Better Buildings Residential Network Peer Exchange Call Series:

Smart Homes in Stay-at-Home Times

May 28, 2020

Agenda and Ground Rules

- Agenda Review and Ground Rules
- ASHRAE Guidance for Building Operations During COVID-19
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
  - **Dan Fredman**, Vermont Energy Investment Corporation
  - **Scott Taylor**, Sense
  - **Chris Bilby**, Holy Cross Energy
  - **Abi Daken**, U.S. Environmental Protection Agency
- 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.

ASHRAE Guidance for Building Operations During the COVID-19 Pandemic

ASHRAE Journal article, March 24, 2020

By Lawrence J. Schoenberg, P.E.

Chair, ASHRAE Committee that wrote the "ASHRAE Position Document on Airborne Infectious Diseases"

President & Principal Engineer, Schoen Engineering Inc.

https://www.ashrae.org/news/ashraejournal/guidance-for-building-operations-during-the-covid-19-pandemic

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):

- Jun 11: Indoor Air Quality and Ventilation in the Current Climate: Perspectives from the Field
- Jun 25: Remote Energy Efficiency Assessments – the New Normal?
- Jul 09: The New Focus on Health in Buildings

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

Dan Fredman

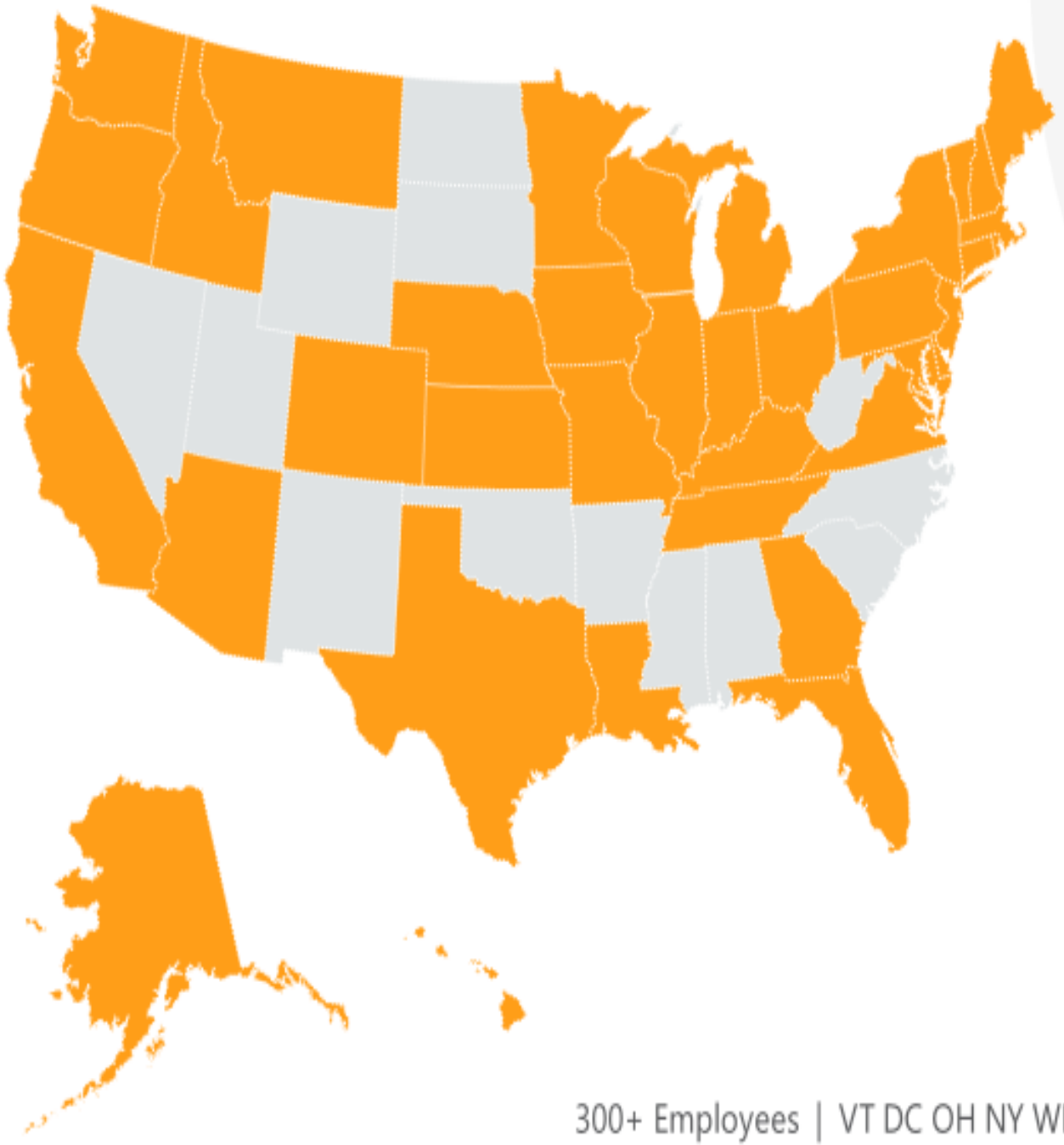
Vermont Energy Investment Corporation

U.S. DEPARTMENT OF ENERGY

Smart Home Programs
Considerations for COVID-19 and Beyond

DOE BBRN Peer Exchange | 2020.05.28

Dan Fredman, PhD | Senior Consultant



Where we work

Energy Efficiency

Building Electrification

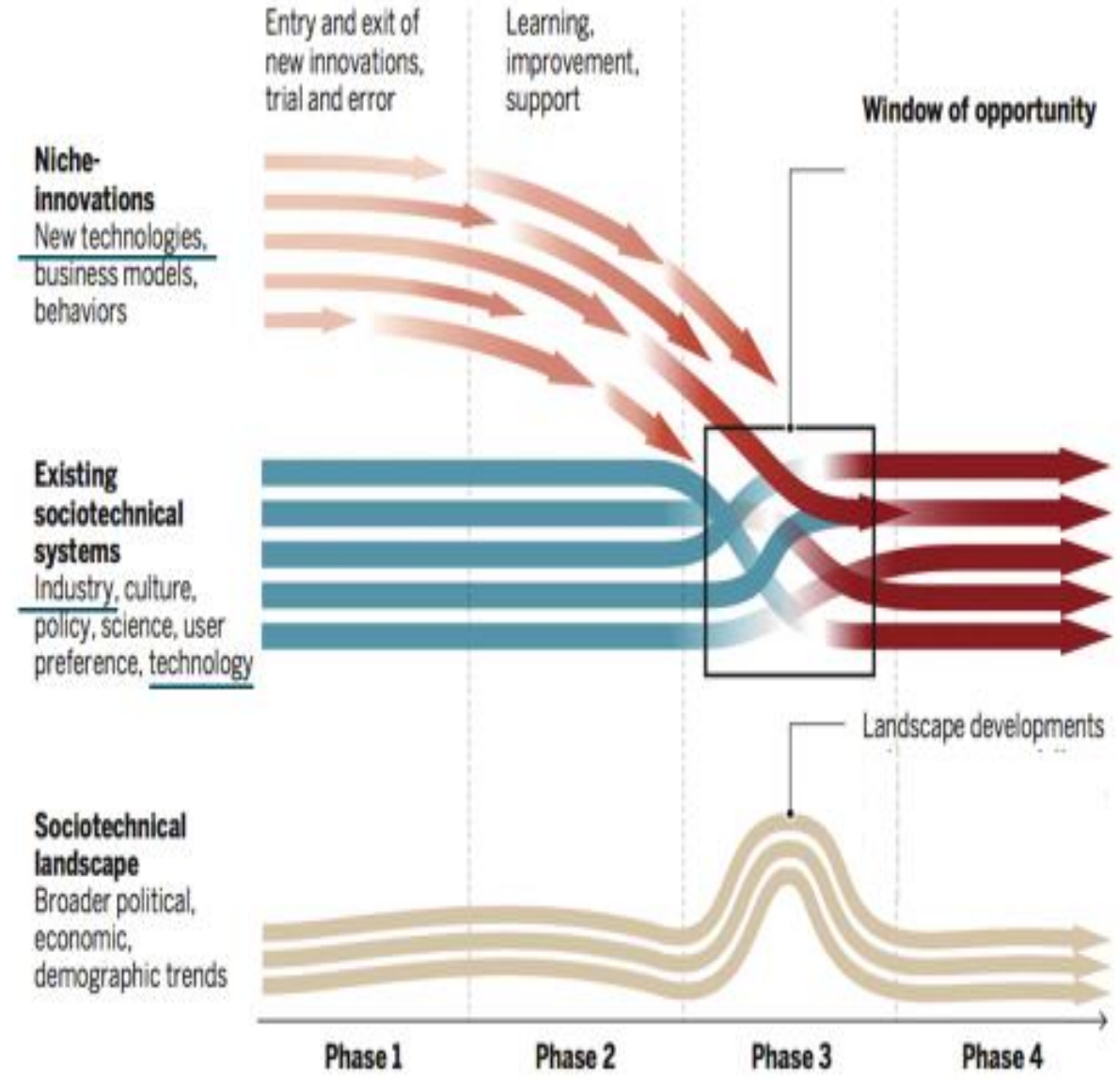
Transportation Electrification

Clean & Flexible Grid

300+ Employees | VT DC OH NY WI | Non-profit founded in 1986 veic

Let's get into it:

The multi-level perspective on system transitions



It's about more than new tech or energy!

veic

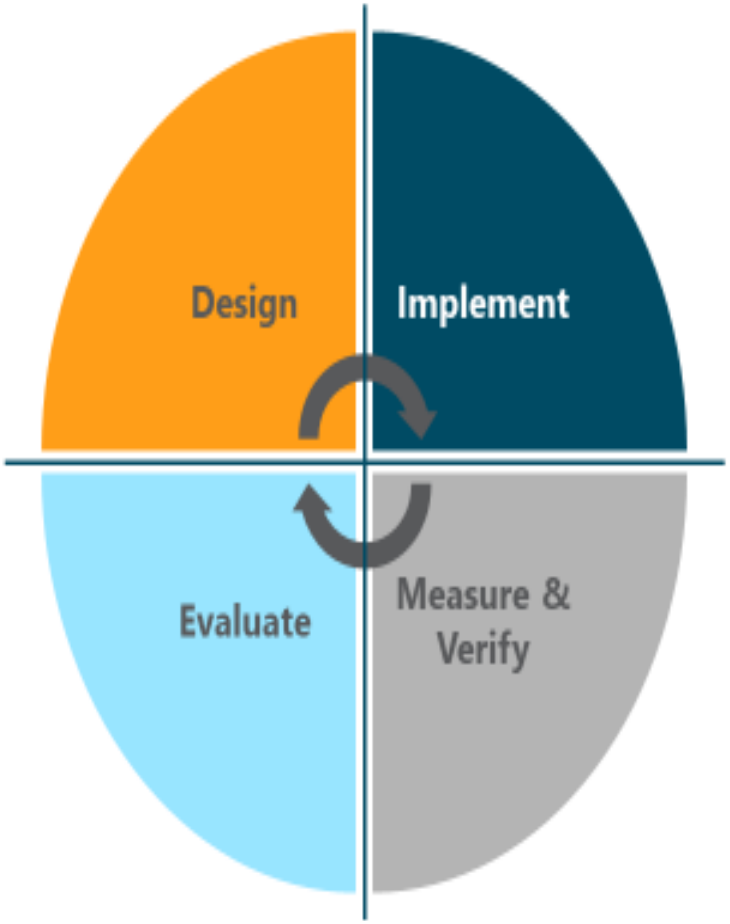
EE Considerations for the Smart Home

- How do "smarts" integrate and influence aspects of Energy Efficiency programs?
- What are the challenges and barriers to increased adoption of these products/services?
- What do we need to do to increase adoption of smart home products (and should we)?

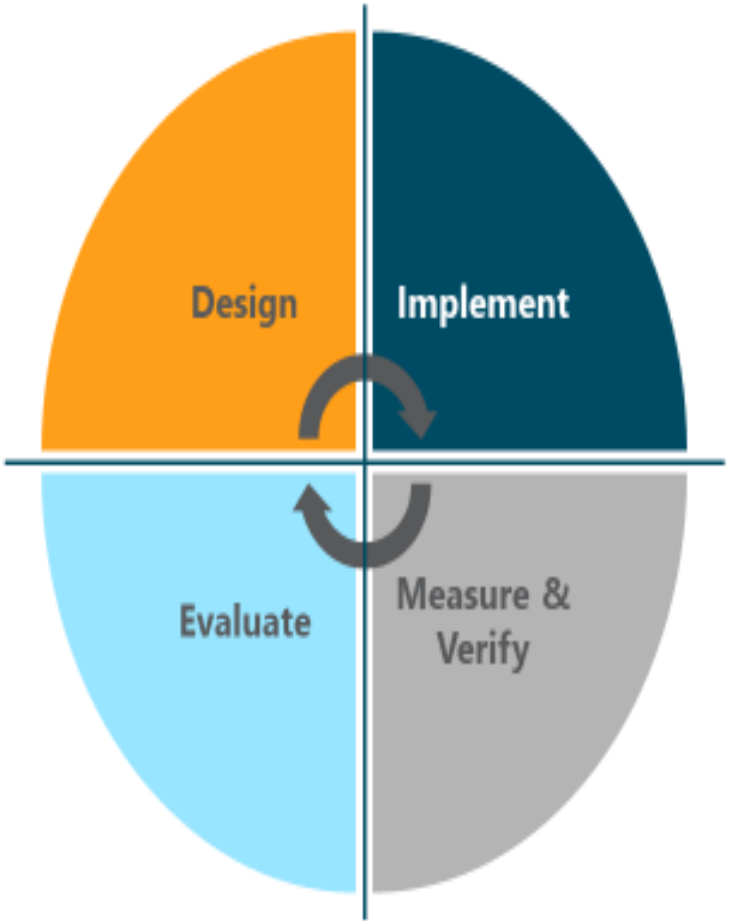
EE Considerations for the Pandemic

- How are users' energy consumption characteristics being influenced?
- How are existing products/services being affected?
- How might smart home products help, if at all, in this **new normal**?

