US Ventilation Systems

Status & Commissioning

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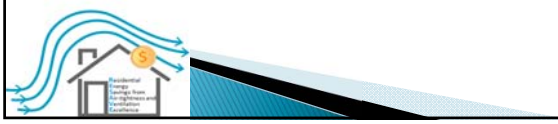
Overview

- What is the status of the quality of ventilation systems in homes in the US?
  - Quick snapshot
- How can we optimize residential ventilation rates to for both health and energy?
  - Example of proposed method
- Air flow Measurement Tools

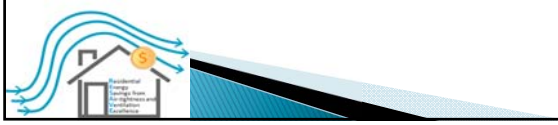
Residential Systems

- No ventilation tradition in the US
  - Very few houses have mechanical dilution systems
  - Kitchen and bath extract is common
- Mandated in few *new* homes
  - California, Maine and a few other states
  - High performance programs (e.g. Energy Star)
- Some *retrofit* programs require ventilation
  - DOE Weatherization guidelines
  - Home Performance with Energy Star



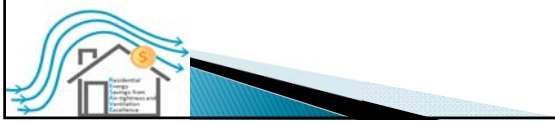
Market & Products

- Low market penetration
  - <5% of stock; <20% of new construction
- ASHRAE Standard 62.2 is standard of care
  - Not a regulation; a standard (norm)
  - Counties (sometimes states) may make it a code
- Home Ventilating Institute rates equipment
  - Trade group: http://www.hvi.org
  - Method of tests for rating
  - 62.2 refers to these ratings



Process

- DESIGN: 62.2 or other requirements specify
- INSTALLATION: Voluntary guidance/labeling
- COMMISSIONING: Mostly on paper
  - 62.2 requires some flow measurement
- INSPECTION: Checklist
- OPERATIONS: Up to user
- MAINTENANCE: Poor
  - Up to user and little guidance; no requirement



Energy Calculation Impacts

- No single energy calculation method, but many assume very leaky if no system
  - California “Title 24”
  - DOE Home Energy Score http://hes.lbl.gov
  - RESNET “HERS” Rating is most widely used
- Energy performance is assumed
  - Based on design only
- IAQ performance is assumed
  - No health impacts

Status Quo Not Acceptable

- Let's look into how to justify better in-situ performance

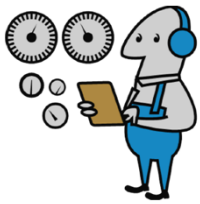
Value of Commissioning

- California-funded, but applicable
  - Find a "level playing field"
- Find "total" energy cost of ventilation
  - E.g. include peak power issues
- Find health "cost" of ventilation
  - Exposure->DALY->money
- Optimize

BACKGROUND

- Questions:
  - Do ventilation systems perform as intended?
  - Is Cx worth doing?
  - Do we have necessary tools for Cx?

- Work Scope:
  - Review available related literature
  - Simulate energy & IAQ impacts of Cx
  - Assess Cx-related tools in lab & field



Cx LITERATURE REVIEW

- Locate/review 295 documents from past 11 yrs
- Focus on mechanical ventilation airflows
- Sources: ACCA, ACEEE, AHRI, AIVC, ASHRAE, ASTM, BPI, BSRIA, CEC, CEN, CGSB, CMHC, CSA, HVI, IEA, NEN, RESNET, textbooks, reports, web
- No ANSI-accredited standards for measuring airflows or for calibrating related equipment

BENEFITS + COSTS OF Cx

- Focus on two ventilation system types
  - Whole-house exhaust only
  - Heat recovery ventilator (HRV)
- Assess impacts of eight system malfunctions
  - Energy (using TDVs)
  - Health (formaldehyde & acrolein using DALYs)
- Use computer modeling approach
  - LBNL's REGCAP + one-zone pollutant mass balance
  - Three each: climates, building sizes, emission rates
- Ventilation rate optimization also addressed

