



National Center for Healthy Housing

Creating healthy and safe homes for children through practical and proven steps.

Green and Healthy Housing Research



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Project Partners

- MN Green:
 - Southwest Minnesota Housing Partnership
 - Center for Sustainable Building Research
 - Greater Minnesota Housing Fund
- DC Green:
 - Community Preservation & Development Corporation (CPDC)
 - Wiencek and Associates
 - Wheeler Terrace Tenant Association



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Research Funding

- MN Green:
 - US Environmental Protection Agency
 - Blue Cross Blue Shield Foundation of MN
 - Enterprise Community Partners
- DC Green:
 - HUD Office of Healthy Homes & Lead Hazard Control



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Pre-Rehab Building Descriptions

- Both multifamily apartment complexes
- Both mostly subsidized rentals
- DC Green constructed in 1947; MN Green in 1974



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Before and After Renovation-MN Green





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Kitchen Renovations- MN Green





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Community Amenities- MN Green





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Before & After Renovation-DC Green



Kitchen Renovation-DC Green



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Bathroom Renovation- DC Green



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Common Green Rehab Elements

- Low-VOC adhesives, paints & coatings
- Ventilation: ASHRAE 62.2
- Integrated pest management
- No carpet in wet areas
- Energy Star fans exhausted to exterior



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Common Green Rehab Elements, cont'd

- Geothermal heating & cooling
- Enhanced insulation of building envelope
- Energy Star appliances & fixtures
- Energy-efficient lighting



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Unique Green Elements

- MN Green:
 - Radon test pre- & post
 - Metal roofing
 - Cement Fiber siding
- DC Green:
 - PVC free resilient flooring tiles in common areas
 - continuous bathroom exhaust fans



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Data Collection & Training

- Health Questionnaire
- Visual Assessment
- Resident Training
- Radon, CO₂ Testing (MN only)
- Allergen Testing (DC only)

Baseline Resident Characteristics



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	MN Green		DC Green	
	Adults	Children	Adults	Children
% Born in US	43%	82%	95%	97%
Age in years (mean)	39	6	36	7
% Female	58%	37%	79%	66%
Ethnicity:				
White/Hispanic	10%	3%	2%	0%
White/non-Hispanic	27%	7%	2%	1.6%
African	35%	31%	0%	0%
Black/African American	8%	45%	96%	97%
American Indian	4%	3%	0%	0%
Some other race/don't know	16%	10%	0%	0%
# people/apt (mean)	3	--	3	--
Annual income (mean)	\$29,000	--	<\$10,000	--



Adult Health Changes

	MN Green		DC Green	
	Pre	Post	Pre	Post
General Health Status				
• Very good or excellent	33%	62%	31%	41%
• Good	48%	24%	35%	30%
• Fair or poor	19%	14%	32%	30%
Injury	9%	9%	14%	4%



Child Health Changes

	MN Green		DC Green	
	Pre	Post	Pre	Post
General Health Status				
• Very good or excellent	53%	65%	58%	61%
• Good	35%	35%	31%	39%
• Fair or poor	12%	0%	9.5%	0%
Injury	0%	18%	3%	0%
# ER Visits due to Asthma	NA	NA	14	0

Specific Housing Condition Changes



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	MN Green		P-value	DC Green	
	% Pre	% Post		% Pre	% Post
Water/dampness	33%	7%	p<0.102	84%	16%
Mildew odor/musty smell	25%	0%	p<0.046	60%	0%
Dehumidifier use	25%	0%	p<0.046	11%	0%
Cockroaches	25%	13%	p<0.414	57%	8%
Mice/rats	25%	0%	p<0.046	66%	12%
Smoke inside home	60%	47%	p<0.157	93%	72%
Stove exhaust fan	85%	100%	p<0.046	0%	100%



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Environmental Testing-MN Green