A New Efficiency Program Lifecycle?



A New Efficiency Program Lifecycle?



The Big Idea … ?

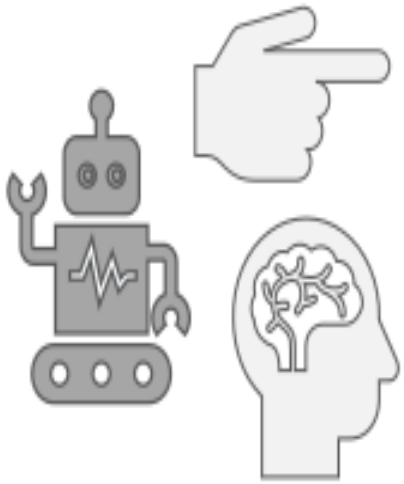
Monitor Energy [Using Technology]

- Accurate
- Precise
- Reliable
- Appropriate
- Affordable

Deliver Feedback [Information]

- Clear
- Compelling
- Frictionless

Change ["Behavior"]



Measurable:

- **Experience** (Happy End-Users)
- **Actions** (Behaviors & Projects)
- **Savings** (Performance)

A Vermont-based Smart Home Survey

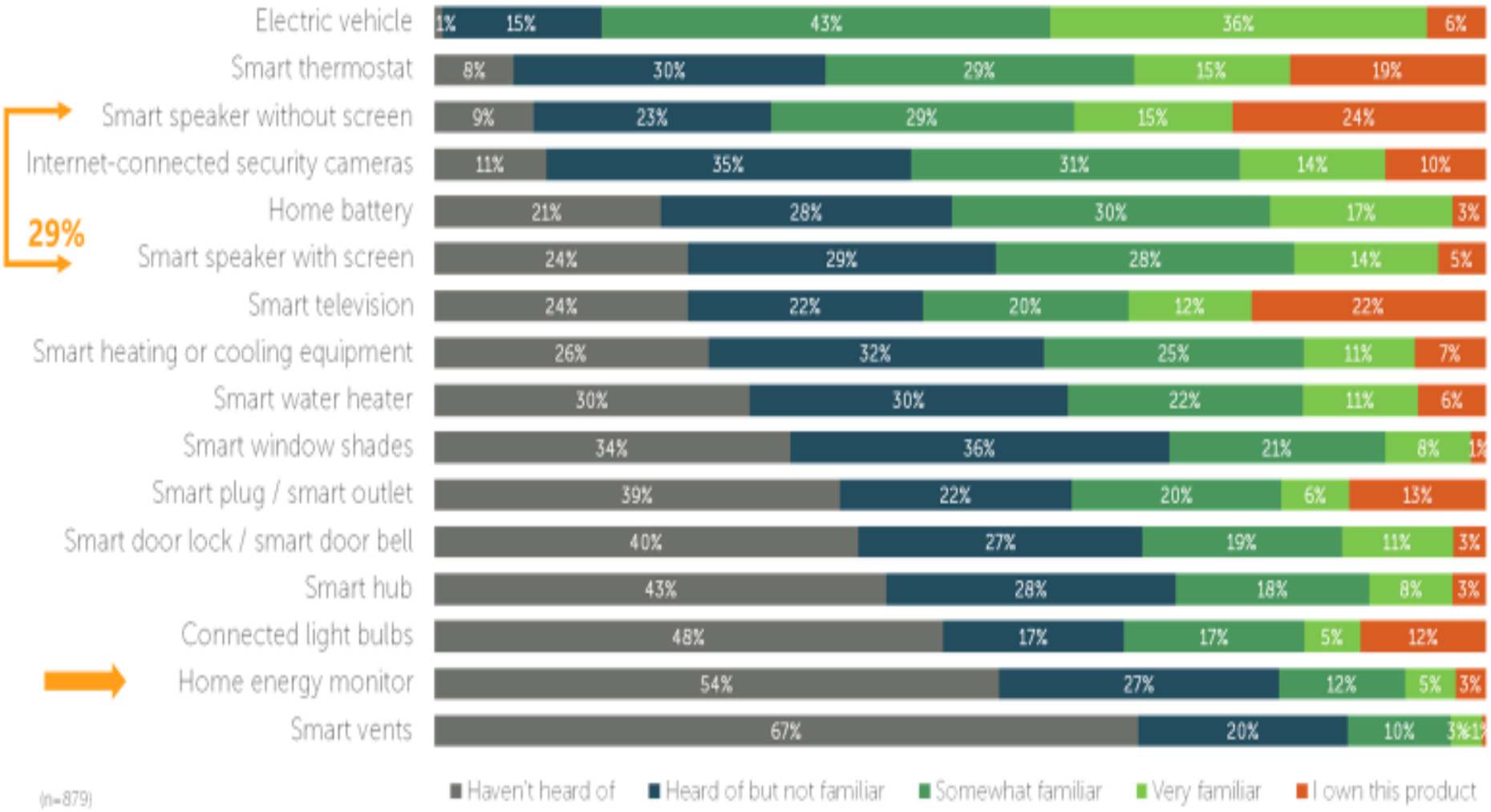
- **Online survey via Qualtrics (part of a behavior-based pilot's RED)**
- **Recruitment**
  - Ads on Front Porch Forum (hyperlocal), Facebook, Google, and via referrals from other respondents.
  - Promoted the survey as sponsored by Efficiency Vermont, about smart home products, and offered a chance to win a $100 gift card in a drawing.
- **Excluded responses if:**
  - Incomplete,
  - Not from a Vermont resident,
  - From a respondent who is under 18,
  - Failed an attention check question.

Results

- 1605 Responses → 976 Completed
- 976 Complete → 879 Vermonters + Attention Check
- Low enrollment via RED
  - Re-encouraged respondents
  - Pivot to mass-market program promotion
  - Preparing for quasi-experimental methods

Awareness

Vermonters' familiarity with smart home products varies by **product**.



(n=879)

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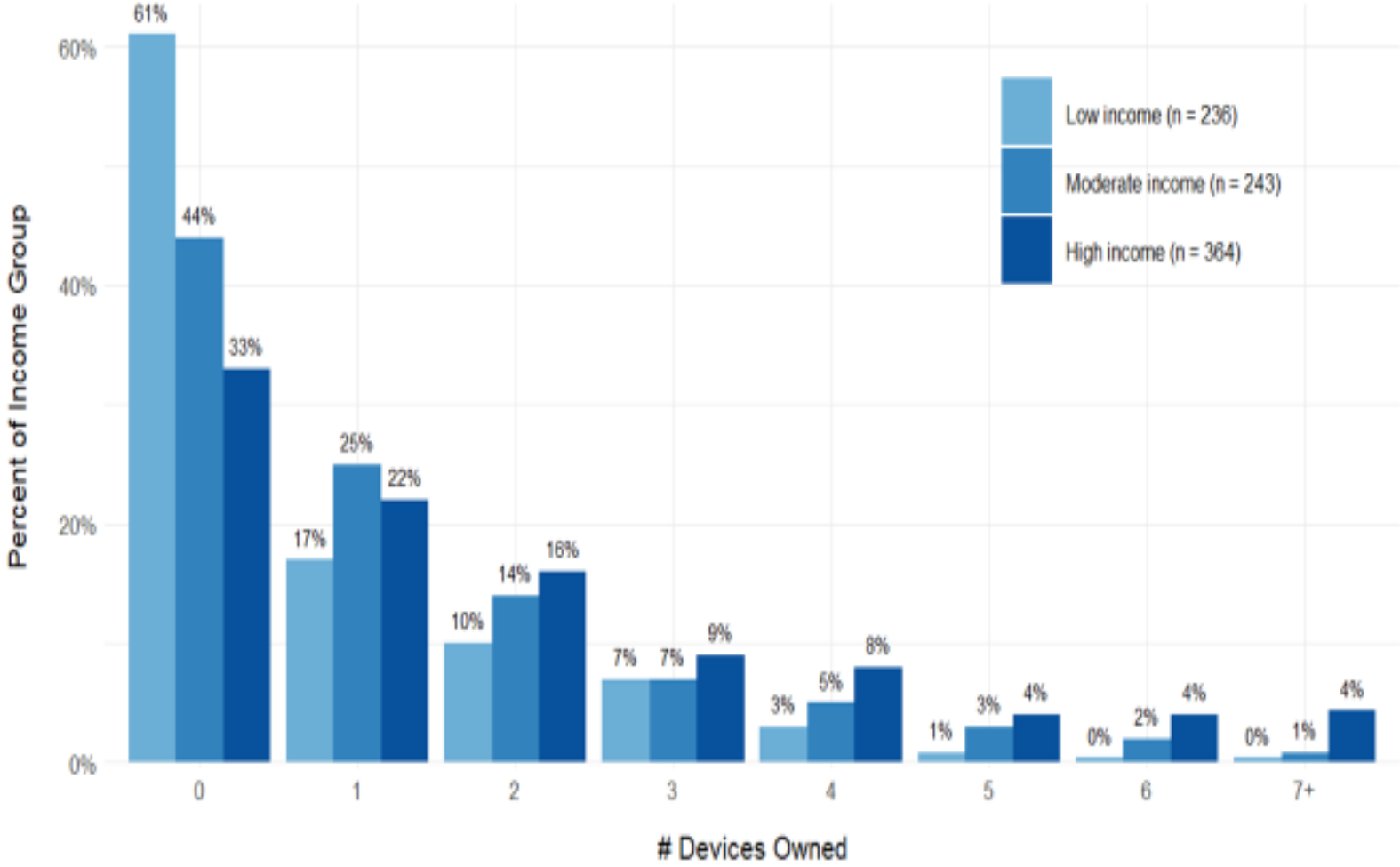
Ownership

Most respondents own **zero or a few** connected home products.

Number of products owned is inversely correlated with income.



