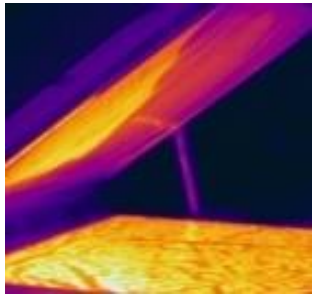
Using Communicating Thermostat Data to Automate and Scale Home Energy Performance Evaluations



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Kurt Roth, Ph.D.

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Motivation

- Space heating is the largest end use for homes in cold/very-cold climates
- Homes with poor/no insulation or inefficient heating systems have higher heating energy consumption
  - ~20-25 percent of homes
- Several measures can significantly reduce space heating energy consumption
- Programs face high customer acquisition costs
- Slower market uptake of these proven measures
  - ~1% of households/year in Massachusetts

Sources: DeMark Home Ontario, DOE/PNNL, Mass RASS, DOE/EIA.

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Project Objectives

Develop a tool for utility EE programs that **analyzes communicating thermostat (CT) data** to **automatically identify** and **quantify the benefit** of **targeted outreach** identifying **customer-specific retrofit opportunities.**

Customer and Utility Benefits:

- Increase uptake of the target energy conservation measures (ECMs)
- Decrease the cost of EE programs via targeting
- Reduce retrofit performance risks using remote EM&V
- Increase customer engagement

***Ultimate Vision*:** CTs deployed in most homes identify high-impact opportunities to reduce HVAC energy consumption *and* ensure retrofit performance

Key Aspects: Customization and Targeting

- Provide targeted energy efficiency offerings to households
- Identify household-specific retrofit opportunities
  - Wall and/or attic insulation – R-value
  - Air sealing – ACH_{50}
  - HVAC system upgrades – Condensing vs. non-condensing furnace, boiler
- Calculate household-specific energy savings potentials

By insulating your home, you can reduce your heating bill by ***$183*** *per year …*

Image Source: S. Edwards-Musa.

We fit CT data to a model for each home's thermal response – this can be challenging!

???

- Different physical parameters can create similar building thermal responses
  - Separating conduction and infiltration losses
- Different HVAC systems have different response times and characteristics
- Many homes have multiple CTs
- Thermal response "noise" from internal heat gains
- Varying CT data among vendors

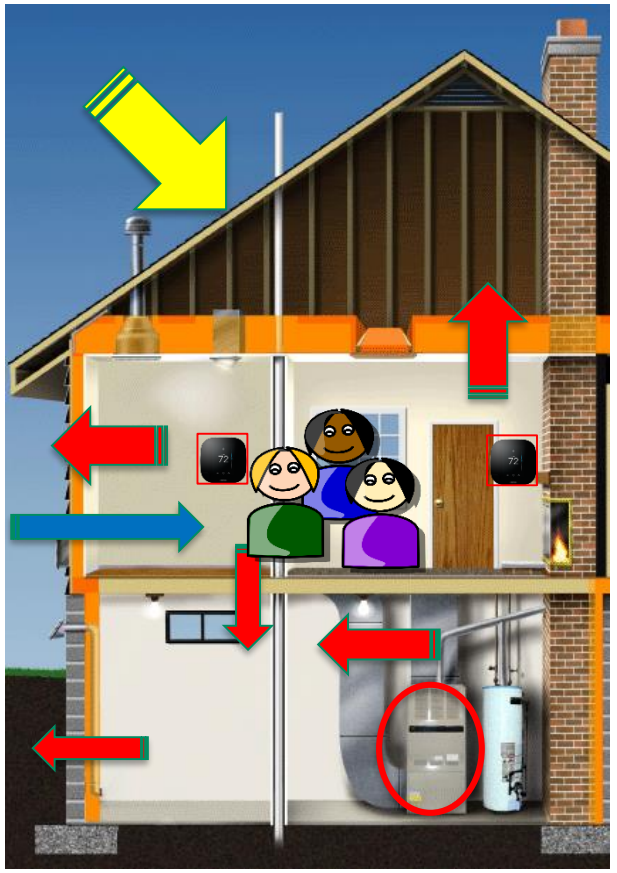
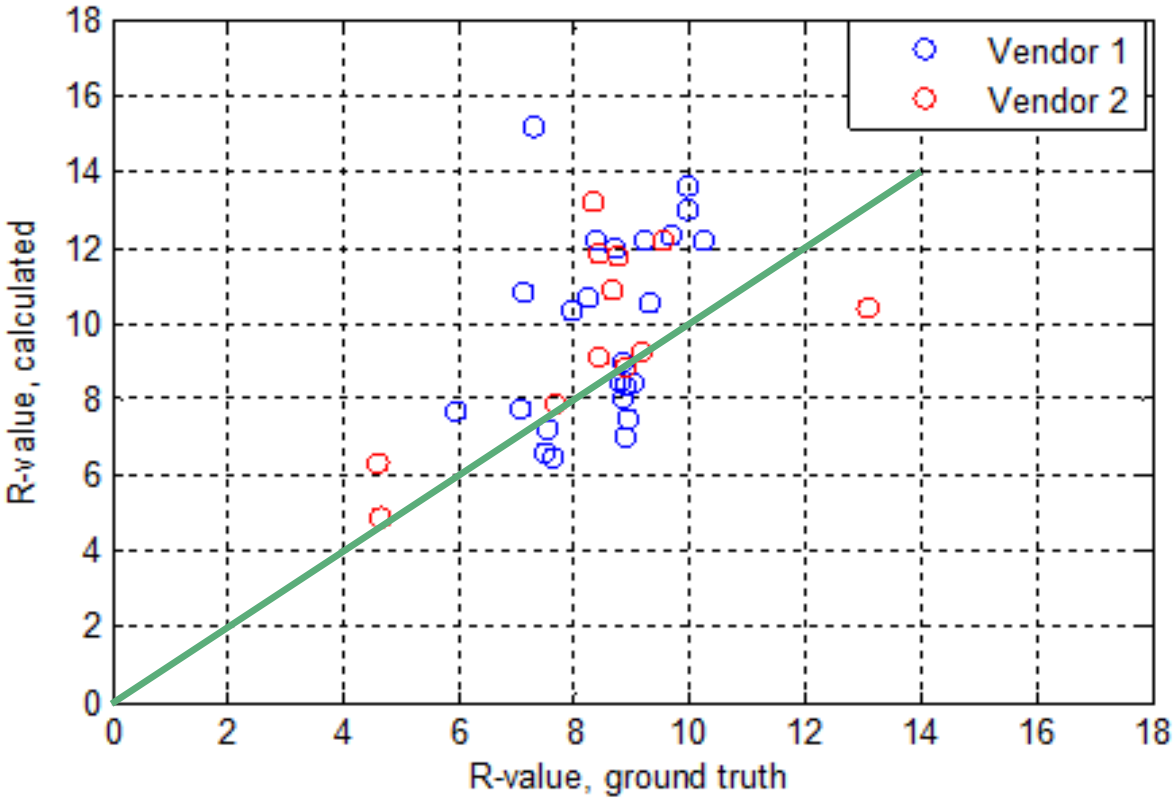


