

April 3, 2019 | HPC Chicago

# Advanced Home Energy Monitors

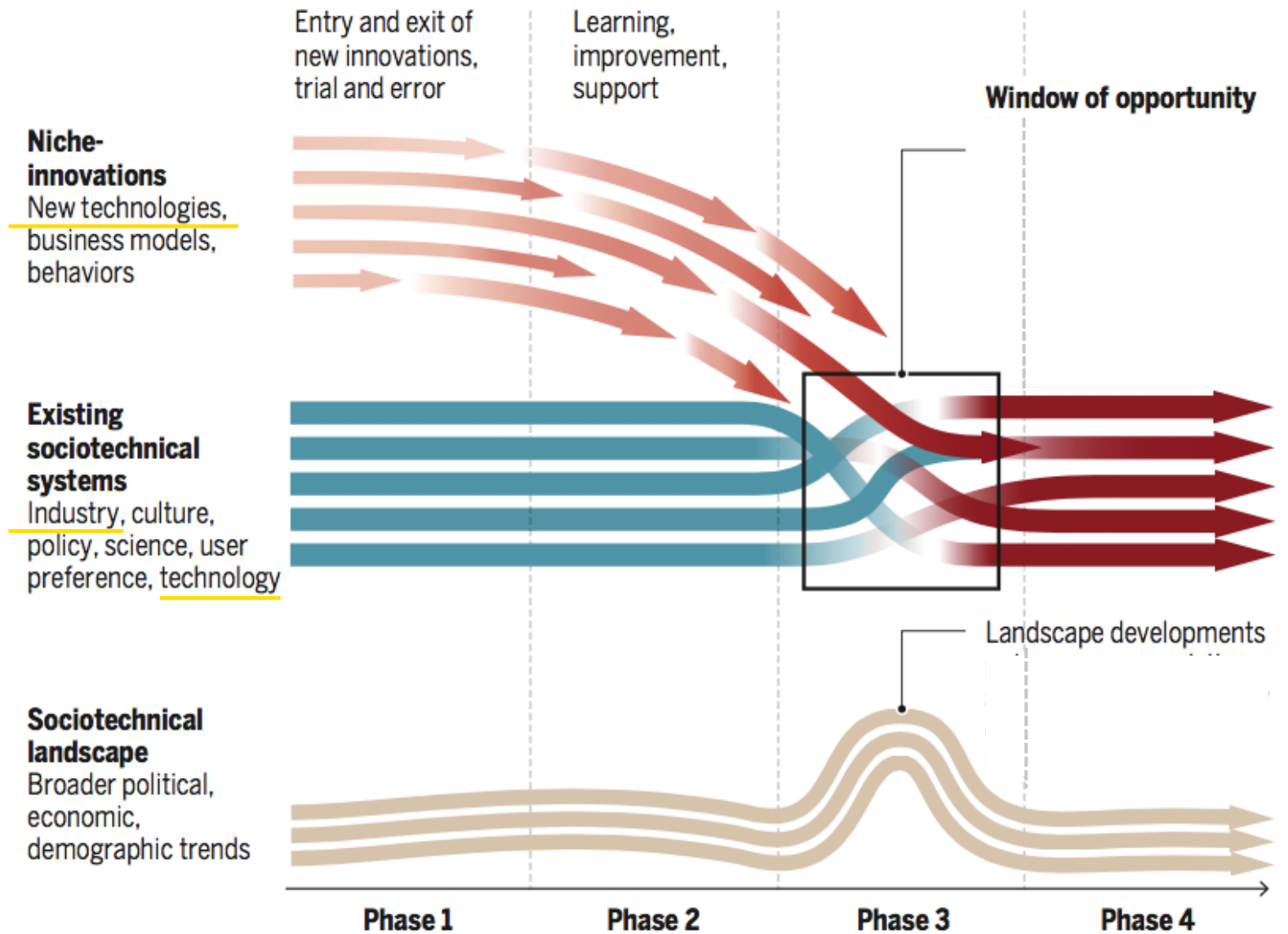
Capturing savings and hidden benefits

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# What are we doing here?



Geels et al. (2017)

# Home Energy Monitors

- A class of technology – whole home + devices
- Connected to a smart grid – or not
- Real-time – or not
- May or may not include robust feedback systems



# The Vision

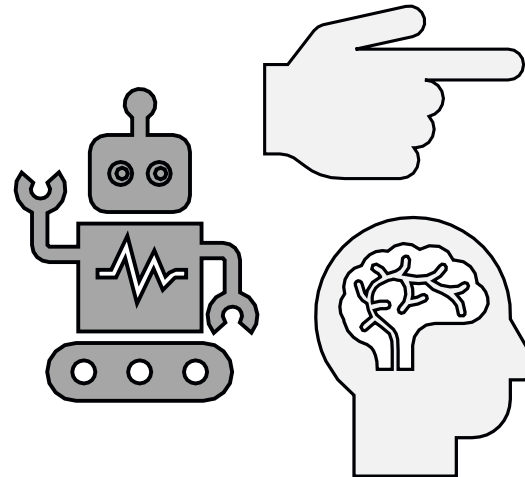
Monitor Energy [Technology]

Accurate  
Precise  
Reliable  
Appropriate  
Affordable

Deliver Feedback [Information]

Clear  
Compelling  
Frictionless

Change [Behavior]