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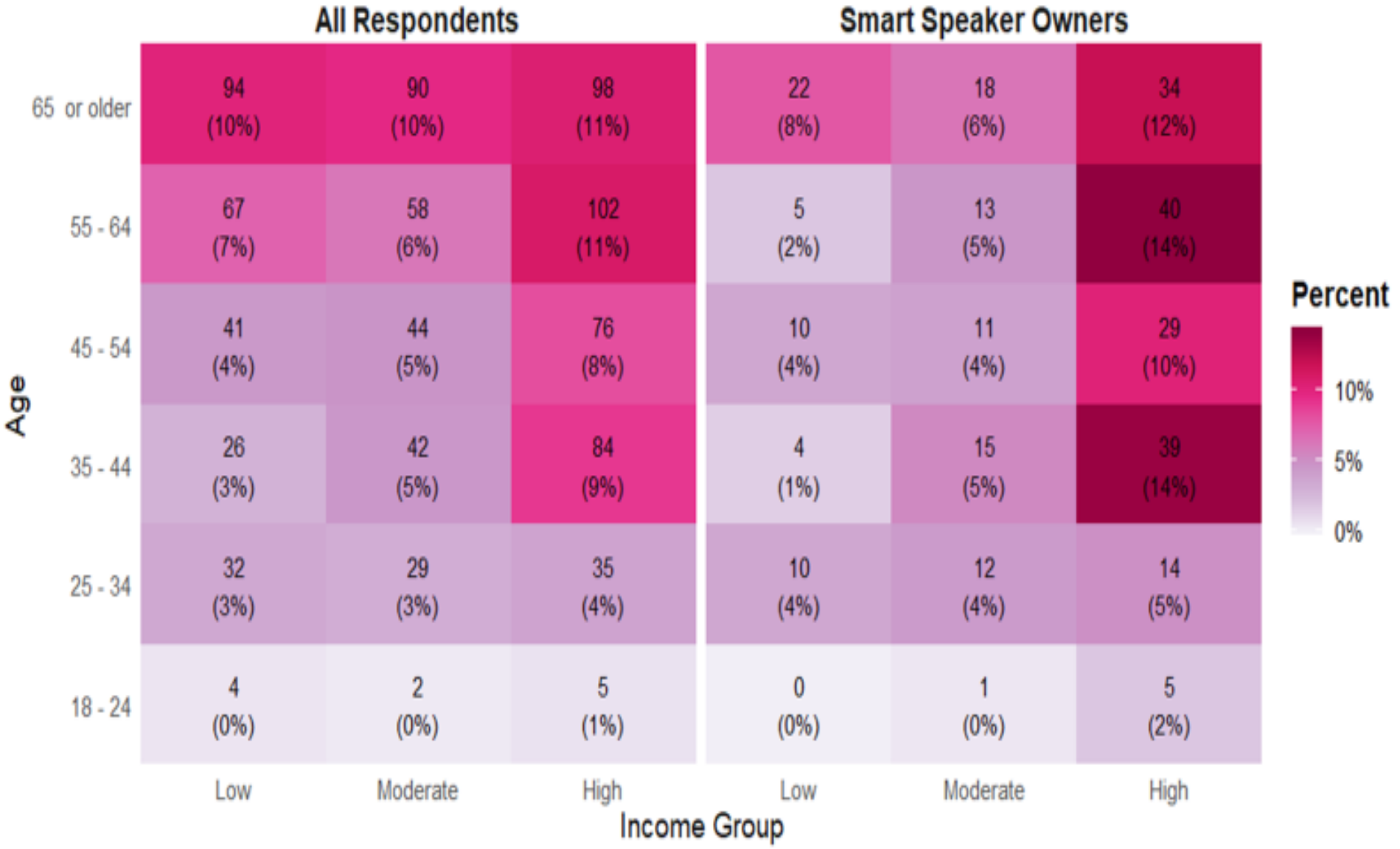
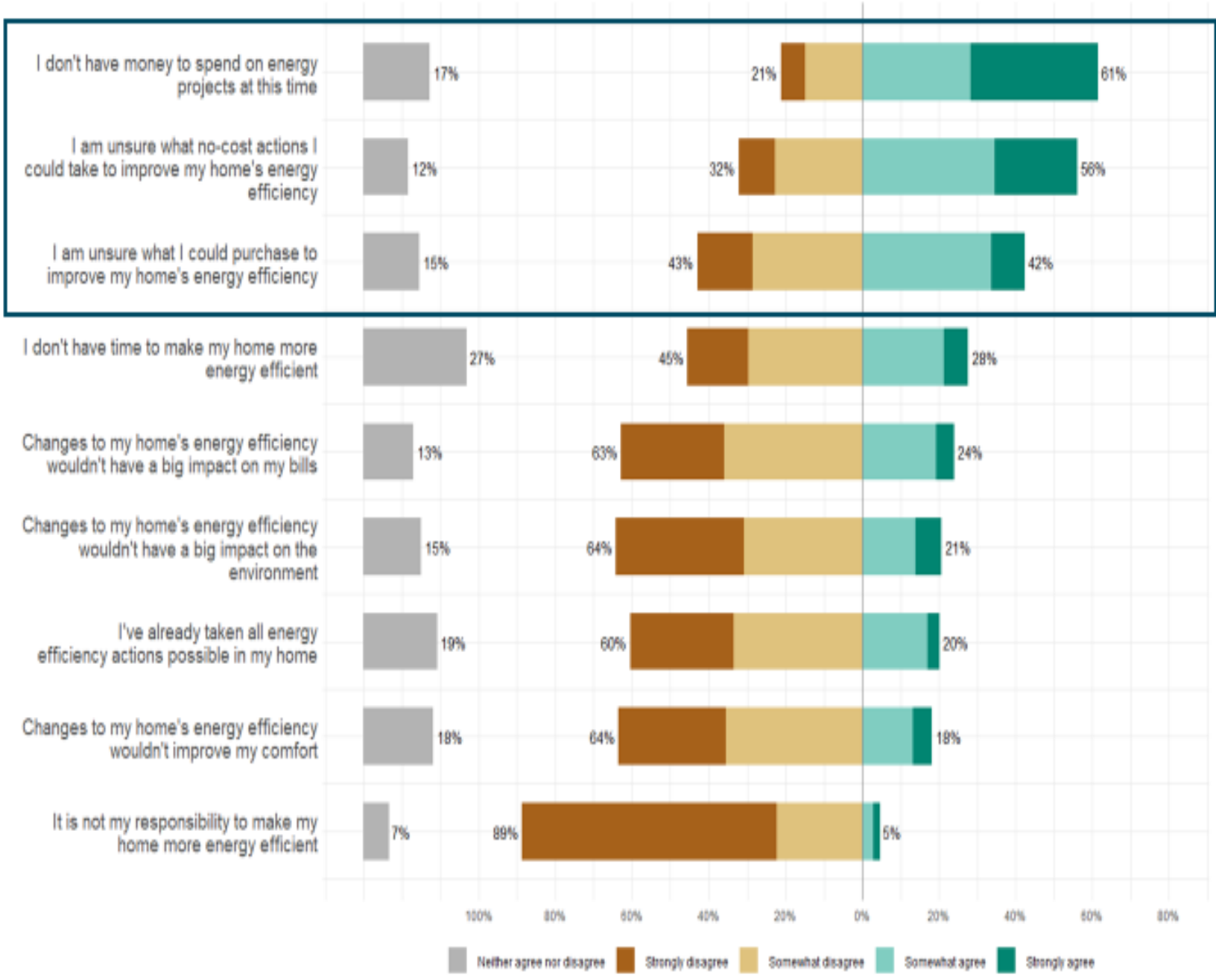
Ownership by Age/Income : Speakers



Ownership by Age/Income : Thermostats

Barriers



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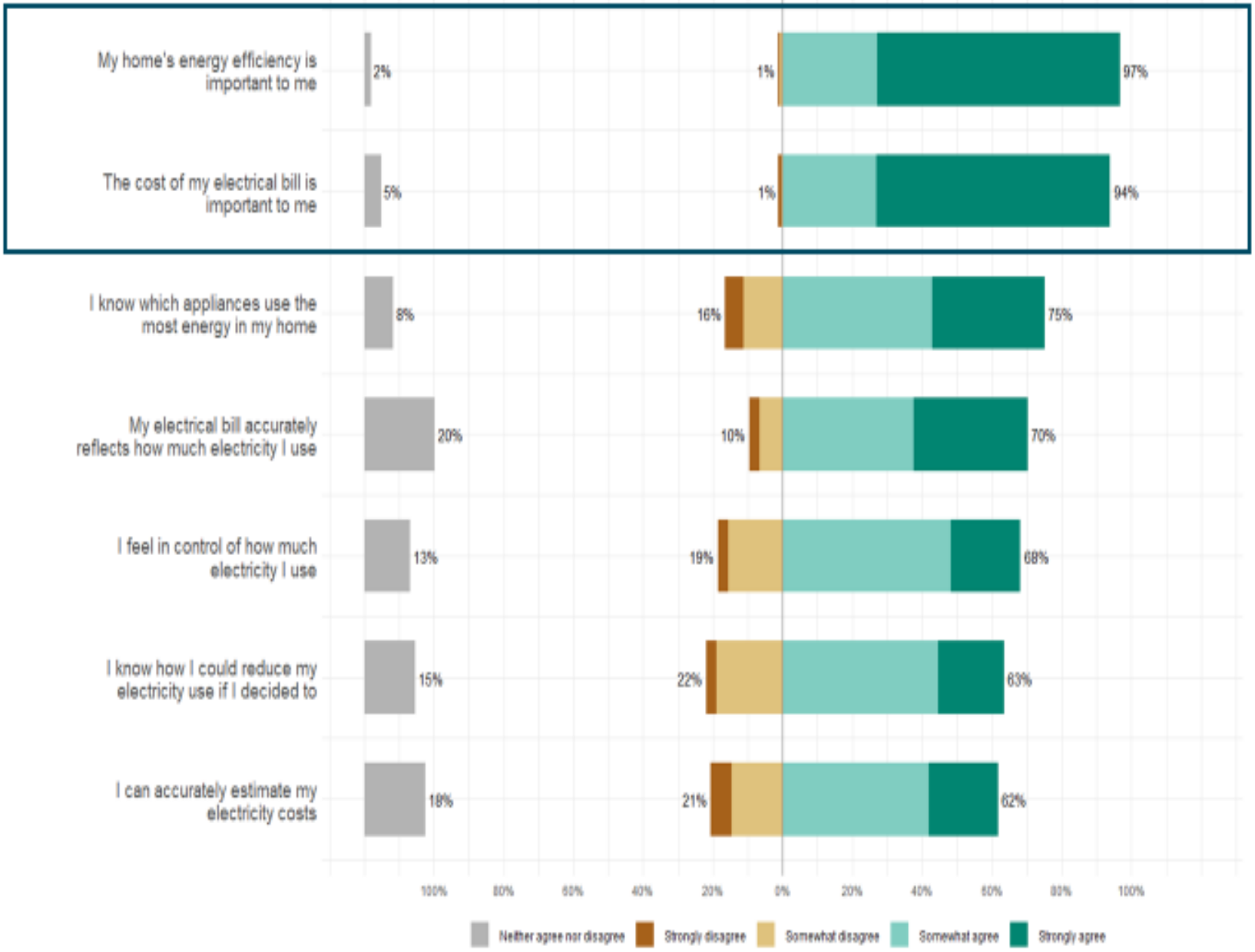
A Continuing Role for EE



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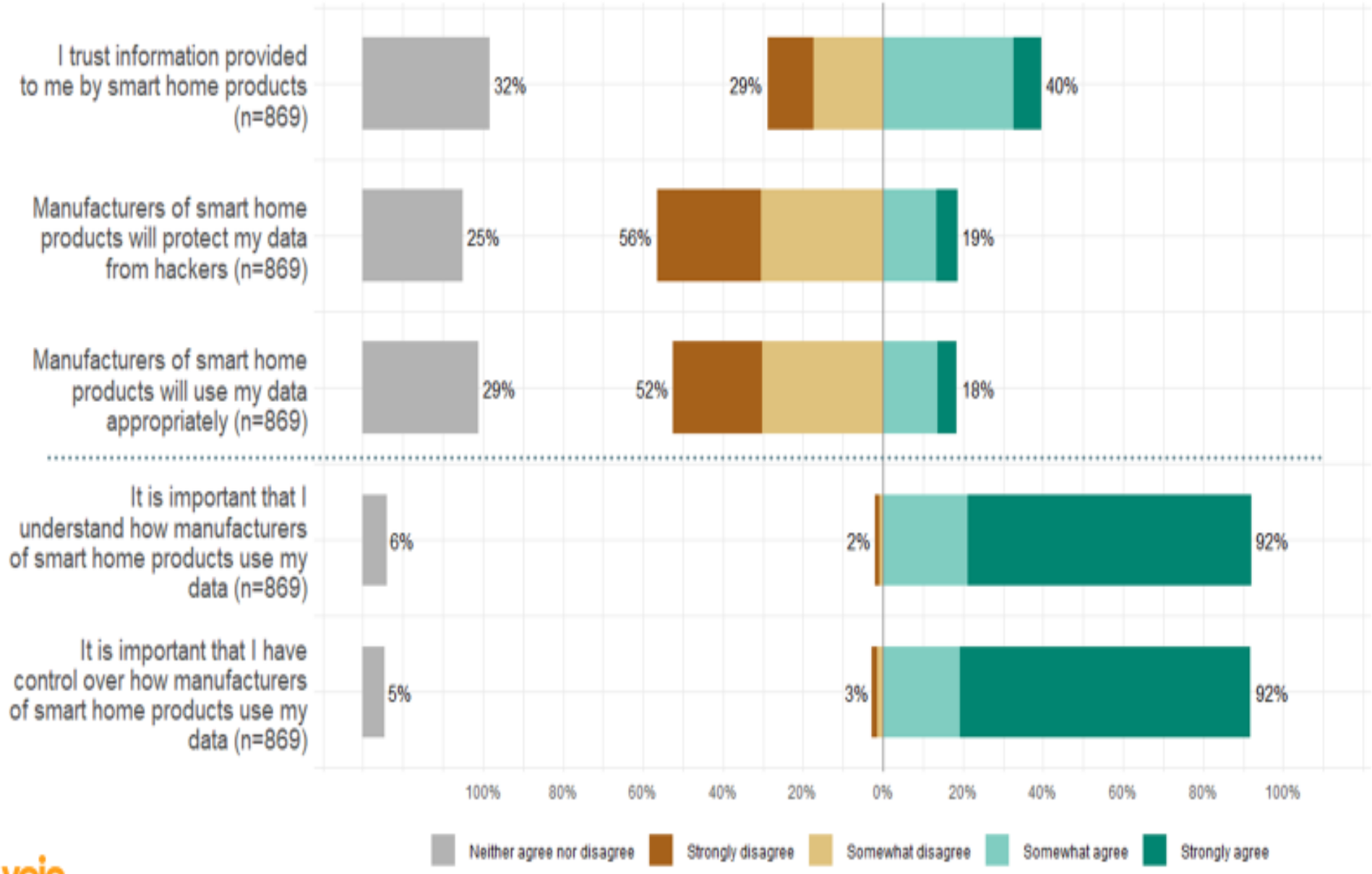
Trust, Control, Protection



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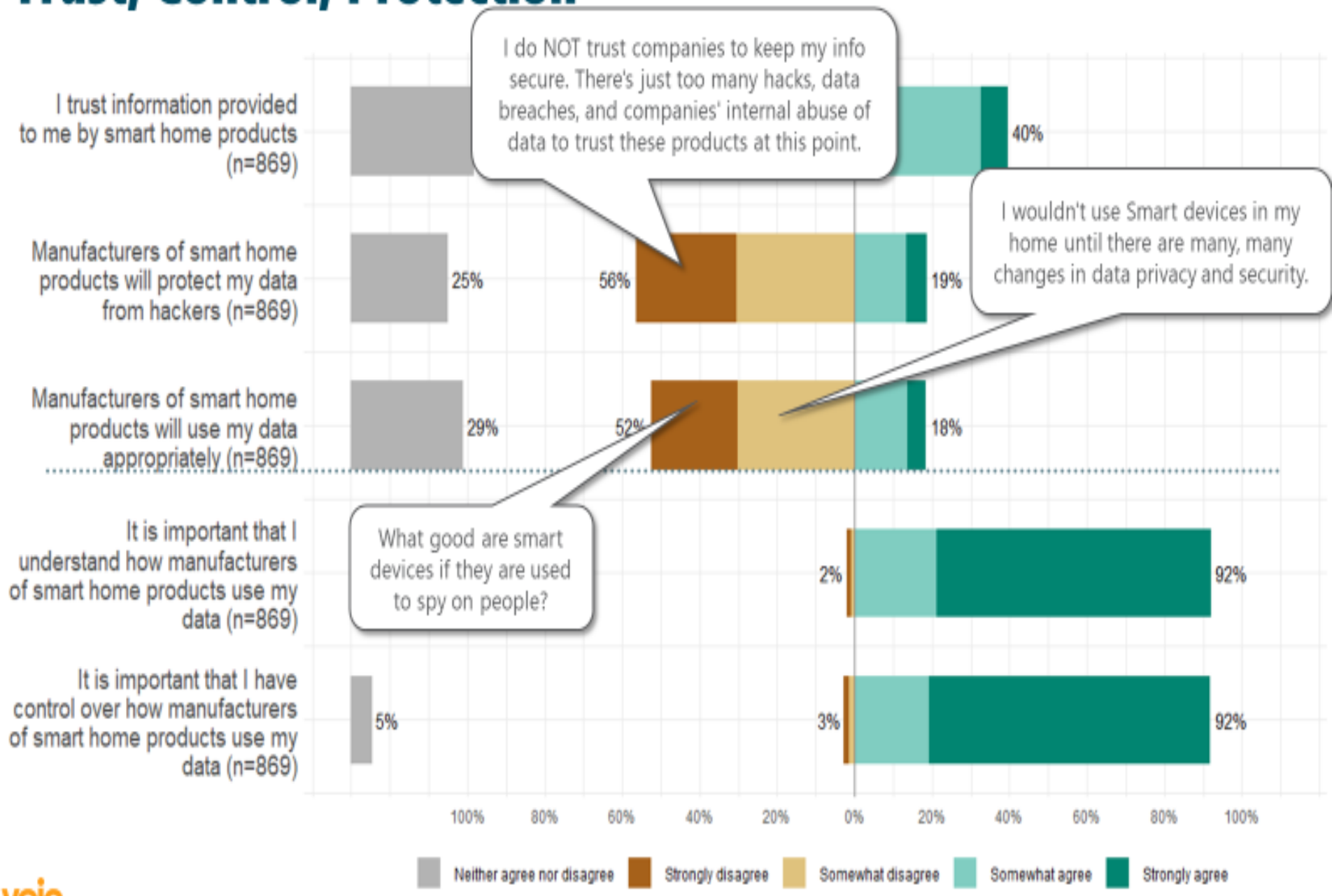
Trust, Control, Protection