Image Source: DOE, ecobee.

We have obtained promising R-value classification results for a range of homes with one CT and one furnace.



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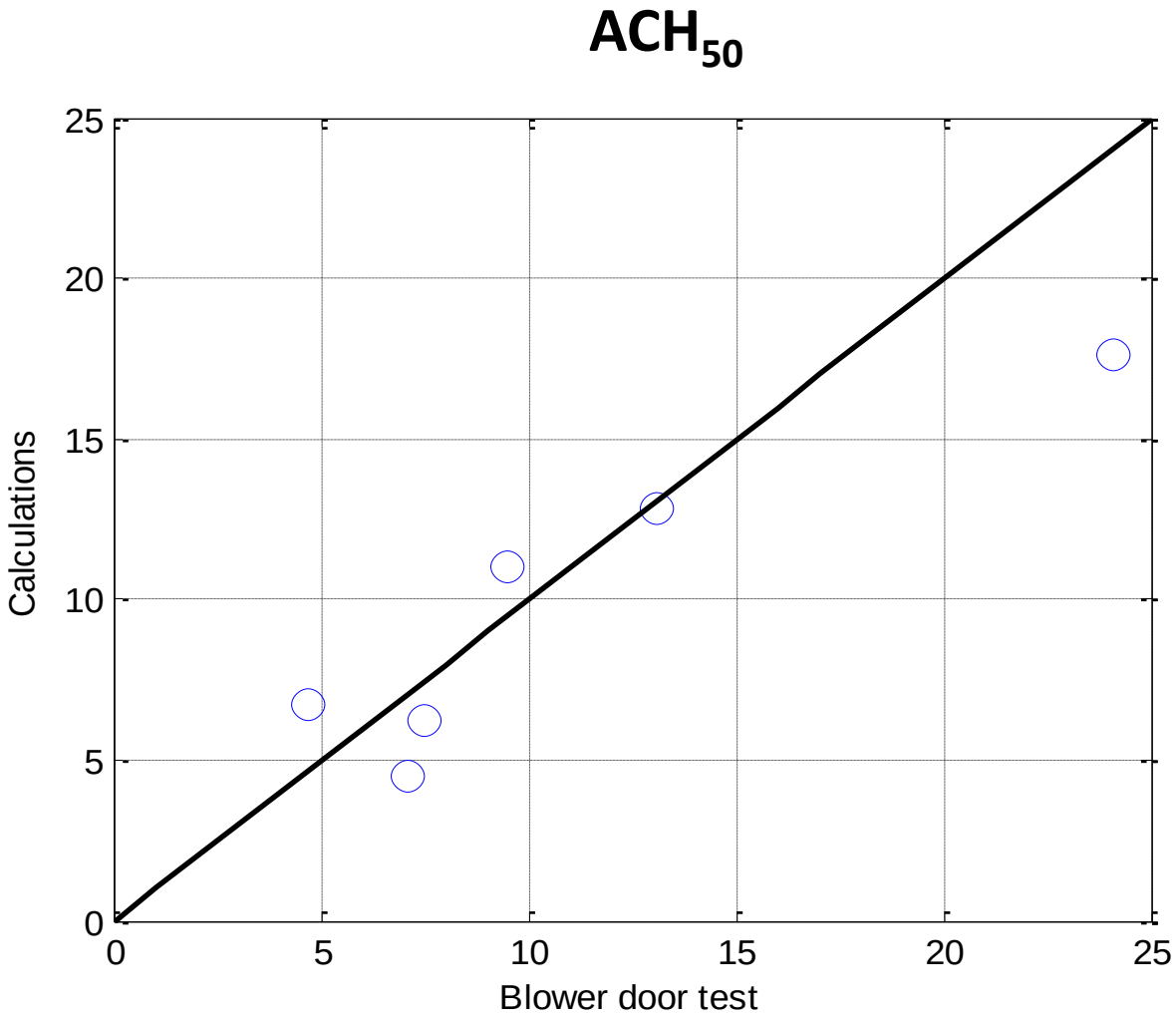
Preliminary results for classifying air leakage are also promising.