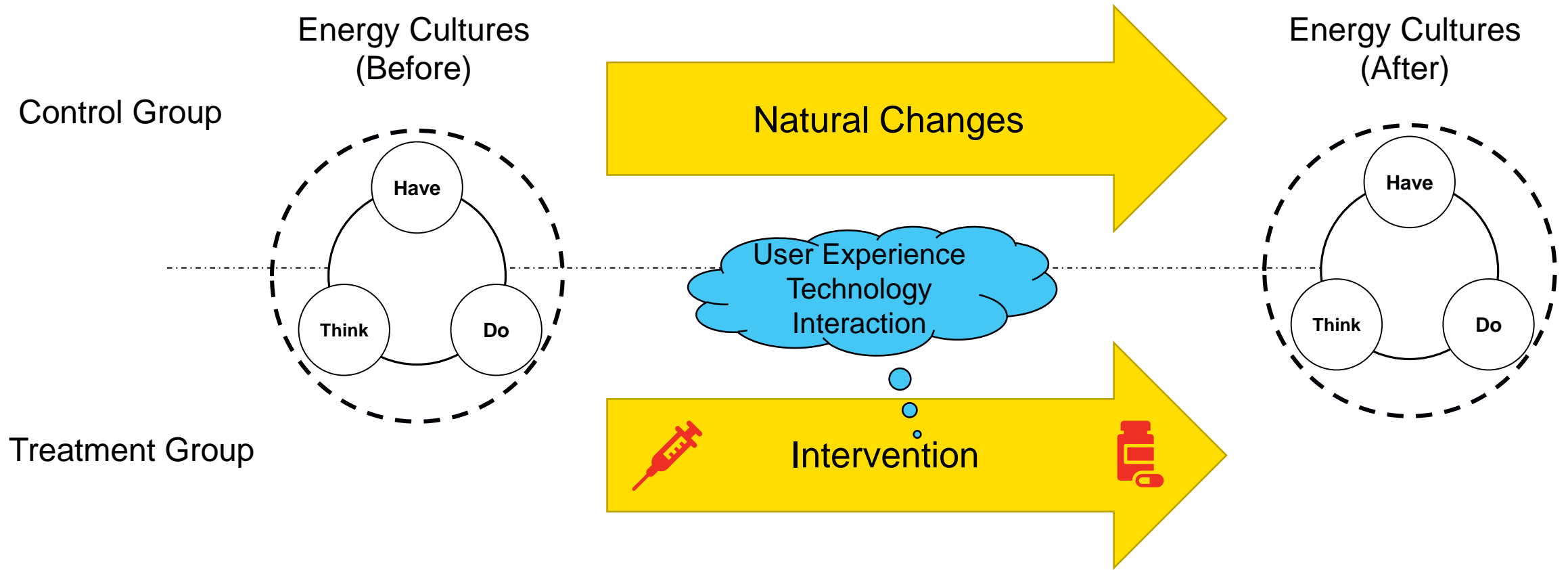
**Measurable:**

**Experience**  
(Happy End-Users)

**Actions**  
(Behaviors & Projects)

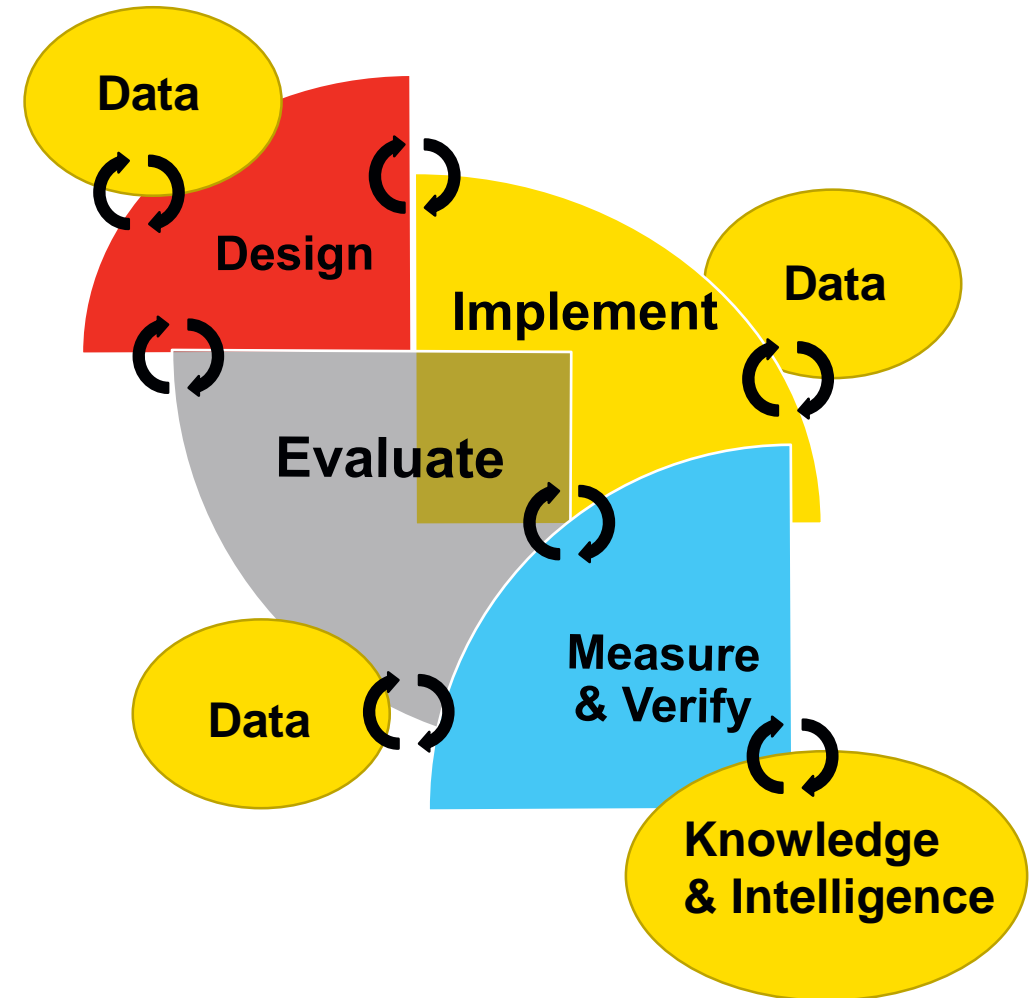
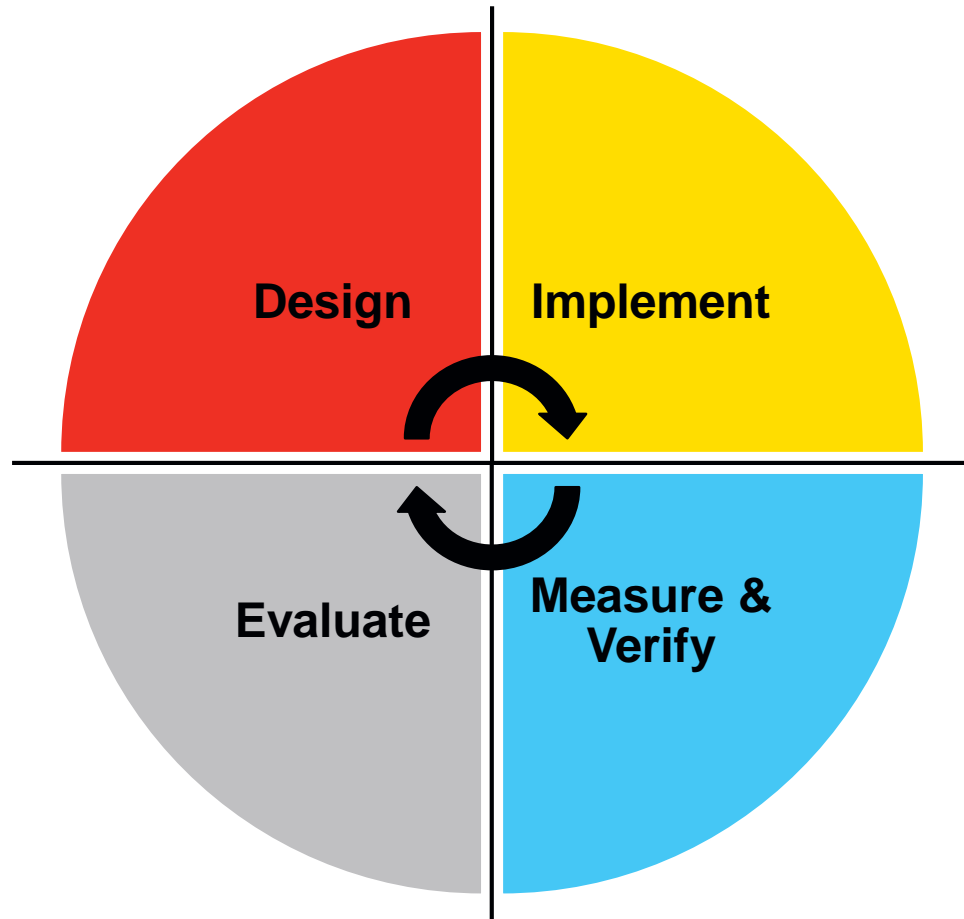
**Savings**  
(Performance)

# Quantifying changes in behavior



Based on IEA-DSM Task 24 & Karlin et al. (2015)

