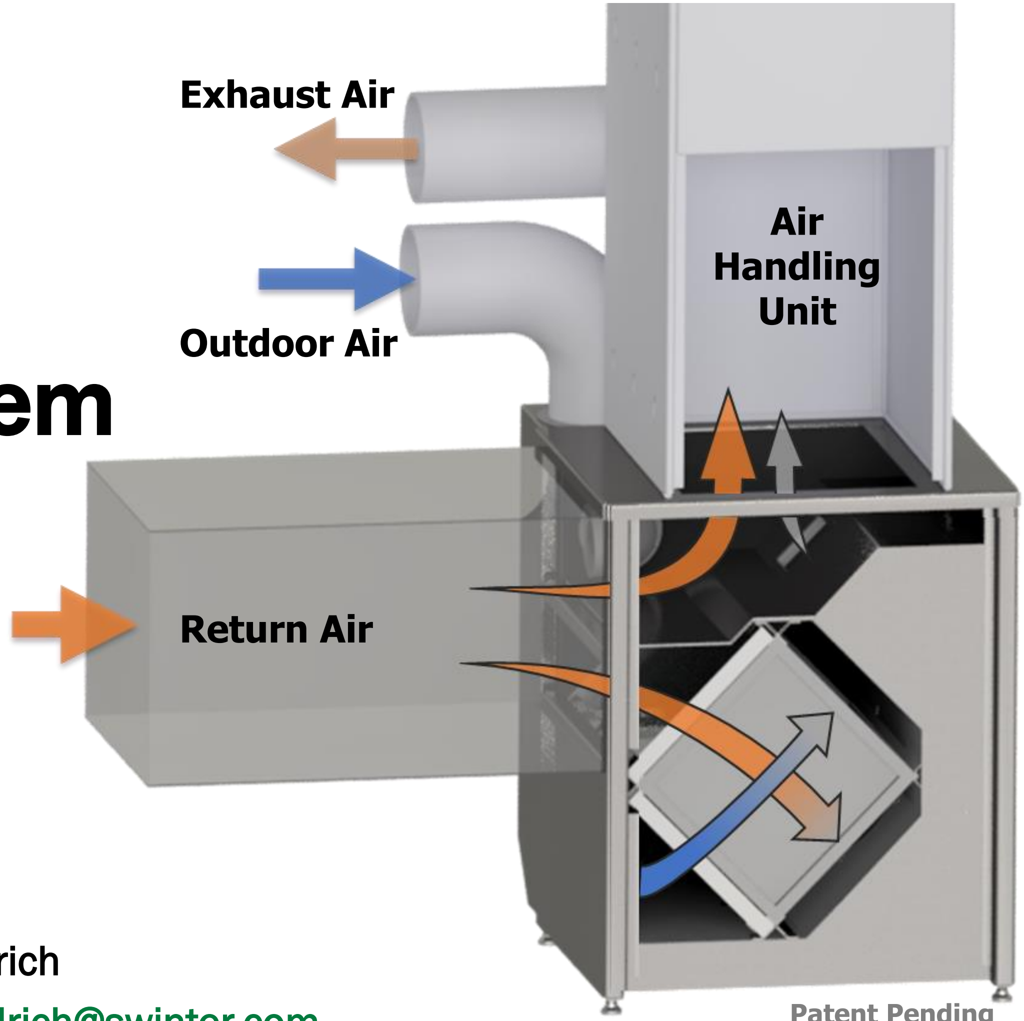
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Ventilation Integrated Comfort System (VICS)



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Project Summary

Timeline:

Start date: August 2016

Planned end date: July 2019

Key Milestones

1. Fully-functional Prototype Testing – Aug 2018
2. Second Prototype Complete – Nov 2018

Budget:

Total Project $ to Date:

- DOE: $729,993
- Cost Share: $210,346

Total Project $:

- DOE: $902,438
- Cost Share: $231,262

Key Partners:

Therma-Stor LLC
Mitsubishi Electric Trane US
CORE Energy Recovery Solutions

Project Outcome:

