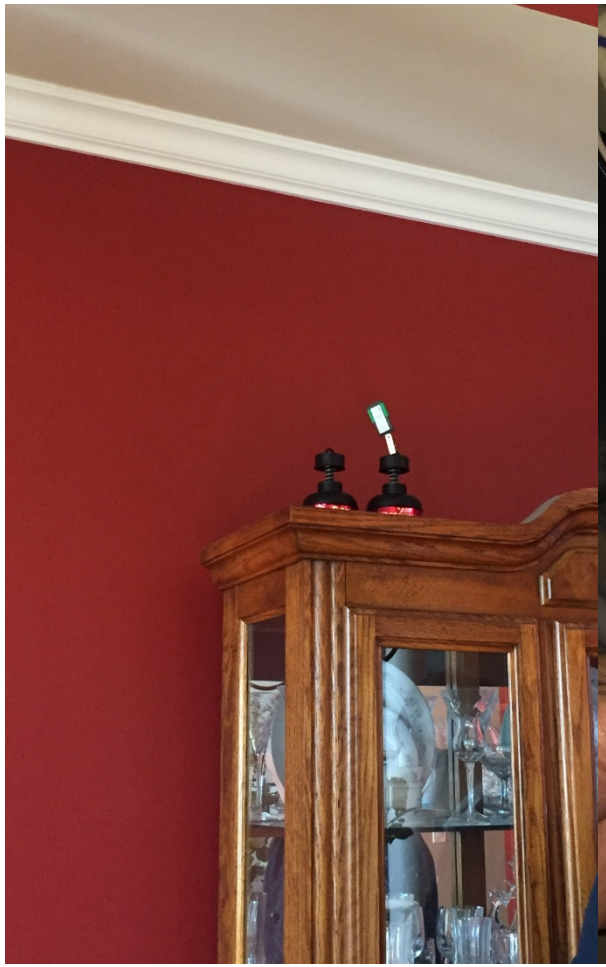
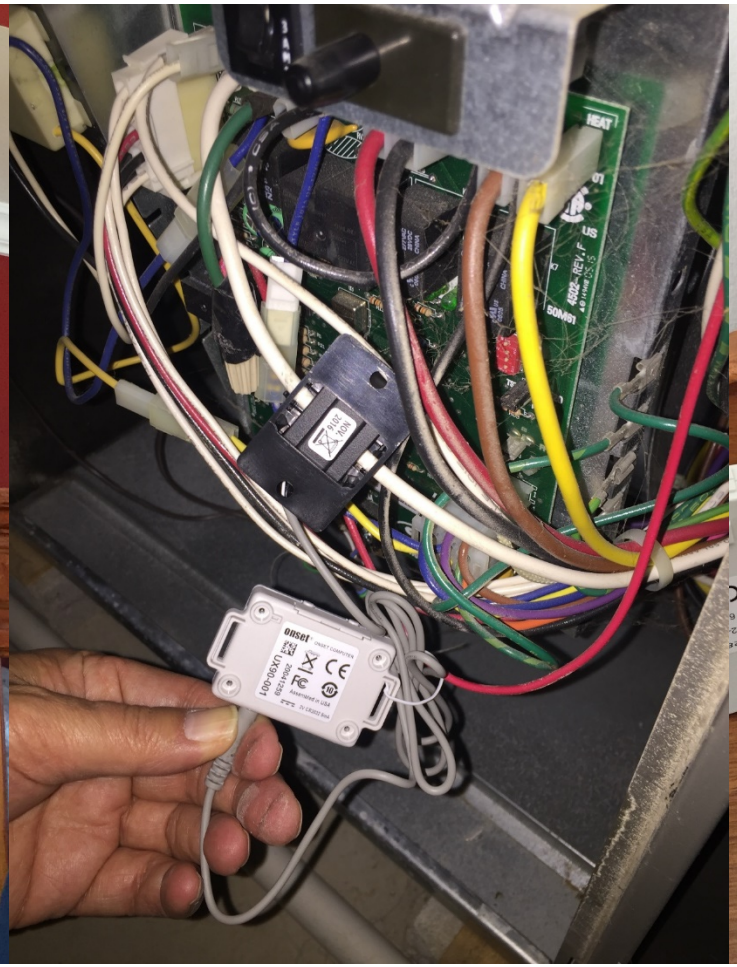
Energy Savings with Acceptable Indoor Air Quality Through Improved Air Flow Control in Residential Retrofit

2017 Building Technologies Office Peer Review





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

Paul W. Francisco, pwf@Illinois.edu
University of Illinois at Urbana-Champaign
(GTI/PARR team)

Project Summary

Timeline:

