Better Buildings Residential Network Peer Exchange Call Series: *Hibernation Mode: What Smart Thermostats Can Do for You (301)*

December 15, 2016

Call Slides and Discussion Summary

Agenda

- Agenda Review and Ground Rules
- Opening Polls
- Brief Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - **Mark Jerome**, Senior Building Science Consultant, CLEAResult *(Network Member)*
  - **Michael Blasnik**, Senior Building Scientist, Nest Labs
  - **Nick Lange**, Senior Consultant, Emerging Savings Opportunities, Vermont Energy Investment Corporation (VEIC) *(Network Member)*
- Discussion
  - How has your energy efficiency program used connected thermostats or other smart home technologies?
  - What are challenges in deploying smart thermostats and how can they be addressed?
  - Has your program used smart thermostat data to improve service for customers?
  - Other questions, best practices, or lessons learned related to smart thermostats?
- Closing Poll

Better Buildings Residential Network

Better Buildings Residential Network: Connects energy efficiency programs and partners to share best practices and learn from one another to increase the number of homes that are energy efficient.

Membership: Open to organizations committed to accelerating the pace of home energy upgrades.

Benefits:

- Peer Exchange Calls 4x/month
- Tools, templates, & resources
- Recognition in media, materials
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Residential Program Solution Center guided tours

Commitment: Provide DOE with annual number of residential upgrades, and information about associated benefits.

For more information or to join, email bbresidentialnetwork@ee.doe.gov, *or go to* energy.gov/eere/bbrn *and click Join*

Peer Exchange Call Series

We hold one Peer Exchange call the first four Thursdays of each month from 1:00-2:30 pm ET

Calls cover a range of topics, including financing & revenue, data & evaluation, business partners, multifamily housing, and marketing & outreach for all stages of program development and implementation

Upcoming calls:

- January 12: Home Improvement Catalyst: Engaging Trades in Optimizing HVAC System Performance
- January 19: State of the Union: Best Practices from "Most Improved" Energy Efficient States in 2016
- January 26: 0 to 60: Best Practices for Accelerating Program Performance

Send call topic ideas to peerexchange@rossstrategic.com

See the Better Buildings Residential Network Program website to register

Best Practices: CLEAResult

U.S. DEPARTMENT OF ENERGY

CLEAResult®

Hibernation Mode: What Smart Thermostats Can Do for You (301)