- Enable **heating, cooling,** and whole-building **ventilation** in one integrated system.
- Improve Indoor Air Quality (IAQ) – critical for air-tight homes.
- Achieve up to **10%** energy savings by reducing heating & cooling loads from ventilation;
- Reducing installed cost by 30% over separately ducted HRV/ERVs

Team

MITSUBISHI ELECTRIC
TRANE HVAC US

Therma-Stor®

core
ENERGY RECOVERY SOLUTIONS

Challenge

Per MYPP, Building America is solving challenges related to:

- "optimal comfort systems for low-load homes"
- "optimal ventilation systems and [IAQ] solutions for low-load homes"
- "solutions for homes with a high latent load (high moisture)"

BA Research to Market Plan, Ventilation Roadmap: "Heat recovery is not required or encouraged in ASHRAE Standard 62.2, and it is less commonly specified."

As homes get more efficient, ventilation is a bigger fraction of overall home energy.

40%-60% Savings Target - Up to 10% from H/ERVs

Balanced, distributed ventilation → better IAQ

Challenge

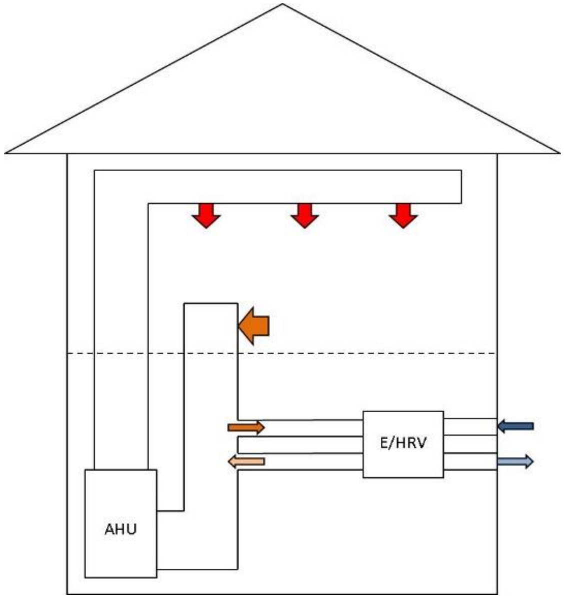
Why is heat recovery not standard?

#1 Reason: **COST**

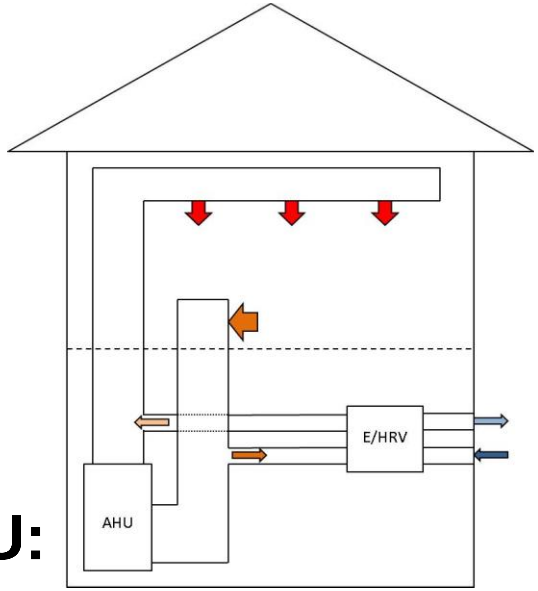
(median $2,000 - $3,000 installed)

Other reasons:

- Space constraints
- Maintenance
- Reliability
- Uncertain about energy benefits
- Wall penetrations
- Not required by codes/programs



Inconsistent flow when adding to AHU:



Approach

VICS strategy made possible by:

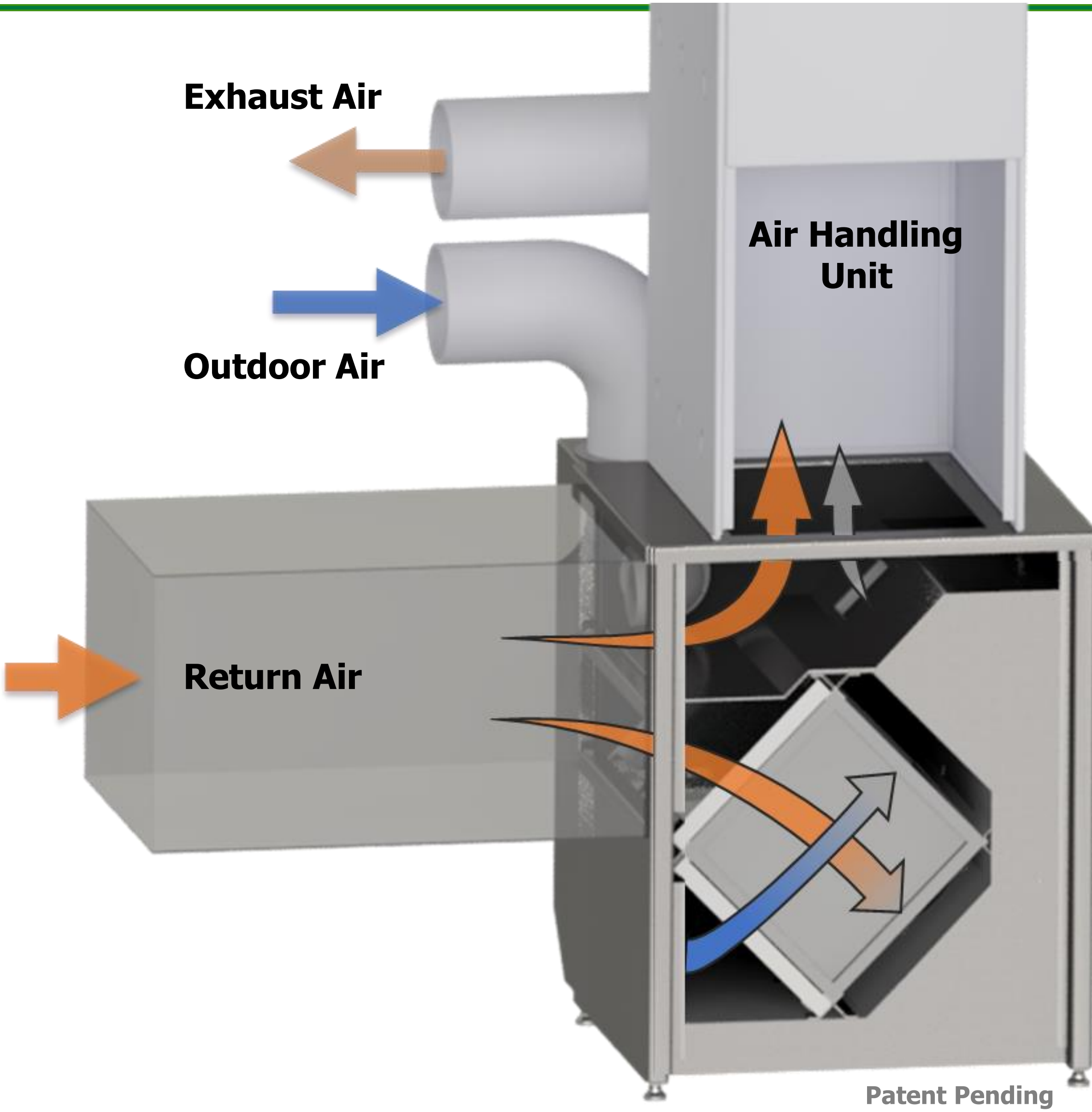
1. Lower heating/cooling loads in high-performance homes
2. Small, efficient H/C equipment

Manufacturers Develop Low-Load HVAC and Dehumidification Equipment (For whole-house comfort. Address design and installation issues)

H/C flow rates now more similar to ventilation flow rates.