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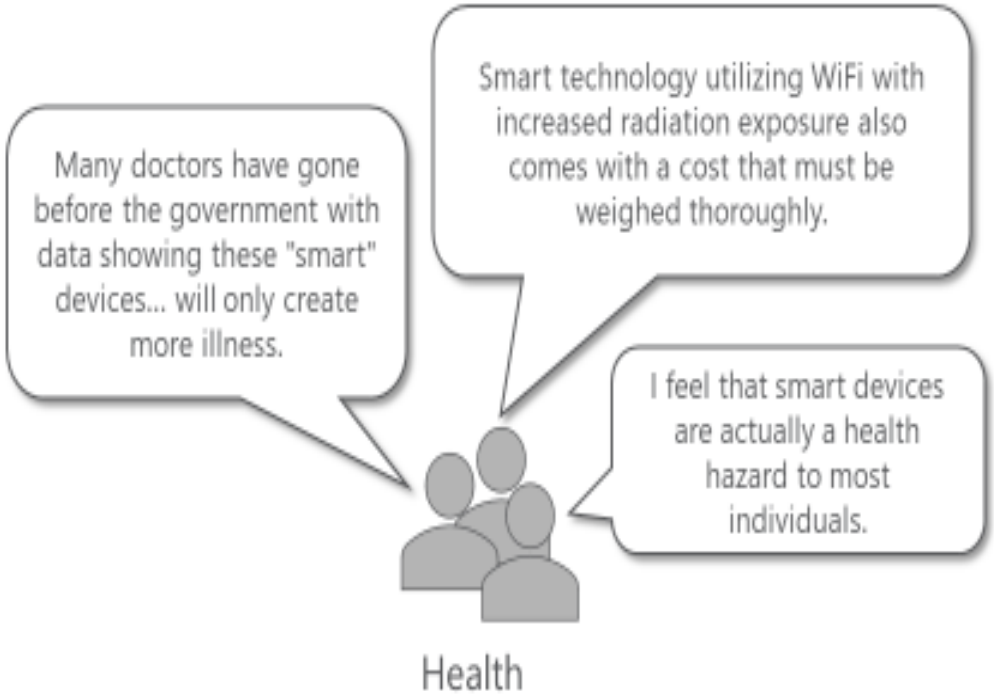
Additional Concerns

A small portion of respondents stated additional concerns about health and Internet connection speed (in open-ended additional comments)



Survey key findings

- More than half (~ 55%) of Vermonters own some kind of smart/connected home device. Most that do own have just one or two.
- Income correlates with awareness and ownership of connected home products.
- Some products may not meet Vermonters' expectations for energy savings.
- Smart speakers are the most divisive type of connected home product. People who own them think of them positively but roughly half of the people who don't own them think of them negatively.
- Data security is important to Vermonters, but few trust manufacturers of connected home devices to manage their data appropriately.

Parting thoughts

- We have to think about smart homes differently → **NEBs, Quality of Life, Peace of Mind**
- Broader policy concerns: health, internet access
- Opportunities exist to align benefits for utilities/grid with customer needs → **Integration**
- Purchase order and constellations of devices matter
- Transparency and control is important for users – we need some leadership in this area that will benefit everyone → **build trust!**
- The pandemic gives us an opportunity to rethink the user experience with smart products
  - Remember how products, services, and programs make life easier (+ better?)
  - Don't forget to protect your users!


veic
Thank you
dfredman@veic.org

Scott Taylor
Sense

U.S. DEPARTMENT OF ENERGY

sense

Home Energy Monitoring during COVID-19 and beyond

Sense
Smart-home energy monitor on the market since 2016

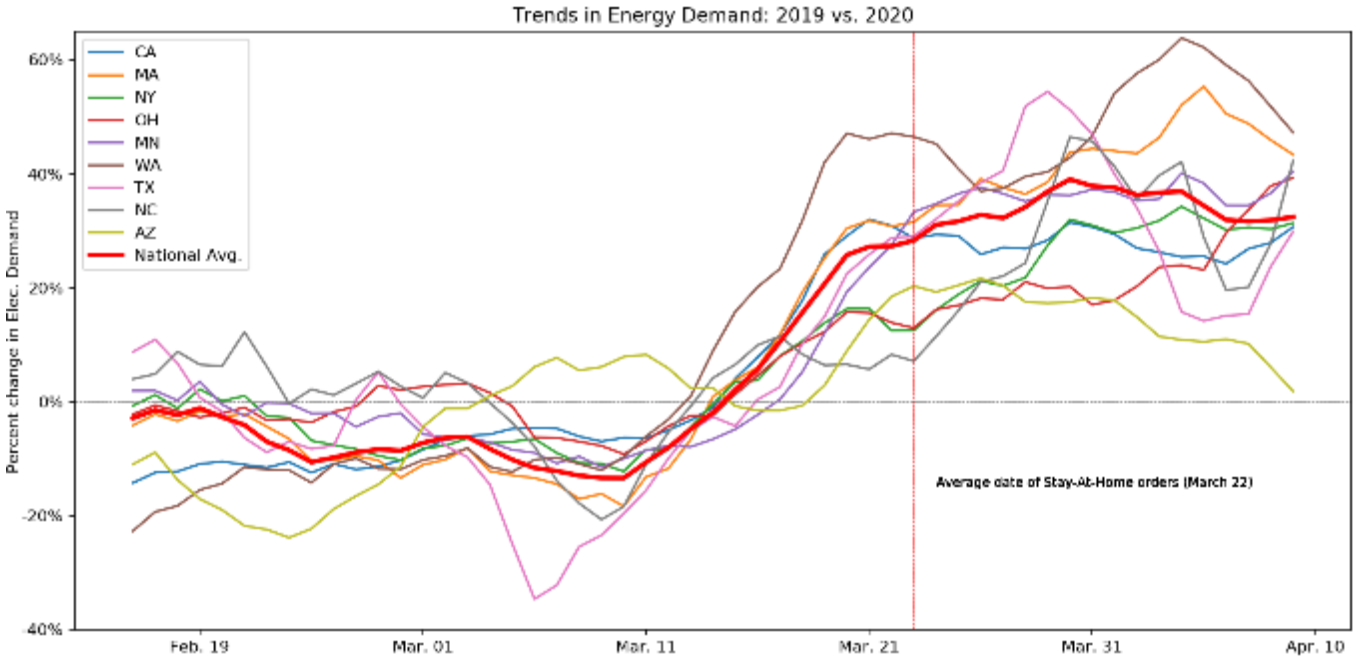
Saving consumers money/energy

Raising awareness of home activity

Very high levels of consumer engagement

Real-time, granular measurement of electric usage, solar production, and efficiency for programs and utilities

Home energy demand trends during lockdowns, March-April 2020



Changes in home energy demand, comparing 2020 to 2019

Data has been normalized for weather.

5000 Sense homes across 30 states

Homes began using more energy starting on March 10, soon after state emergencies were announced but more than a week before state stay-at-home orders were issued.

Energy demand continued rising as more people made the decision to stay home, until reaching a plateau in late March.

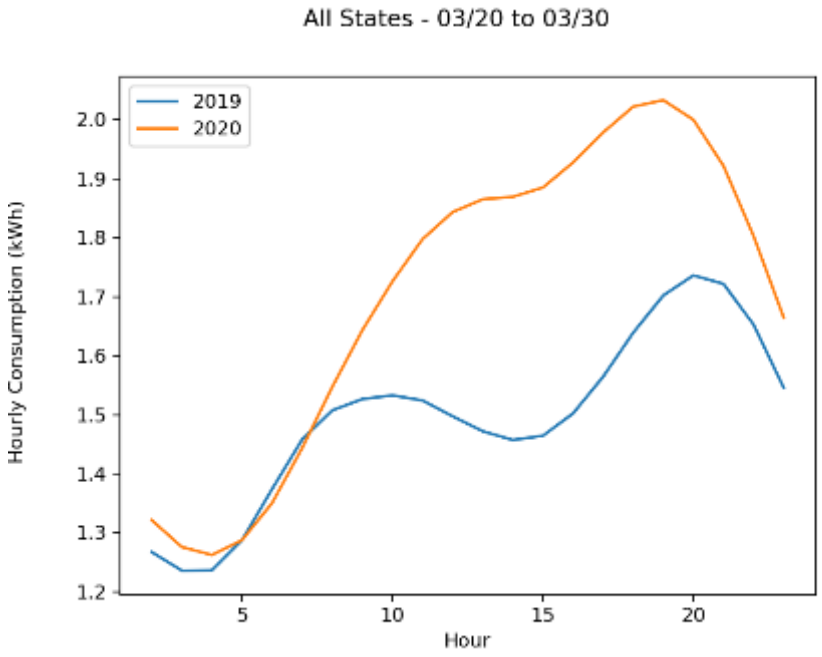
Sense homes tend to be bigger than average homes and use on average 23% more energy than national average

Increases in usage by state

Differences represent changes in usage before and after March 14 through April 10. This date was chosen based on when increases start to be evident in most states. This is not normalized for weather.

State	Mid-day Increase in Consumption (10 am to 3 pm)	Daily Increase in Consumption
California	28.8%	21.1%
Massachusetts	40.4%	26.6%
New York	26.6%	15.0%
Ohio	19.8%	14.4%
Minnesota	36.4%	24.3%
Texas	32.7%	20.0%
North Carolina	19.0%	9.6%
Arizona	18.6%	8.6%
National	**35.1%**	**22.4%**

Daily 24-Hour Energy Usage Nationwide



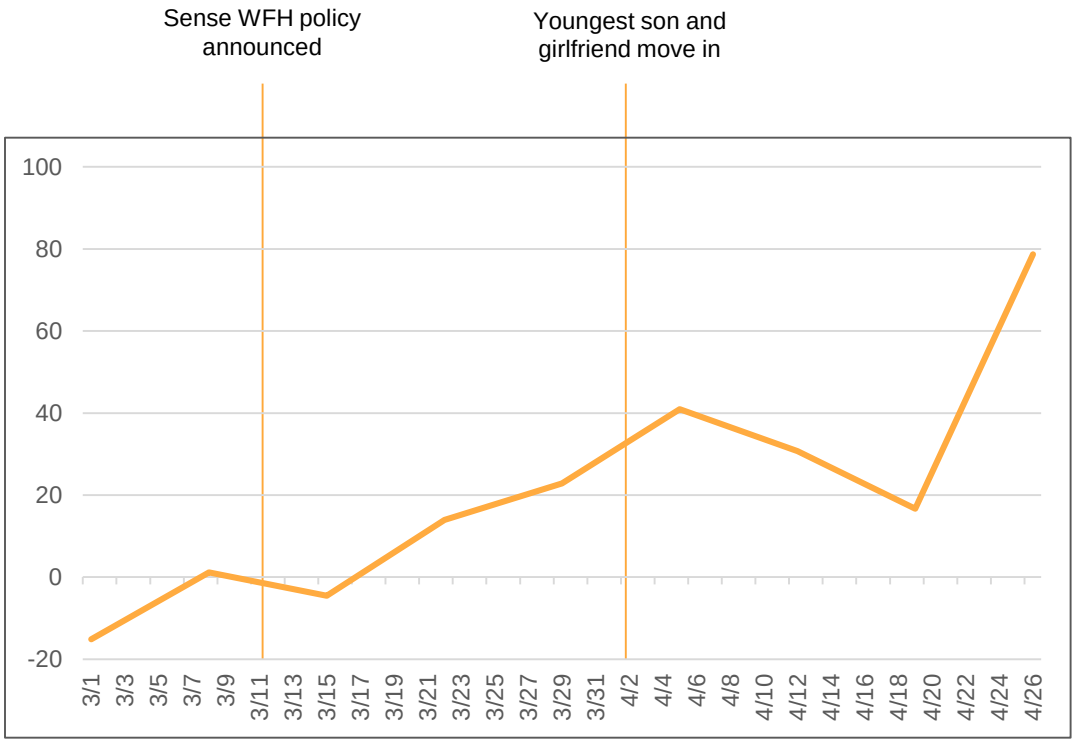
In late March 2019, the average home's energy usage peaked at about 9 am and 7 pm, and dipped in the middle of the day between 10 am and 4 pm, when many people were away from home at work or school.