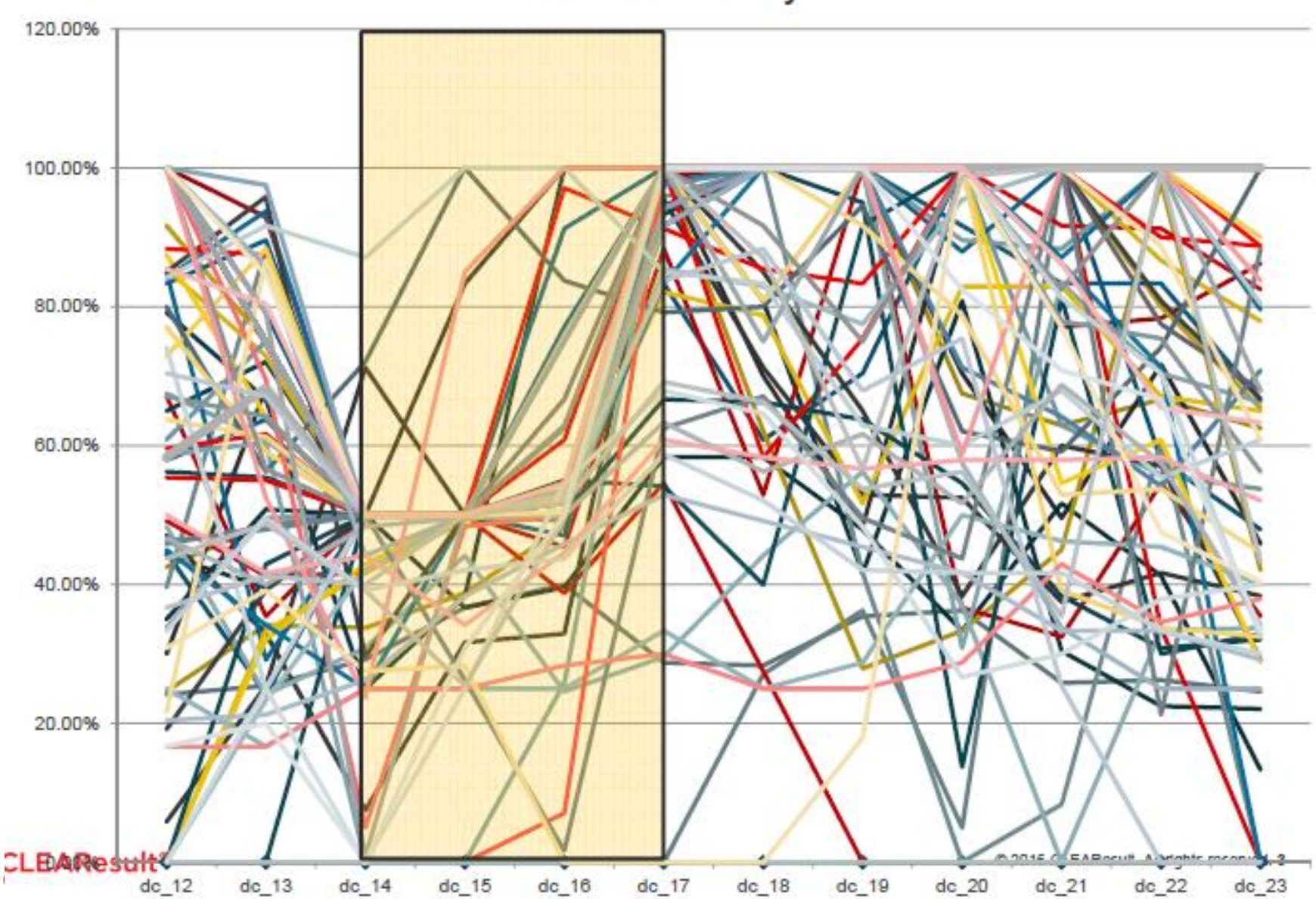
Data Collection & Usages

We change the way people use energy™

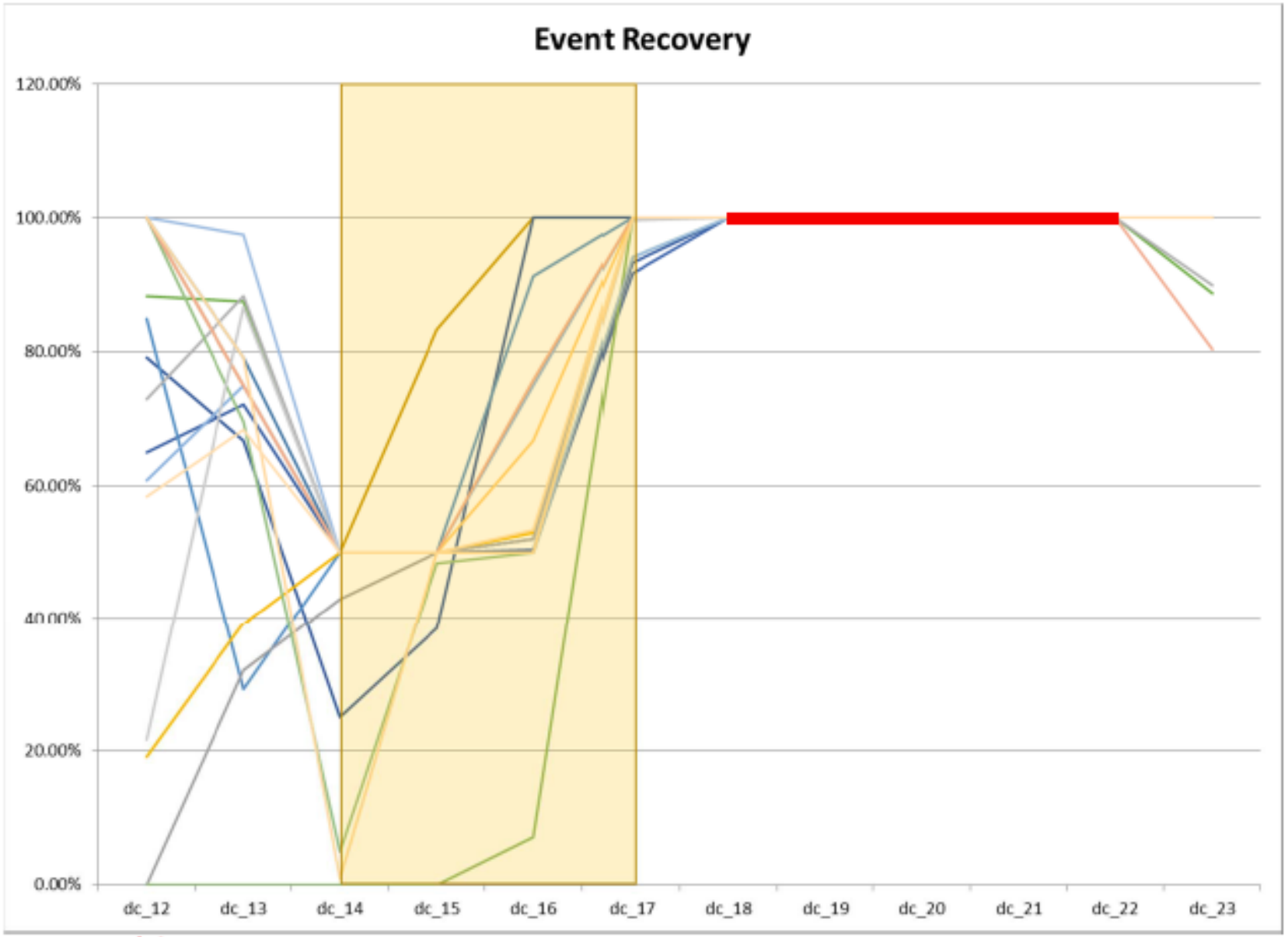
Smart Thermostat Data

- Entry Point
- Improving Evaluations
- Targeted QA / QC
- Targeted Programs

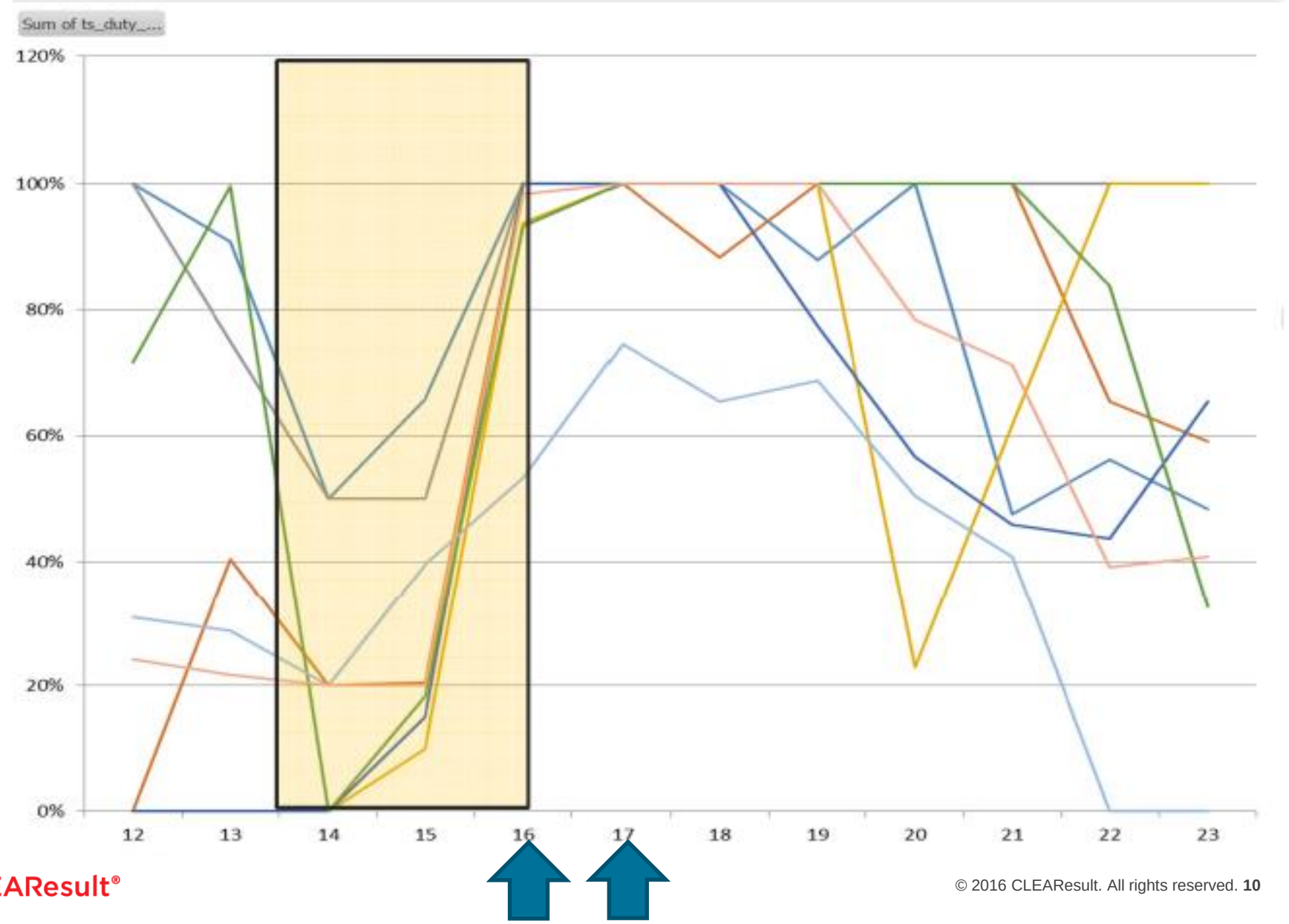
August 3 Event



August 3 Event

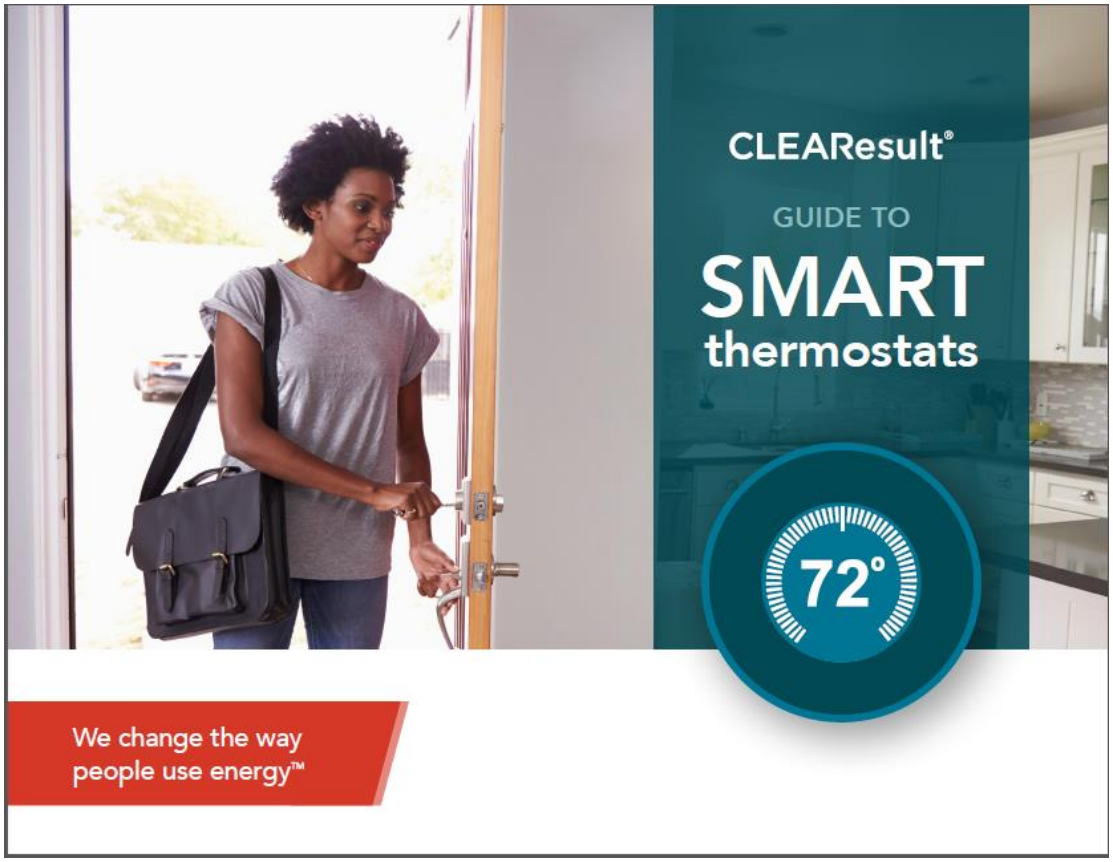


September 22 Event



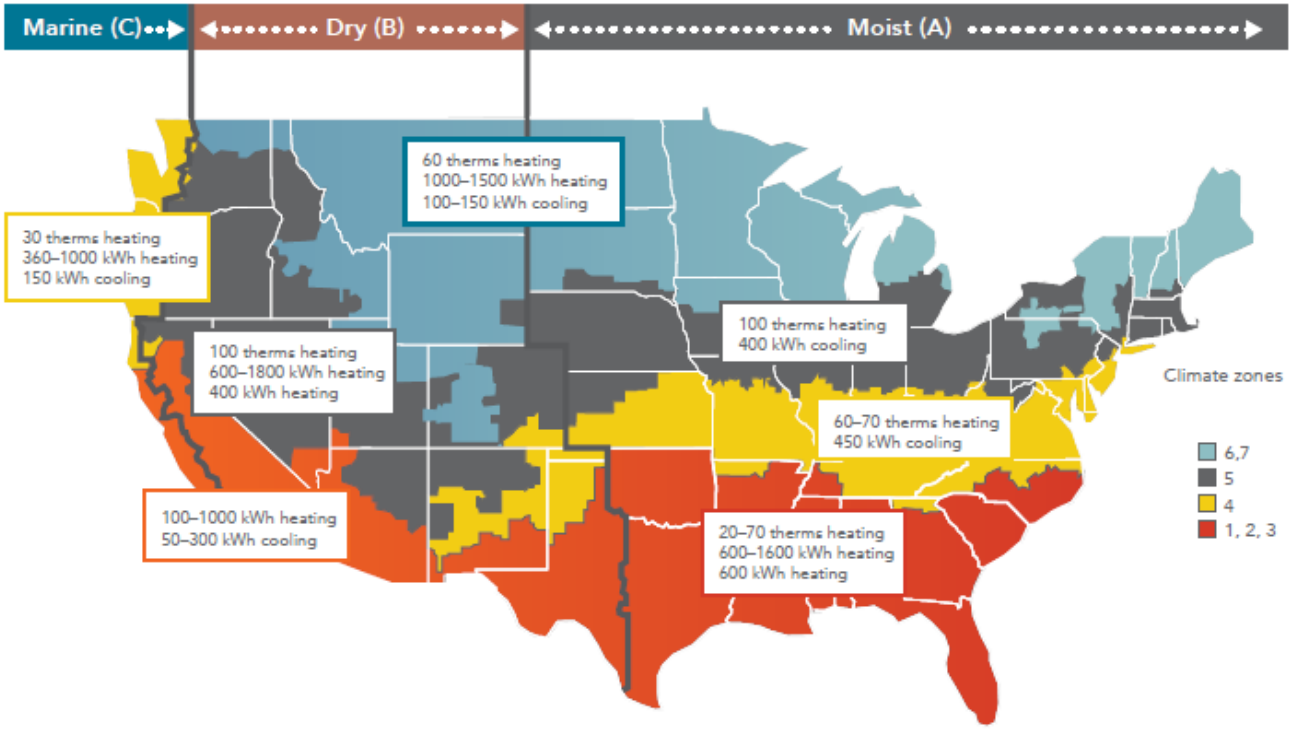
CLEAResult®

Smart Thermostat Guide



https://www.clearesult.com/insights/papers/guide-smart-thermostats

Energy Savings



https://www.clearesult.com/insights/papers/guide-smart-thermostats

- Mark Jerome
- Senior Building Science Consultant

Presentation Highlights: CLEAResult

- **Smart thermostats can be used for more than just controlling heating or cooling systems as a tool for data collection.**
  - Data collected from smart thermostats create opportunities for targeted efforts like energy assessments, HVAC upgrades, or tune-up programs.
  - For example, in a demand response pilot supported by CLEAResult, poor performing homes that experienced extremely long runtimes were treated with the targeted cooling tune-up program.
- **Key actors spearheading emerging best practices for using smart thermostats with demand response programs are manufacturers and service providers.**
