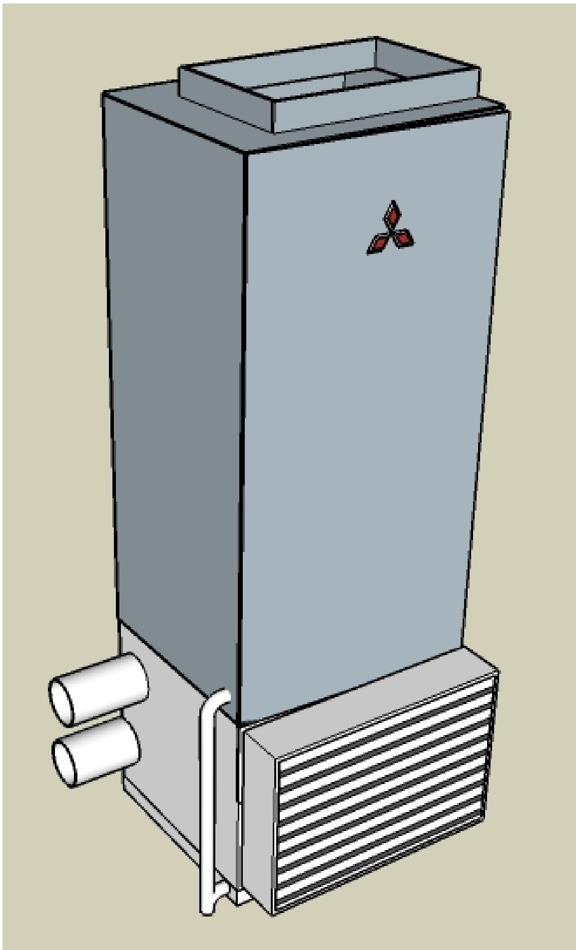
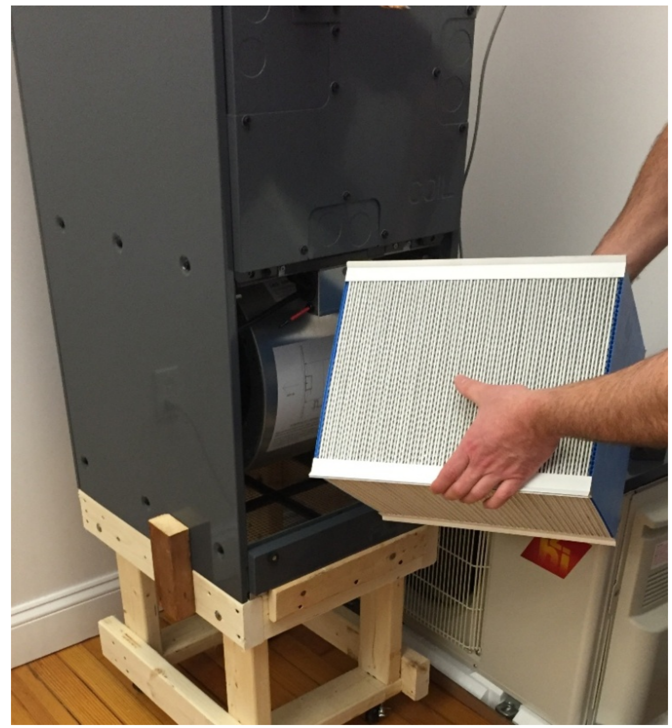
Ventilation Integrated Comfort System (VICS)

2017 Building Technologies Office Peer Review



Integrating energy recovery ventilation with efficient heating and cooling.



