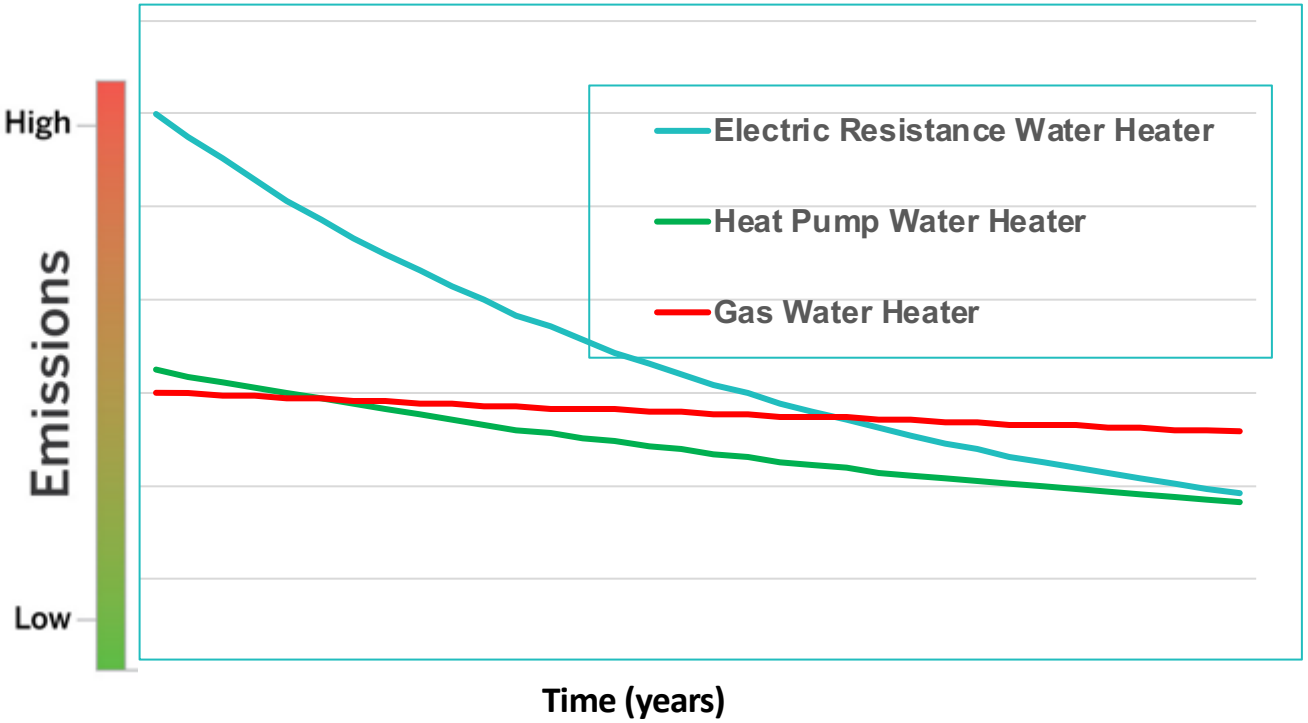
Heat Pump (ENERGY STAR®)

7,754 kWh/year

50% Gas; 50% Coal
1,400 lb CO_2/MWh

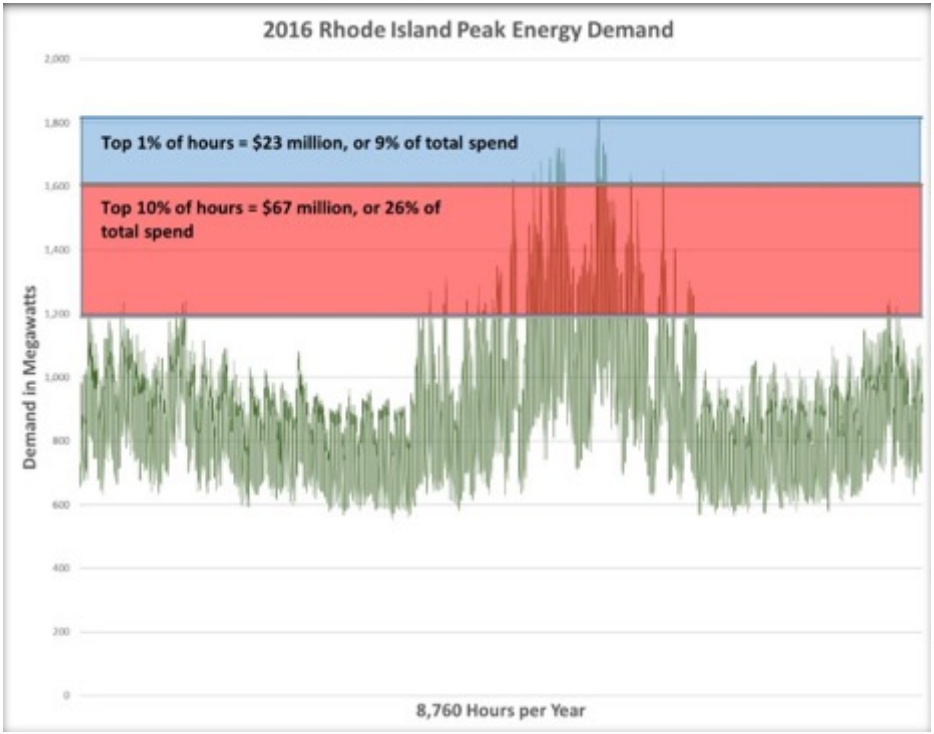
10,855 lb CO_2/year

As the Grid Gets Cleaner, Electric Options Become More Beneficial



Grid Benefits: Avoid High-Cost Hours

- Top 1% of hours = 9% of total spending
- Top 10% of hours = 26% of total spending



Source: Rhode Island Power Sector Transformation, Phase One Report to Governor Gina M. Raimondo (November 2017)

Grid Benefits: Boost Load Flexibility

	Generation capacity avoidance	Reduced peak energy costs	System peak related T&D deferral
Direct load control	X	X	X
Interruptible tariff	X	X	X
Demand bidding	X	X	X
Time-of-use (TOU) rates	X	X	X

Source: Brattle, 2019. https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf

BE and EE: Put Efficiency First

More Efficient End Uses

New EE Technologies Are Emerging

- Sound waves “shake” moisture out of clothes
- 80% reduction in electricity

- Induction cooktops 90% efficient, compared to 55% for electric coils and 50% for gas

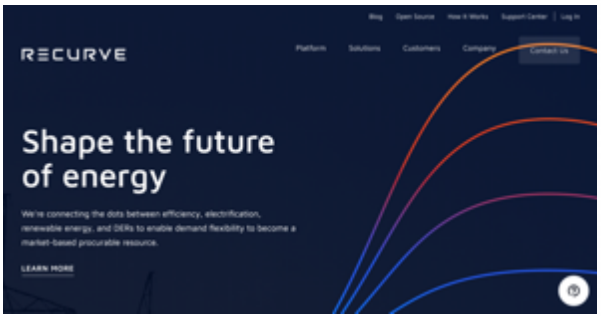
Standard & Poor’s Utility Practice: *“Expect little net load growth going forward.”*

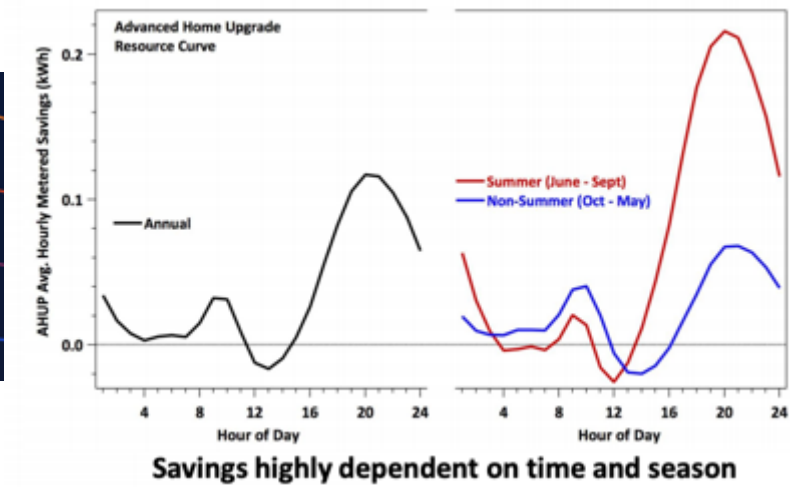
Today's EE/ Demand Side Management (DSM) "Eddy"

Capacity Resources
Renewables & DERs
Fossil Resources
Ancillary Services
Utility EE/DSM

Markets: DERs & “Metered EE”

- “Law of Big Numbers” can make EE ***work like any other DER***
- **Value** (and **compensate**) EE’s grid benefits, flexibility, non-energy benefits, etc.