  - Manufacturers provide technologies and processes to keep customers happy through performance improvements (e.g., pre-cooling).
  - Service providers offer thermostat optimization services by creating an environment of comfort while saving energy.

Best Practices: Nest Labs

U.S. DEPARTMENT OF ENERGY

Hibernation Mode: What Smart Thermostats Can Do for You

Better Buildings Residential Network Peer Exchange
December 15, 2016

Michael Blasnik, Senior Building Scientist

Prior Research on Thermostat Energy Savings

- Many programmable thermostats aren't actually running any program
- Many homes with programmable thermostats don't have set points that are much better than homes with manual thermostats
- Very few studies measured energy savings, mixed results

Research led to EPA ending Energy Star programmable thermostats in 2009

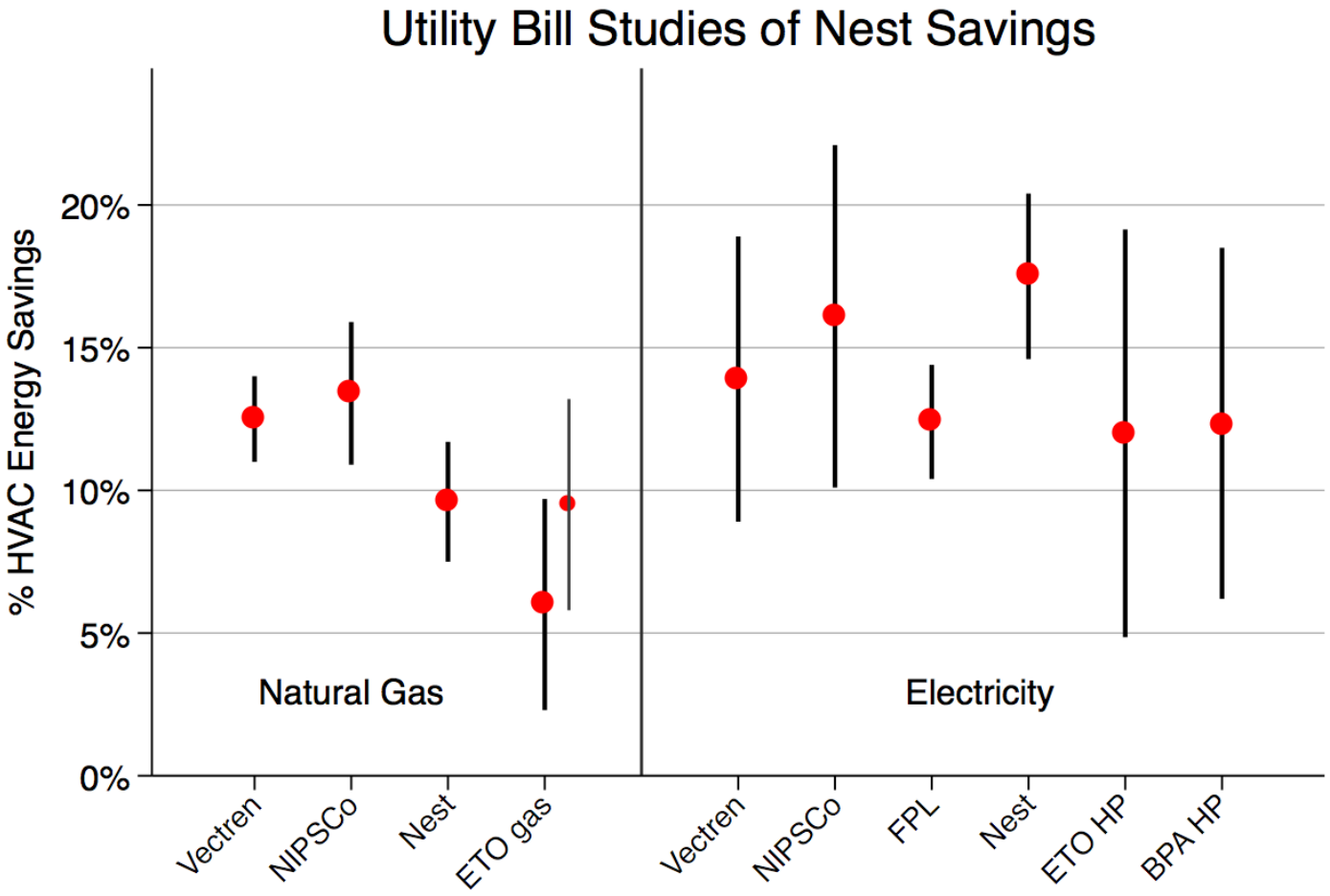
Connected Thermostat Savings Mechanisms

Optimize Temperature Set Points

- Schedule: programmed, learned, nudged
- Occupancy Detection
- Behavior Feedback, Remote Control

Optimize HVAC Control

- Heat Pumps: manage auxiliary heat
- Cooling: fan over-run for evaporative cooling
- Other potential methods?



note: only includes publicly available Pre/Post Utility Bill Studies using standard M&V methods

Also: multiple studies found that customers really like them!