3. Efficient, variable-speed fans
   - Smaller
   - Lower cost
   - Constant flow

Approach, cont'd



Impact

Energy savings example:

- VICS compared to 10-Watt exhaust fan
- 65 cfm continuously
- Home heated/cooled with efficient ASHP

	Annual Savings
Chicago	950 kWh
DC	600 kWh
Orlando	70 kWh

Up to 10% savings towards BA's 40-60% goals.

Impact

Balanced, distributed, filtered ventilation supports Building America IAQ goals

Lower installed cost: $1,500 - $2,000

(current median ~$2,000 - $3,000)

From Census & AHRI data (2017):

120,000 ducted HP in new homes <22 kBtu/h

Growing!

Progress

80% complete - on budget, on schedule
Ending July 2019

- ✓ Market & Stakeholder Assessment

- ✓ Prototype #1 Design
- ✓ Prototype #1 Benchtop Testing
- ✓ Prototype #1 Full testing (with heat pump)

- ✓ Prototype #2 Design
- ✓ Prototype #2 Construction & Testing

- ✓ Cost & "Manufacturability" Assessment

Progress - Performance Overview

ERV matched CORE spec's

- 70% Sensible eff. @ 120 cfm
- 50% Total eff. @ 120 cfm
- Both ~10% higher at 60 cfm