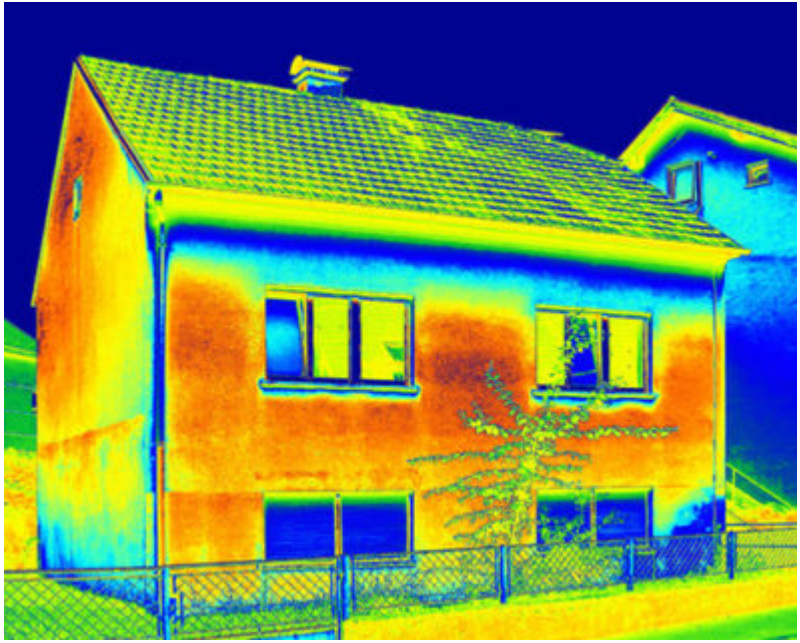




https://cedmc.org/wp-content/uploads/2019/02/2019-01-31-emv-event-slide-deck.pdf

Building Codes

- Importance of thermal efficiency
- Move toward requiring high-efficiency electric space heating and cooling
- New residential structures “all electric ready”?



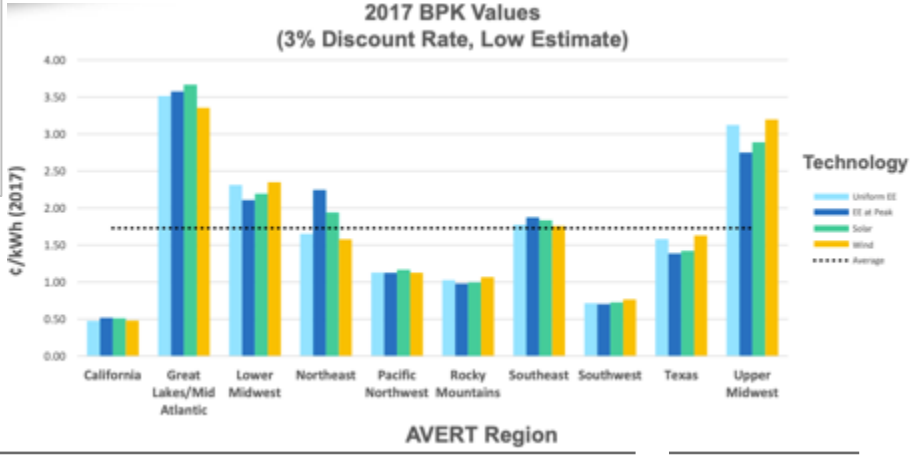
Need to Re-Imagine Today's Energy Efficiency

- Revise state **Energy Efficiency Resource Standards** to avoid kWh-consumption limits
  - BE decreases total energy use, but increases kWh
- Remove **fuel-switching** prohibitions for BE
- Remove **load-building** prohibitions for BE
- Enable "***EE as a DER***" using analytics, so it can be a genuine market resource

Good News from EPA for EE

HEALTH BENEFITS per kilowatt hour

https://www.epa.gov/statelocalenergy/estimating-health-benefits-kilowatt-hour-energy-efficiency-and-renewable-energy



"We must use less electricity where we can, so we can use more where we should."

-- Former EPRI CEO Steve Specker

About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org

Contact Jessica at:
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Emily Levin

Vermont Energy Investment Corporation

U.S. DEPARTMENT OF ENERGY

December 12, 2019

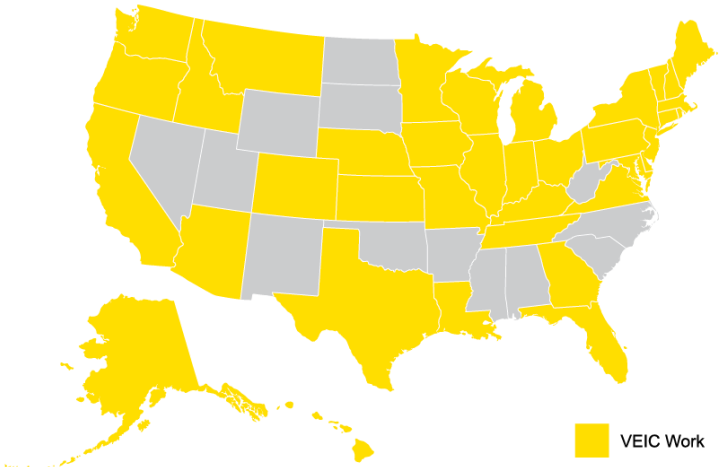
BBRN Webinar: Electrification and Energy Efficiency

Efficiency & Electrification:
Steps to Success in Leading States

Emily Levin
VEIC

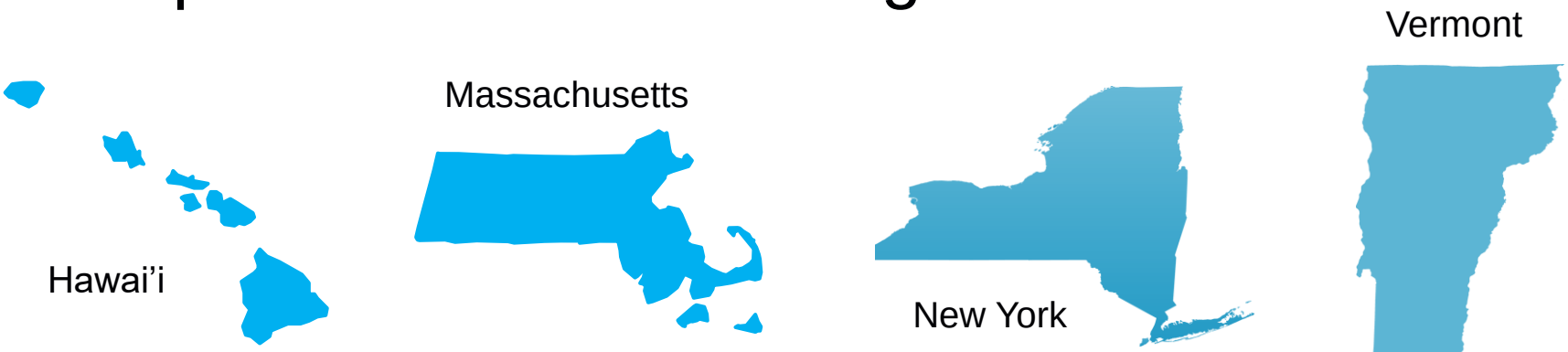
About VEIC

- Nonprofit founded in 1986
- 300+ employees
- Locations: DC, NY, OH, VT
- Design and deliver programs and policies nationwide:
  - Energy efficiency
  - Clean transportation
  - Building electrification
  - Renewable energy



