Smart Ventilation - RIVEC

2014 Building Technologies Office Peer Review

Inputs

Secondary Ventilation Activity

- Required air flows
- Weather
- DR / price signal
- Occupancy / schedule
- Outdoor air quality

Residential Integrated VEntilation Control System

Outputs

Control Ventilation to Ensure Acceptable Indoor Air Quality

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

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Project Summary

Timeline:

Start date: 2011

Planned end date: 2016

Key Milestones

1. Performance Simulation; 2013
2. Licensing agreement; 2014
3. Add more sophisticated controls; 2015

Budget:

Total DOE $ to date: $680k

Total future DOE $: $320k

Target Market/Audience:

All residential buildings

HVAC & controls equipment manufacturers, distributors and installers

Key Partners:

California Energy Commission	TempoAir/Air King
Davis Energy Group	BC Institute of Technology
XEROX - PARC	AprilAire

Project Goal:

Minimize the energy required to provide acceptable indoor air quality

Purpose and Objectives

Problem Statement: The energy used to condition air required for acceptable indoor air quality is a barrier to lowering energy use in homes – particularly for net-zero ready new construction. There is a limited number of energy end-uses in homes that can be demand responsive and smart ventilation allows ventilation to be a good source of DR savings.

Target Market and Audience: The target market is all residential buildings with a focus on energy efficient homes. The audience is comprised of HVAC & controls equipment manufacturers, distributors and installers as well as utility programs. Ventilation and energy codes and standards need to be changed to account for smart ventilation.

Planned Contribution to Energy Efficiency:
Smart ventilation systems that save 40% or more of ventilation related energy use (600 kWh/yr/home) and enable up to 2 kW of peak demand savings. National potential savings is 1.1 Quads.
Near-term (1 yr) smart ventilation will be used in roughly 10,000 installations
Partner projections: U.S. market 500,000 to 750,000 units annually plus Middle East 150,000 to 225,000 units annually

Approach

Approach: A combination of field demonstrations and sophisticated simulations used to establish potential performance. Active participation with codes and standards bodies to allow/credit smart ventilation. Collaboration with controls/equipment manufacturing industries to find a licensing partner to manufacture, distribute and install smart ventilation systems.

Key Issues: Current activities include: adding control capabilities (outdoor temperature reset, occupancy sensing) and pursuing additional licensing and sub-licensing agreements to broaden industry base.

Distinctive Characteristics: First step towards being smarter about home energy use – using monitoring of other equipment in the home, using equivalent ventilation principle to allow time shifting of ventilation and resulting energy savings.

Approach

RIVEC Principles

Maintain equivalent IAQ to ASHRAE 62.2

- Relative dose (24 hour integrated exposure) and exposure (instantaneous)

Account for operation of other fans: bath, kitchen, dryer

Time shift to more favorable times

Account for unoccupied times

Limit peak exposure

Include infiltration

RIVEC Operation

OFF if other fan flows are sufficient to meet air flow requirements
OFF if house unoccupied
OFF at peak times

ON at higher rate
ON if peak exposure too high
ON to maintain same relative dose and exposure as continuous 62.2 fan

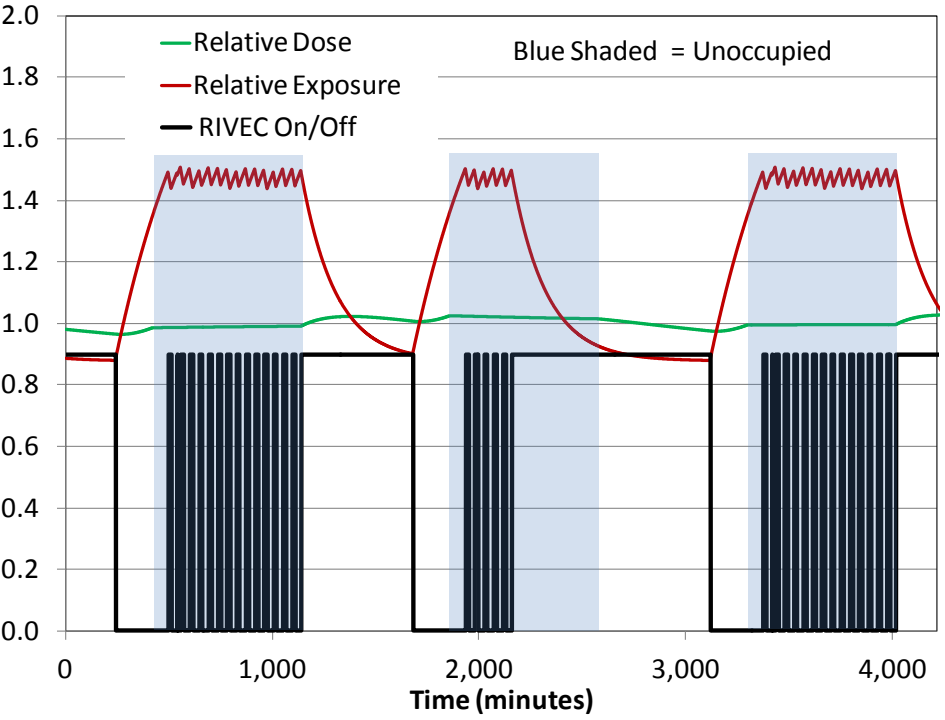
Fan sized greater than 62.2 minimum (approx 25%)