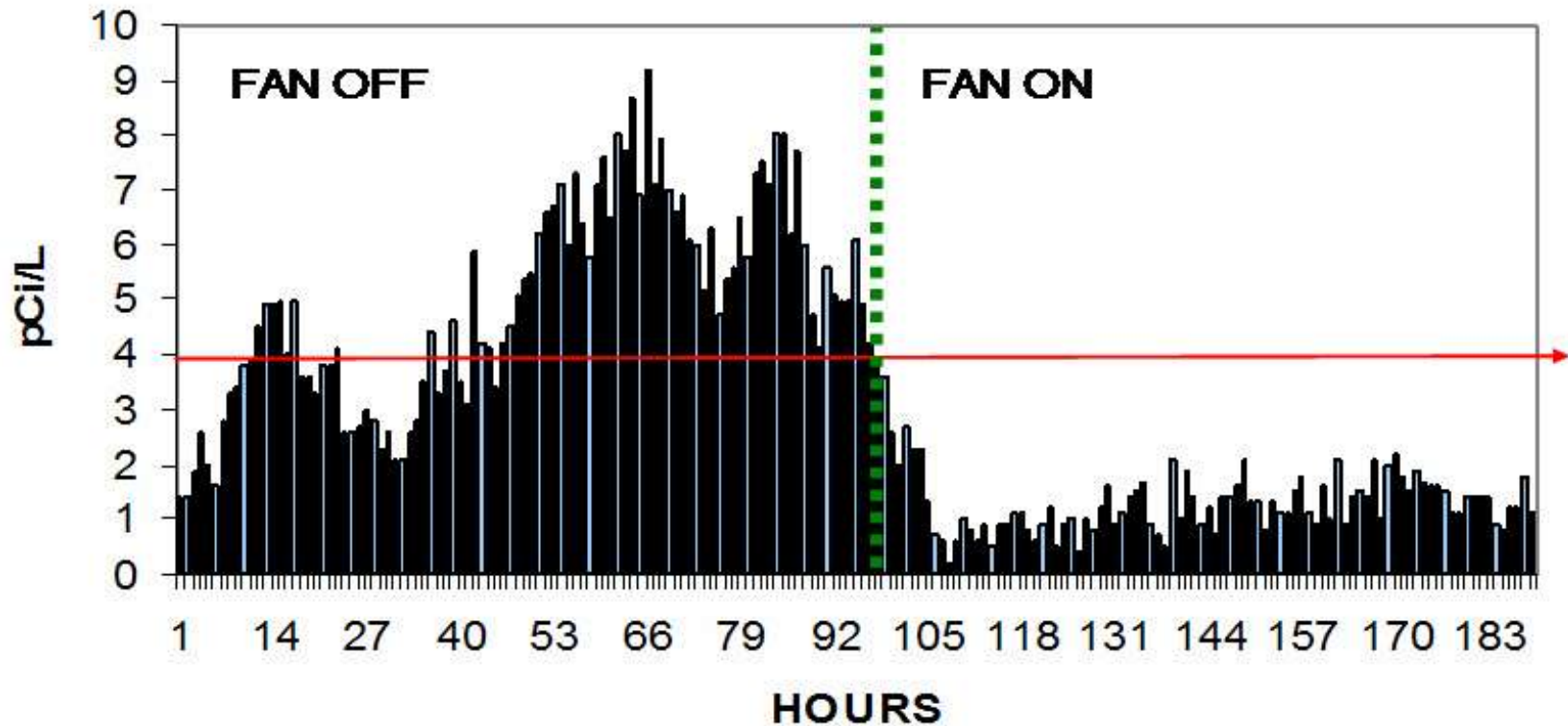
	Min	Mean	Max	Comparison Value
CO ₂ (ppm)				
Pre-Renovation	NA	NA	NA	1000
Post-Renovation	253	982	2499	1000
Radon (pCi/L):				
Pre-Renovation	1	3.1	6.7	4
Post-Renovation (post-mitigation)	0.3	0.7	2.2	4



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Radon Mitigation-MN Green





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Summary of Results

- For both projects, we want to conclude that green renovation produced improvements in resident health, lowered levels of environmental contaminants



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Conclusions to Date

- Low-income housing can be renovated using Green & Healthy principles that promote energy conservation, sustainability, & public health and safety
- Ventilation & environmental testing help ensure that building renovation design performs as intended
- Collaboration of housing, health and environmental professionals is essential



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Study Limitations and Research Needs