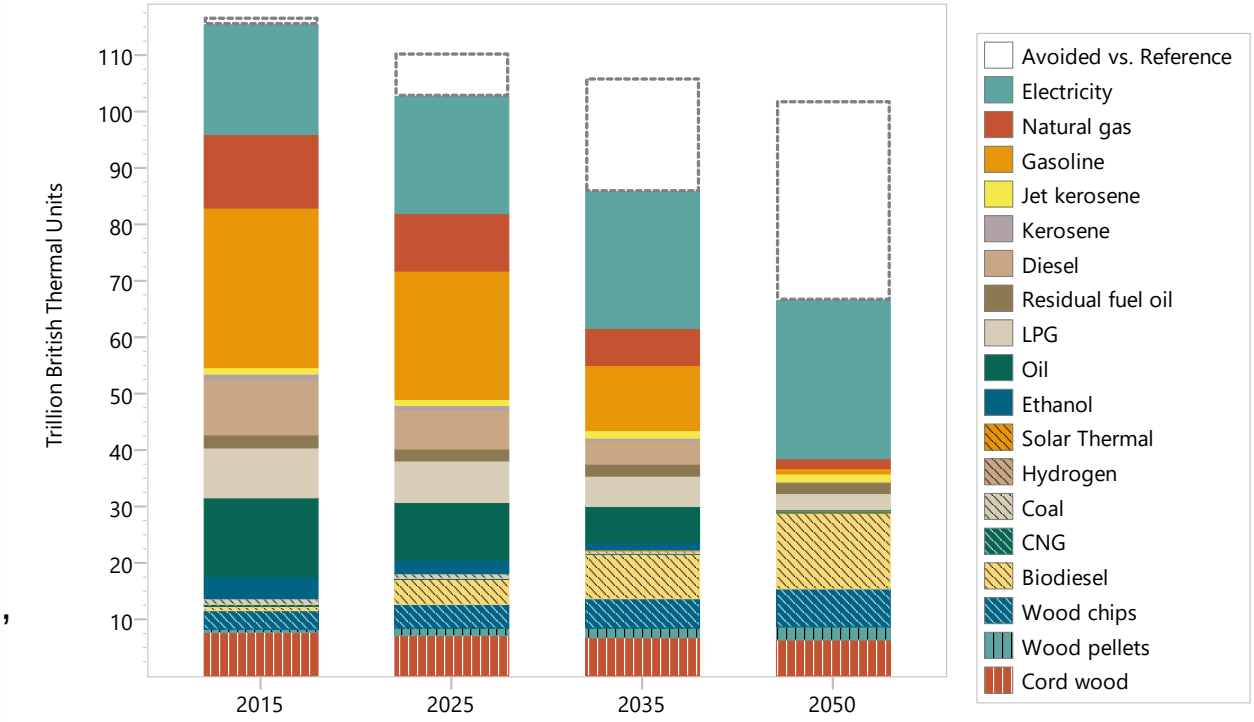
- Our customers:
  - Utilities
  - Government
  - Foundations
  - Environmental & consumer groups
  - Business

Deploying EE and Electrification Strategically: Steps to Success in Leading States



Step 1: Continue EE as Foundation of Clean Energy Transition

Vermont's Pathway: Efficiency, Electrification, and Renewables



Powered by SunShot U.S. Department of Energy

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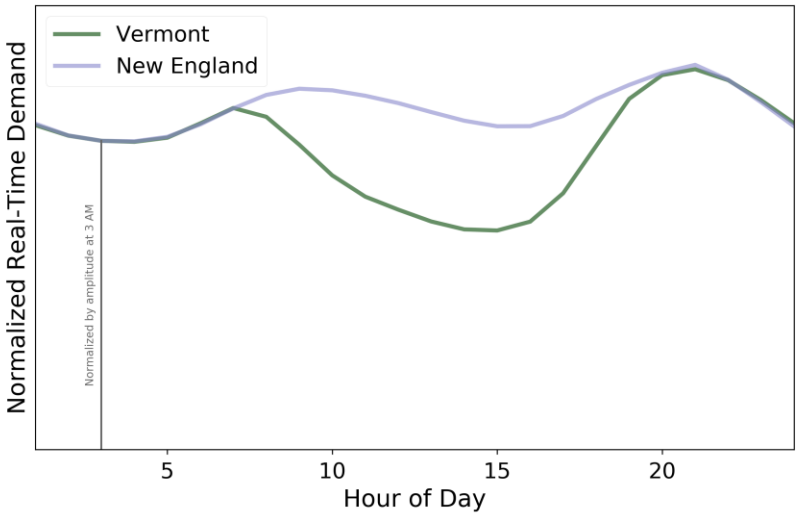
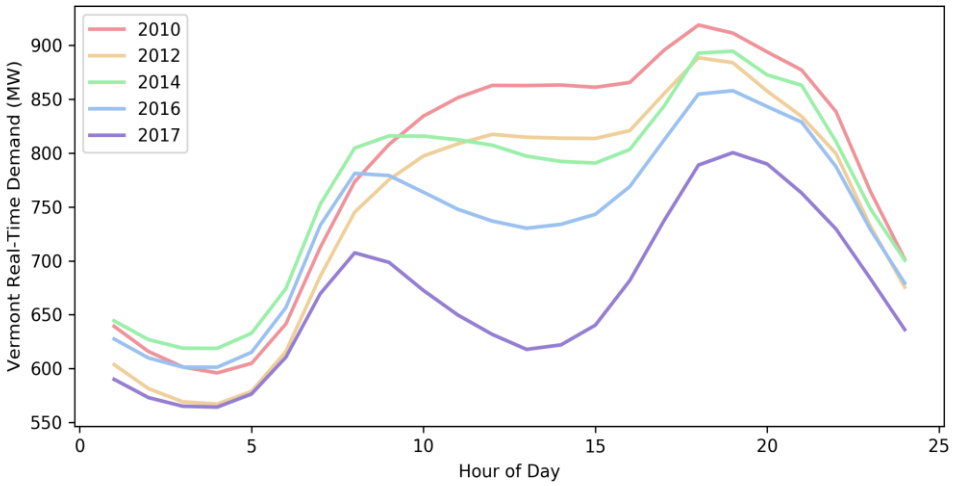
Step 2: Make Efficiency Smarter