Factors Affecting Thermostat Savings

Lower Savings	Higher Savings
Already set back every night	Didn't set back at night
Home all day or already setback	Go out but didn't setback
Setback whenever away/vacation	Go away but didn't setback
Tight, well insulated home	Leaky, poorly insulated home
Heat Pump using little strip heat	Heat Pump using lots of strip heat
Mild climate: less energy, higher %	Severe climate: more energy, lower %
Modulating condensing boilers?	Hot dry climate: airwave savings
Disable Nest features	Enable Nest features

Factors Not Affecting Savings (much?)

Self-Install vs. Pro Install

- Nest data: self-installed settings >= pro install

Prior Thermostat Type

- Direct studies inconclusive: 2 of 3 found higher savings with programmable thermostat baseline than manual thermostat (not significant)
- Research on programmable thermostats indicates it shouldn't make much difference: set points no better than manual thermostats, led to loss of Energy Star

Early Adopters vs. Mass Market

- Evaluations have actually found larger savings for less engaged customers
- Excellent savings in pilots providing free thermostats with many customers not using app or even WiFi

New Opportunities from Connected Thermostats: Nest's Seasonal Savings Algorithm

Automated "Tune-up" for Schedule Set Points

- Customers opt-in (~80%), slowly adjusts set points over a few weeks

Evaluation of Energy Savings

- Can use thermostat data (have pre and post)
- Analyze set point changes, run time data (like billing data analysis)
- Control Group: RCT / RED design feasible

Savings Results

- 2%-5% heating and cooling usage reductions (adds to existing savings)
- More results from many large scale deployments after this winter

Presentation Highlights: Nest Labs (1 of 2)

- **There are many ways in which smart thermostats can provide savings**, such as through:
  - **Smart scheduling wizards:** Various thermostat features that can help people have a more efficient schedule are available for phones, tablets or laptops.
  - **Learning algorithms:** Based on people's routine practices at different times of the day (e.g., turning down the heat at night), the smart thermostat can create standard schedules and provide additional recommendations for more efficient schedules.
  - **Seasonal adjustments:** Devices can move people towards more efficient practices through automatic seasonal adjustments in temperature.
  - **Occupancy detection:** Smart thermostats can determine when the house is unoccupied and automatically change the settings to a more efficient temperature. Nest is currently doing some research to verify how much of the savings comes from occupancy detection.

Presentation Highlights: Nest Labs (2 of 2)

(continued)

- **Feedback to occupants about their actions** when they interact with the smart thermostats, and **monthly emails** that people can get about their energy use can also drive higher savings and more efficient behaviors.
- **Remote control:** People can change the smart thermostat's heating and/or cooling set points when they are not home from their phones, tablets or laptops.

- **The most important aspect related to savings is what you did before you had a smart thermostat.**
  - People who weren't very efficient provide more savings opportunities than people who were very careful with their energy efficiency.
- **The market for smart thermostats** has expanded in the last few years, and we are heading towards an "**early majority" of adopters.**
  - Their **increased availability at retail** and the **many rebates** offered across the country also helped spread their use.

Best Practices: Vermont Energy Investment Corporation (VEIC)

U.S. DEPARTMENT OF ENERGY

How Could Connected Thermostats Lead to More Energy Saving Opportunities?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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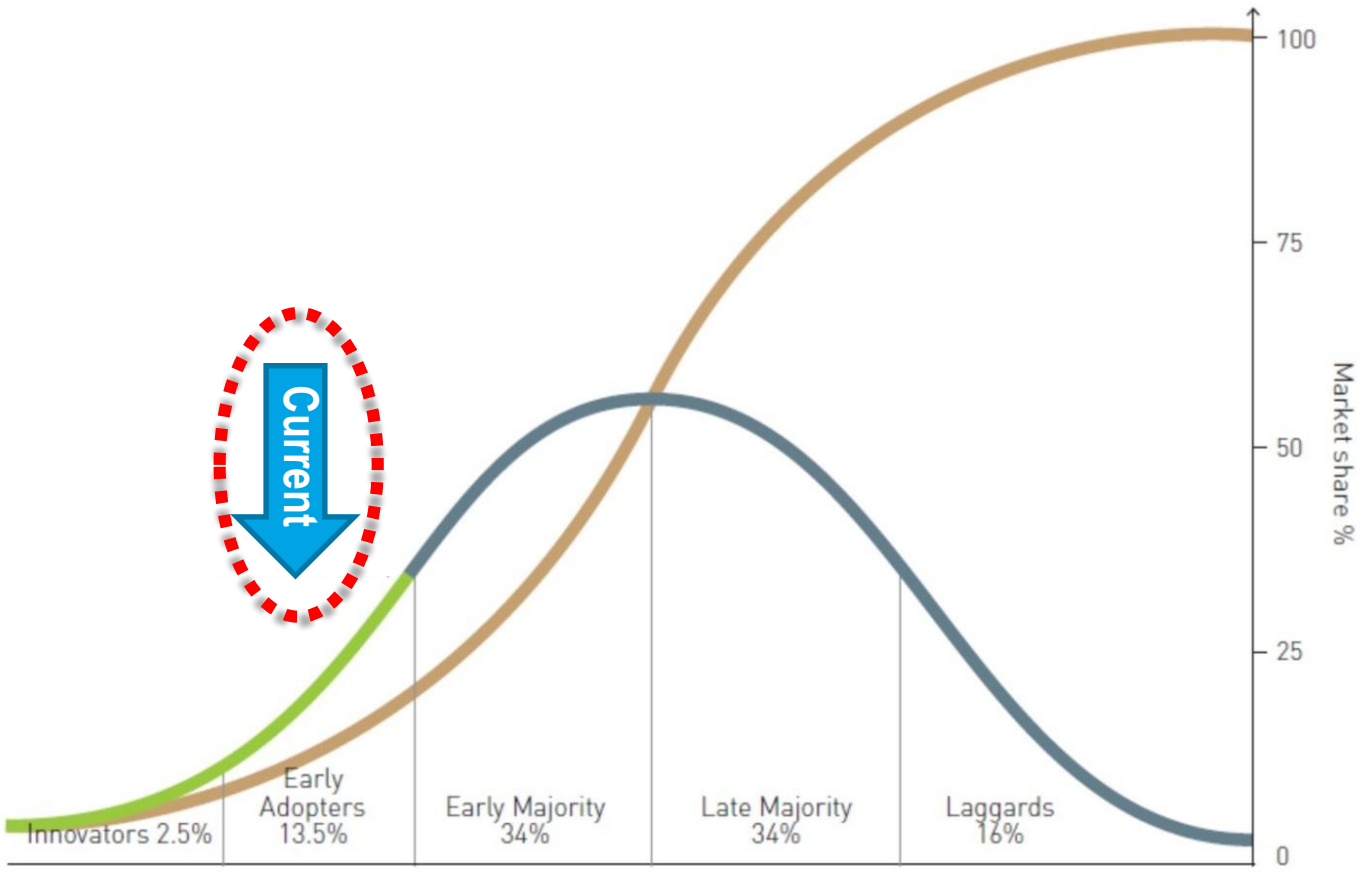
Vermont Energy Investment Corporation

Connected Thermostat: Where are we?



Project Background: Who are we?

veic.org

Efficiency Vermont

EFFICIENCY$MART

DC SUSTAINABLE ENERGY UTILITY

National & International Clients

Vermont Energy Investment Corporation is a 30+ year old non-profit with a Mission:

to Reduce economic & environmental costs of energy

Energy efficiency, renewables, and transportation **Program Implementation, Planning & Design**,

Our perspective on Connected Thermostats:

- Context: Historical "Baggage"
- Broader Potential
- Vendor/Service Neutrality
- Market opportunities and challenges

Project Background: Who are we?