# The Efficiency Program Lifecycle



# The Efficiency Program Lifecycle

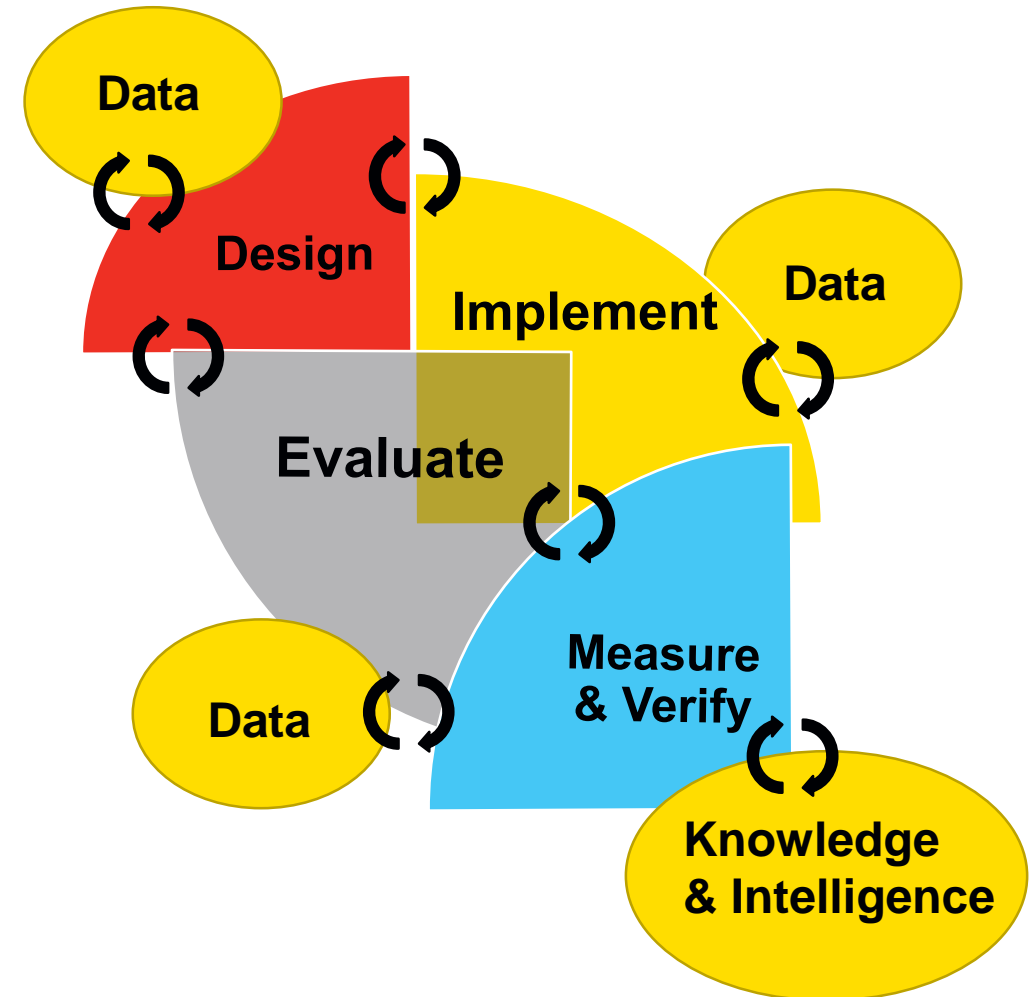
**A**dvanced

**R**esidential

**I**ntegrated (Intelligent)

**E**nergy (Efficiency)

**S**tudy → Services (Systems)

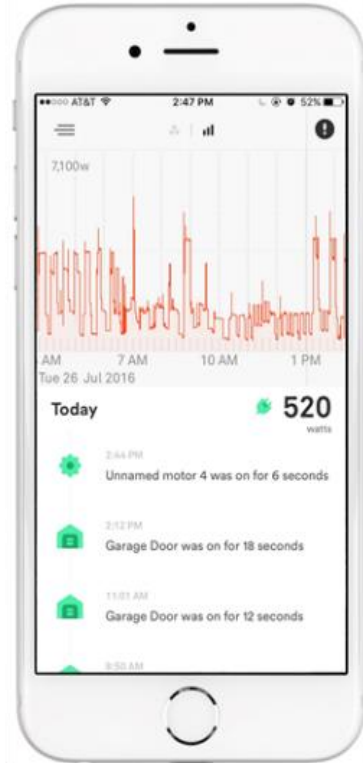




# ARIES: A hybrid path to savings?



home screen



power meter



trends

## Off-the-shelf “virtual sub-metering”

In-panel hardware + App + ‘cloud’

Measure mains current and voltage

Very high frequency sensing (Mhz)

Pattern recognition → device detection

‘Edge’ Computing + Human-aided Machine Learning





# ARIES: How it works

(In practice)

Participant Intake Form

Utility Data (Monthly / AMI)

Contractor Match + Installation

High-Resolution Home Energy Monitor Data

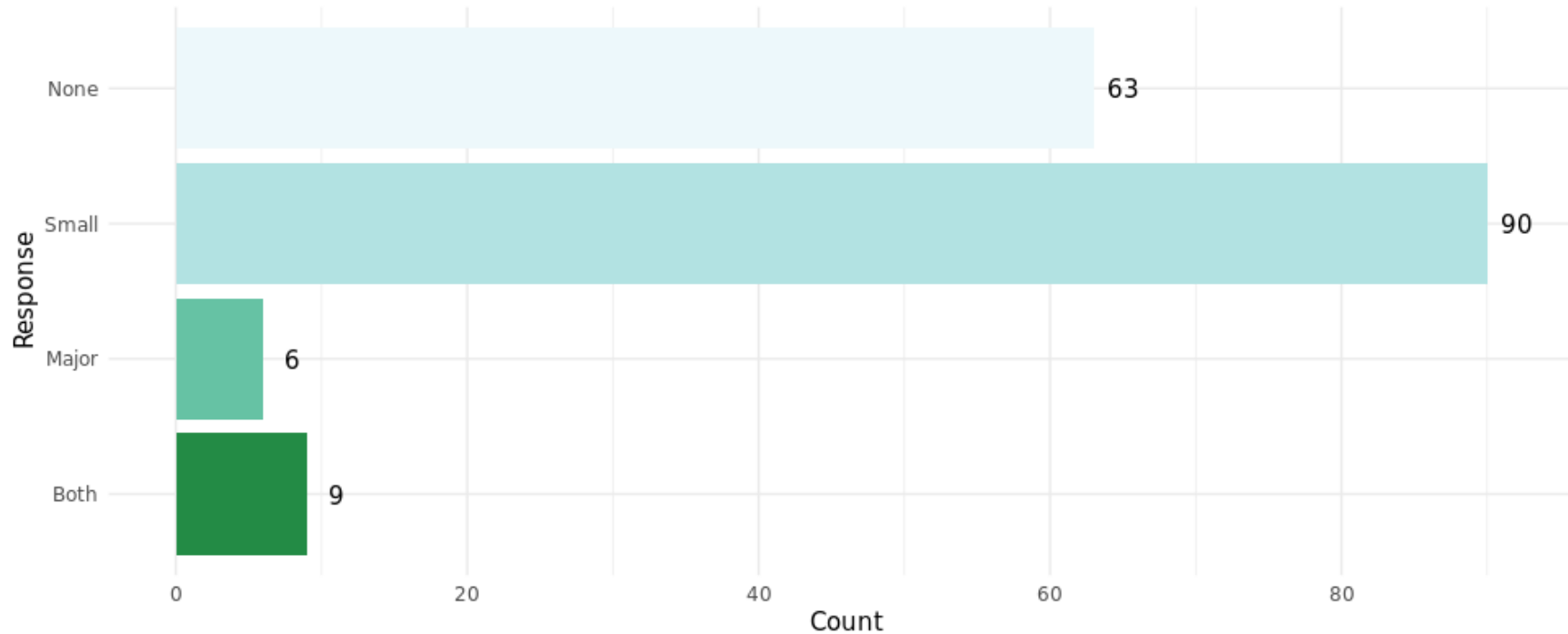
Email Campaigns +  
Surveys

Implementation Feedback, Evaluation + Adaptation



Promising  
Results &  
Insights

# Energy-saving changes at home since monitor installation



## Small Changes

Open text response → NLP

Could be anything: e.g. “Behavior”

Focus of communications

## Major Changes

Structured responses (checkbox)

Weatherization, solar, EV, heat pump, etc.