Goal: Flatten Vermont's Growing Duck through Time-Targeted EE

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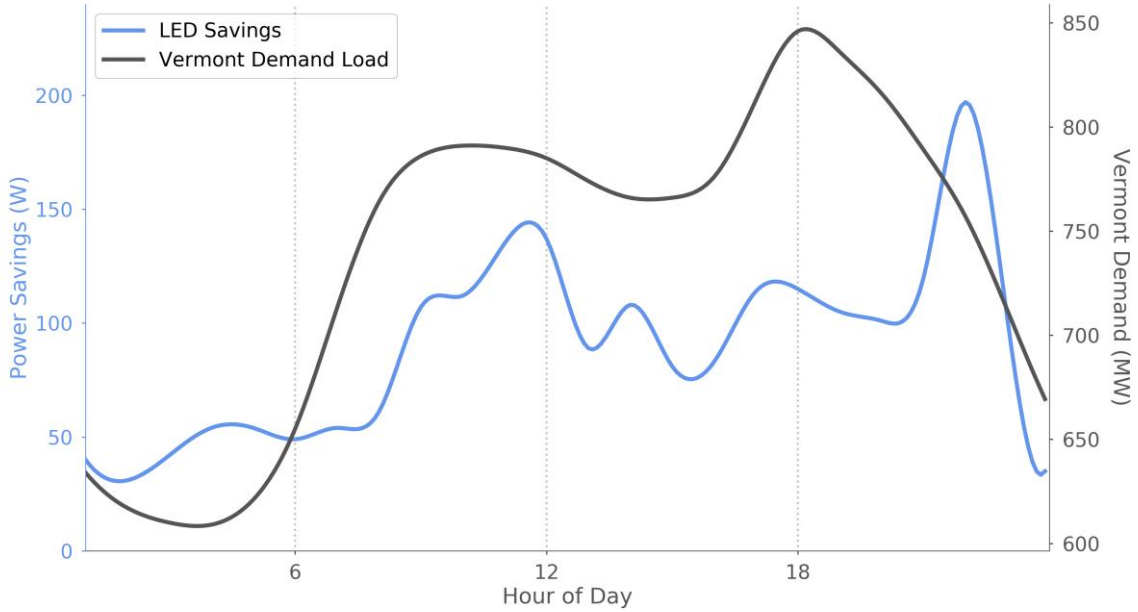
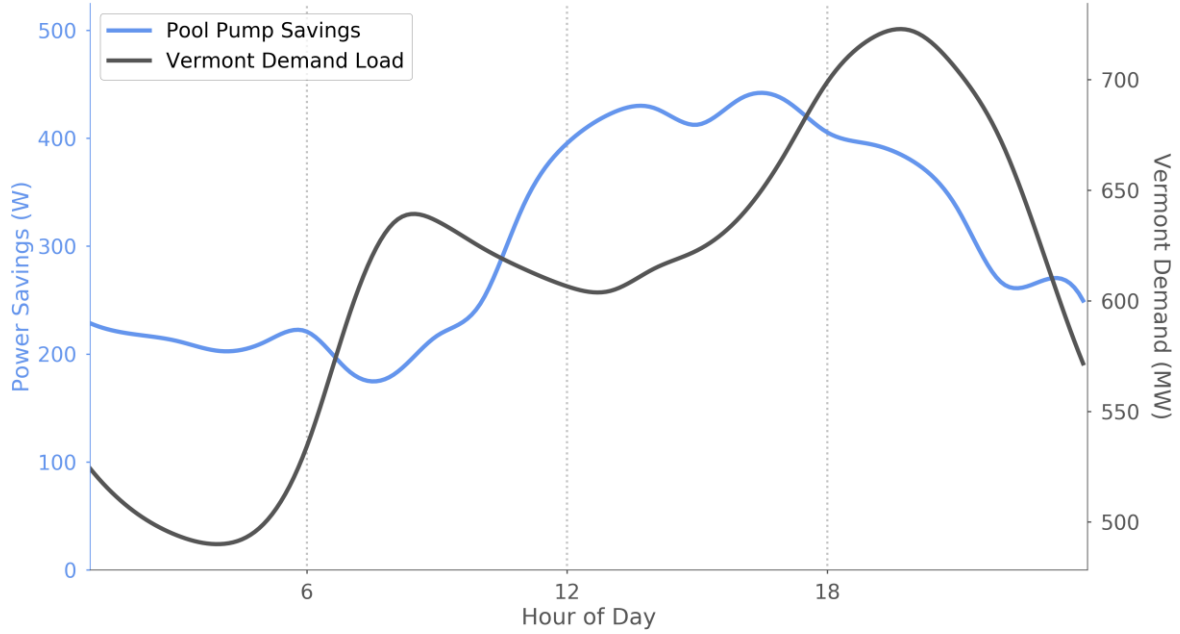
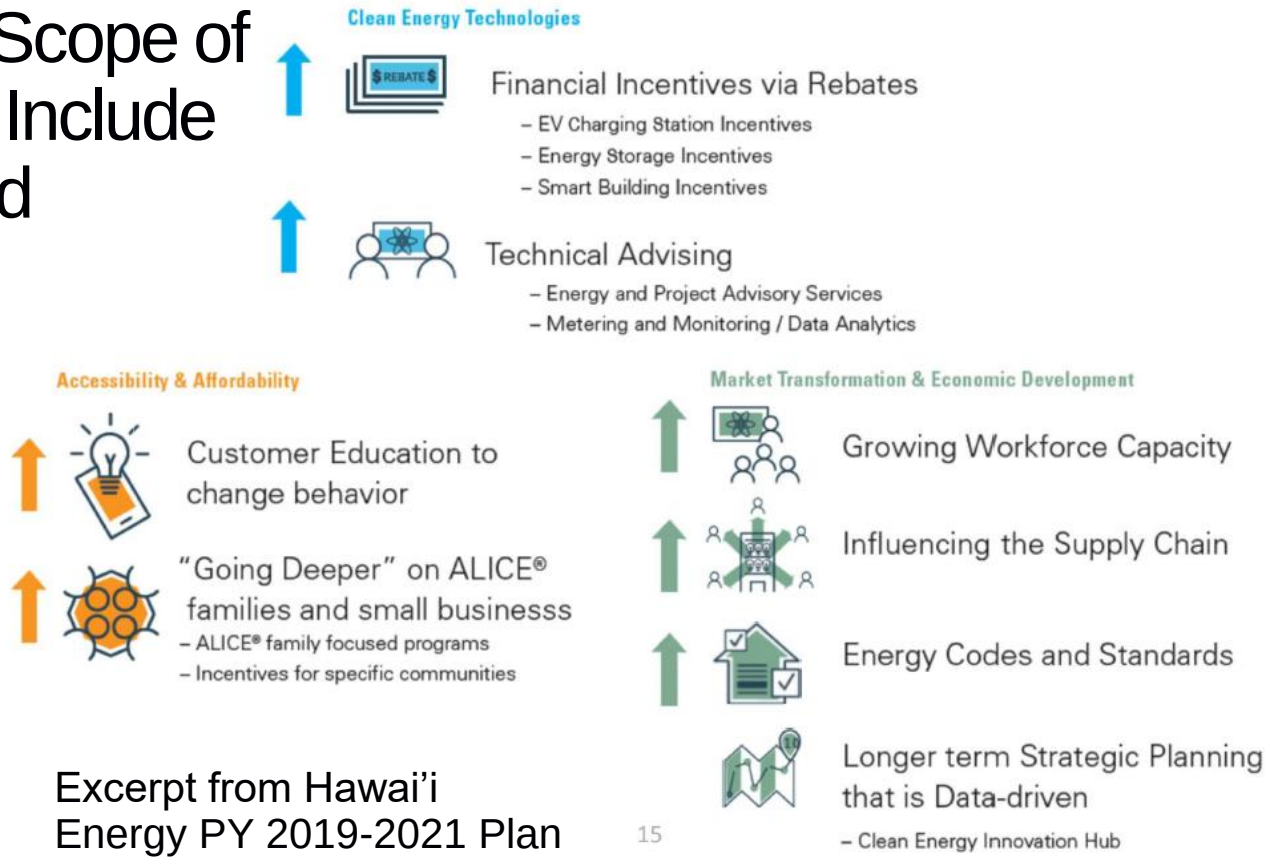
Savings Curve for LEDs on High Stress Cold Days