- “Green” vs. “normal” renovations
- Cultural differences between interviewer and interviewee
- Small enrollment: pilot studies
- Medical data vs. self-reported health



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For More Information:

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www.nchh.org

Moving Into Green Health Housing: The Yield (in health)

Emily Q. Ahonen, PhD

Colin Murphy, Sherry Dixon, PhD,

David Jacobs, PhD, CIH

HUD Grant # ILHH0191-08



Learning Objectives

1. To identify challenges in the design and implementation of a study that measures health changes associated with moving from public housing into green and healthy housing.
2. To understand the feasibility of using Medicaid data to assess health impacts of improvements to housing quality.
3. To discuss the benefits and challenges of collaboration with community data collectors in research.

Why Do the MIGHTY STUDY?

- Because 'green' housing mainly refers to energy efficiency in the housing unit – little connection to health of inhabitants. What are connections to health?
- To determine if Medicaid data can be used to measure a difference in health care expenditures associated with improved housing in the U.S.
- To explore potential implications for health care cost containment and housing policy.

For example:

Lead Poisoning Cost Benefit

Gould E. Environ Health Perspect 117:1162-1167

Costs of lead paint hazard control (\$1–\$11 billion)

In terms of:

Health care costs

Lifetime earnings

Tax revenue

Special education costs

Attention deficit–hyperactivity disorder

The direct costs of crime

Each dollar invested in lead paint hazard control
results in a return of \$17-221, or net savings of
\$181-269 billion

Medical Care Costs and Housing Improvement

Living conditions and health promotion strategies

P J Ambrose

Peter J Ambrose, BA, AKC, MA, DPhil, FRSA, Visiting Professor in Housing Studies, Health and Social Policy Research Unit, University of Brighton, Falmer, East Sussex BN1 9PH, England

Received 17 August 1999, revised and accepted 19 October 2000

Key words

Exported costs; health gain; health promotion strategies; living conditions; urban regeneration

Health care costs declined 7-fold in a large housing improvement project in South London (n~450 units)

Environmental Burden of Disease (EBD) associated with inadequate housing

- In 2005, WHO Regional Office for Europe developed an approach to quantify housing-related health impacts for the region.
- They used a method based on the Environmental Burden of Disease (the amount of disease caused by environmental hazards).
- Their results show that health consequences associated with inadequate housing (DALYs) are substantial and they recommend that health considerations should be at the center of all housing policy decisions.

The MIGHTY study: Design

Goal

Characterize occupant health and health care expenditures related to new green affordable healthy housing in Chicago.

Design

- 2 study groups (former residents of traditional high-rise low-income housing, now in new housing built to affordable green standards)
- 1 comparison group (residents of traditional, old subsidized housing rehabbed traditionally)

What makes these units “green”?

Formaldehyde free insulation and moisture barriers	Exhaust & Fresh Air Ventilation per ASHRAE 62
Window air infiltration and noise transmission criteria	Radon testing completed all below 4 pCi/L
Wall infiltration criteria	Energy Star
Acoustical sealant for wallboard	Air-infiltration barrier
Efficient Furnaces & AC	Air infiltration for storm doors < 0.05cfm/sq ft and condensation resistance
Vibration isolators for noise	Kitchen exhaust vented to outside
Ventilation system balancing	Water heaters preset to 110 F (Chicago City Code)

The MIGHHTY study: Data

Data sources

- Self-report health interview (adapted from CDC NHIS)
- Visual assessment (Healthy Housing Inspection Manual protocol)
- Medicaid data (obtained from the Illinois Department of Health Care and Family Services)
- Limited air sampling (non-smoking households)

A typical visit

- Informed consent
- Obtain Medicaid numbers for all household members who had one
- Concurrent health interview and visual assessment of housing unit
- Air sampling equipment left in eligible homes for 24 hours

Example:

Medicaid ICD Codes & Health Interview

Condition	Interview question	Medicaid 3-digit ICD Codes
Comfort of temperature in home	39, 40	E900, E901
Headache/Migraine	46	339, 346
Overweight	47, 59	278
Three or more ear infections per year	47	381,382
Learning disability	47	314
Attention deficit/hyperactivity (ADD/ADHD)	47	314
Lead poisoning	47	984
Any kind of respiratory allergy	48	477
Eczema or any kind of skin allergy	48	691, 692
Hay fever	48, 59	477
Chronic bronchitis	48, 59	490, 491
Child behavioral problems	50-55	314
Adult need physical limitations	56, 57	NONE
Hypertension	58A	401, 402
Coronary heart disease	58A	428
Angina Pectoris	58A	413
Heart attack (also called myocardial	58A	410

Table 2: Visual Groups

Number	Visual Group
1	Bathroom/Kitchen
2	Building Structure
3	Doors
4	Electrical
5	Fall safety
6	Fire safety
7	Grounds/Pavement
8	Pests
9	Play Areas
10	General Safety
11	Ventilation
12	Walkways/Floors
13	Water Damage/Mold
14	Water Systems
15	Windows

Visual Assessment Data

The MIGHHTY study: Air Sampling Data



Cannisters
(VOCs)

Passive
badges
(HCHO)

Data
loggers
(CO, CO₂,
PM)

Nominal 24-hour samples



The MIGHTY study: Initial air sampling results

Contaminant	Old Dev.		New Dev. 1			New Dev. 2		
	n	g. mean	n	g. mean	p	n	g. mean	p
Average CO ₂ (ppm)	8	635	20	839	0.02	15	777	0.10
Average CO (ppm)	8	0.31	20	0.43	0.42	15	0.38	0.65
Formaldehyde (ppb)	10	21.7	19	27.5	0.14	15	25.7	0.28
PM _{2.5} (ug/m ³)	10	25.3	18 ¹	27.6	0.76	15	20.5	0.50
TVOC as Hexane (ppbv)	9 ¹	46.9	19	93.5	0.02	14	63.9	0.19

Concentrations of pollutants from the three developments, as well as the p-value (p<0.05 is bold) from the T-test comparing the old development to the new developments.

¹ Outlier removed

Challenges: Design and implementation

Design

- Epidemiology idea of cohorts or a “control” group not really applicable here – we are really comparing housing sites and needed to find a comparison site, which was a challenge
- Limitations of self-report data
- Aging of residents and health status

Implementation

- Training of community member researchers (human subjects research, use of data collection tools)
- Community and University researcher strengths and weaknesses
- Eligibility not clear-cut

Medicaid data – feasible?

- Extensive data use agreements required between attorneys of both entities – staff turnover
- IRB and HIPPA protections
- Patchy time periods on Medicaid rolls (income requirements)
- Huge dataset
- Controlling for changes in medical care access, aging, increasing medical costs

Summary of learning objectives, steps forward

1. Study of housing units AND the people in them – not a straightforward experimental environment, many field implementation challenges
2. May be the most clear cut way to show differences in expenditures, maybe fewer expenditures - which is useful to impact policy.

But is this necessarily the same as differences in health?

What about aging, chronic disease and increasing medical costs in general?

3. Community data collectors were instrumental in getting the study done – extensive training and follow-up support essential.



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New study on deep green & healthy housing

June 20, 2011

Ellen M. Wells, Matt Berges,
Mandy Metcalf, Stuart Greenberg,
and Dorr G. Dearborn



New study on deep green & healthy housing

Ellen M. Wells¹, Matt Berges², Mandy Metcalf², Stuart Greenberg², Dorr G. Dearborn¹

1: Swetland Center for Environmental Health, CWRU School of Medicine; Cleveland, OH

2: Environmental Health Watch; Cleveland, OH

PRESENTATION OUTLINE

Background and purpose

Study design

Current status

Next steps & related projects



The Deep Green & Healthy Homes Study

PARTNERS

Environmental Health Watch (EHW), grantee

Swetland Center for Environmental Health, CWRU School of Medicine

Cleveland Housing Network (CHN)

Intwine Connect

Affordable Comfort, Inc.