This year, during the period March 20-30, the average home across the US showed steadily rising energy usage starting at 5 am and peaking at 6 pm, followed by declining use through the evening and overnight. The biggest increase happened at 4 pm when the average home increased its energy usage by 425 Wh.

This change in energy usage reflects that most people are home all day and using electricity.

One home – example

YoY increase in kWh



Main culprit!

Dryer usage in April up 250% YoY

Washer/Dishwasher also way up (natural gas)

Lockdowns are pushing up home electric bills, and air conditioning season is hardly here yet

By Hiawatha Bray Globe Staff, Updated May 26, 2020, 3:54 p.m.

Connected thermostats know:

Setpoints and schedules

Indoor and outdoor temperatures

HVAC runtimes

High resolution energy monitors know:

Actual energy use

Detailed equipment behavior (for performance tracking and fault detection)

Sense is leveraging data from both to:

Identify HVAC faults and maintenance issues

Track HVAC performance

Future: combine with building/equipment modeling for residential continuous commissioning

HVAC – potential opportunity

710 homes with Sense+Ecobee

Summer 2019, normalized for weather and other factors

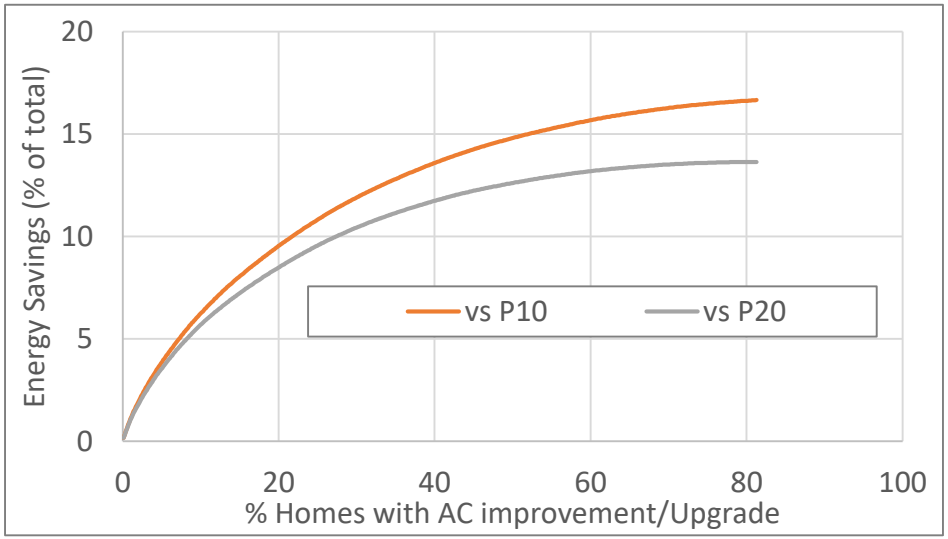
Clustering by degree-days

Comparing homes against most efficient 10th percentile (P10) and most efficient 20th percentile (P20)

Can save approx. 9-10% total power by improving 20% of the worst performing ACs

Potential improvements:

- AC repair/tune-up
- HVAC upgrade
- Ductwork, insulation, etc.



10% thresh =$500/year, 20% thresh = $350 per year (assuming $.13 per kWh)
Excludes any estimates for heatings savings, comfort benefits, etc.

High resolution data can also be used to identify faults and preventive maintenance issues

Thank you

www.sense.com

Chris Bilby
Holy Cross Energy

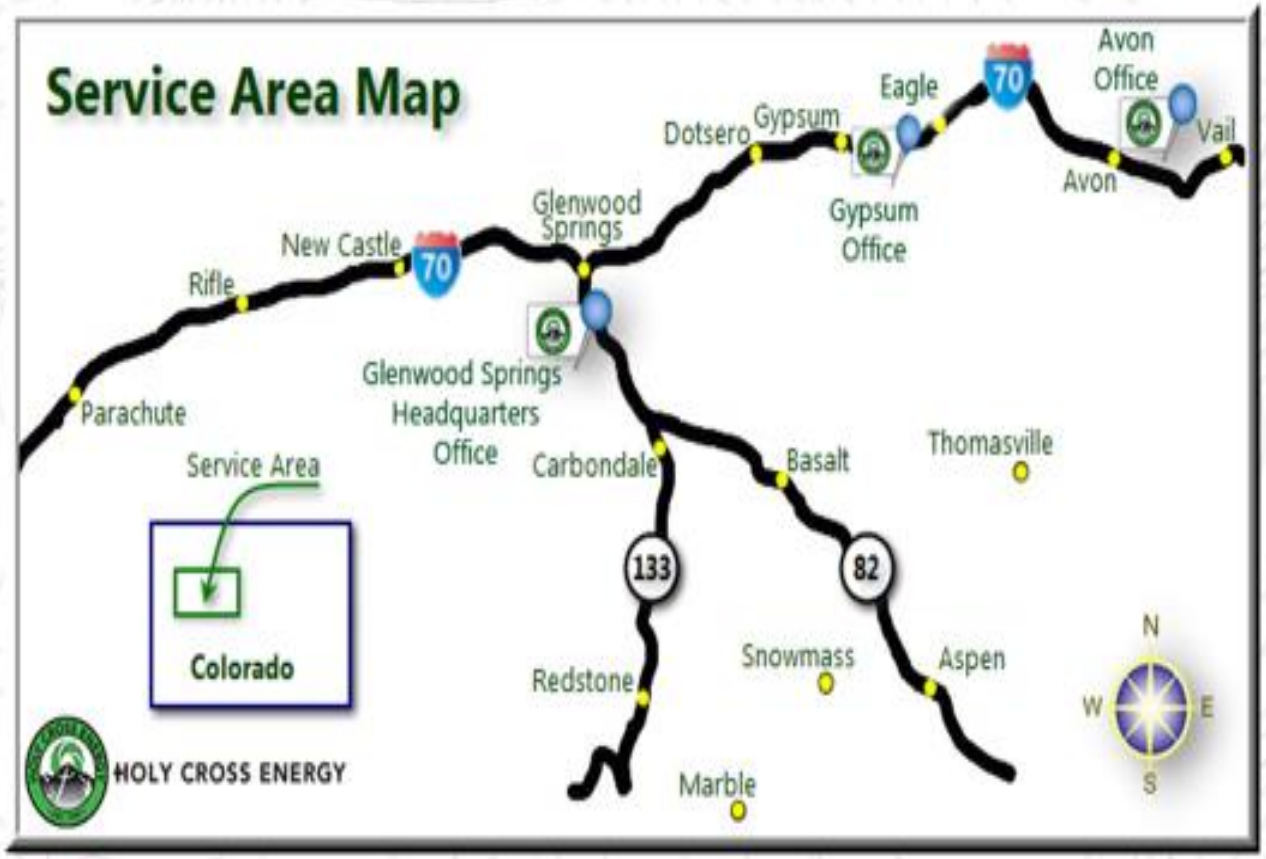
U.S. DEPARTMENT OF ENERGY

Smart Home Growth as a Result of the Coronavirus

May 28th 2020

Chris Bilby
Research Engineer
Holy Cross Energy

Holy Cross Energy



Member-Owner
Not-for-Profit
Electrical Cooperative

$130 million revenue
160 employees
269 MW winter peak
61,000 meters
3,000 miles of distribution
120 miles of transmission
40% RE Mix

Basalt Vista Affordable Housing Project

- Habitat for Humanity, Pitkin County, Basalt School District
- 27 homes for teachers and local workforces.
- Designed to ZNE building with *all electric* construction
- Adjacent to Basalt High School
- 4 selected for HCE's field deployment

Home Equipped with Controllable Loads

- Rooftop solar
- Energy storage
- Mobility charging (EVSE)
- Comfort (Hot Water + HVAC)

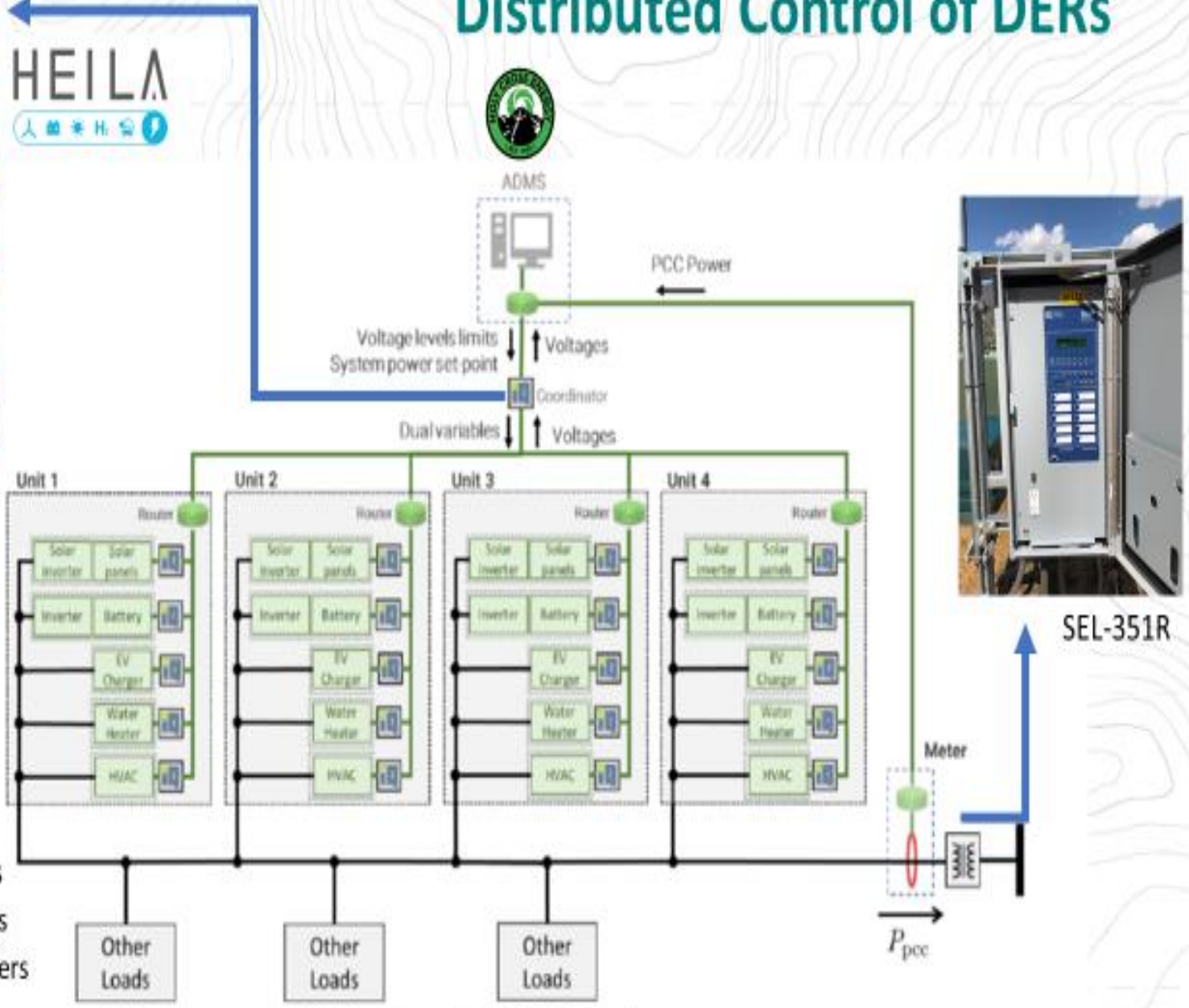
Basalt Vista Case Study

Project Goal: Demonstrate the ability for a distribution utility to control and dispatch Distributed Energy Resources (DERs) to provide value to the grid as well as to the individual consumer.

- **Microgrid controllers coupled with DER**
  - Flexible
  - VPP at All Levels
    - Feeder, Community or Individual Buildings
- **ADMS: Simple Management and Visibility of DER**
- **Studied High Penetration of DERs**
- **Interoperability of different "Systems"**
- **Resilient Soft Microgrid**

Distributed Control of DERs

HEILA



SEL-351R

- 4 units
- 5 devices per unit
- Total Loads
  - 40kW of PV
  - 48kWh of Storage
  - 30 kW of EV chargers
  - 24 kW of Heat pumps
  - 22 kW of Water heaters

Figure 8. Field System Details

Distributed Control of DERs

Advanced Distribution Management System (ADMS)

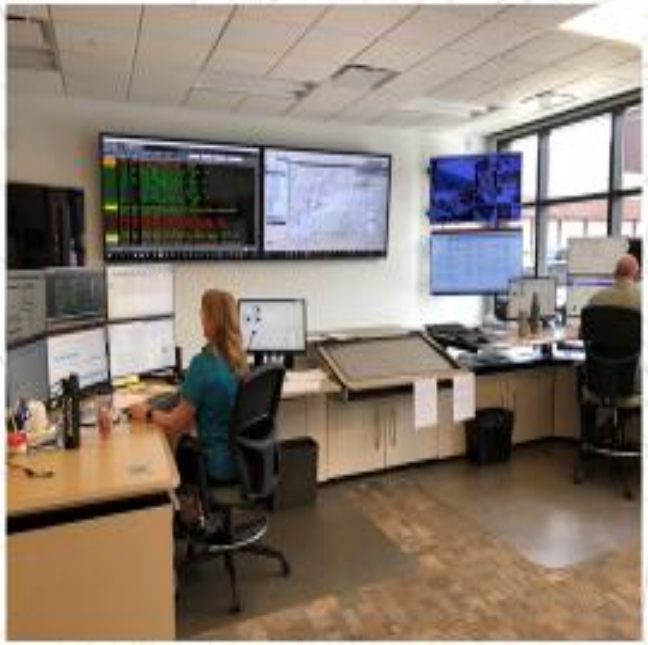
Fully integrated:

- Supervisory Control And Data Acquisition (SCADA)
- Outage Management System (OMS)
- Distribution Energy Resource Management System (DERMS)