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CT Data – Lessons Learned

- Ease of obtaining CT data varies greatly among CT vendors
- Data field vary among CT vendors
  - Ecobee dataset strongest – 0.1°F and 1s runtime resolution, data reported every 5 min.
  - We have developed a Draft CT Data Specification
- Missing or unreported heating system runtime data not uncommon
  - Noted in prior work
- EE measure data has appreciable uncertainties
  - Foremost for estimated air leakage rates
  - Furnace/boiler capacities also estimated
  - Areas, volumes, wall and attic insulation seem to be pretty good

Sources: Building36, ecobee, Honeywell.

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Looking Forward

- Evaluate performance using data for many more homes
- Extend algorithms to homes with boilers and multiple CTs
- Evaluate ability to predict energy savings from target retrofits
- Perform RCT to test hypothesis: Does targeted, customized outreach increase rate of HEAs conducted *and* ECM implementation?
- Finalize recommendations for scale-up: CT Data Specification, Best Practices Guide for Utility Program Integration

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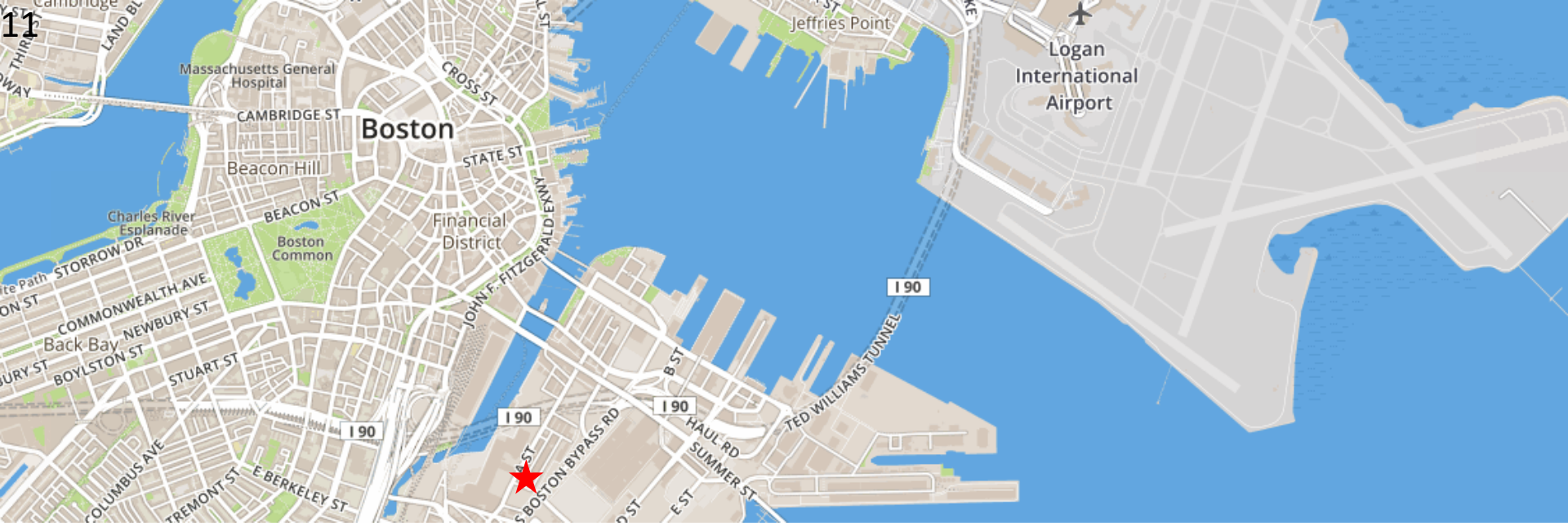

Contact

Kurt Roth, PhD
kroth@cse.fraunhofer.org
+ 1 617 575-7256

5 Channel Center Street
Boston, MA 02210
https://www.cse.fraunhofer.org/

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