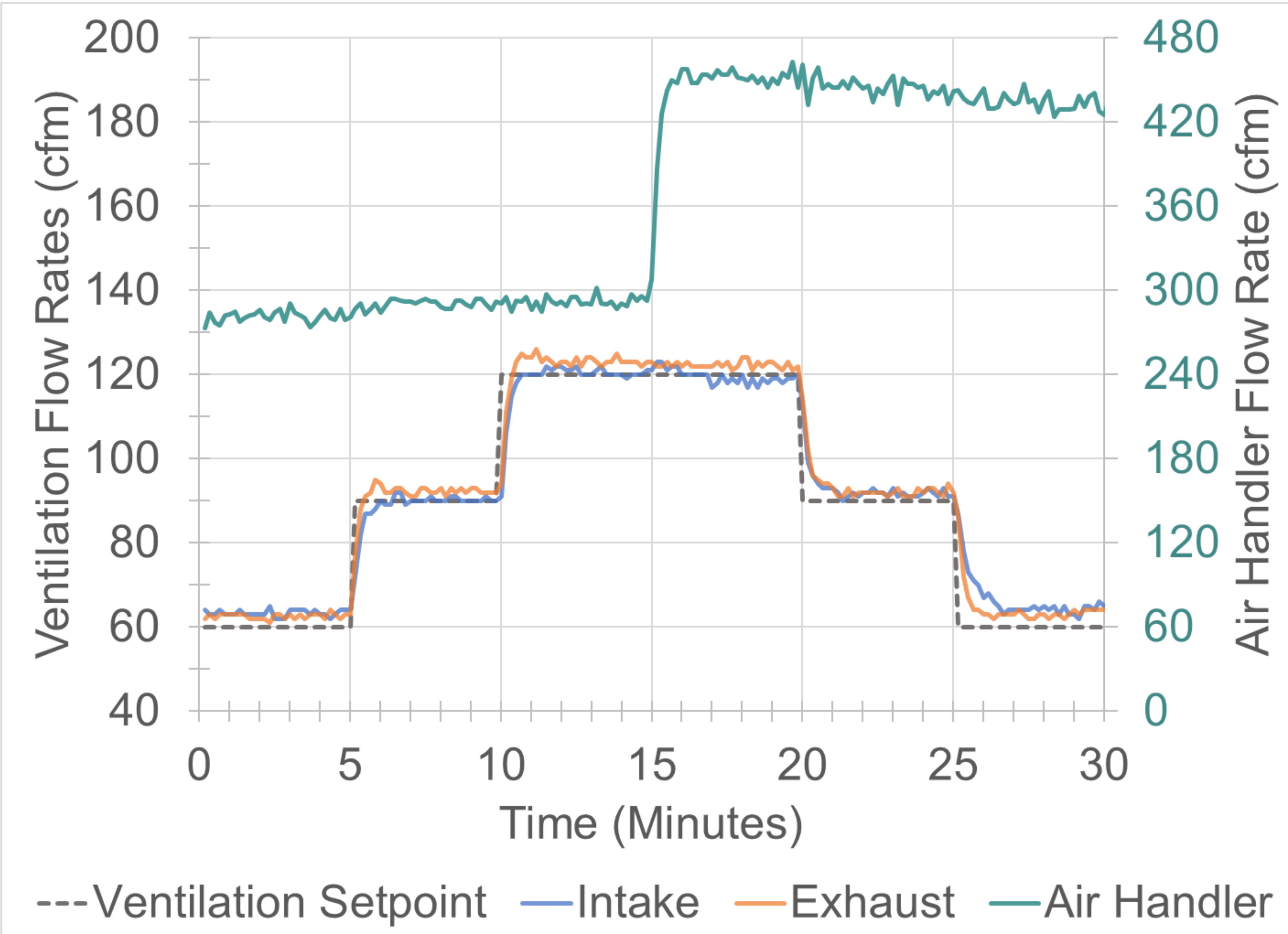
Power

- 50-120 cfm using 40-80 Watts including AHU

Flow Control

- Independent control of outdoor air and exhaust
- Maintains ventilation rates regardless of h/c operation
- Maintains flow rates during frost prevention

Flow Control



Stakeholder Engagement

Worked with partners throughout design & testing:

MITSUBISHI ELECTRIC
TRANE HVAC US

Therma-Stor®

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Distributing information and a survey:

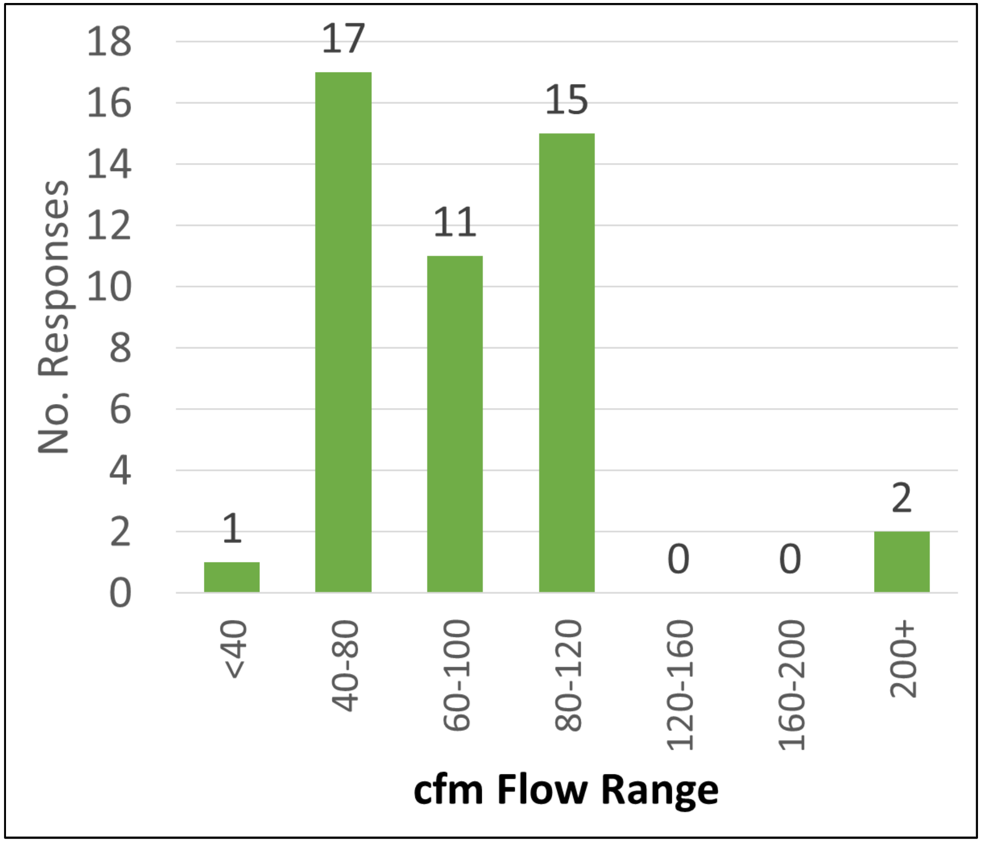
- SWA press release, blog article, contacts, and clients
- NYSERDA affiliates and contractors
- Green Building Advisor
- Energy Design Update
- EEBA Newsletter
- BTO Peer Review Poster
- Builder Magazine (pursuing)