Savings Curve for High Efficiency Pool Pumps on High Stress Hot Days



Step 3: Expand Scope of EE Programs to Include Electrification and Flexibility



Hawaii Energy

Excerpt from Hawai'i Energy PY 2019-2021 Plan

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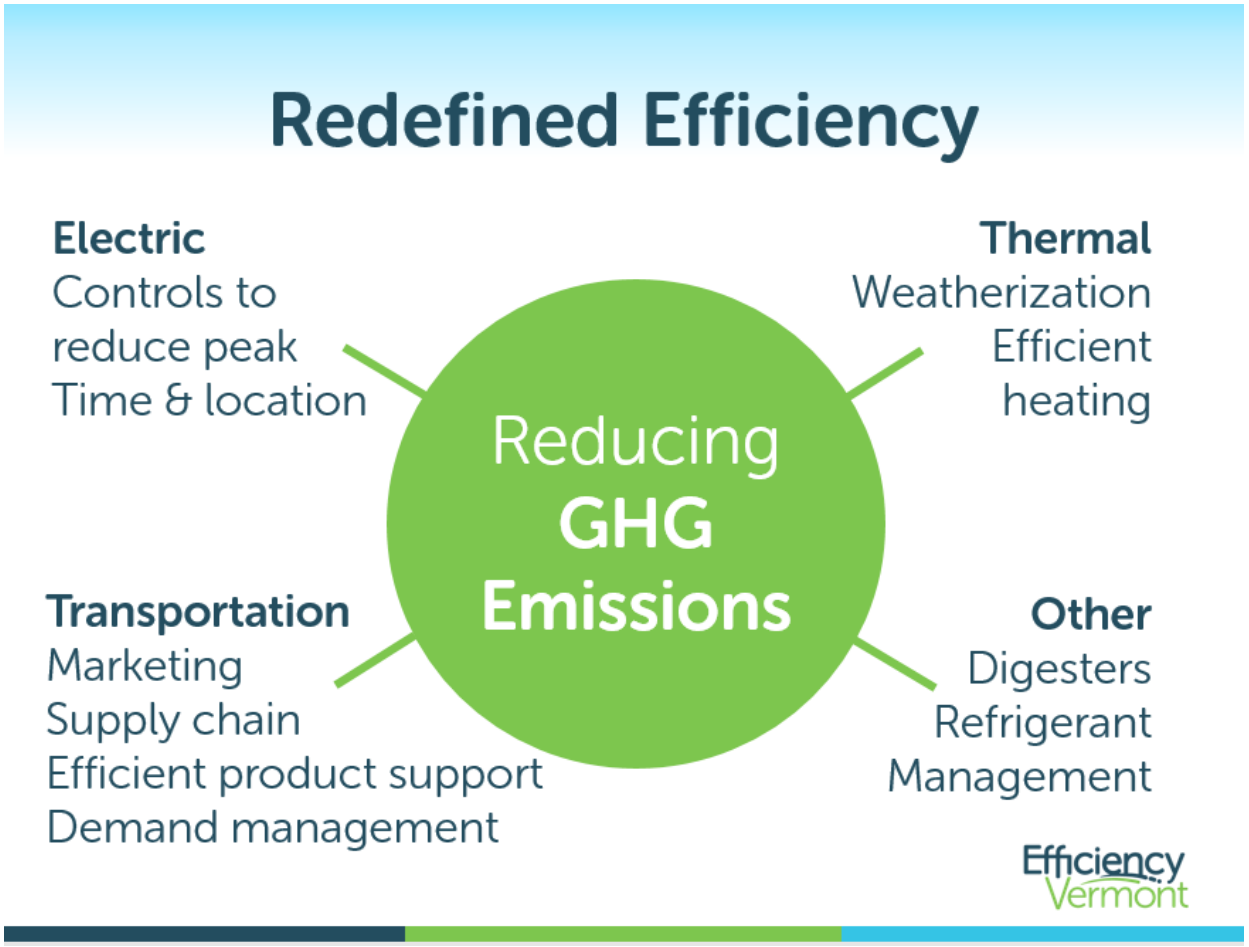
MA Clean Energy Bill Expanded EE Scope

- MA Legislature passed clean energy bill on July 31, 2018
- Key provisions of H.4857, An Act to Advance Clean Energy:
  - **Replaces “electric” with “energy”** in EE statute
  - Adds **energy storage, active demand management, and strategic electrification** as eligible under EE programs
  - Adds programs that result in customers switching to **renewable energy** sources or other clean energy technologies to EE plans
  - Broadens cost-effectiveness screening to ensure that programs "obtain energy savings and **other benefits with value greater than the costs** of the program" rather than energy savings and system benefits
  - Requires **cost-effectiveness at sector level** rather than measure level

Efficiency Vermont Future Vision



Step 4: Get Started with a Targeted Approach

- At current fuel prices, it often makes sense to target:
  - **Existing homes** that currently heat with electric resistance, oil, or propane
  - **New construction:** Net zero program tiers and stretch codes to promote construction integrating heat pumps with high-performance building shells

Efficiency Vermont: Zero Energy Modular Home

Mass Save: Higher Incentives for Fuel Switching

Fuel Optimization Rebates				
Primary Fuel Type	**Delivery Method**	**Efficieny Requirements**	**Additional Requirements**	**Rebate Amount[1]**
Oil or Propane	Ducted, Mixed-Ducted	AHRI SEER ≥ 15, HSPF ≥ 9	Integrated Controls[2] required unless central heating system is removed[4]. Refer to qualified product list MassSave.com/ICQPL	$1,000 per ton
	Non-Ducted	Must be on the NEEP[3] Qualified Product List. Visit ashp.NEEP.org		$1,600 per ton

Much higher "fuel optimization" rebate for fuel switching from oil or propane ($150-350 per ton for standard install)

Integrated controls required unless central heating system is removed

Mass Save rebates for mini-split heat pumps: https://www.masssave.com/en/saving/residential-rebates/electric-heating-and-cooling/

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Step 5: Break Down Silos

- **Integrate and coordinate delivery** of efficiency, demand flexibility, electrification programs to break down program silos

Integration Example: Electrification with Controls

- Pilot testing grid-interactive water heaters as a virtual thermal battery
- Collaboration between WEC and Efficiency Vermont

Integration Example: Weatherization + Heat Pumps

- Vermont Zero Energy Now Pilot:
  - Wx + heat pumps + PV
  - 50-80% reduction in total energy use
- NYSERDA Heat Pump Ready Pilot:
  - Demonstrate affordable standard packages of whole house load reduction measures (air sealing, insulation, duct repair/sealing, low E windows, smart controls)
  - Create a viable and innovative service model for contractors

Zero Energy Now 2016 Summary Statistics

Participants	22 Vermont existing homeowners
Customer investments	$1.2 million (split relatively evenly between efficiency and solar PV)
Median total project cost	$44,739 (ranging between $22,000 and $170,000)
Net customer project cost	$31,090 (after incentives from Zero Energy Now, Efficiency Vermont and 30% Federal tax credit)
Median energy cost savings	$3,692/year
Average annual energy savings	95 MMBtu (60 MMBtu from efficiency and 31 MMBtu from solar PV) from 120 MMBtu pre- to 25 MMBtu post-improvement
Customer return on investment	11.9%

http://bppa-vt.org/page-1737726

ZERO ENERGY NOW

Building Performance Professionals Association of Vermont
BPPA-VT
Vermont's Authorities on Energy Efficiency

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Step 6: Set Next-Generation Goals

- **Align EE program goals (and utility performance incentives) with state policy goals:**
  - Peak demand reduction
  - Fuel-neutral energy savings or GHG reduction
  - Market transformation indicators
  - Energy or GHG savings for low-income customers or other target groups

Massachusetts:
EE Program Metrics in 2019-2020 Period

Old Goal	New Goal	Advantage
Lifetime kWh savings	Lifetime MMBtu savings	• Converts electric, oil, and propane savings to common units • Encourages **energy optimization** by providing holistic view of tradeoffs such as electrification
NA	Peak kW savings	• Measures savings from both active and passive demand reduction

New York: Incenting Key Outcomes

- Under REV, New York seeks to:
  - Transition from cost-of-service to **performance-based ratemaking**
  - Provide incentives (**earning adjustment mechanisms** or EAMs) to utilities for achieving desired outcomes
- New Efficiency New York plan includes both EE and heat pump adoption as key components of statewide 185 TBtu by 2025 savings target