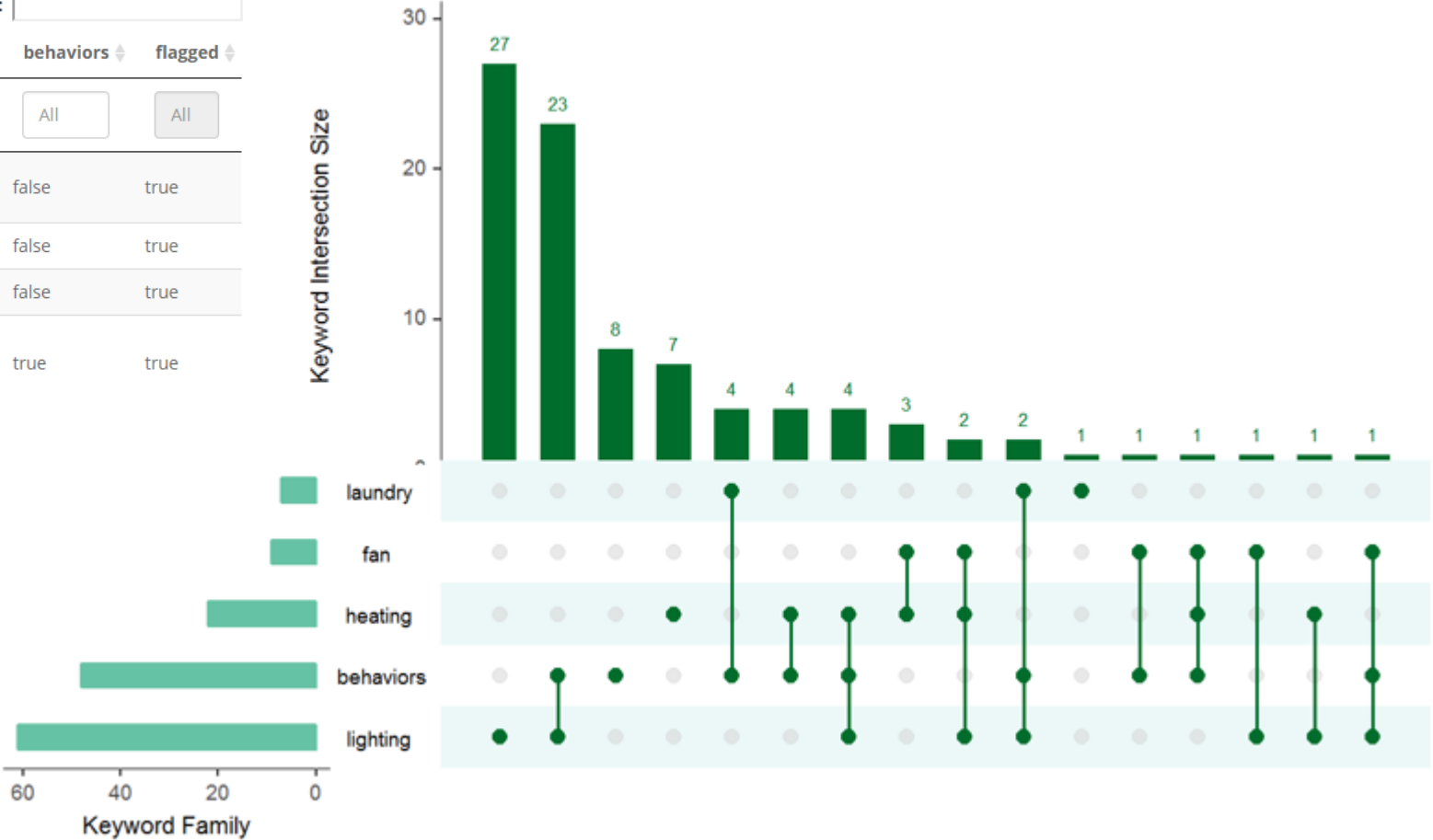
Drives non-routine event (NRE) handling  
in savings assessments

# Open Response → Structured data

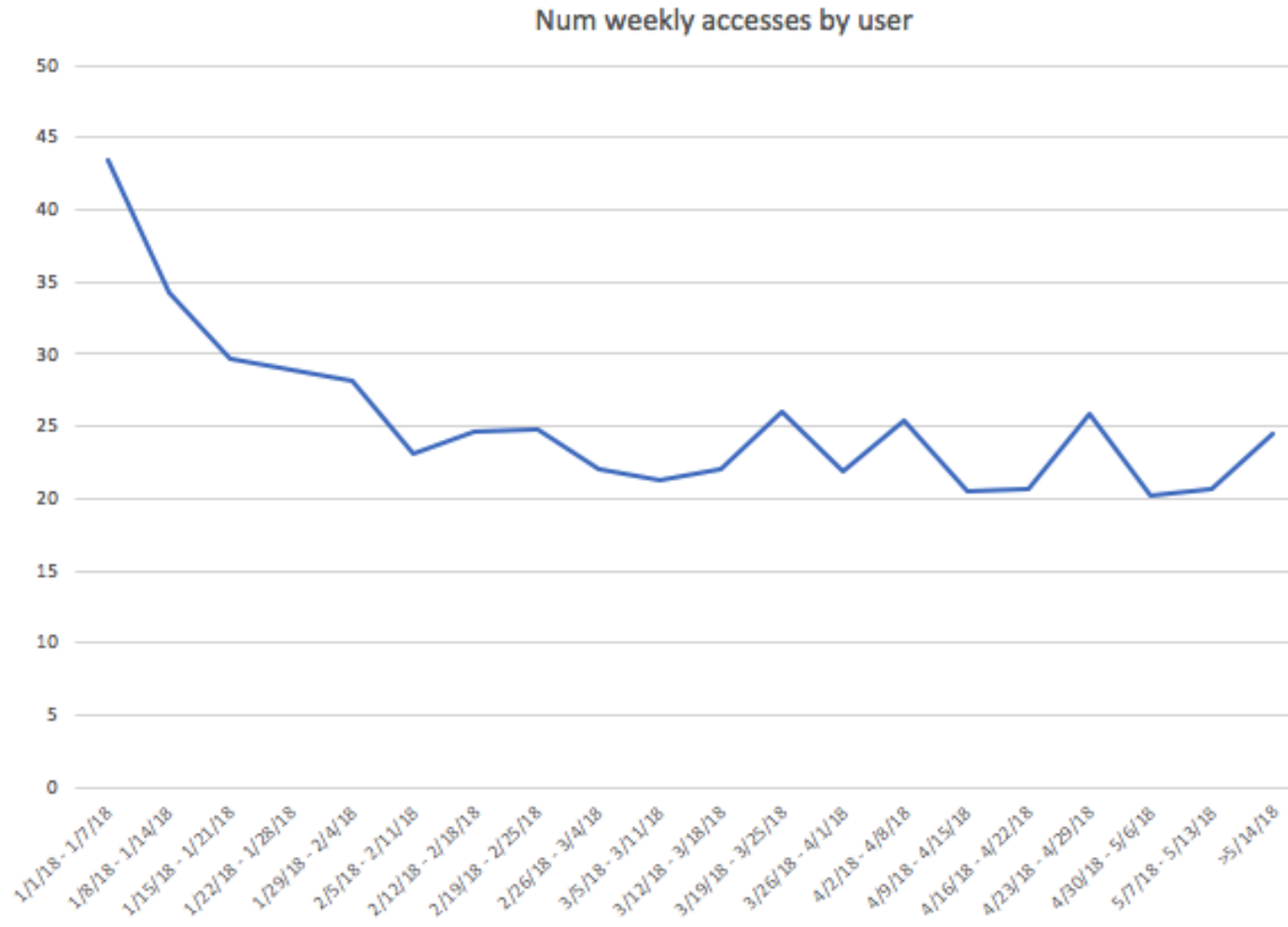
Show  entries

Search:

	answer	lighting	fan	heating	laundry	behaviors	flagged
	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>
1	new thermostats and hot water heater	false	true	true	false	false	true
2	smart bulbs	true	false	false	false	false	true
3	replaced light fixtures	true	false	false	false	false	true
4	LED bulbs, more mindful of appliance usage such as dryer	true	false	false	true	true	true



# Sustained Engagement



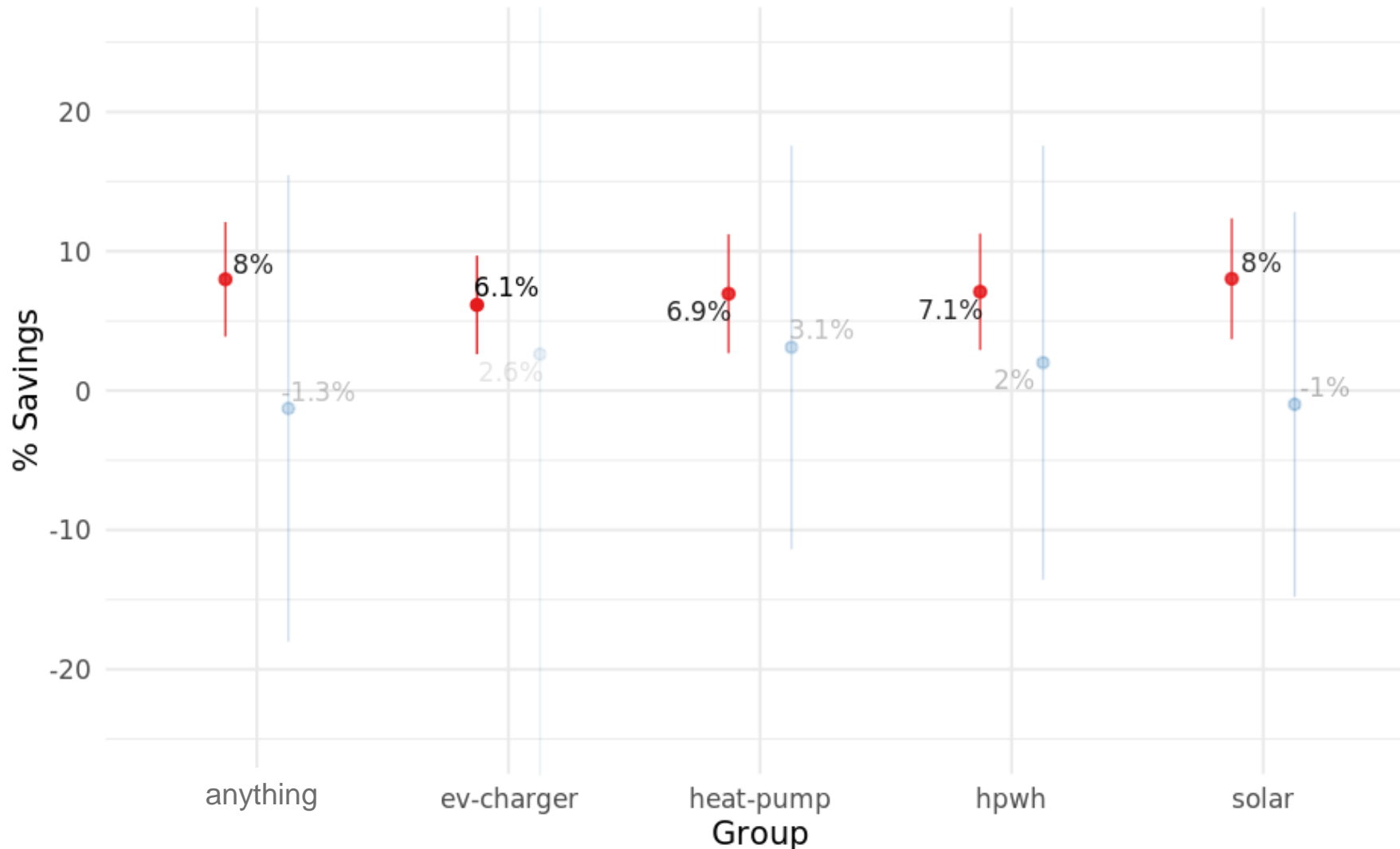
## Cohort 1: First 6 months

20 to 25 app sessions per week

Spikes align with e-mails/surveys

Similar to customers who bought the product (i.e. not given for free)