Stakeholder Engagement

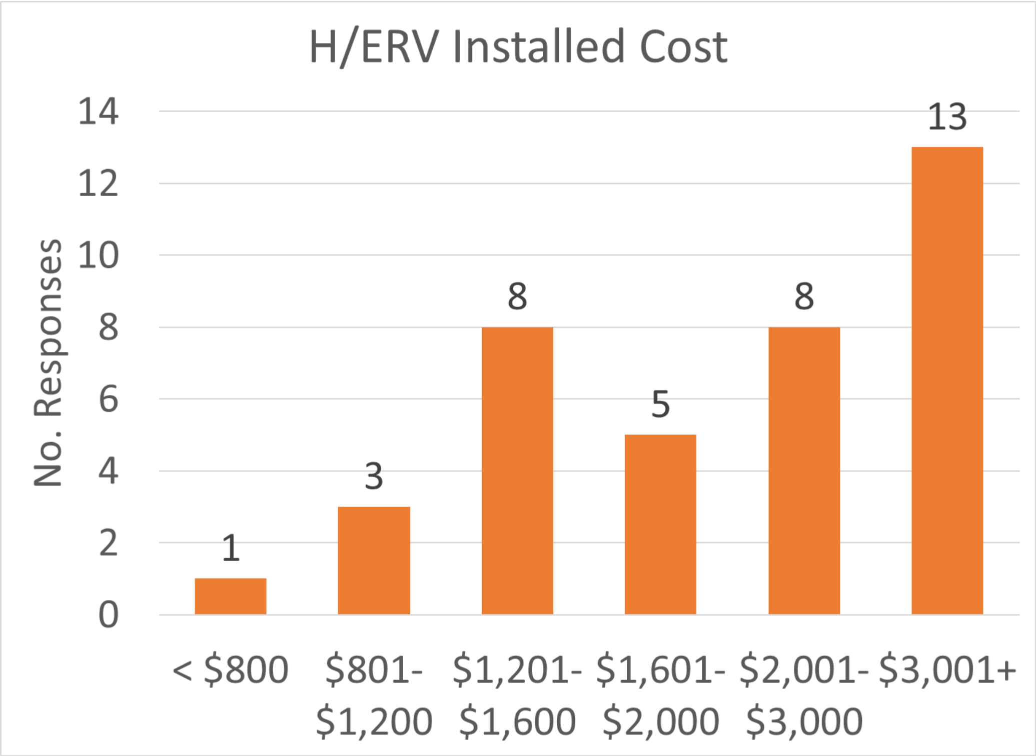
Market Feedback:

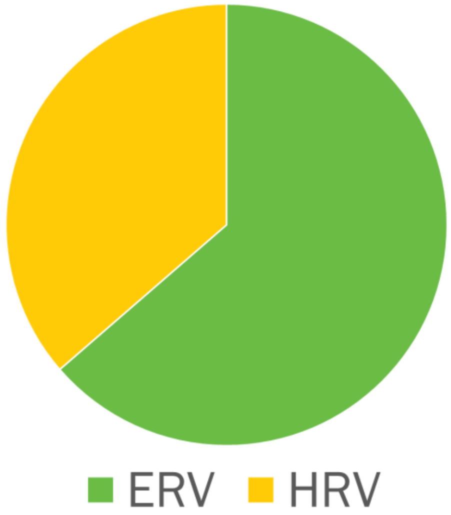
- **Initial interviews with builders & developers**
- **Current survey:**
  - builders
  - developers
  - contractors
  - designers
  - other stakeholders

What range of whole-building ventilation capacity do you most often specify or install?