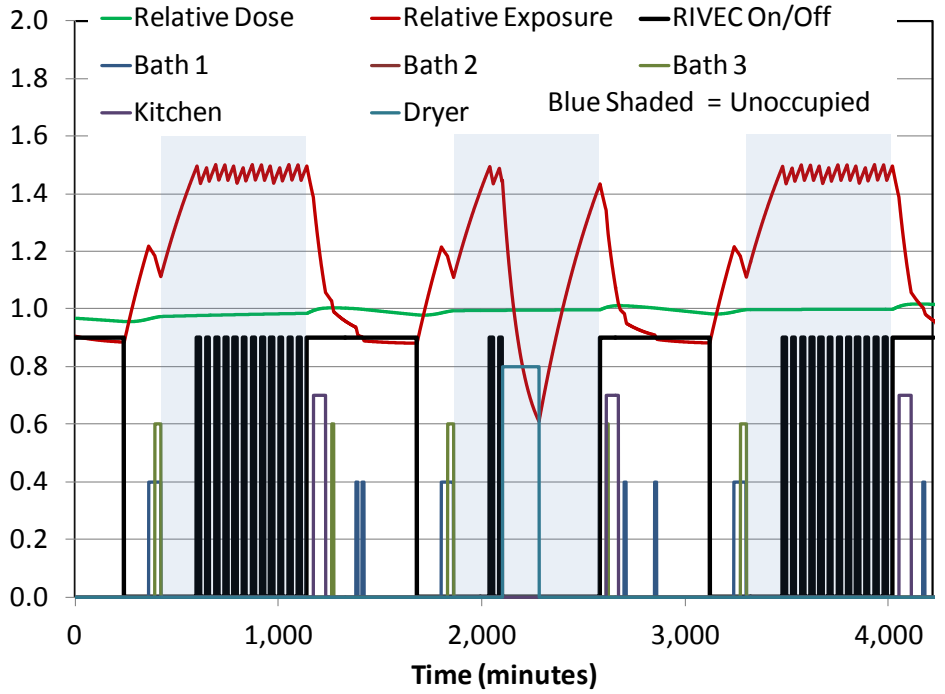
Approach

RIVEC fan turns on and off to maintain Relative Dose and Exposure

Exposure allowed to be higher when unoccupied

RIVEC fan responds to operation of other fans





Progress and Accomplishments

Discoveries: Greater potential energy savings than anticipated. The importance of DR responsiveness as utilities prepare for greater grid flexibility with increasing renewables. Proof of concept in six homes.

Accomplishments: Demonstrated potential 40% energy savings. Demonstrated control strategies for occupancy response while limiting potential for acute pollutant exposure. Licensing agreement with TempoAir/AirKing to manufacture, distribute and install first 10,000 units. Patent application.

Project Contribution to Energy Efficiency : Industry partner has advance orders for 10,000 units. Principle behind the controls (equivalent ventilation) has been adopted by the leading industry IAQ standard ASHRAE 62.2. Planned changes to energy codes and standards and advanced home performance programs (e.g., HERS, DOE Challenge Home) to allow/credit smart ventilation. Results match planned Purpose and Objectives.

Awards/Recognition: Used in Honda Smart Home in Davis, CA. UC Berkeley Cleantech-to-Market program.

Project Integration and Collaboration

Project Integration:

- Building America Teams to field test outdoor temperature reset.
- California Energy Commission (CEC) funded initial development & considering changes to state energy code to credit smart ventilation.
- ASHRAE Standard 62.2 service to ensure smart ventilation acceptability.
- Licensing agreement with TempoAir/AirKing to manufacture, distribute and install systems. NDA's with Panasonic, BCIT, AprilAire, BCIT, DEG for further study and potential sub-licensing.

Partners, Subcontractors, and Collaborators:

- TempoAir/AirKing – licensee
- CEC funding through Energy Innovations Small Grant.
- PNNL, Washington State University Energy Program and PARR Building America team field testing temperature control.

Communications: UC-Berkeley Cleantech to Market, Building America Technical Updates, Dry Climate Home Performance Conference,

Next Steps and Future Plans

Next Steps and Future Plans:

1. Continue collaboration with licensee for sub-licenses for more applications, e.g., integration into existing HRV, economizer or furnace controls
2. Develop additional control capabilities, e.g., response to utility DR signals, time shift to avoid high outdoor humidity, outdoor air pollution
3. Work with exhaust fan and appliance manufacturers to integrate their operation into a controls network to enable easier/cheaper smart ventilation
4. Continue to push codes and standards to recognize smart ventilation as a method to provide acceptable IAQ and to credit for reduced energy use. Extend to HERS, Passive House, DOE challenge Home, EnergyStar homes, utility programs, etc.
5. BTO work on energy and IAQ codes and standards, appliance standards, emerging technologies, can all support the adoption and development of smart ventilation

REFERENCE SLIDES

Project Budget

Project Budget: Total proposed budget $1m.
Variances: None.
Cost to Date: $680k.
Additional Funding: CEC EISG grant $95k. CEC RESAVE Project $200k. Non-Recurring Engineering for licensees $100k.

Budget History					
FY 2008– FY2013		FY2014 (current)		FY2015 – FY2016 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$600k	CEC $295k	$100k	$100	$320k	

Project Plan and Schedule