FUNDERS

HUD Healthy & Green Technical Study

Cleveland Foundation



BACKGROUND AND PURPOSE



Home energy use reduction is needed

Energy use costs money

- Utility costs are increasing
- Median household incomes are declining

Residential energy use causes pollution

- ~ 1/4 of regional greenhouse gas emissions
- Local impact air pollutants

For more information, see:

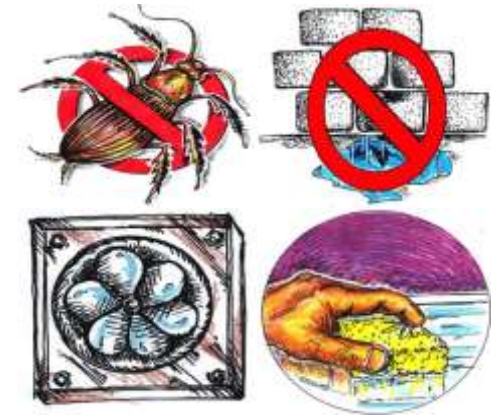
<http://www.ehw.org/climate-change/climate-housing/>



Healthy homes are also needed

A healthy home is ...

- Dry
- Well ventilated
- Clutter-free
- Free of pests
- Free of chemical hazards
- Safe



We can have energy reduction and health

We can have efficiency and health

“Build it tight, ventilate it right”

Historic emphasis either green or healthy

Current weatherization trend

“Avoiding Health Pitfalls of Home Energy-Efficiency Retrofits.”

February 2011, *EHP*; doi:10.1289/ehp.119-a76



STUDY DESIGN



Deep Green and Healthy Homes Goals

Compare two energy efficiency standards using

- Energy use
- Affordability
- Environmental quality
- Self-reported health, comfort

Pilot the use of new remote sensing technologies

- Continuous, real-time data on energy use and air quality



Overall design

12 homes renovated for energy efficiency

Leased to low or moderate-income families

- Lease-purchase program

Homes and occupants followed for one year

- Remote monitors providing continuous data
- Baseline and quarterly home visits



Energy Star vs Deep Energy Retrofit

All homes meet the guidelines for

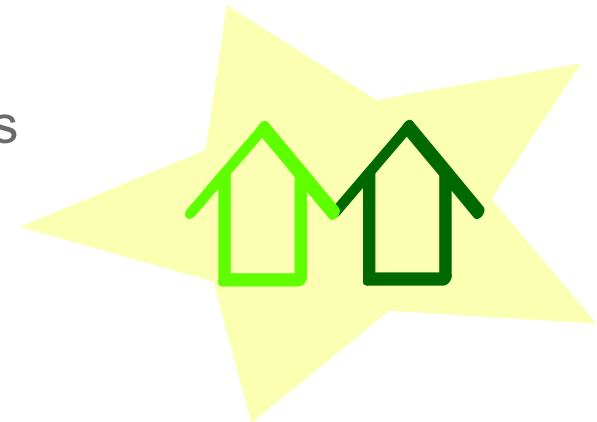
- Enterprise Green Communities
- Cleveland Green Standard