Stakeholder Engagement





Other Survey Topics:

- Local Exhaust
- Filtration
- Geography
- Building type, volume
- VICS features
- Control features
- Home certifications

Remaining Project Work

Initial Plans: Build, install, and evaluate prototype in home

Revised Plans:

- **Fully functional prototype(II) in office**
- **Market Assessment & Survey**
- **Work with Therma-Stor (manufacturing partner)**
  - Tune frost prevention (test chambers)
  - Fan selection(s)
  - Core size
  - Control capabilities
  - Assessing product ratings & certifications
  - Price point

FY2018 award: Working with Therma-Stor to develop integrated heating, cooling, and dehumidification.

Thank You

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REFERENCE SLIDES

Project Budget

Project Budget: 3-year project divided into two 18-month Budget Periods. Total budget $1,133,700 including cost share.

Variances: No variation in budget, but late stage tasks shifted to work more closely with Therma-Stor on commercialization challenges.

Cost to Date: $940,339 - 83% of total project cost. Cost Share contribution to date is 22%.

Additional Funding: None.

Budget History					
FY 2017 – FY 2018 (past)		FY 2019 (current)		FY 2020 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$614,246	$191,119	$288,192	$40,143	NA	NA

Project Plan and Schedule – BP1

Project Schedule		
Project Start: 8/1/2016		Completed Work
Projected End: 7/31/2019		Active Task (in progress work)
		Milestone/Deliverable (Originally Planned)
		Milestone/Deliverable (Actual)

Task	Q1 (Aug-Oct 2016)	Q2 (Nov 2016-Jan 2017)	Q3 (Feb-Apr 2017)	Q4 (May-Jul 2017)	Q5 (Aug-Oct 2017)	Q6 (Nov 2017-Jan 2018)	Q7 (Feb-Apr 2018)	Q8 (May-Jul 2018)	Q9 (Aug-Oct 2018)	Q10 (Nov 2018-Jan 2019)	Q11 (Feb-Apr 2019)	Q12 (May-Jul 2019)
Past Work												
Q1 Milestone: Project Management Plan												
Q1 Milestone: Test Plan												
Q2 Milestone: Market Assessment												
Q3 Milestone: Design Specifications												
Q4 Milestone: Alpha Prototype - Interior Components												
Q5 Milestone: Sensor/Control Strategies												
Q5 Milestone: Prototype Benchtop Testing												
Q6 Milestone: Go/No-Go Decision for Successful Indoor Components of Prototype												
Q7 Milestone: Alpha Protytpe Completion (Interior Components)												

Project Plan and Schedule – BP2

Project Schedule		
Project Start: 8/1/2016		Completed Work
Projected End: 7/31/2019		Active Task (in progress work)
		Milestone/Deliverable (Originally Planned)
		Milestone/Deliverable (Actual)

Task	Q1 (Aug-Oct 2016)	Q2 (Nov 2016-Jan 2017)	Q3 (Feb-Apr 2017)	Q4 (May-Jul 2017)	Q5 (Aug-Oct 2017)	Q6 (Nov 2017-Jan 2018)	Q7 (Feb-Apr 2018)	Q8 (May-Jul 2018)	Q9 (Aug-Oct 2018)	Q10 (Nov 2018-Jan 2019)	Q11 (Feb-Apr 2019)	Q12 (May-Jul 2019)
Q7 Milestone: Alpha Protytpe Completion (Operational with Outdoor Components)												
Q9 Milestone: Alpha Prototype Performance Evaluation												
Q9 Milestone: Cost and Manufacturability Opportunities												
Q10 Milestone: Completion of Beta Prototype												
Current/Future Work												
Q12 Milestone: Testing in Office/Lab and Environmental Chamber - Draft Technical Report												