# VERY Early “Savings” Estimates?



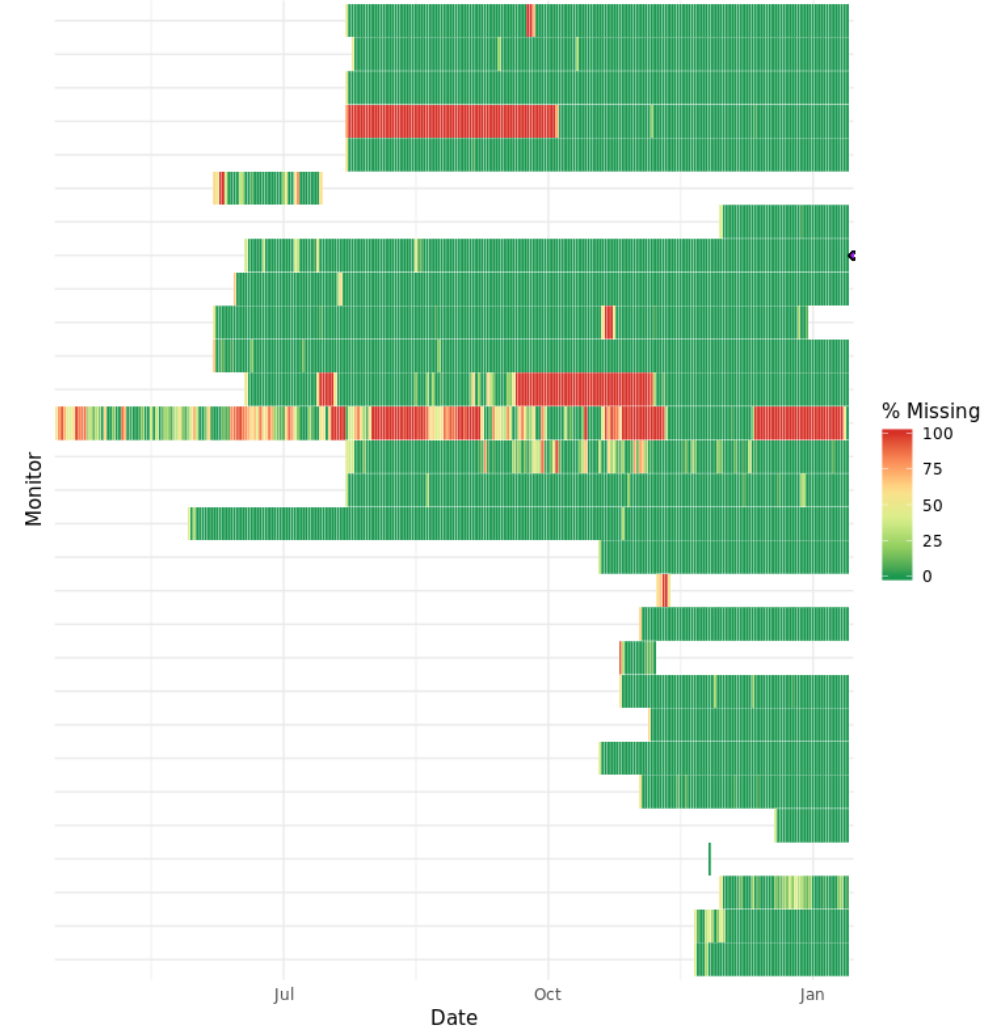
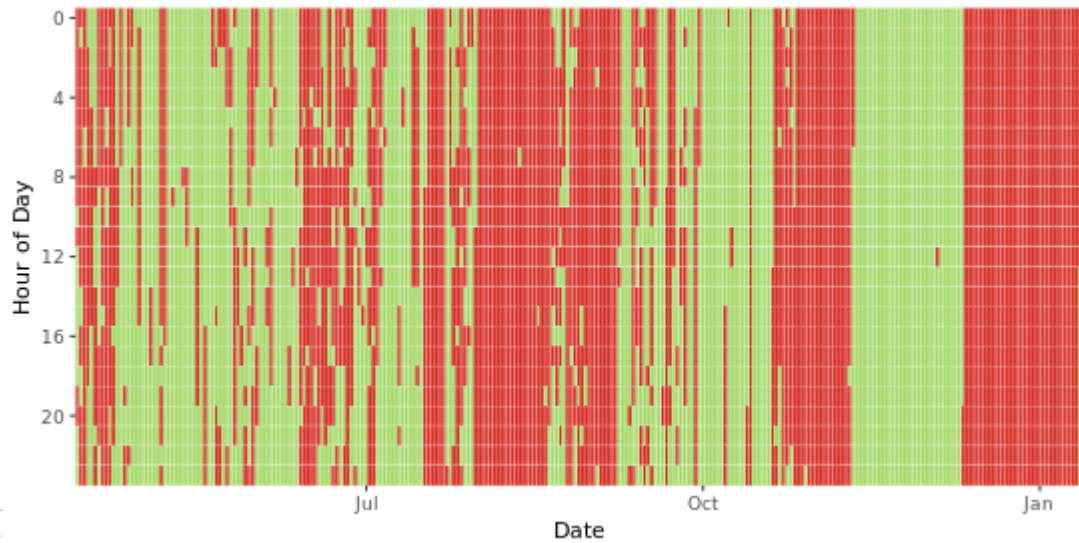
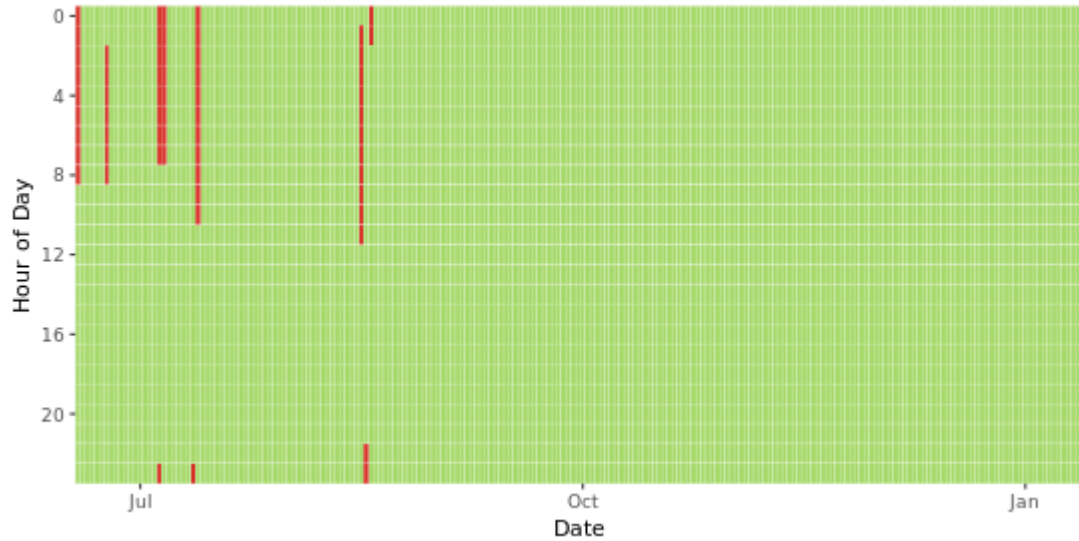
- M&V 2.0 methods
- Segmenting on ‘anomalies’ revealing
- Passes “is something here?” pilot test



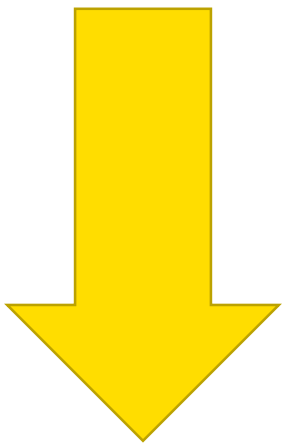
# Future Opportunities + Recommendations