6 homes meet DOE's Energy Star guidelines

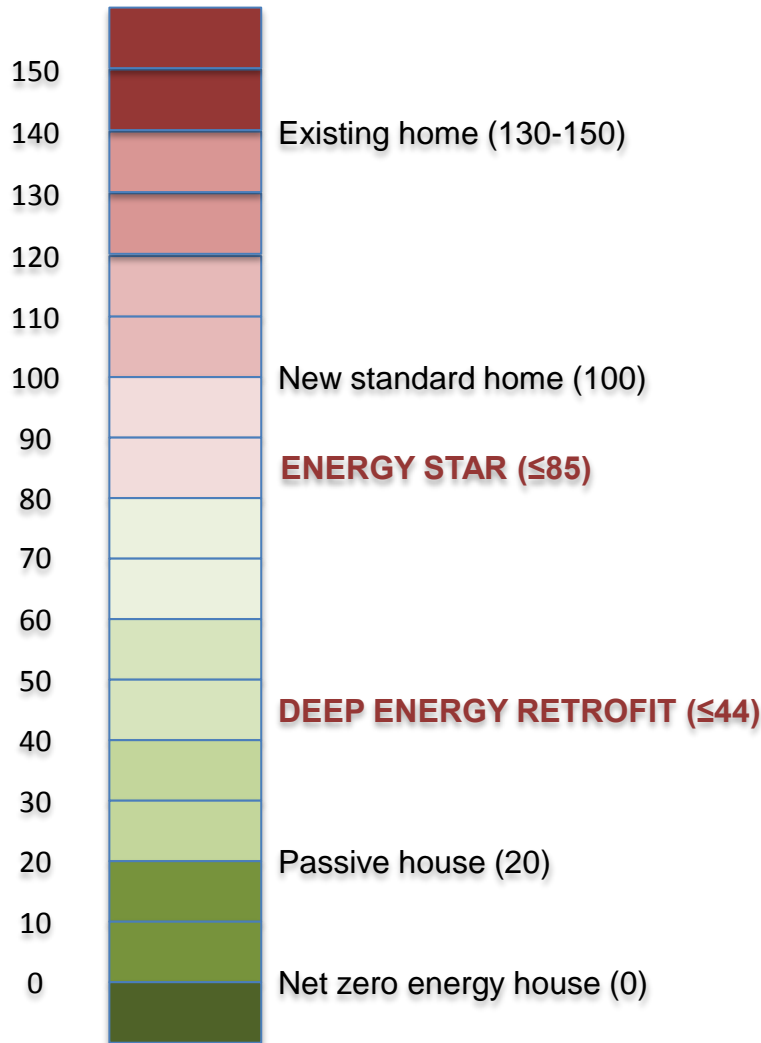
- ≤ 85 HERS Rating

6 homes meet EHW's Deep Energy Retrofit specs

- ≤ 44 HERS Rating



HERS Index



The HERS index is a scoring system established by the Residential Energy Services Network (RESNET).

Each 1-point reduction refers to a 1% reduction in energy cost compared to the reference home (100).