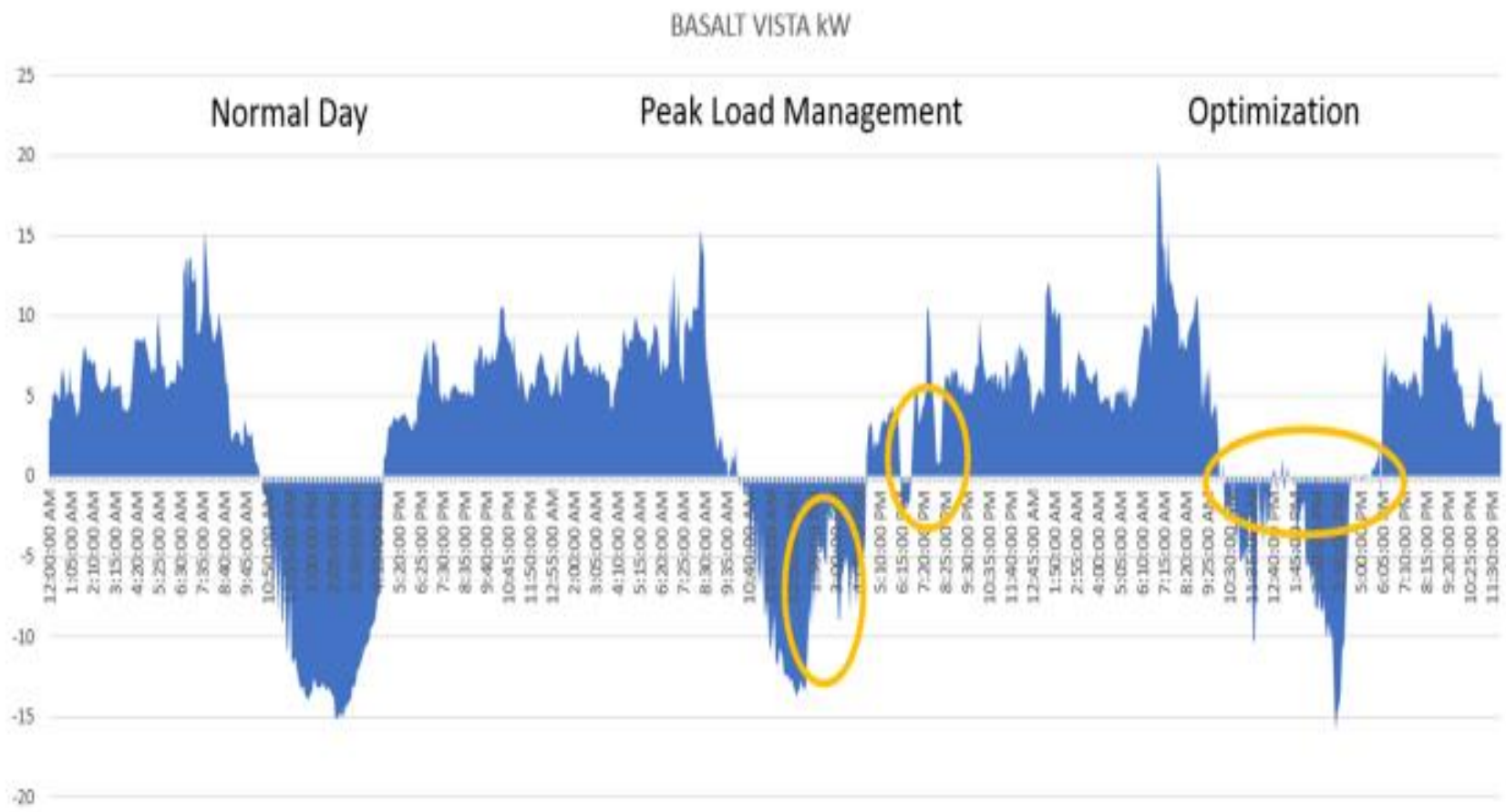
Enhanced Situational Awareness for:

- Load Flow and State Estimation
- Vehicle Location
- Switching Validation
- Outage and Restoration Information from AMI
- Also runs applications, including:
  - CVR – conservation voltage reduction
  - VVO – volt/var optimization
  - FLISR – fault location, isolation and service restoration

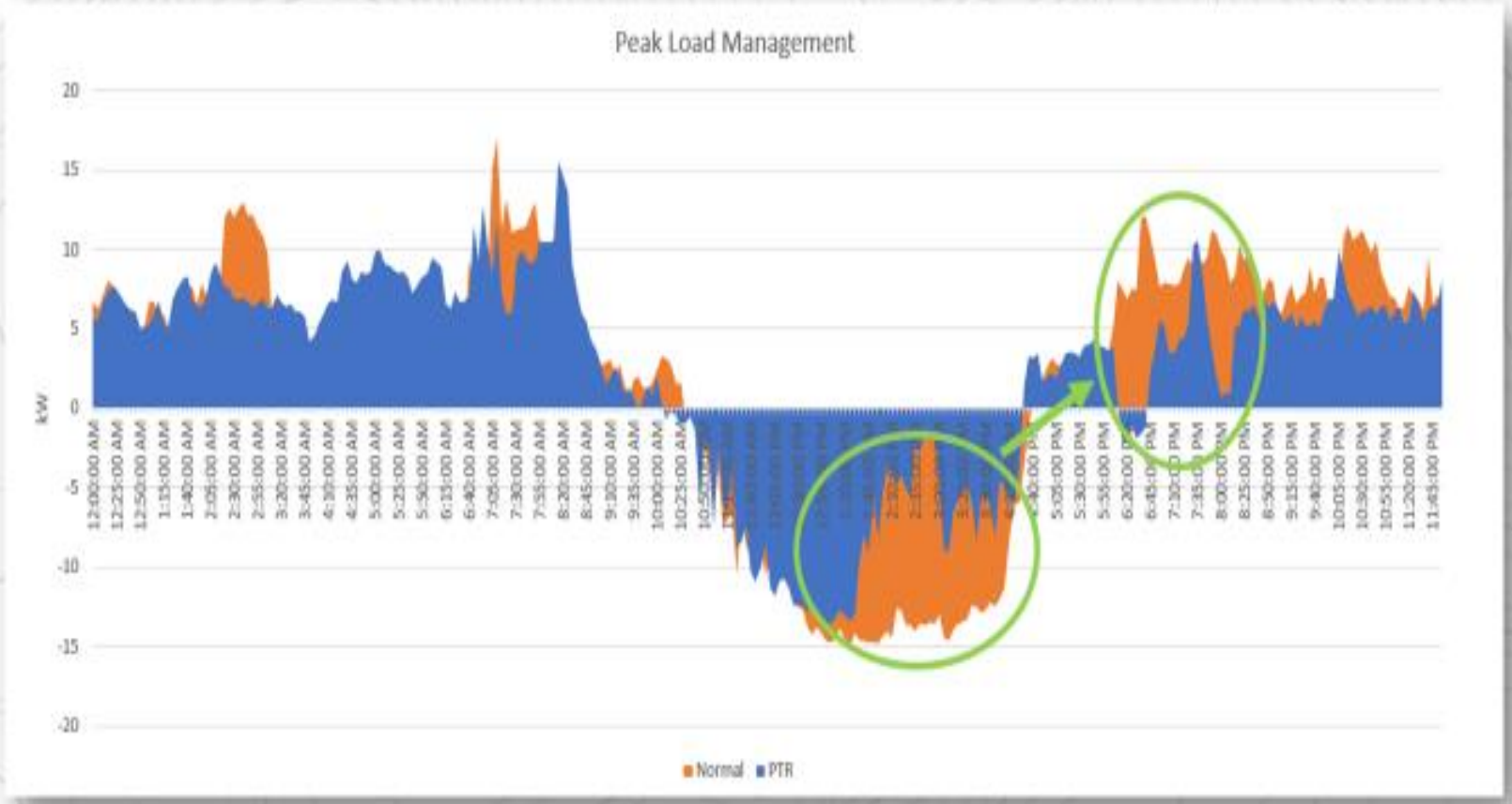
One easy-to-use graphical interface provided by Survalent (existing HCE partner)



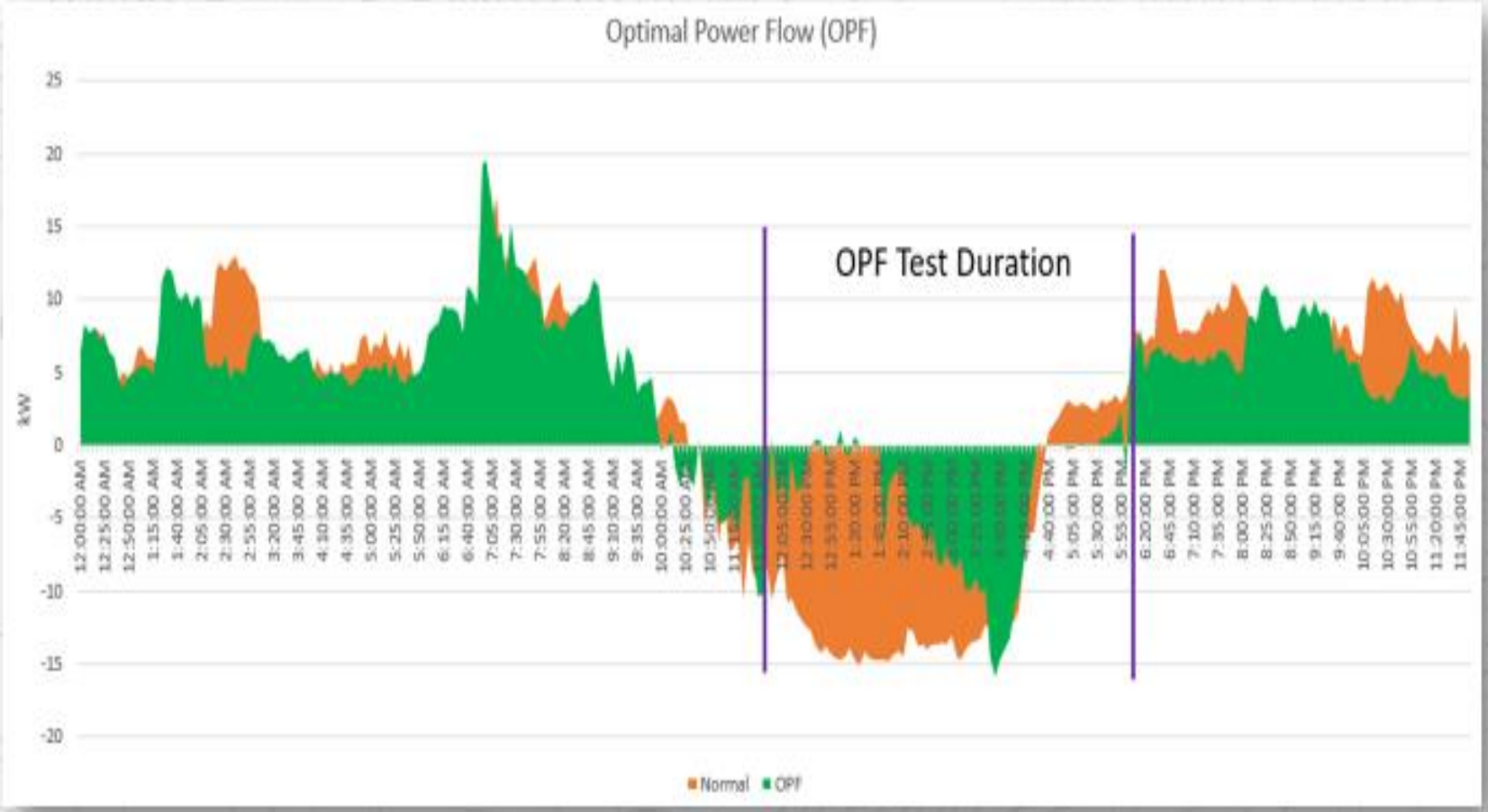
3 Day Test at BV (Nov) – 4 homes



3 Day Test at BV
Peak Load Management



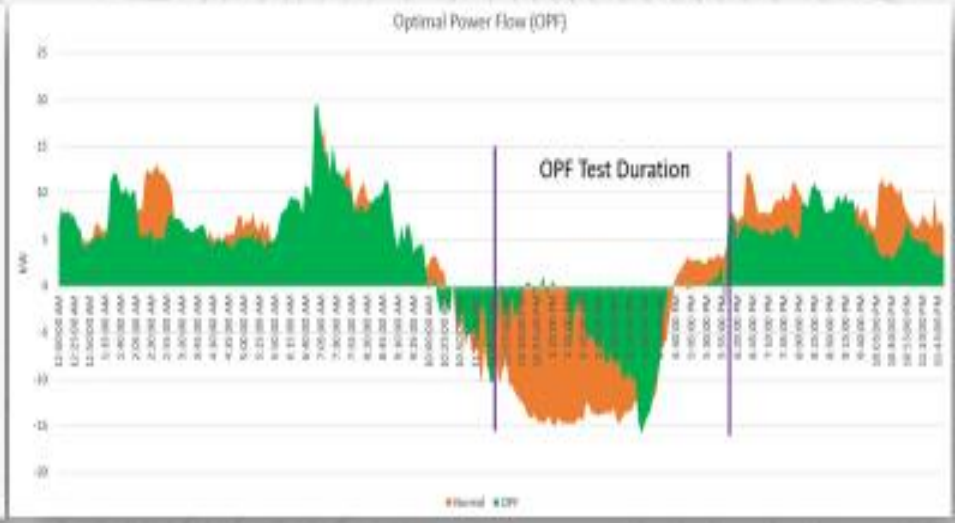
3 Day Test at BV
Optimal Power Flow



Power at Transformer set to 0 Watts throughput. System set to aggregated optimization.
PV set to charge batteries than to grid. Option to curtail PV to create a true 0 Watts load profile.