Our experience with Connected Thermostats**:**

→ Programmable Thermostat Implementations

→ **2012 R&D** Connected Thermostat Data Analysis

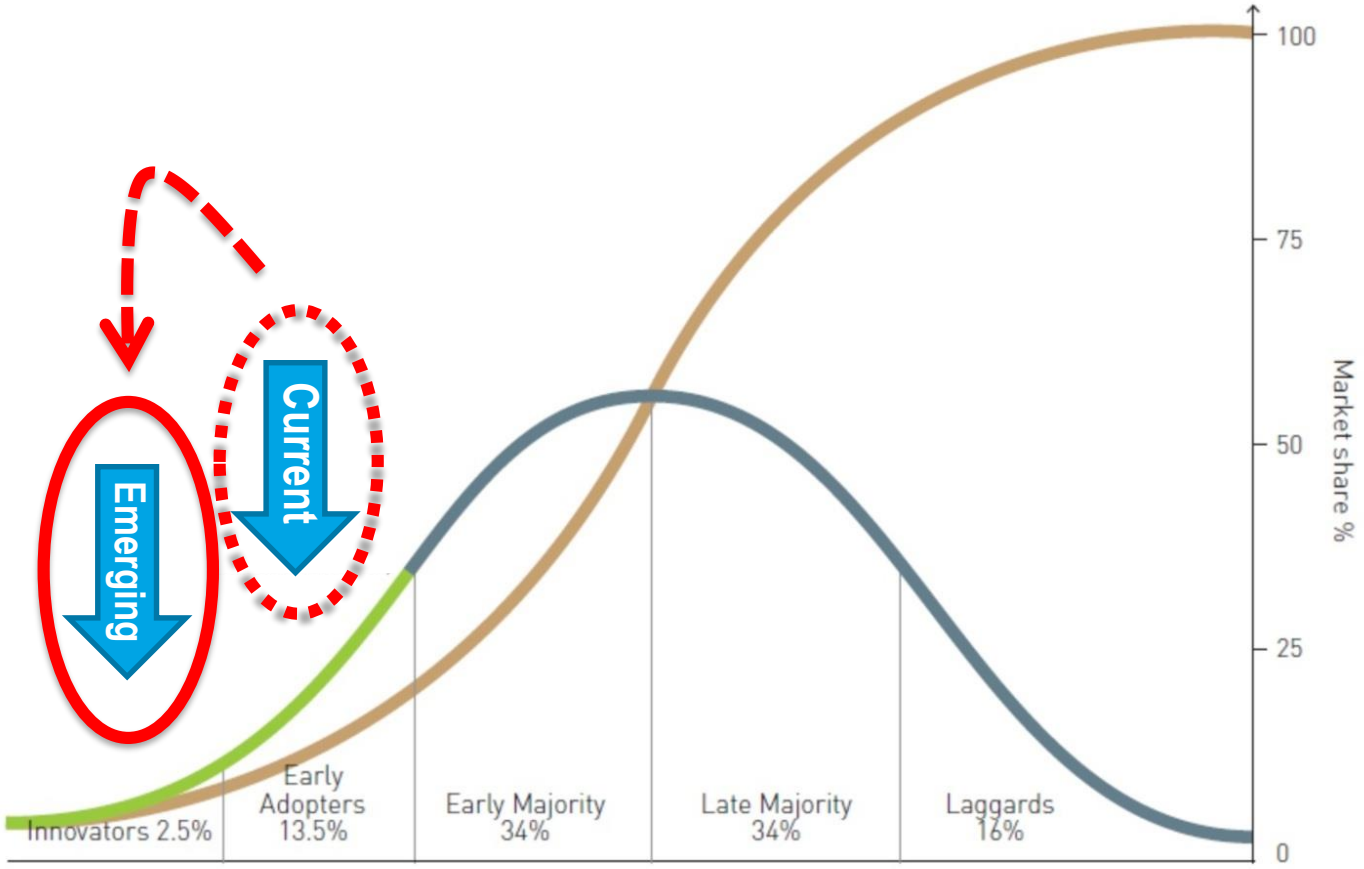
→ **2013 – (Present)** Scale Study Program in VT

→ **2014 – (Present) Multiple Collaborative Working Groups:**

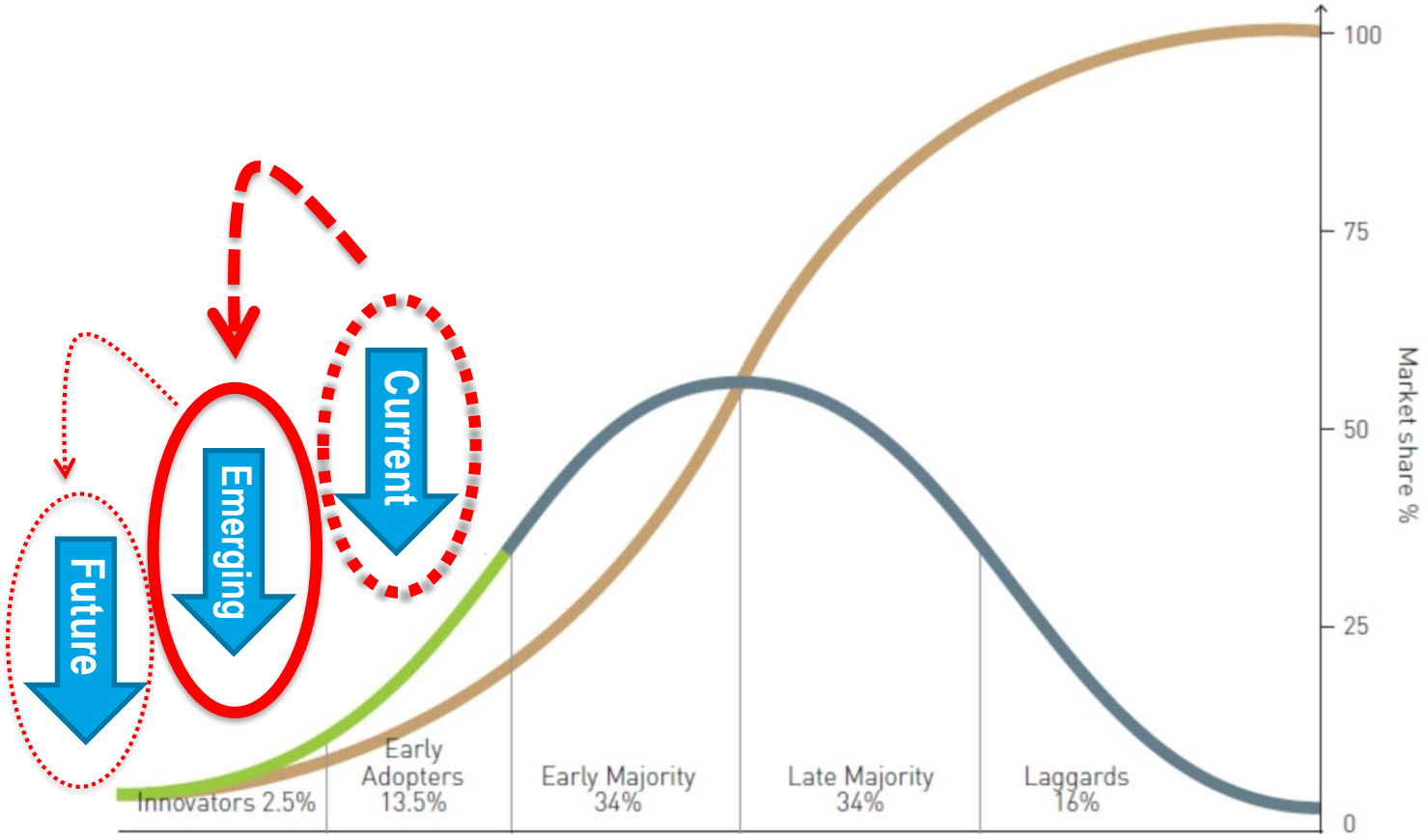
- ENERGY STAR
- CEE (Consortium for Energy Efficiency)
- EPRI (Electric Power Research Institute)
- Several Others (details available in Q&A)

→ **This Project: We Approached DOE about opportunities and challenges we saw…**

CT Use Cases: Where are we headed?



Connected Thermostat Use Cases: Where are we?