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Project Summary

Timeline:

Start date: August 2016
Planned end date: July 2019

Key Milestones

1. Completion of fully functional prototype for testing in unoccupied space
   Jan. 2018 (GO/NO-GO)
2. Installation of prototype in occupied home
   Aug. 2018

Budget:

Total Project $ to Date (1/31/17):

- DOE: $107,569
- Cost Share: $35,327

Total Project $:

- DOE: $902,438
- Cost Share: $231,246

Key Partners:

Mitsubishi Electric	Several builders & developers of high-performance homes.
dPoint Technologies	

Project Outcome:

- Enable **heating, cooling,** and whole-building **ventilation** in a single system.
- Address **IAQ concerns** in air-tight homes achieving 40%-60% savings
- Help achieve the 40%-60% savings by reducing thermal **ventilation loads**
- Reducing **cost** by 30-50% over separate HRV/ERVs

Purpose and Objectives

Problem Statement: (MYPP) BA 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)"

Demonstrate & integrate energy efficient technologies & practices in representative homes → Competitive R&D funding focused on demo, testing & validation by Building America & national lab researchers in field homes → Space conditioning, water heating & IAQ Building America upgrade packages & techniques for existing & new homes across climates

Balanced, heat recovery ventilation is becoming a more obvious choice in very tight, efficient homes. It remains very expensive and can be challenging to integrate effectively.

How can we efficiently, practically, and affordably combine heating, cooling, and whole-building ventilation?

Target Market and Audience:

- Homes with design loads < 10-12 kBtu/h (multiple systems for higher loads)
- Thousands of SF homes (ZERH, Passive House, etc.) and growing
- MOST new MF apartments, ~350,000 starts in 2016 (FreddieMac)

Purpose and Objectives (cont'd)

Impact of Project:

Final Product: Fully functional prototype evaluated in occupied home

- Projected energy savings compared to exhaust only (65 CFM)
  - ~**500 kWh/y** in DC, ~**1,000 kWh/y** in Chicago (efficient heat pump)
  - **0-10%** reductions towards **40-60%** goals, but addresses **IAQ** & moisture concerns.
- Cost of adding heat/energy recovery ventilation ***30-50% less*** than with a separate, ducted HRV/ERV.
- Improved IAQ (balanced, filtered, distributed OA), improved heat pump efficiency and better humidity control.

After the Project:

Last Year of Project	1-2 years after project	3-5 years after project
• Agreement with manufacturer(s)	• Pre-production prototypes, testing & certification (UL, AHRI, HVI, etc.)	• Manufacture and distribution, 5–10k/y

Approach

New homes that achieve 60% energy savings have:

- Greater need for balanced, distributed ventilation
- Very small design H/C loads
  - ➢ They need much smaller H/C systems
- In general, H/C manufacturers have not responded to this demand
- Exception: efficient, variable-speed ASHPs
- New Mitsubishi product: 1-ton, full static AHU.

Opportunity: With smaller heating/cooling equipment, air flow rates needed for H/C are *closer* to those needed for whole-building ventilation.

Key Issues: Many current H/ERV installations have poor integration, inconsistent controls, questionable delivery of outdoor air, and/or have high energy use. And they are *expensive*.

Distinctive Characteristics: Integrated system. One duct system, little extra space, smart controls, lower cost.

Progress and Accomplishments

Accomplishments: Active 6 months. On or ahead of schedule.

- Market Assessment Milestone (November 2016)
- Prototype Design/Performance Specification Milestone (February 2017)
- Construction of first prototype under way.

Market Impact: Interviewed eight east-coast builders/developers (built hundreds of efficient homes in 2016).

Have you used ERVs/HRVs?

- Not standard for any, but most had some experience
- "**Nightmare**" used by three builders
- Most suspect codes/programs will require in the future

Half of the builders were <u>very</u> interested in VICS concept. "When can we try one?"

Appeal: <u>Integrated</u> system, low capacity, lower cost, better humidity control.