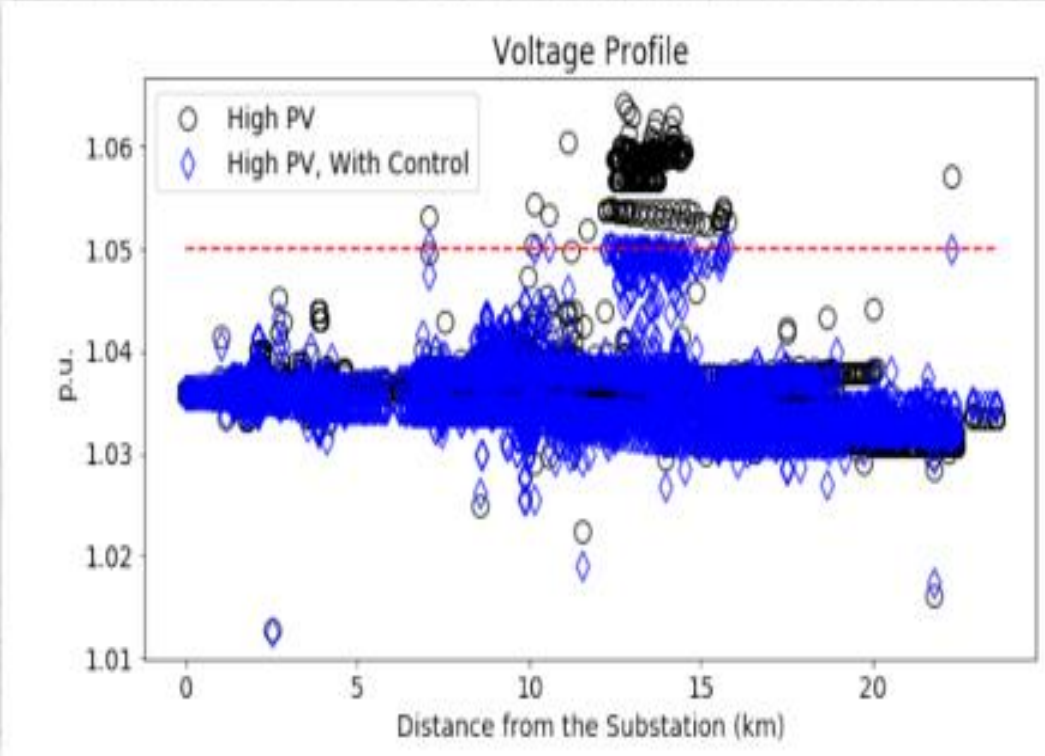
Learnings from the Grid Edge

- Stay focused on the Big 3 – PV, EV, and BESS
  - Some members show willingness to allow utility control of DERs
  - Battery Storage may provide voltage and frequency support to a high penetration grid
  - Distributed resources can help manage overall cost of service for members
- DER will have a greater value if they work together in small groups to provide VPP and Microgrids
- Cost of capital can have a material impact on project viability



More Learnings

- Only need to control a subset of DER in a high penetration system
- Coordination & Computations is best left at the grid edge
- There is a need for multiple and redundant communication systems



HCE Program Offerings

Distributed Energy Resource Service Agreement (DERSA)

- Low interest on-bill payments for DERs

Distribution Flexibility (DF)

- Credit for allowing HCE to control DER assets
- Consists of PTP or DRP

Peak Time Payback (PTP)

- Credit for voluntarily *reduction* in consumption during forecasted "peak" events
- Available to all members

Dynamic Renewable Pricing (DRP)

- Credit for voluntarily *increase* in consumption during forecasted "oversupply" events
- Pilot starts March 1

Time of Use (TOU)

- Method of measuring and charging a member's energy consumption based in when energy is used

Purchase Renewable Energy (PuRE)

- The green pricing program

Ongoing Research at Basalt Vista

$$s(p,t) = \frac{\partial q(p,t)}{\partial t}$$

SLAC NATIONAL ACCELERATOR LABORATORY

SIEMENS Ingenuity for life

NREL NATIONAL RENEWABLE ENERGY LABORATORY

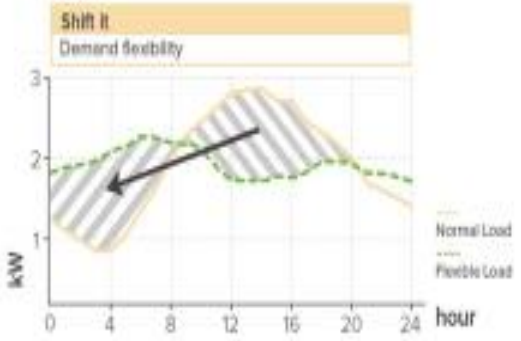
- Transactive Energy
- Market Dashboard
- Member App
- DER Flexibility

- Security (Physical & Cyber)
- PV Forecasting
- Resiliency thru Black start
- Microgrids

- Home Energy Management System for residential members
- Building-Grid Integration

Recommended Articles

- **Rocky Mountain Institute (RMI)**
  - *The Economics of Load Defection*
  - *The Economics of Demand Flexibility*
- **National Renewable Energy Laboratory (NREL)**
  - *Small Colorado Utility Sets National Renewable Electricity Example Using NREL Algorithms*
  - *Performance Evaluation of Distributed Energy Resources Management System via Advanced Hardware-in-the-Loop Simulation*
- **Wired (April 7, 2020)**
  - *The Power Plant of the Future Is Right in Your Home*
- **IEEE Power & Energy (Jan/Feb 2020)**
  - *Distribution Management - Investing for the Future*
- **Southwest Energy Efficiency Project (SWEEP)**
  - *Colorado's Basalt Vista Neighborhood: "A Net Zero Affordable Housing Community"*



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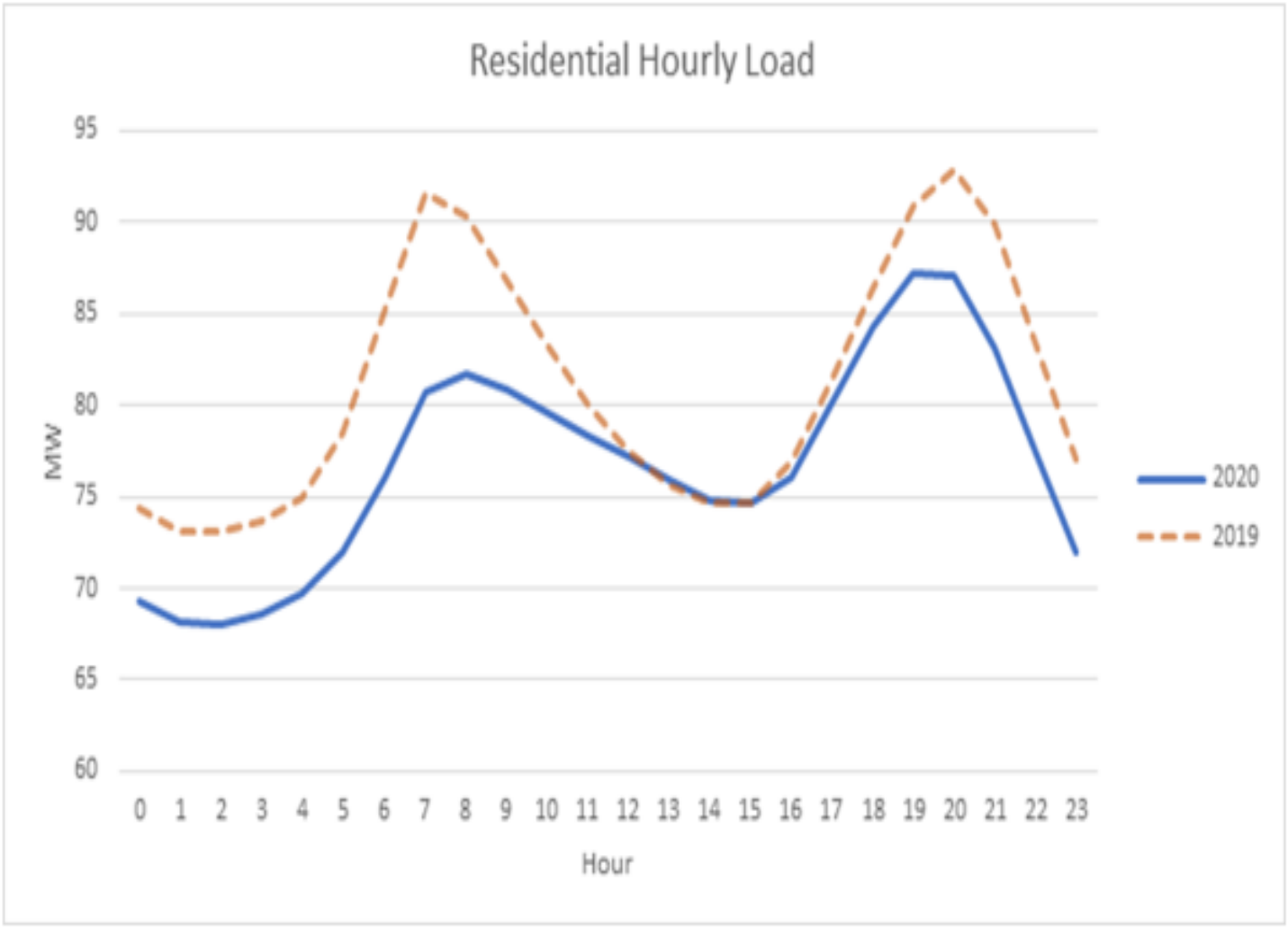
Covid Residential load



Abi Daken

U.S. Environmental Protection Agency

U.S. DEPARTMENT OF ENERGY

Absence Makes the Savings Deeper

Coronavirus, the Smart Home, and ENERGY STAR Products

Better Buildings Residential Network Peer Exchange Call
5/28/20

Abigail Daken, ENERGY STAR HVAC and Connected Product Manager

ENERGY STAR Smart Products

- Two specifications cover **specifically smart products**
  - Smart thermostats: first certifications 2017, paving the way for other products
  - Smart Home Energy Management Systems (SHEMS) finalized 2019, first certifications expected 2020
- For these controls, savings from complex interaction of technology, design, and user choices
  - Analyzed and aggregated data from users' homes reveals actual use and demonstrates savings are achieved and persist
  - Specifications also address standby power and basic product capabilities

ENERGY STAR Smart Products

- **Smart versions of other products** included in specifications
  - Lighting (bulbs, fixtures, ceiling fans)
  - Appliances (refrigerators, dishwashers, laundry, room air conditioners)
  - Specifications focus on standby power, functionality, and grid response (as appropriate for each product type)

Why EPA Relies on Field Data to Demonstrate Savings

- The problem with thermostats was always that people didn't use them, or use them well
- Data from users in the field gives a window into actual use
- To avoid privacy concerns, provide analysis software to vendors to use on a defined sample of installations and submit statistical summary of results
- SHEMS specification similarly requires statistical analysis of installations and their operation

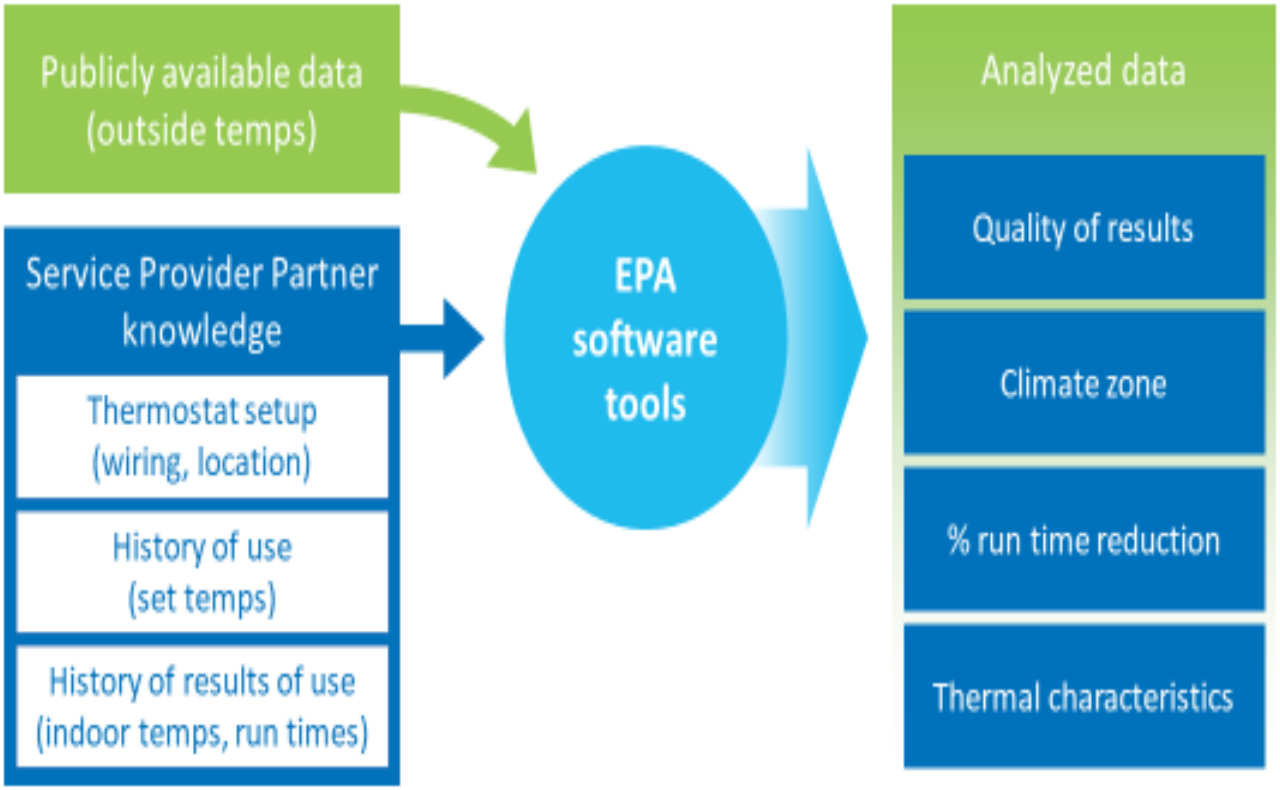
Earning the ENERGY STAR

1. Thermostat device passes basic tests

2. Thermostat product (hardware + service) demonstrates basic capability (e.g. scheduling)

3. Demonstrate field savings using EPA software tools to analyze and aggregate data from hundreds of US homes

Metric For Each Home



For Sample of Hundreds of Homes

Certification Data

- Cold/Very Cold savings
- Marine savings
- Mixed Humid savings
- Hot Dry/Mixed Dry savings
- Hot Humid savings
- Weighted average National savings
- Statistical information: deciles, standard error of the mean, etc.