Earnings Adjustment Mechanisms : New Upside Performance Incentives in Niagara Mohawk Power Co. Joint Proposal

nationalgrid

EAM Category	Metrics	Measurement	Drivers
System Efficiency	Peak Reduction	NYCA-coincident peak load	Demand response, Storage, Peak-focused EE, DG Interconnection, VDER, VTOU, off-peak EV Charging, heat electrification, VVO/CVR
	DER Utilization	Sum of annualized MWh for incremental load-reducing DERs	
Energy Efficiency	Incremental EE	Incremental MWh EE Savings	ETIP, incremental NMPC administered EE, EE financing, E-Commerce Platform, LED Street Lighting, Project Juniper, NYSERDA coordination, 3rd party coordination
	LED Street Lighting	LED SL conversions	
	Resi Energy Intensity	% decrease in MWh/customer	
	C&I Energy Intensity	% decrease in MWh/customer	
Interconnection	Meeting SIR standards is threshold for earning		Developer cost sharing; Developer opportunity to construct upgrades; online interconnection portal
	Developer Satisfaction	Survey score	
Carbon Reduction	Beneficial Electrification	MT CO2 reduced from incremental heat pumps and EVs	Electric heat initiative, EV charging & marketing, rate design, Juniper

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Hawai'i and Vermont: Evolution of Third-Party Administrators

GHG Reduction

- Hawai'i now tracking GHG tons and barrels of oil saved based on HECO generation composition
- Efficiency Vermont will be proposing as part of next 3-year plan

Grid Service-Ready Technologies Installed / Customers Served

- Hawai'i Energy has performance incentive worth 5% of overall award
- Efficiency Vermont will be proposing as part of next 3-year plan

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To Recap

- ✓ Continue EE as foundation of clean energy transition
- ✓ Make EE smarter with data-driven insights and time & location targeting
- ✓ Expand EE program scopes to include electrification and flexibility
- ✓ Get started with targeted approaches
- ✓ Break down program silos to coordinate efficiency, electrification, and flexibility
- ✓ Set next-generation performance metrics and incentives

Thank you!

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Scott Blunk

Sacramento Municipal Utility District

U.S. DEPARTMENT OF ENERGY

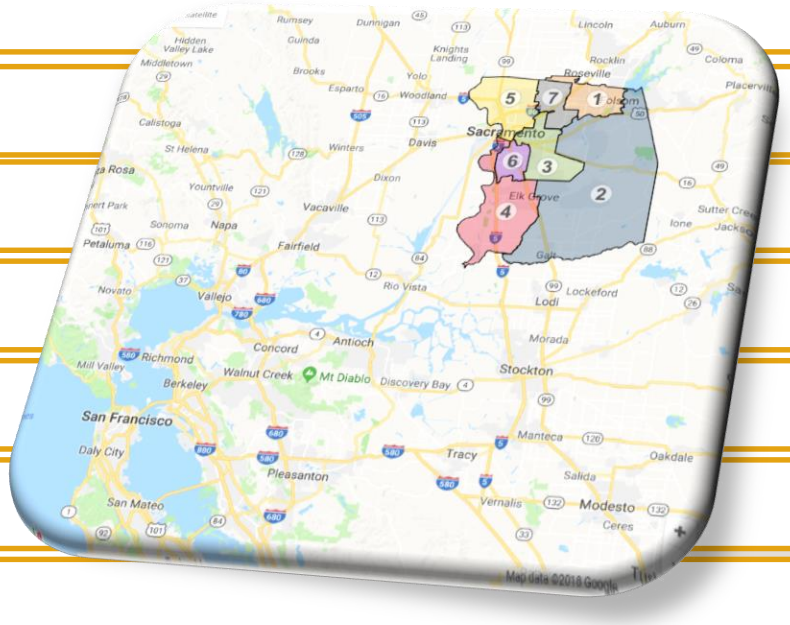
SMUD

Electrification – What does it mean for Energy Efficiency

December 12, 2019

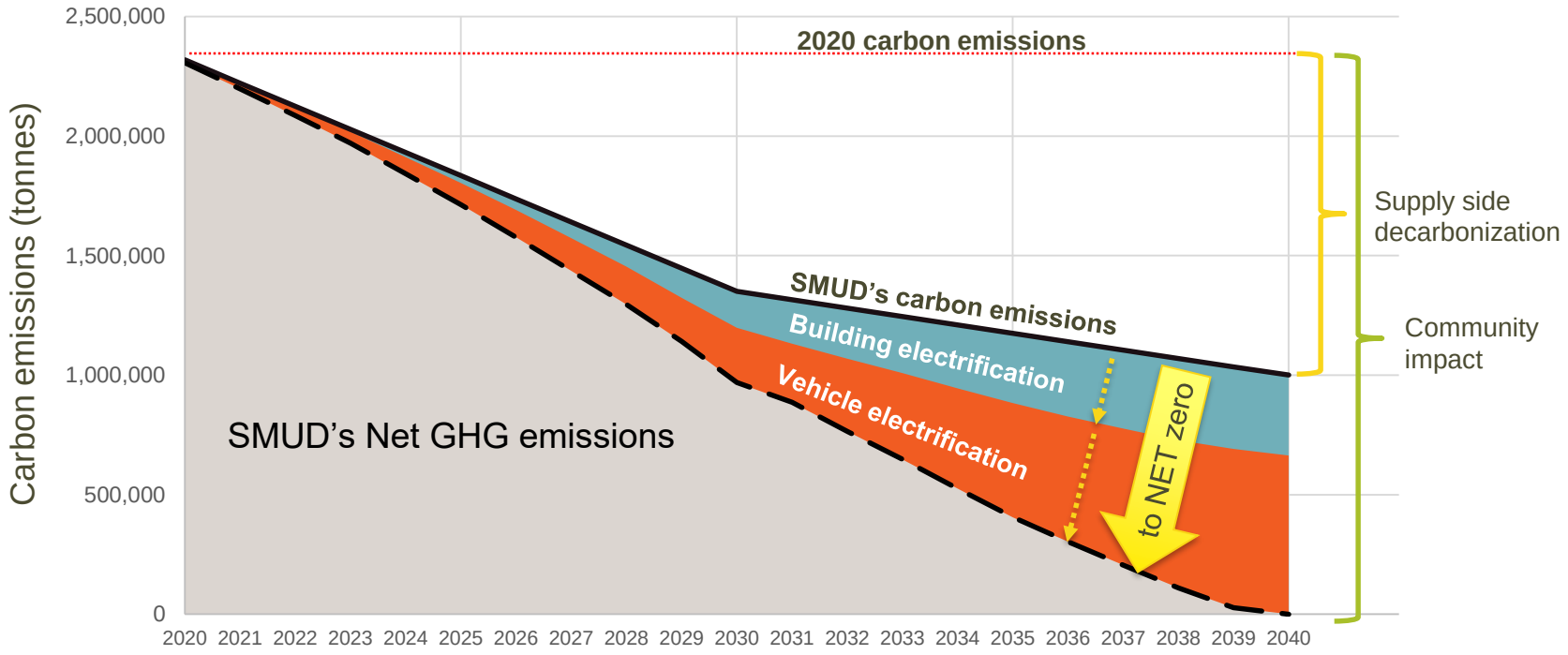
Sacramento Municipal Utility District (SMUD)

- Electric utility
- Community-owned not-for-profit
- Established 1946
- Population 1.5 million
- 2,219 employees
- 50% carbon free electricity
- 626,460 accounts



SMUD

IRP plan to achieve net zero carbon



Path to Electrification Programs

1) Calculate the carbon equivalence between electricity and gas

- Use to claim electrical savings from electrification

2) Calculate the monetary value of electrification to the utility

- Hint, it is much more than net revenue times new load
  - With this, set incentives