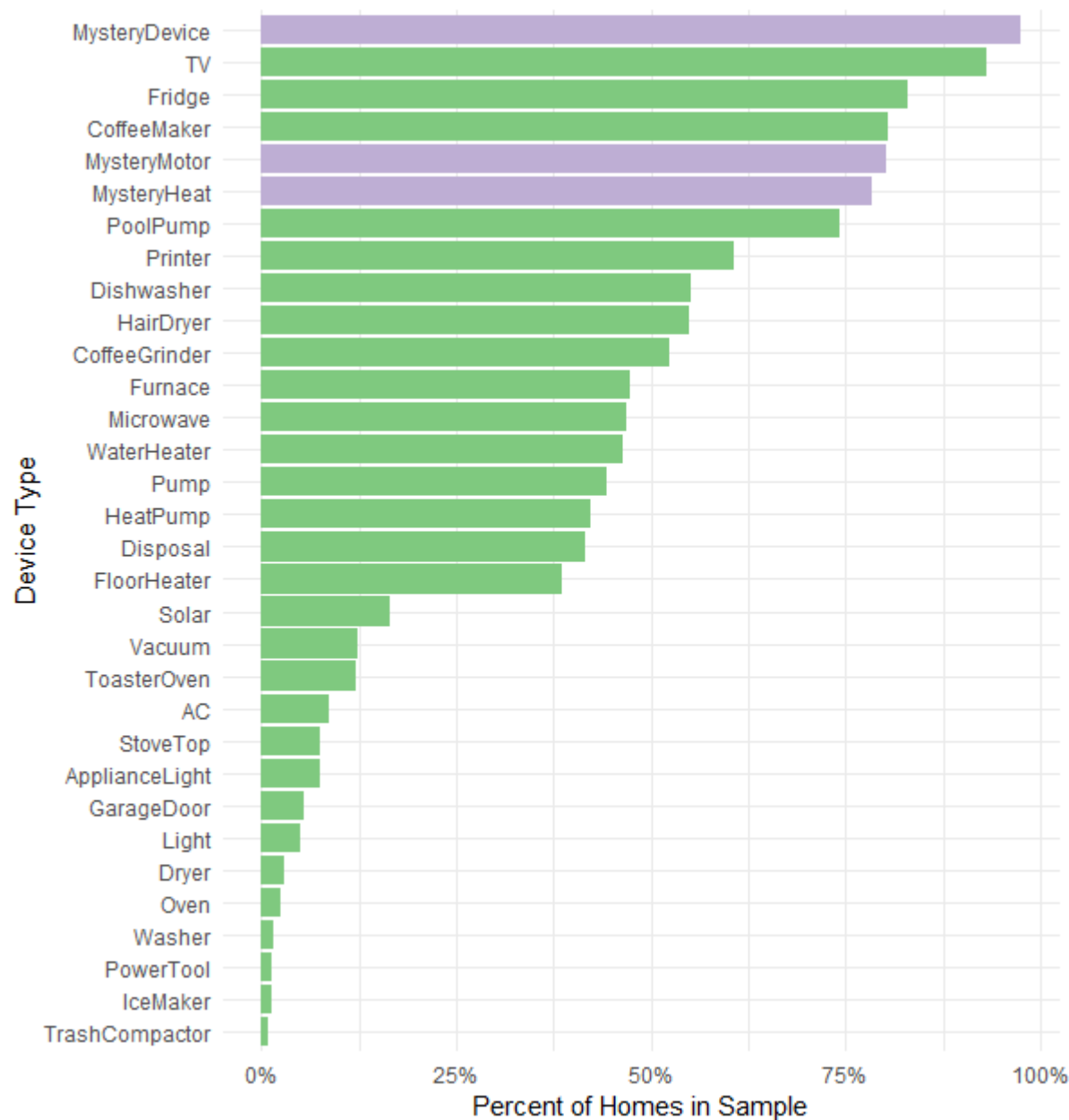
# Ensure Monitor Uptime (Data Quality)



# Fleet Device Diversity



More precise market  
characterization and  
segmentation



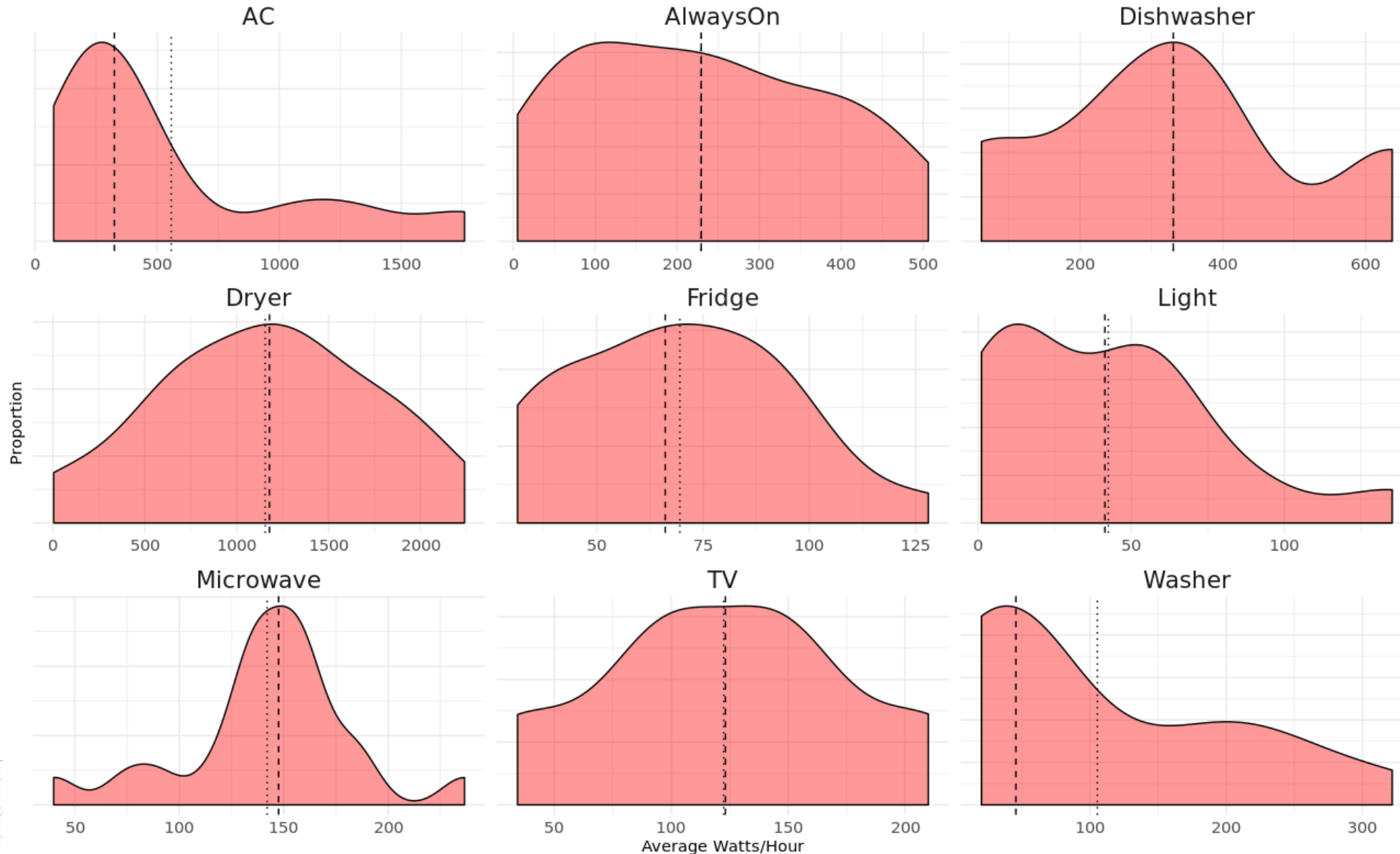
Example only.  
Labels have  
been randomly  
shifted!