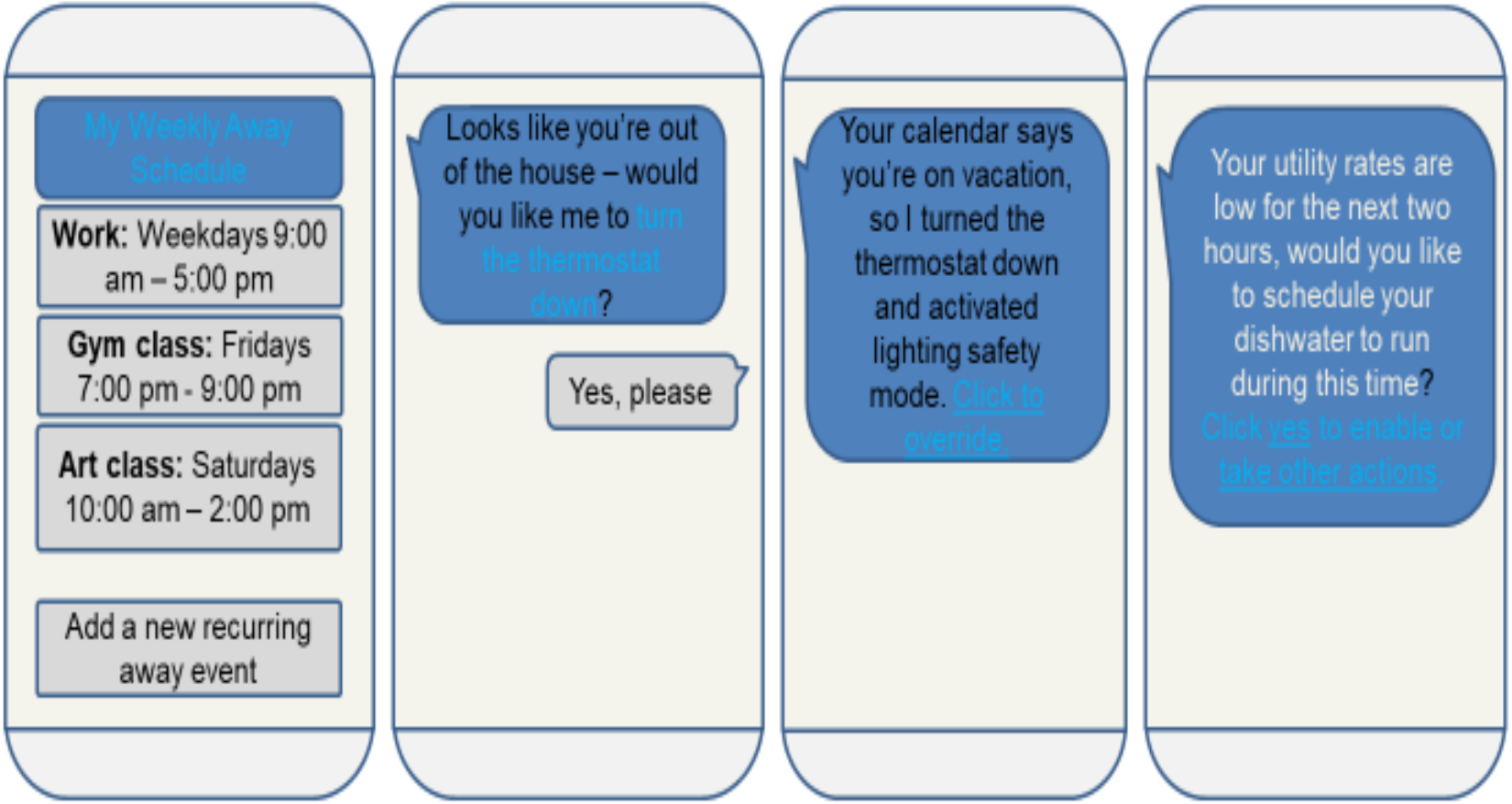
EPA's ENERGY STAR Smart Home Strategy: Bring Energy Savings Along for the Ride

As the market for "smart" products and systems grows, EPA aims to help drive and optimize energy savings through their use:

- Guide energy characteristics of smart products and systems
- Explore system models and ways to work with Service Providers
- Leverage the ENERGY STAR brand and position to advance energy efficient behaviors and practices in the connected and smart home market

Device Bundle + Occupancy-based optimization + Other Services = Certified Product

What SHEMS could look like for the end user



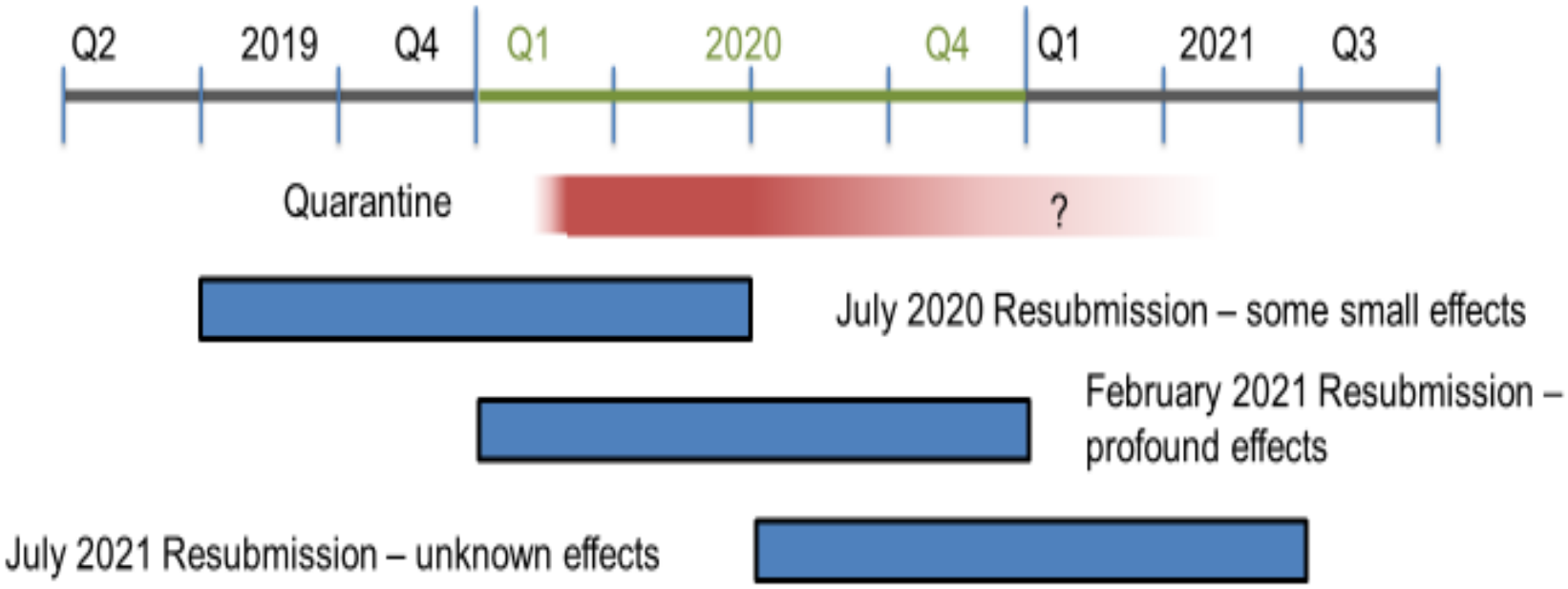
Effect of Quarantine on Field Data Results

- One issue with field data: Also effected by field conditions!
- Large sample intended to even out field conditions that effect homes differently, e.g. having a baby, kid going to college, losing a job, etc.
- Quarantines are different – effect everyone at once.

- For thermostats, metric is based on showing that most homes use set back and set up to save energy → **best opportunity is when the home is unoccupied**
- Similarly, the SHEMS specification is based on unoccupied periods providing savings opportunities

→ Expect significantly lower savings during quarantine

Smart Thermostat Field Data in a COVID-19 Era



- Treat data covering quarantine period as anomalous
- Also applies to SHEMS data associated with first submissions
  - No required level of achievement in version 1 specification
  - May cause delay developing metric, or may act as fortuitous baseline

Notes from Partners

- **Retailers** have emphasized the importance of continuing programs during quarantine
  - Price breaks even more important now that people are losing income
  - Still able to sell many items online or for curbside pickup
- Checked in with several **smart thermostat and/or smart home vendors** about sales
  - Contractor channel is down, exacerbating slow sales from the mild winter
  - Retail channel is about steady: theorize that more time to work on home purchases is offsetting more careful spending
  - Did not hear back from one vendor because our contact was laid off, an example of general nervousness in industry
- Mostly, it's too early to tell
- Personally concerned that customers may expect significant savings, but won't get them if their home is constantly occupied

Diverse drivers & energy implications

Example products	What connectivity provides	Driver of market adoption	Energy Implication and/or Opportunity
Pool pumps, water heaters	Flexibility of large loads, no consumer impact	Grid services	Enable cleaner grid
Electric vehicle chargers, HVAC	Flexibility of large loads, some consumer impact	Grid services	Enable cleaner grid; protect consumer interest
White goods, HVAC	Convenience and quality of maintenance	Blended: consumer, brand owner, grid	Better maintenance saves energy
Door locks, window sensors	Safety and security	Consumer interest	Added load; occupancy info?
Color changing lights, smart speakers	Additional functionality	Consumer interest	Added load

ENERGY STAR Connected Criteria

	Connected T'stats	SHEMS	Lighting	Room Air Purifiers	Refrigerators & Freezers	Clothes Washers	Clothes Dryers	Dishwashers	Room A/C	EVSE	Pool Pumps	Ice Makers
Energy Consumption Reporting		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*
Operational Status Reporting			✓	✓	✓	✓	✓	✓	✓		✓	✓*
Remote Management		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*
Demand Response	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
Connected Capability not Optional	✓	✓										
Capabilities or DR Summary	✓	✓								✓		✓
DR Test Method					✓				✓		✓	

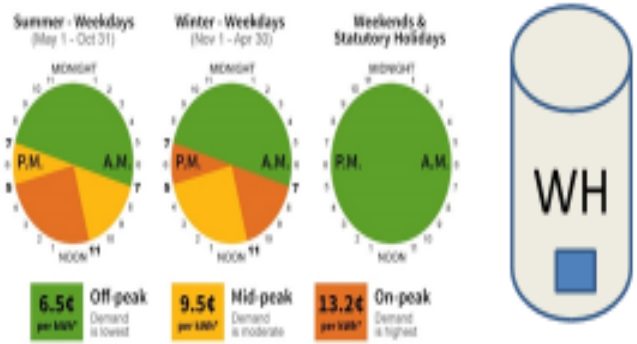
*Products that meet the Smart Grid Interoperability Panel (SGIP) standards are understood to have incorporated energy consumption reporting, operational status reporting and remote management into the foundation of their connectivity.

What is required of an ENERGY STAR SHEMS?

4.1 Service Capabilities

Optimize

4.2 Additional Required Platform Capabilities



4.3 Minimum Compatible Device Bundle

4.4 Grid Services

4.5 Field Data Reporting

May be compatible with:

Connects to:

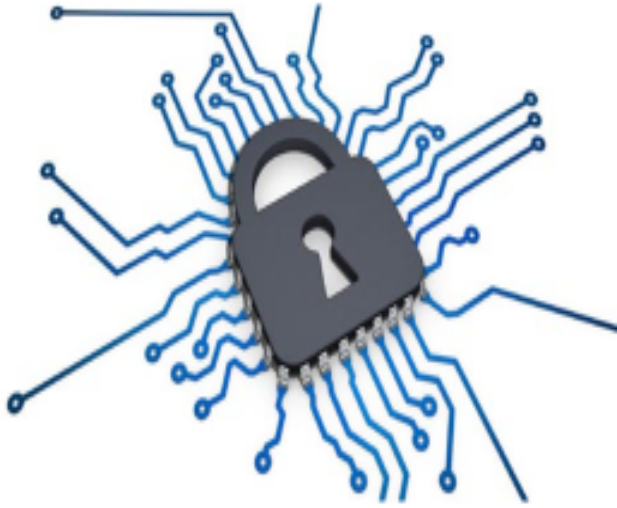
Minimum device bundle:

Device-level savings and standby power

Device	Standby Power Limit	EPA Savings Estimates
Connected Thermostat (1)	3.0 watts	8% of heating and cooling bills
Connected lighting (2)	Lamp: 0.5 watts Luminaire: 0.5 to 1.5 watts Smart switch: 0.5 watts	Not differentiated from non-connected lighting
Connected Plug Load Device	1.0 watts	-
Hub (optional)	No limit; must be reported	-

A Quick Note on Security

EPA understands there can be security risks associated with smart products and systems. Recognizing that this is not our area of expertise, we do not intend to take the lead on developing security standards in the smart home market. To the extent that sound security standards arise, EPA may point to them in ENERGY STAR specifications as appropriate.



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.

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