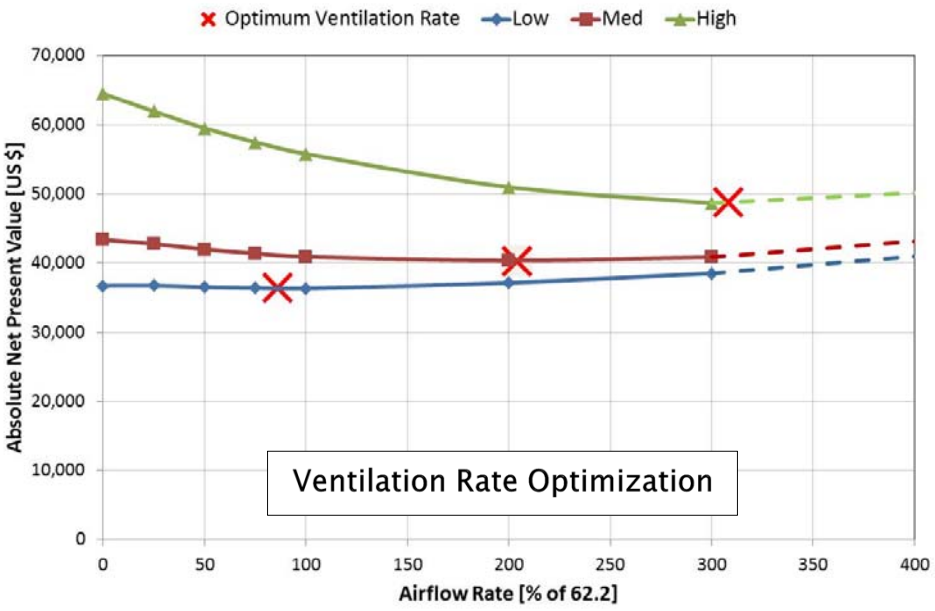
California Data

- Emission Rates
  - Taken from field study of new CA homes
  - 3 different levels
- Ventilation Rates
  - 100% Title 24/62.2 as base case
- Energy Costs
  - CA uses "Time Dependent Value"

BENEFITS OF AIRFLOW

NET BENEFITS OF AIRFLOW

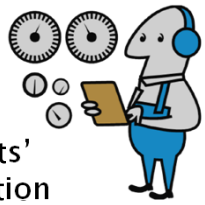
TOTAL COSTS: Energy+Health



BENEFITS + COSTS OF Cx

- Health benefits dominate
- Providing 62.2 minimum airflows insufficient metric for whole-house ventilation system Cx (due to strong emission rate dependence)
- Metric should be net present value of combined energy and IAQ benefits
- Cx cost decisions should be relative to this NPV even if 62.2 minimum flows exceeded

Cx TOOL ASSESSMENTS



- Context
  - Flows must be measured so that occupants' health not compromised by under ventilation
- Method
  - Six commercially-available flow measuring devices evaluated against reference flows in **lab** conditions
  - Addressed variables such as flow asymmetry, flow angle, and flow direction (but not insertion loss)

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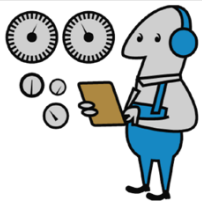