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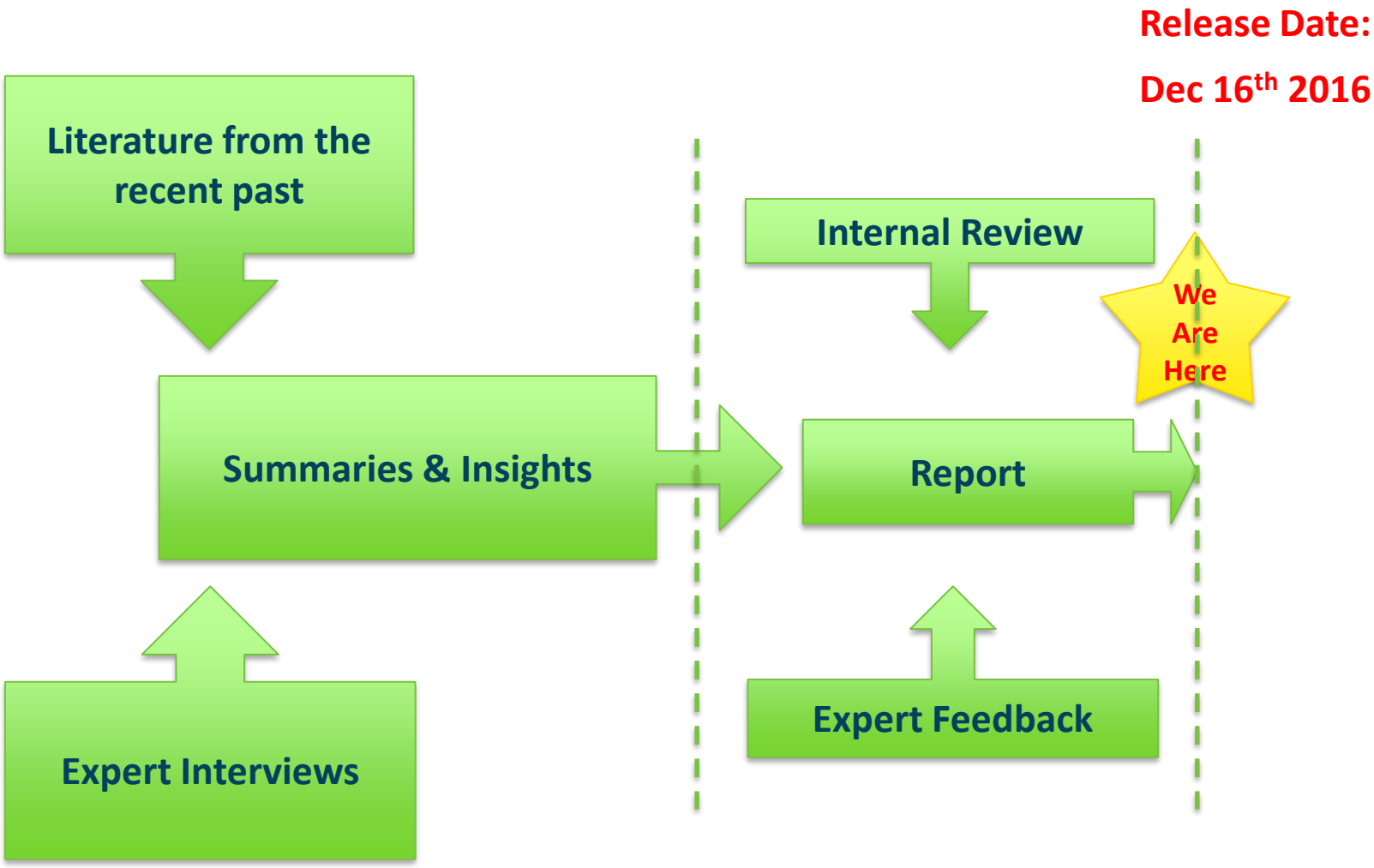
Roadmapping Project Overview



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Current Use Cases: HVAC Energy Savings

Key Finding: Residential deployment of CTs does NOT automatically produce energy savings. Literature review reveals a wide range of reported CT-related energy savings.

- **most literature report savings between 1% and 15%**
- **in a few cases energy consumption increased following CT deployment.**

Numerous factors influence HVAC operation, making it difficult to estimate CT-related energy savings for the general population of homes and products.

"What's a program to do?!"

Where is ENERGY STAR?

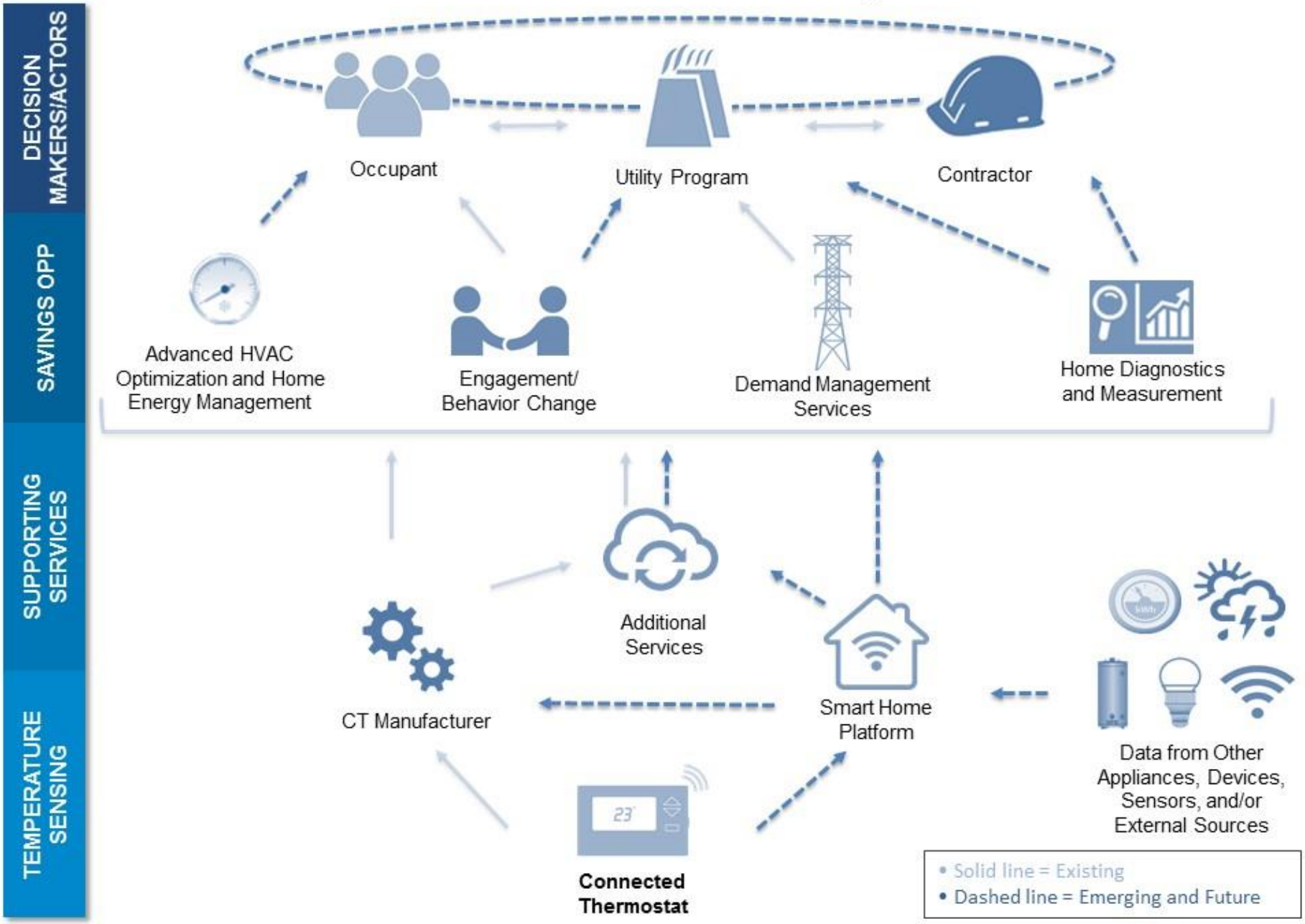
1. (Old) ENERGY STAR History… → Ease of Use…
2. Connected Thermostat Savings capabilities can't be reliable, or effectively tested in the laboratory (New!)
3. Products in the field can report back! (New!)
4. Standard metrics could fill-in for lab tests… (New

On June 9, 2014 EPA announced a new approach under which residential HVAC controls would be recognized as ENERGY STAR based on their ability to save energy as demonstrated by aggregate data from homes.

Where is ENERGY STAR?

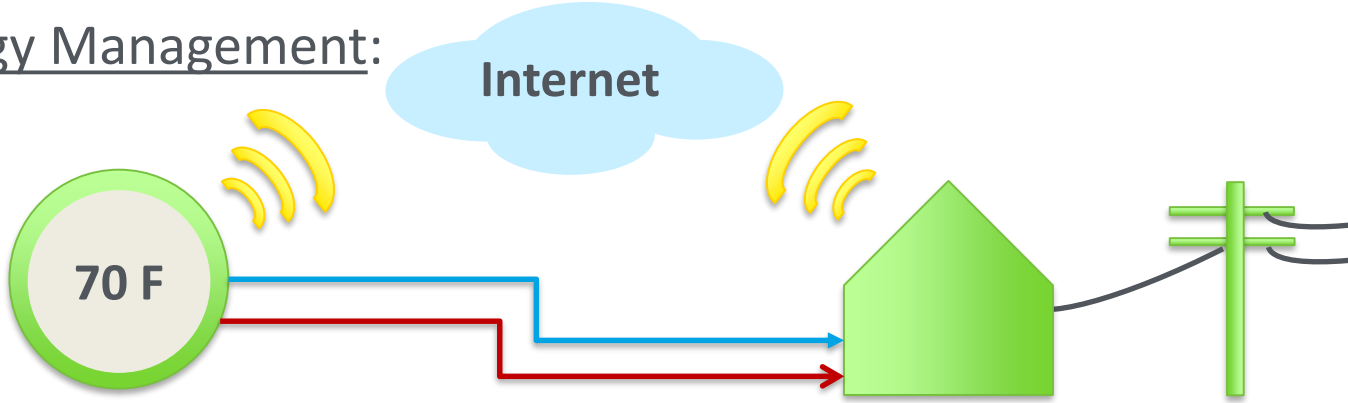
1. Version 1.0 Connect Thermostat Specification finalized this month (Finally!)
2. Final Written Comments due Tomorrow (If you're interested…)
3. First products certified in early 2017 (Woo Hoo!)
4. Many issues not yet worked out… (But it's a start!)