3) Calculate the hourly long term marginal emissions

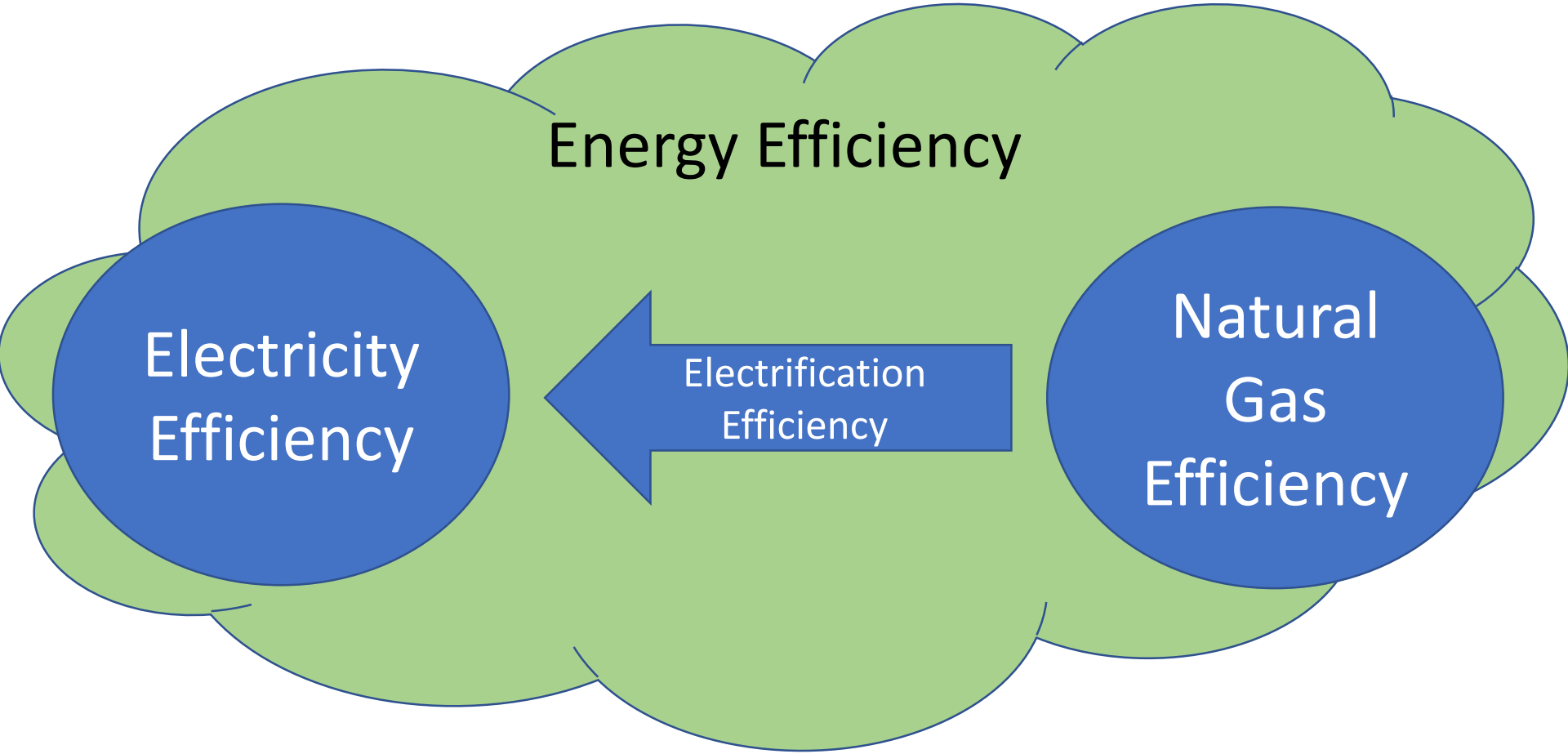
- Use to change the metric used to manage EE programs

Along the Way, Defined or Redefine some Terms

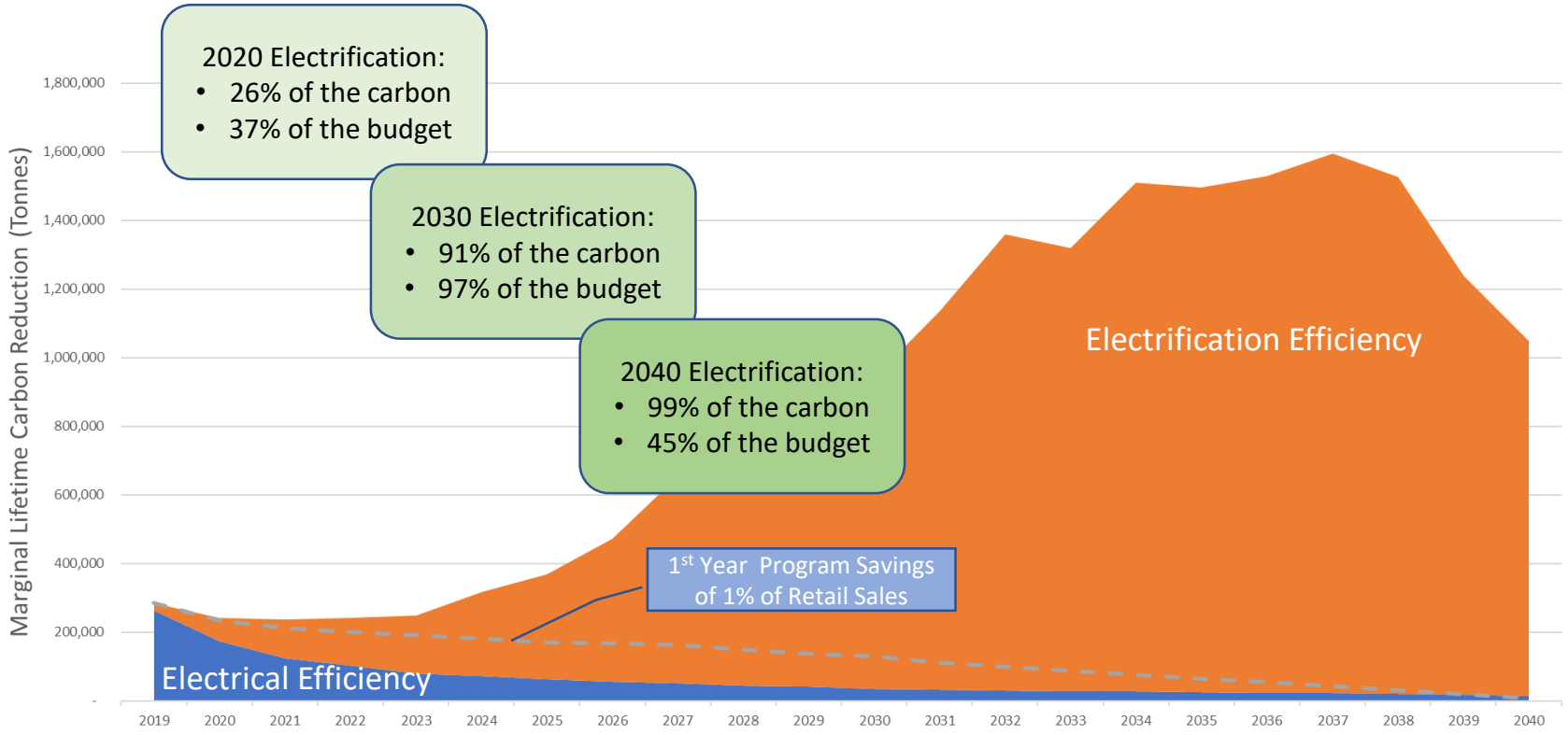
- "Energy" is often treated as a synonym for Electricity
- "A clean energy revolution is taking place across America, underscored by the steady expansion of the U.S. renewable energy sector." according to the DOE

- "Clean energy revolution" is **bogus** there is only a "clean electricity revolution" happening

What is Energy Efficiency?