Start date: September 1, 2015

Planned end date: March 30, 2019

Key Milestones

1. Expert and Practitioner Meetings; 5/2016
2. Go/No-Go Budget Period 1; 8/2016
3. Recruitment; Underway, homes are currently being monitored

Budget:

Total Project $ to Date:

- DOE: $195,596
- Cost Share: $93,979

Total Project $:

- DOE: $750,000
- Cost Share: $250,000

Key Partners:

Gas Technology Institute (GTI; prime)
University of Illinois at Urbana-Champaign (UIUC)
Midwest Energy Efficiency Alliance (MEEA)
Priority Energy

Project Outcome:

This project aims to demonstrate that, through systematic management of airflows, indoor air quality and/or energy savings can be increased with no penalty to the other. This will help to reduce EUI while optimizing home performance and validate improved practices that can be applied across a variety of climate zones.

Goals/Impact/Status

- Support retrofit savings from air sealing of approximately 7% (based on impact evaluations of retrofit programs)
  - Air sealing corresponds to potential of about 1.5 quads per year across existing homes (based on MYPP)
  - Corresponds to about $17B in potential consumer energy cost savings (based on MYPP)
- Assume that concerns about IAQ sacrifice 10% of potential air sealing savings in 1% of homes
  - Potential benefits approximately $17M
- For project cost of $750,000, leads to ROI of about 23:1
- Project recently underway in field
  - No field conclusions yet
  - 2016 Accomplishments: Practitioner and Expert Meetings and Test Plan completed

Purpose and Objectives

Problem Statement: Concern about indoor air quality (IAQ) frequently limits energy efficiency upgrades. Airflows within the home are often considered independently. This project aims to demonstrate that systematic management of airflows increases the ability to deliver energy savings without sacrificing IAQ. This addresses the BTO MYPP on Residential Buildings Integration Strategies while serving to unlock the energy savings potential of air sealing in existing homes.

Target Market and Audience: The target market is existing buildings, and supports the goal to reduce energy usage by 25% which would result in a national savings of 5 quads. The audience is the home performance contractor.

Impact of Project: The final product of this project is a protocol for contractors to use to deliver maximum energy savings without negatively impacting IAQ.

a. Near-term: Early adopters have the tools to provide integrated energy and IAQ packages
b. Medium-term: Standards and programs adopt these tools
c. Long-term: Integrated energy and IAQ packages become standard practice

Approach

Approach: We are evaluating how to address IAQ concerns in order to maximize energy savings. We are conducting a case-control study in collaboration with local home performance contractors to adopt a systematic approach that considers multiple air flow streams and measures multiple contaminants.

Key Issues: Energy savings are often sacrificed due to concerns about IAQ. Some interventions may improve one metric while causing problems in another. Airflow management is also typically not viewed systematically, which can result in suboptimal energy and IAQ outcomes.

Distinctive Characteristics: This project involves field measurements of multiple contaminants in a case-control approach.

Delivery of Project Outcomes

- Project will provide data on impact of measures
- Refine measure package and recommendations based on results
- Finalize measure package with guidance document/decision tree for broader use
- Deliver package through conferences, workshops, and trainings

Expert and Practitioner Meeting Outcomes

- Refined list of contaminants to be measured
- Refined ventilation strategies to be considered
- Identified minimum requirements for participant homes
  - Maximum leakage levels
  - Basement foundations
- Identified critical characteristics for matching of treatment and control homes
- Refined testing schedule
- Identified recruitment paths
- Identified potential contractor participants

Energy/IAQ Measurements

- Indoor Air:
  - Formaldehyde (continuous indoor generation)
  - Radon (soil/exterior generation)
  - CO2 (human generation)
  - Humidity (human and outdoor generation)
  - Particles when possible (periodic indoor and outdoor generation)
- Energy:
  - Heating/cooling
  - Ventilation

Airflows Considered

- Infiltration
  - Heating/cooling losses; addressed by air sealing
- Ventilation
  - Provide controlled air exchange; desire to minimize energy use for ventilation
- Duct leakage
  - Leakage to outside is an energy penalty
  - Unbalanced duct leakage causes pressure differentials
    - Impacts infiltration and can cause IAQ problems
- Air handler flow
  - Impacts comfort
  - Impacts humidity control in summer
  - Restricted ducts impact energy use