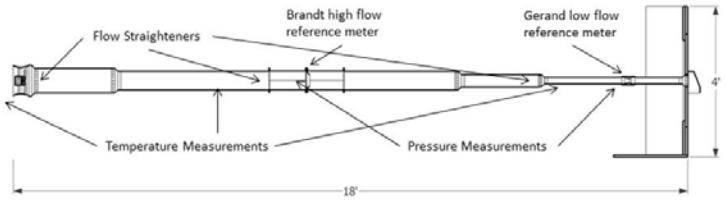

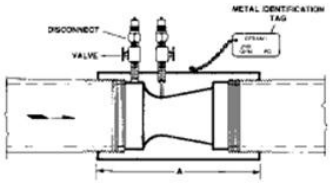

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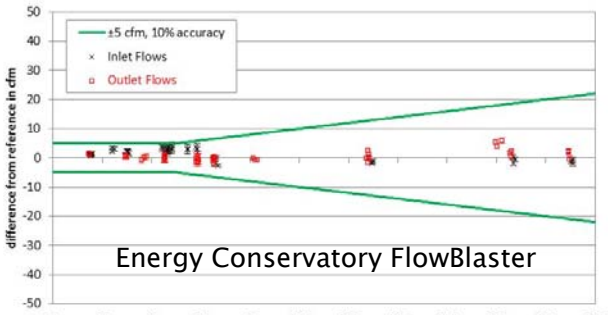
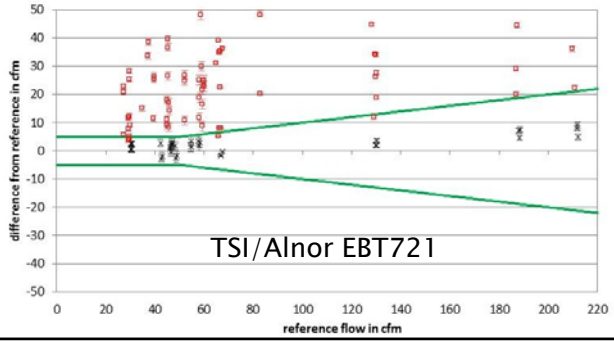
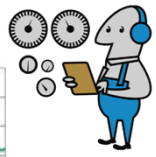


Energy Conservatory FlowBlaster



TSI/Alnor EBT721



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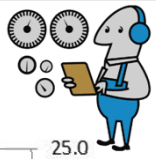

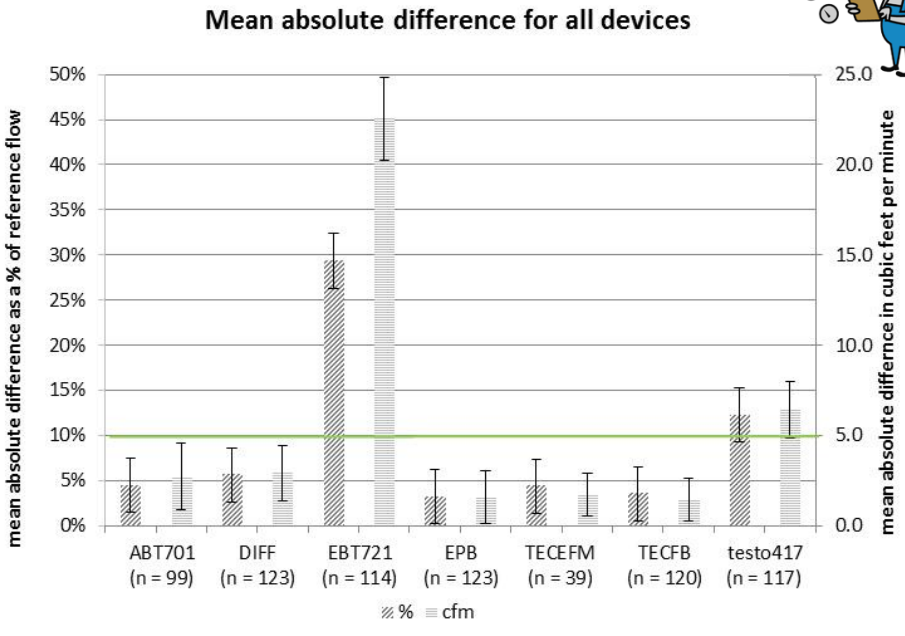

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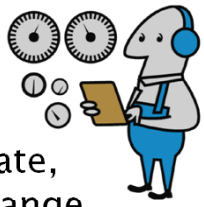

- Powered hoods generally more accurate, applicable to broader measurement range
- Most devices measured inlet flows more accurately than outlet flows
- Little resemblance between accuracy stated by manufacturers' and what we found in our lab (several cases)
- Calibration standard that addresses real world conditions should be developed

THANK YOU