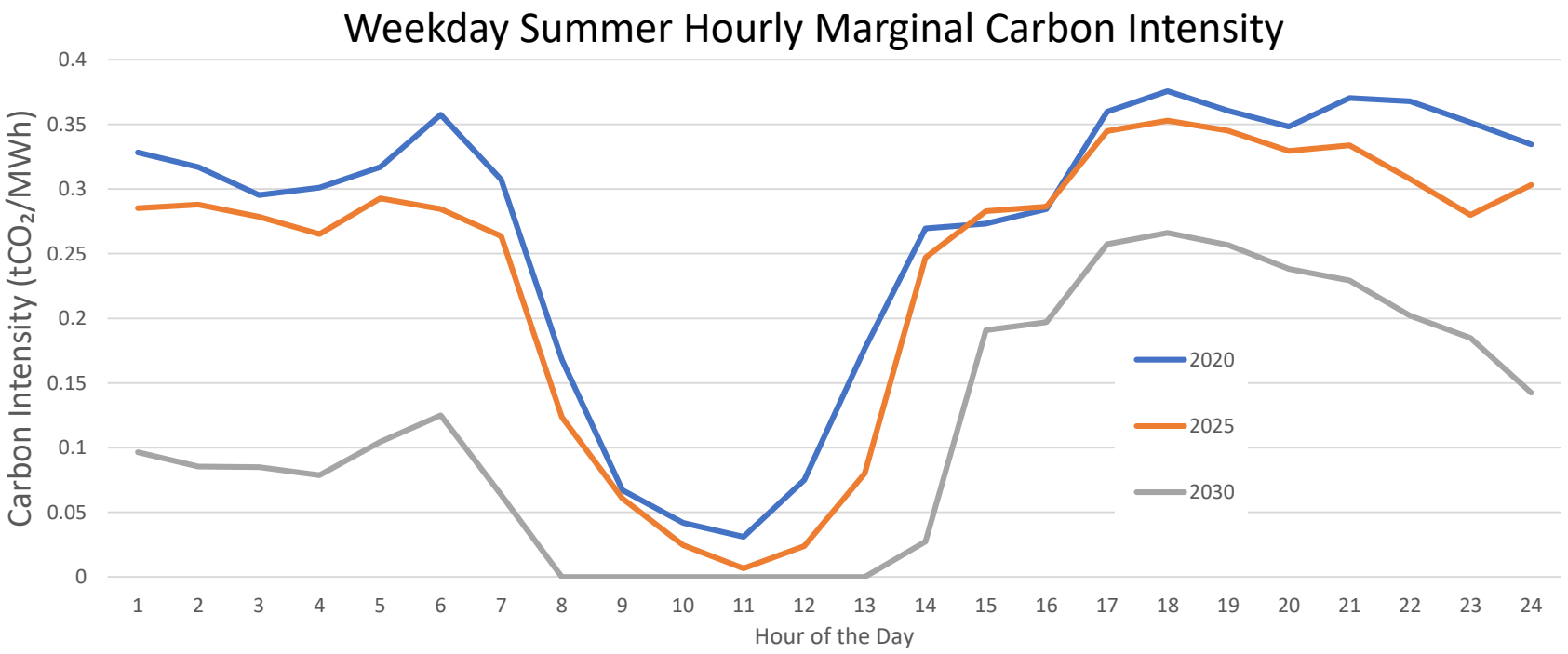


SMUD's Planned Carbon Reduction in Buildings



If you don't measure it you can't manage it

Electrification Efficiency and Electric Efficiency is Temporal



Not all EE is good, it all depends on when

Carbon Savings

Programmatic Carbon is the lifetime long term marginal emission carbon reduction

2020

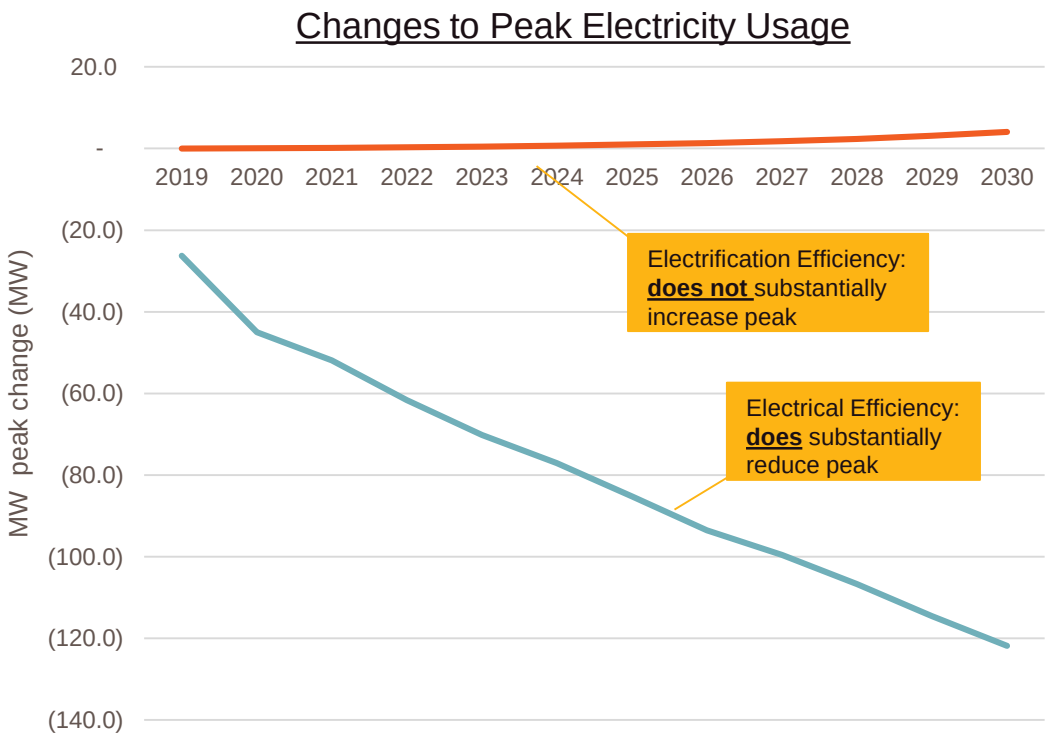
Measure Installed in 2020	Carbon Reduction (tonnes)
Whole House Fan	1.47
Home Energy Report	0.14
AC - 16 SEER	3.28
HPWH	11.00
Heat Pump HVAC	22.81
Induction	0.56

2040

Measure Installed in 2040	Carbon Reduction (tonnes)
Whole House Fan	0.49
Home Energy Report	0.03
AC - 16 SEER	0.64
HPWH	12.97
Heat Pump HVAC	28.96
Induction	1.19

Grid issues with building electrification

- Off peak
  - Most electrification is not at system peak
- Grid utilization
  - Electrification improves utilization of the grid by 5%
- On peak
  - Furnace electrification yields a more efficient AC thus reducing summer peak



SMUD

SMUD Electrification Programs

	Launch Date	Total Possible Incentive	Base Incentive	HP-HVAC	HPWH	Induction	Bonus
Single Family New Construction	March 2018	**$7,000**	$4,000	✓	✓	$1,000	$2,000
Multifamily New Construction	March 2018	**$1,750**	$1,250	✓	✓	$500	x
Single Family Existing	May 2018	**$10,500**	n/a	$4,500	$3,000	$500	$2,500[1]
HPWH Equipment Efficiency	June 2018	**$3,000**	$2,000	n/a	✓	n/a	$1,000[2]
Multifamily Existing	December 2018	**$2,500**	n/a	$1,000	$1,000	$500	x
HPWH Direct Install Program	3nd Quarter 2019	**$3,000**	n/a	n/a	✓	n/a	x
HP-HVAC Equipment Efficiency	3rd Quarter 2019	**$4,500**	$1,500	$2,500	n/a	n/a	$500[3]

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Thank you
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Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.

https://rpsc.energy.gov

Thank You!

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Please send any follow-up questions or future call topic ideas to:
bbresidentialnetwork@ee.doe.gov