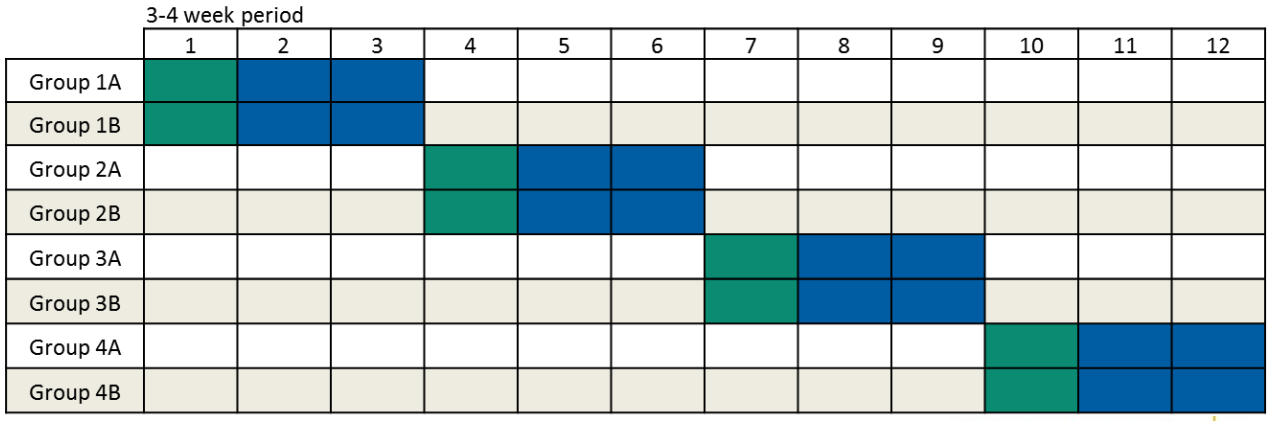
Testing schedule

Anticipated Site Visits:

- V1 – Audit/Qualify (partner)
- V2 – Install Instruments for Baseline Sampling (team)
  - V2+1 Wk – Return HCHO and Radon samples
- V3 – Treatment or Control Measures (partner)
  - V3+1 Wk – Return HCHO and Radon samples
- V4 – Removal (team)

Baseline
Post-treatment

Group A - "treatment" with systematic flow treatment
Group B - "control" with business as usual



Treatment/Control

- Treatment gets all applicable measures
- Control gets “business as usual” per program, plus ASHRAE 62.2-2016
- Must match on a few characteristics, e.g. similar starting airtightness, foundation type
- Test at approximately same time

Progress and Accomplishments

Accomplishments: Two stakeholder workshops

- Expert Meeting - helped refine the project design
- Practitioner Meeting - identified challenges and solutions to project implementation
- Approval of Test Plan - this took longer than expected; the result was an improved project design but an overall project delay
- Partner contractor training, recruitment, and field testing now underway

Market Impact: We have worked closely with a retrofit contractor. The contractor has been trained on the methods and potential benefits. By working with a home performance contractor we are able to accelerate impact by demonstrating not just the theory but the practicality of implementation.

Awards/Recognition: None to date; project is underway without final results

Project Integration and Collaboration

Project Integration: The project team includes multiple members who have strong connections to industry, including the industry team lead (GTI), a weatherization training center (UIUC/ICRT), and a regional energy efficiency alliance (MEEA). The project is also working closely with a home performance contractor, Priority Energy. The connections of the project team with practitioners will expedite adoption of the project outcomes.

Partners, Subcontractors, and Collaborators: Subcontractors under GTI include UIUC/ICRT, MEEA, Chitwood and Associates, and the National Center for Healthy Housing. UIUC/ICRT is leading the scientific effort; MEEA is coordinating with practitioner collaborators and organizing stakeholder workshops. Chitwood and Associates provides contractor insight. NCHH provides a tie to the environmental health industry. The collaborator, Priority Energy, is conducting the field interventions.

Next Steps and Future Plans

Next Steps and Future Plans: Future project activities include completing recruitment and testing on a total of 40 homes, including 20 treatment and 20 control homes. Analysis of the data will indicate the extent to which the systematic airflow management techniques lead to improved energy savings/IAQ outcomes. This will be followed by presentations at stakeholder conferences and appropriate modifications to training and energy efficiency program policies.

REFERENCE SLIDES

Project Budget

Project Budget: $1,000,000; DOE: $750,000; Cost Share: $250,000

Variances: NA

Cost to Date: $289,575; DOE: $195,596; Cost Share: $93,979

Additional Funding: NA

Budget History					
September 1, 2015 – FY 2016 (past)		FY 2017 (current)		FY 2017, 2018, 2019 – March 30, 2019 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$165,902	$91,424	$29,694	$2,555	$554,404	$156,021

Project Plan and Schedule

- See below for original initiation date and project planned completion date, schedule, milestones, go/no-go decision points, and current and future work
- The Field Test Plan was delayed to include input from both Expert and Practitioner Meetings along with longer than expected engagement and review with key stakeholders
- The Air Control and IAQ Best Practices Task and Budget Period 1 Go/No-Go decision were delayed due to delay in finalizing Field Test Plan
- Future task and milestones due dates were extended to recognize Budget Period 1 delays (fully approved and executed). All delayed milestones and tasks are complete and project is back on schedule.