Energy Star

Based on US EPA/ US DOE's program

≤ 85 HERS rating

15% energy reduction

Typical features include efficient

- Home Envelope
- Air Distribution System
- Equipment
- Lighting
- Appliances



Matt Berges

For more information, see: <http://www.energystar.gov/>



Deep Energy Retrofits

≤ 44 HERS rating

Energy reduction

- 56% compared to new house
- 70-90% compared to before renovation

Super-insulation; air-tight

Controlled, balanced ventilation

High R-value windows and doors

Low-load heating system

Specific steps are home dependent



Matt Berges

Data collection

Costs

Energy use

Building performance

Dust sampling

Air quality

Visual housing assessment

Occupant questionnaire



Remote monitors

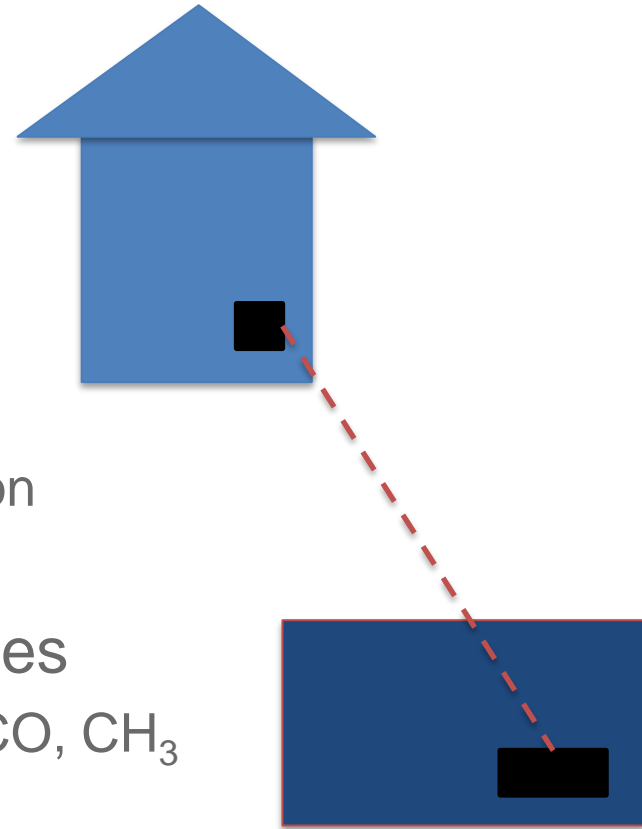
Commercially available sensors

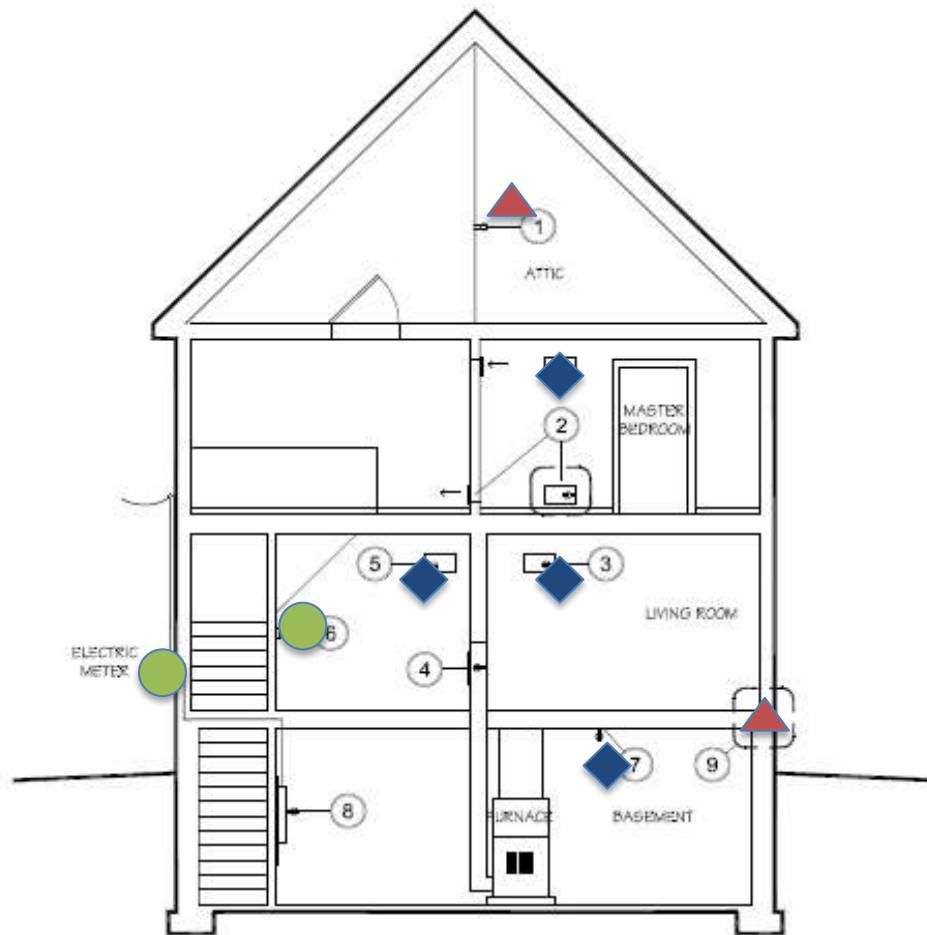
Non-commercially available platform

- Transmits data via wireless connection
- Data collected once/minute

Two platforms used throughout houses

- “Full”: Temp, RH, VOCs, NO_x, CO₂, CO, CH₃
- “Partial”: Temp, RH, CO₂,





◆ Full-sensor array

▲ Mini-sensor array

● Energy monitoring



Intwine Connect



CURRENT STATUS



Overview

3 year HUD grant; 1 year completed
Most housing renovations completed
Some homes occupied
Data collection started



Renovations



Matt Berges



Participation



Cade Martin/CDC Public Health Image Library (PHIL)



Environmental monitoring



EHW/Matt Berges



NEXT STEPS & RELATED PROJECTS



Next steps

Complete project

- Collect 12 months of data on all 12 houses

Prepare reports

- Energy use and costs between renovation types
- Air quality between renovation types
- Experiences with remote monitoring equipment

Promote more education on retrofit potential



CASE WESTERN RESERVE
UNIVERSITY EST. 1826
think beyond the possible™



Lessons learned

Education is important and ongoing

Changes in standards over time

Small details can make a big difference



Passive House Exhibit, July-September



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