Connected Thermostat Data Flow for Existing and Future Use Cases

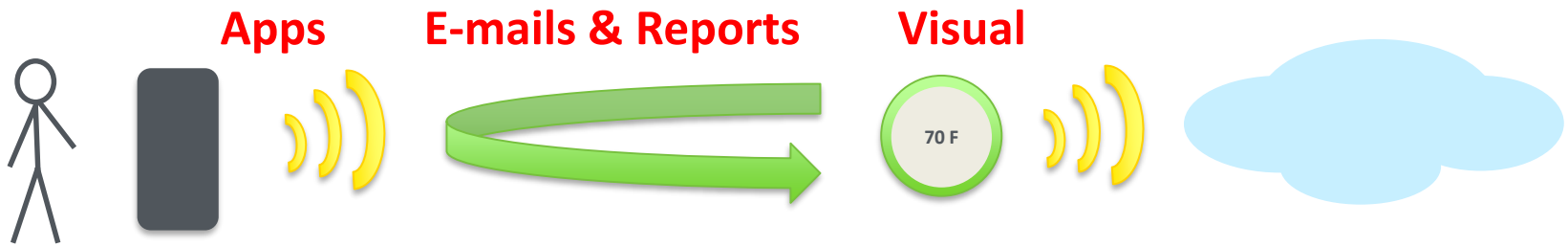


Current Connected Thermostat Use Cases

Grid and HVAC Energy Management:



Basic Feedback



Optimizing Demand Response Program Performance:

Opportunities and Gaps for **Future** CT Use Cases

FUTURE USE-CASE

Active Home Diagnostics & Remote Energy Audit

BENEFIT

- Cheaper and widely available energy assessments
- Accurate and relevant efficiency upgrade recommendations
- Code compliance analysis for new construction and gut-rehabilitations

MARKET GAP

- ❑ Increase stakeholder confidence in the value of the results
- ❑ Characterize the threshold conditions for accuracy, which vary by building, system, region and device

Opportunities and Gaps for **Future** CT Use Cases

FUTURE USE-CASE

Real-Time Measurement & Verification of Efficiency Upgrades

BENEFIT

- Improved reference models for building energy simulations
- Reduced uncertainty in consumption data
- Greater confidence and lower costs of measurement
- Enable Pay for Performance

MARKET GAP

- ❑Establish benchmarks and methods for accurate comparison of results
- ❑Establish standards for usage of data
- ❑Demonstrate technical viability and confirmation of market actor interest

Opportunities and Gaps for **Future** CT Use Cases

FUTURE USE-CASE

Advanced Performance Monitoring & Fault Detection

BENEFIT

- Quality maintenance available to any connected system
- Notify for opportunities to improve comfort & savings

MARKET GAP

- ❑Establish data connections (weather, utility, and customer information)
- ❑Equipment standards for compatibility with newer HVAC equipment

Opportunities and Gaps for **Future** CT Use Cases

FUTURE USE-CASE

Integrated Customer Engagement, Energy Management & Grid Services

BENEFIT

- Delivery of real-time, personalized efficiency interventions
- Convenient energy savings actions for customers
- Automatic, configurable response of devices to grid needs

MARKET GAP

- ❑ Establish standards to work across open access/interoperable devices
- ❑ Demonstrate value of integrated real-time energy data
- ❑ Create user-friendly interfaces for public

Discussion and Questions!

Thank you!

Questions?

Nick Lange

Senior Consultant

Vermont Energy Investment Corporation (VEIC)

Vermont Energy Investment Corporation

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Presentation Highlights: Vermont Energy Investment Corporation (VEIC)

- **There is no guarantee that having a smart thermostat is going to save energy.**
  - The interaction between the occupant, device, and the larger systems that it communicates with all affect energy use.
- **Smart thermostats are not a one-size-fits-all technology**, and their adoption differs among the regions in the country.
- **ENERGY STAR certification** of smart thermostats will be resumed in 2017.
  - The certification will be based on the field data at aggregate level, instead of a potential laboratory test, which proved difficult to develop.
  - ENERGY STAR certification requirements were designed to be reasonable and flexible in order to be met by manufacturers.
- Looking to the future, there are many **emerging opportunities for future connected thermostats**, such as active home diagnostics, remote energy audits, and real-time measurement and fault detection.
  - These potential benefits of connected thermostats also come with challenges to address related to data access, accuracy, management, and privacy.

Discussion Highlights (1 of 2)

There are many ways to promote the use of smart thermostats, enhance customer engagement, and increase energy savings, such as:

- **Making smart thermostats available at the retail level** including at online retailers can further boost customer interest and demand.
- **Offering rebates** has proved to be effective in increasing the size of the market.
- **Clearly communicating the potential of smart thermostats** leads to much happier customers.
  - Some customers might have the impression that smart thermostats save energy on their own. Do not over-promise, and make sure that people are aware of the potential constraints.
- To capture more energy savings, keep it simple for the customer. **Make smart thermostats easy to use**, don't expect people to engage in extraordinary ways, and design efficiency into the technology through automatic features.
- **Running an algorithm or other seasonal schedule tune-ups** can lead to high opt-in rates from customers.
  - For example, **Nest's Seasonal Savings algorithm** had an **opt-in rate of approximately 80% on average during summer 2016**.

Discussion Highlights (2 of 2)

- **Pay attention to your study's participation patterns, look at the data, and check your assumptions**. There is a lot of regional variation that is worth taking into consideration.
- The analysis of aggregated data from smart home devices can be very valuable for program improvement, informed decision-making, and additional energy savings.
  - For example, targeted utility programs can identify opportunities for demand response event optimization, which results in lower program costs and higher energy savings.
- With the increased data from smart thermostats, there also can be concerns about data access and privacy.
  - Smart thermostats are normally designed to protect against any privacy and security vulnerabilities.
  - Customers should also consider the costs and benefits of sharing the data and the value it brings in the context of different programs/pilots.

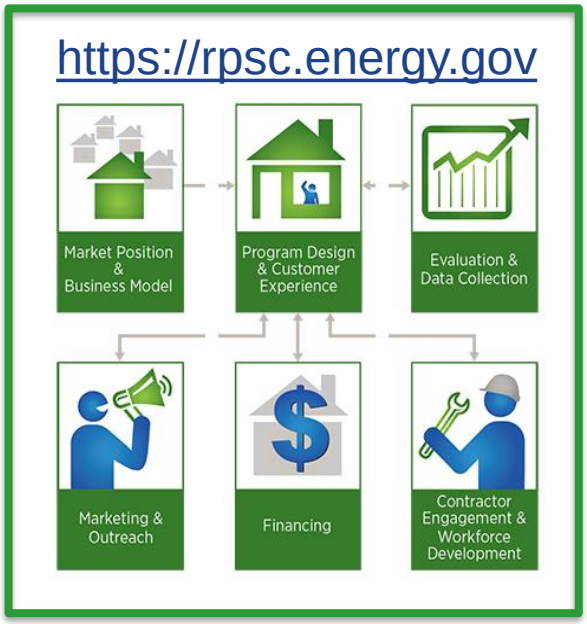
Additional Resources

- ***NEW!* U.S. DOE Building Technologies Office's report on *Overview of Existing and Future Residential Use Cases for Connected Thermostats*, December 2016.**
  - This report is intended to help inform future technology deployment opportunities for connected thermostats, such as remote energy audits and real-time measurement and verification of energy efficiency upgrades.
- **Nest Lab's White Paper on *Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results*, February 2015.**
  - The paper features the results from three studies of energy savings of Nest Learning Thermostats based on comparisons of utility bills from before and after installation.
- **CLEAResult's *Guide to Smart Thermostats*, October 2016.**
  - This report provides a brief history of smart thermostats, compares different thermostat technologies, and outlines experiences, best practices, and opportunities for energy savings.

Related Resources in the Residential Program Solution Center

Explore resources related to connected homes:

- Read this Nest white paper summarizing analyses of Nest Learning Thermostat energy savings, analyzing energy bills before & after installation.
- Consider the potential for peak-hour savings from behavior-based programs using smart meters in this SEE Action report.
- Explore strategies to build support for the expansion of your program with the Program Design & Customer Experience –Communicate Impacts handbook.



