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Building Efficiency and Electrification for the Environment

Environmental Council of the States 2021 STEP Meeting: *Partnering on Climate* Climate & the Built Environment Roundtable

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Overview of Building Electrification

- Electrification trends and background
- How we talk about energy and electrification is part of the problem we need to think about
- What do we want to do with building efficiency and electrification?
 - a) reduce energy system costs,
 - b) reduce consumer costs, and
 - c) reduce pollutant emissions.
- Advanced technologies now allow regulators, consumers and the market to get there

1 Building Electrification and the Environment: The U.S. Basics

Electricity Sector Emissions Down & Building Sector Emissions Up



Source: EIA Adapted from Rocky Mountain Institute slides

Annual CO₂ emissions from electric power and buildings sectors

Million metric tons CO₂, US total, 2007-2019

Beneficial Electrification Means Using More Electricity Efficiently

- Instead of using petroleum at 20% efficiency in vehicles, we can use electricity at 80% in electric vehicles.
- Instead of heating oil, gas, propane at 80 to 90% efficiency in furnaces, we can use electricity at 300% in heat pumps (air or ground source).

Q: Do consumers know this?

Building Electrification Trends by U.S. Region



Source: EIA RECS and CBECS

Fuels Still Dominate Space and Water Heating

Final energy use in residential buildings by fuel and end use application



Clean Air Act: Strategies to Prevent Air Pollution Recognized

The **Clean Air Act** – EPA to develop "nonregulatory strategies and technologies for air pollution prevention," including "end-use efficiency, and fuelswitching to cleaner fuels."

CAA Section 103(g), <u>42 USC Section 7403g</u>.

Energy Policy Act (2005): Recognizes Consumers Energy Consumption Needs

Energy Policy Act (2005) -- EPA and DOE to implement:

- "a voluntary program to identify and promote energy–efficient products and buildings...through voluntary labeling of ... products and buildings that meet the highest energy efficiency standards."
- Develop test procedures to determine
 - (i) estimated annual operating costs of all covered products ... and
 - (ii) at least one other measure of energy consumption of such products which the Administrator determines is likely to assist consumers in making purchasing decisions.

Energy Policy Act (2005) Sections 324, 323(4)

2 What are the environmental benefits of efficiency and electrification?

It's hard to talk about the technical aspects BUT quite possible to communicate them in better ways.

Communications: Can metrics be precise yet more compelling?

MPGe is a metric that allows for a comparison between vehicles regardless of how they are fueled.

Would the following metric be compelling to EV buyers:

Emissions Efficiency (lbs. X per/mile)

Colburn, Lazar, Dennis



"fuel-switching to cleaner fuels." CAA Section 103(g)

"to assist consumers in making purchasing decisions." **Energy Policy Act** Section 323(4)

Energy Efficiency Messages and Policy Influence Customer Choices

• Which water heater saves more energy? ... costs (lifetime, initial purchase)? ... emissions?



- Tend to reward switching to a more efficient appliance that uses the same fuel
- Programs often explicitly disallow fuel switching so consumers get mixed messages



Source for images: The Home Depot

Current efficiency metrics make comparisons difficult

For Oil & Natural Gas Furnaces

Annual Fuel Utilization Efficiency (AFUE)

For Air Conditioners & Heat Pumps

Heating Seasonal Performance Factor (HSPF)

Energy Efficiency Ratio (EER)

Seasonal Energy Efficiency Ratio (SEER)

Coefficient of performance (**COP**)



Compelling metrics:

R-value of insulation

VS.

Building heat loss to outside after 5 hours



Based on a sample of over 80,000 European homes

Source: https://www.tado.com/t/en/uk-homes-losing-heat-up-to-three-times-faster-than-european-neighbours/



3 What do we want to do with building efficiency and electrification?

Get it right!

Regulatory Assistance Project (R

Design pricing to reflect electricity grid management needs at multiple levels:

- Regional
- Utility
- Zonal
- Nodal
- Circuit



Beneficial Electrification Reduces a) **energy costs & demand**, b) **emissions**, and (c) **customers' costs**





4 Advanced Energy Technologies Enable Beneficial Electrification

Advanced Energy Technologies Allow Regulators, Consumers, and the Market to Reduce Costs & Emissions

From Optimizing Solar Plus Storage ...



The figure shows the distribution of average monthly billing demand reductions across all building types, locations, solar sizes, and storage sizes. Each data point is the average percentage reduction, for a single load/solar/storage combination, across all months of the 17-year historical weather period.

Source: Gagnon et al. (2017). *Solar* + *Storage Synergies for Managing Commercial-Customer Demand Charges*. Lawrence Berkeley National Laboratory.

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Uncontrolled Household Loads Add Up















Controlled Water Heaters

The CTA 2045 socket enables any control network to connect to any new water heater.







Flexibility Dramatically Cuts Peak Demand

Shift EV, Water Heat, Major Appliances, and Pre-Condition Spaces



Image credit: https://electriqpower.com/powerpod/



Retail Pricing and Price-Responsive Demand

Charges for electricity services

Federal environmental improvement surcharge

\$0.90



Your electricity bill

Your service plan: Standard Rate

Customer account charge

Delivery service charge

Cost of electricity you used

Environmental benefits surcharge

System benefits charge

nower supply adjustment*

Fort Collins: Smart Residential Rate

Customer Charge	\$ 6.78	
	Summer	Winter
Off-Peak	\$ 0.069	\$ 0.067
On-Peak	\$ 0.241	\$ 0.216
Tier Charge (Over 700 kWh)	+ \$.0194 / kWh	



BG&E TOU Pilot



Excludes weekends and holidays, which are billed at off-peak rates. Holidays include New Year's Day, President's Day, Good Friday, Memorial Day, Independence Day, Thanksgiving, Christmas and the Monday following if any of these holidays fall on a Sunday.

By Using Demand Response to Manage Seasonal Loads



If there is a significant increase in energy prices or energy demand in the summer months, typically between June and September, your PeakRewards device may receive a signal to cycle your air conditioner up to your chosen cycling level (50%, 75% or 100%).

Source: Baltimore Gas & Electric

Reducing Commercial Demand Charges



STEM: 12 kW Savings Off 68 kW Peak



Energy and Environmental Programs

- Encourage beneficial electrification
- Optimize investments over all programs
- Coordinate across programs





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



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Resources from RAP

- Beneficial Electrification: 4-part series
- We All Wish We Were More Flexible: Electrification Load as a Grid Flexibility Resource (blog)
- Flexibility for the 21st Century Power System
- Renovating Regulation to Electrify Buildings: A Guide for the Handy <u>Regulator</u>
- Principles of Modern Rate Design
- Blog post Making a Clean Energy Future and Equitable One
- Energy Infrastructure Inequities and Policy Solutions
- RAP's newsletter sign-up