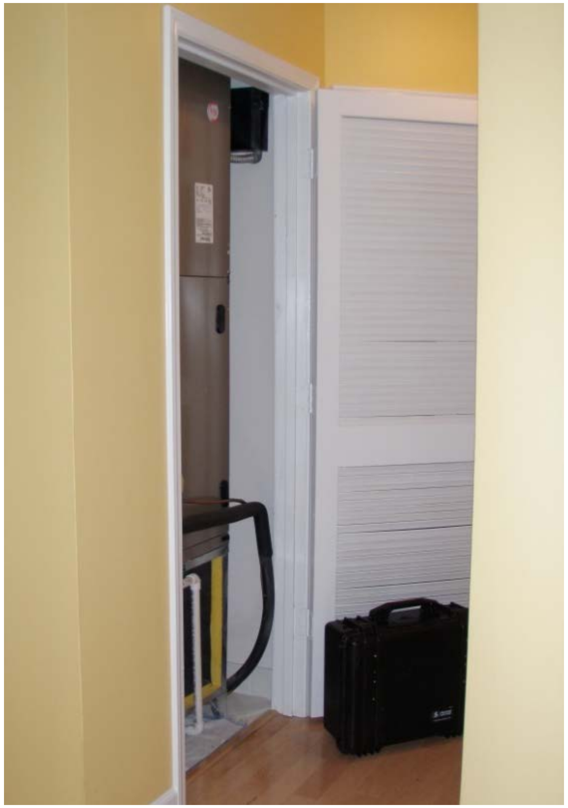
Builder/Developer Interviews

What barriers/challenges prevent you from using balanced, heat recovery ventilation?

- **COST**. Uniformly largest barrier. ~$3,000/home installed.

Other barriers/challenges:

- No/questionable energy benefits
- Space constraints
- Wall penetrations
- Maintenance
- Reliability
- Not required by codes/programs



Lessons Learned: Size is a critical design factor. More challenging to achieve pressure/flow characteristics in a small package.

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Project Integration and Collaboration

Project Integration: R&D - close communication with manufacturing partners. Weekly (at least) communication with Mitsubishi engineers.

Partners, Subcontractors, and Collaborators:

- **Mitsubishi** – extremely interested, supportive, and responsive. Provided equipment, controls support, design/integration advice, etc.
- **dPoint** – visited our office, support re. configuration, flow, pressure dynamics, etc.
- **Builders/developers** – interviews, some eager to try a prototype

Communications: Limited outreach; still in R&D. Several inquiries based only on DOE press release alone. "When can we get one?" Significant interest. Working on provisional patent in parallel.

Next Steps and Future Plans

Next Steps and Future Plans:

- Construction of first prototype under way. Benchtop testing Spring-Summer 2017.

- **GO/NO-GO** decision before installation of second prototype in unoccupied building during Winter 2017-18.

- Installation and testing of third prototype in occupied home mid 2018.

Beyond Current DOE Project

- Currently working on provisional patent.
- With initial prototype results, talk with manufacturers late 2017-2018.
- Explore integration with wider range of heating/cooling equipment.

REFERENCE SLIDES

Project Budget

Project Budget: 3-year project divided into two 18-month Budget Periods , BP1 August 1, 2016 – January 31, 2018.

Variances: No significant variances to date. Supply costs are higher than initially proposed, but less than $5,000 variance.

Cost to Date: 26% of the Total Approved BP1 budget of $542,651. Cost Share contribution to date is 24.7%.

Additional Funding: None

Budget History					
Aug. 1, 2016 – FY 2016 (past)		FY 2017 (current)		FY 2018 – July 31, 2019 (FY 2019) (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$11,960	$6,702	$698,757	$175,000	$191,721	$49,544

Project Plan and Schedule – Budget Period 1

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												
Current/Future Work												
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 (Operational with Outdoor Components)												

Project Plan and Schedule – Budget Period 2

Project Schedule		
Project Start: 8/1/2016	(blue)	Completed Work
Projected End: 7/31/2019	(dark blue)	Active Task (in progress work)
	◆ (red)	Milestone/Deliverable (Originally Planned)
	◆ (black)	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)
Current/Future Work												
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								■	■	■ ◆		
Q12 Milestone: Demonstration in Occupied Home Draft Technical Report									■	■	■	■ ◆
Q12 Milestone: Demonstration in Occupied Home Final Technical Report									■	■	■	■ ◆

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