- Check out the latest Proven Practices post on Engaging Media to Garner Credibility.
- The Solution Center is continually updated to support residential energy efficiency programs—**member ideas are wanted**!

DOE Health and Home Performance Initiative

3 Phases:

1) DOE Literature review (NCHH, Ellen Tohn), **Home R_X: Health Benefits of Home Performance** – *Available Now!*

2) Roadmap to leverage health and home performance connection to grow industry – *Ongoing*

3) Create consumer messaging for stakeholder marketing and training – *Forthcoming*

GET SOCIAL WITH US

Stay engaged and connected with the Better Buildings Residential Network and our partners from the residential and multifamily sectors!

Follow us to plug into the latest Better Buildings news and updates!

Share with us your top stories on how your organization is accelerating energy savings through efficiency upgrades, strategies, and investment!

Better Buildings Twitter with #BBResNet

Better Buildings LinkedIn

We can't wait to hear from you!

Addenda: Attendee Information and Poll Results

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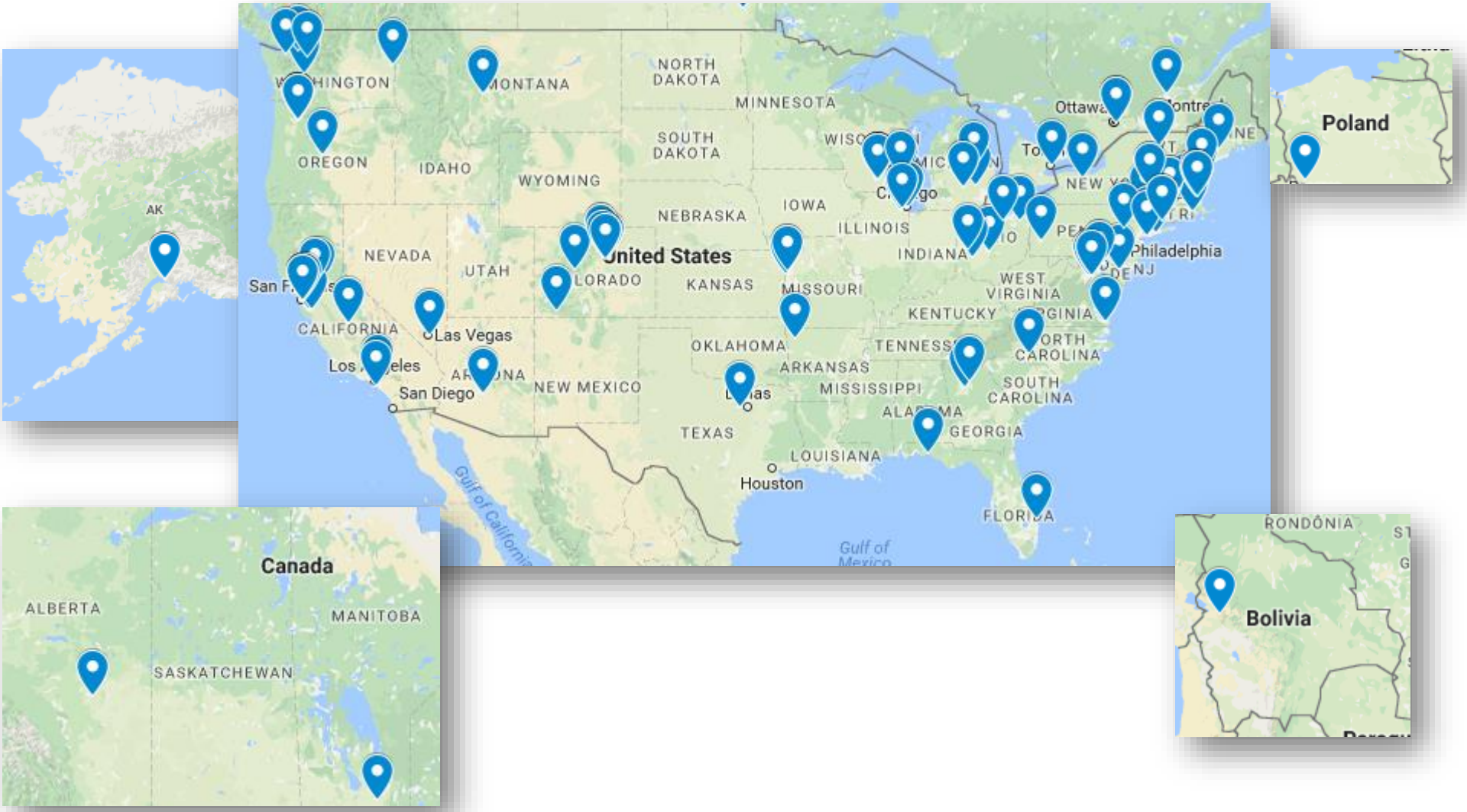
Call Attendee Locations



Call Attendees: Network Members (1 of 2)

- Alaska Housing Finance Corporation
- AppleBlossom Energy Inc.
- Arlington County Government (Virginia)
- Boulder County (Colorado)
- City of Cambridge (Massachusetts)
- City of Kansas City (Missouri)
- City of Melrose (Massachusetts)
- City of Sunnyvale (California)
- Civic Works
- CLEAResult
- Davis Energy Group
- City and County of Denver (Colorado)
- Earth Advantage Institute
- Efficiency Maine
- Emerald Cities Seattle
- Energy Efficiency Specialists
- Energy Smart Home Performance
- Enhabit
- International Center for Appropriate and Sustainable Technology (ICAST)

Call Attendees: Network Members (2 of 2)

- Midwest Energy Efficiency Alliance (MEEA)
- Mitsubishi Electric Cooling and Heating
- New York State Energy Research and Development Authority (NYSERDA)
- RUPCO
- Stewards of Affordable Housing for the Future
- The Environmental Center
- The Oberlin Project
- TRC Energy Services
- United Illuminating Company
- Vermont Energy Investment Corporation (VEIC)
- Wisconsin Energy Conservation Corporation (WECC)

Call Attendees: Non-Members (1 of 3)

- 1200 Architectural Engineers
- Apogee Interactive
- Aquanta Inc.
- Association for Energy Affordability
- Association of Polish Electrical Engineers SEP
- BAE Systems
- Bay City Electric Light and Power
- Belvedere Homes
- BKi
- Brooklyn Green Home Solutions Inc
- Brooks Kushman P.C.
- C.G.I Technology
- Consortium for Energy Efficiency (CEE)
- CivicSpark, Local Government Commission
- Clallam County Public Utility District (Washington)
- Colorado School of Mines
- Commonwealth Edison (ComEd)
- Community Office for Resource Efficiency (CORE)
- California Public Utilities Commission (CPUC)
- Craft3

Call Attendees: Non-Members (2 of 3)

- Delaware Department of Natural Resources and Environmental Control
- Ebm-papst Inc.
- Emerson Climate Technologies
- Energy Solutions Professionals
- EnergyWize LLC
- Fairfax County
- FCI Management, Inc.
- Fox Energy Specialists
- Franklin Energy Services
- Fraunhofer Center for Sustainable Energy Systems
- Foundation for Senior Living (FSL)
- Government of Canada
- Groundswell
- Home Ventilating Institute (HVI)
- Imaasa De CV
- ICF International
- Institut de recherche d'Hydro-Québec (IREQ)
- Jensen Beach Green (Florida)
- La Plata Electric Association (LPEA)
- Lockheed Martin
- Massachusetts Department of Energy Resources

Call Attendees: Non-Members (3 of 3)

- Missouri Gas Energy (MGE)
- Mercy Housing Management Group (MHMG)
- Montana Department of Environmental Quality
- Natural Resources Canada
- Nest Labs
- National Research Council Canada
- Okaloosa Gas District
- Ontario Ministry of Energy
- OptiMiser
- Pacific Gas and Electric Company (PG&E)
- Rothschild Doyno Collaborative (rdcollab)
- Renew Financial
- Rethinking Power Management (RPM)
- Smith Enterprises, Inc.
- Snohomish County Public Utility District (Washington)
- Sustainable South Bronx
- Therma-Stor LLC
- Third Rail Technologies
- UL LLC
- USG
- U.S. General Services Administration (GSA)

Opening Poll #1

- Which of the following best describes your organization's experience with smart thermostats?
  - Some experience/familiarity – ***44%***
  - Limited experience/familiarity – ***23%***
  - Very experienced/familiar – ***20%***
  - No experience/familiarity – ***12%***
  - Not applicable – ***1%***

Closing Poll

- After today's call, what will you do?
  - Seek out additional information on one or more of the ideas – ***63%***
  - Consider implementing one or more of the ideas discussed – ***28%***
  - Make no changes to your current approach – ***9%***
  - Other (please explain) – ***0%***