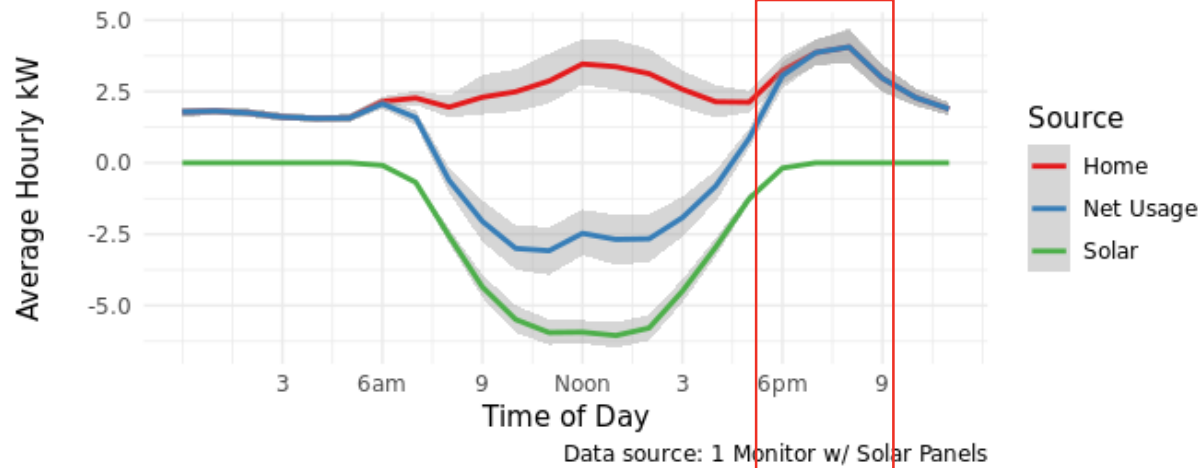
Status

- Known Device
- Mystery Device

# Identify Performance Opportunities

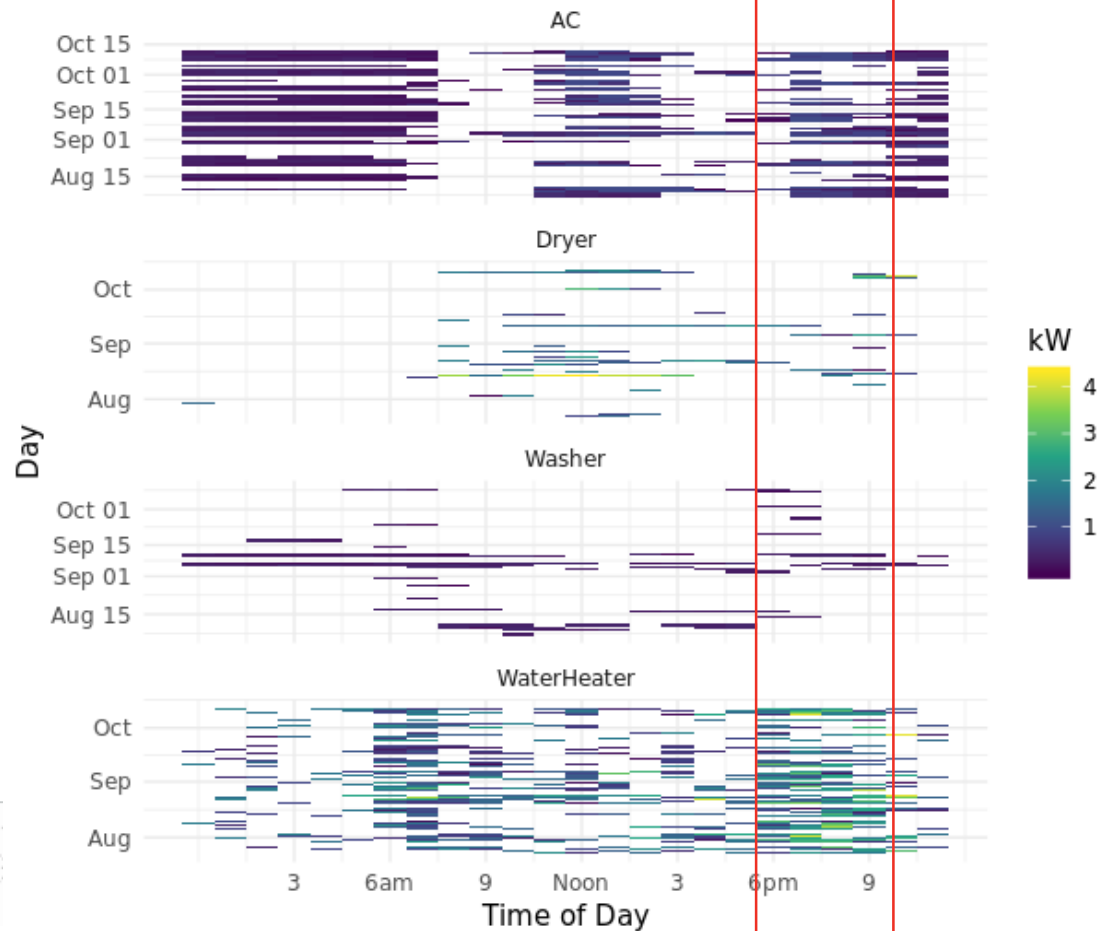
Which devices are operating with normal ranges?





# Grid Impacts?

- Demand response + flexible loads
- Rate guidance
- P4P & BYOD Programs
- Custom messaging
- Anomalous loads



# If you learn something today:

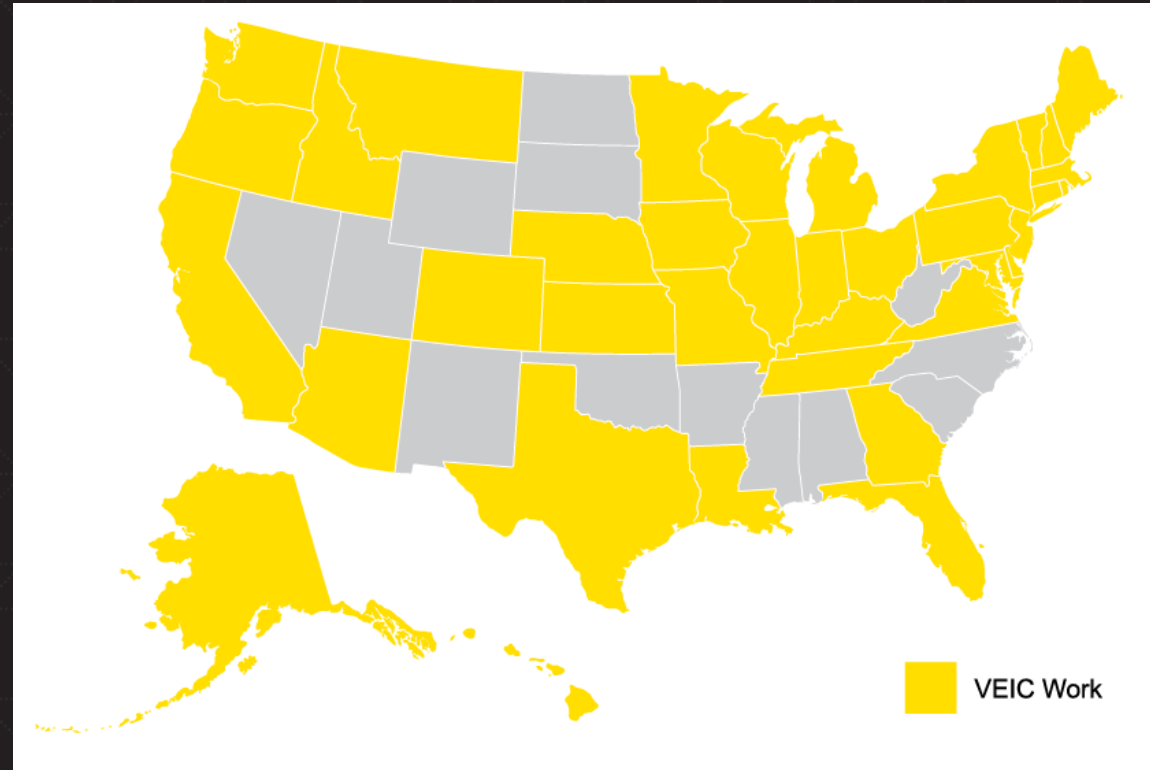
1. Changing EE needs + new technologies require new ways to grow savings and performance
2. Implementers need new tools to get this done → there's something here (and will get better)
3. Innovative programs need a coordinated, open approach  
→ We need your help!

## Get in touch:

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## About VEIC:

- Nonprofit founded in 1986
- 300+ Employees
- Offices: VT, DC, OH, NY, WI
- Design, deliver, and evaluate programs nationwide:
  - Energy efficiency
  - Transportation
  - Renewable energy



## Our Partners:

- Utilities
- Businesses
- Government
- Foundations
- Environmental & Consumer Groups