DCV and Conditioned Energy Recovery

-Active Fresh Air Control for Passive Living-

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Demand Control Ventilation (DCV)

- What is it?
- Why do we need it in our homes?

- Introduction to the CERV™; a residential DCV fresh air conditioning system by Build Equinox/Newell Instruments

Active Control for Passive Living

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DCV FRESH AIR Conditioning

What is the CERV™?

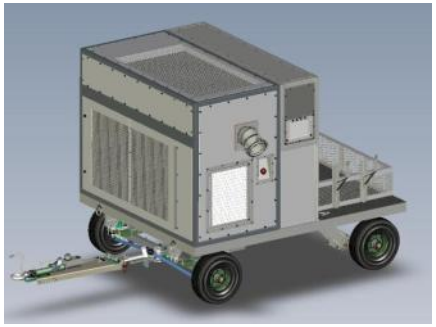
- **C**onditioning **E**nergy **R**ecovery **V**entilator
  - Heat pump technology for exchanging energy
  - A CERV delivers conditioned air to the home
- **D**emand **C**ontrolled **V**entilation (**DCV**) fresh air conditioning system for residences that manages **carbon dioxide** and **volatile organic compounds** (VOC) levels
- "Smart" algorithms for:
  - Heating/cooling/dehumidification
  - Energy "recovery"
  - Energy efficient defrosting
  - "Free" conditioning
- Completed UL "listing" tests August, 2012
  - Continuous UL site visit inspections
- It is NOT a whole house heating/air conditioning system
  - 700-1,000Watts Cooling/2,000-3,000Watts Heating
  - Smoothly interacts with house conditioning systems

Newell Instruments

Two Divisions

Automotive

Appliances



Military Systems

R&D for Industry

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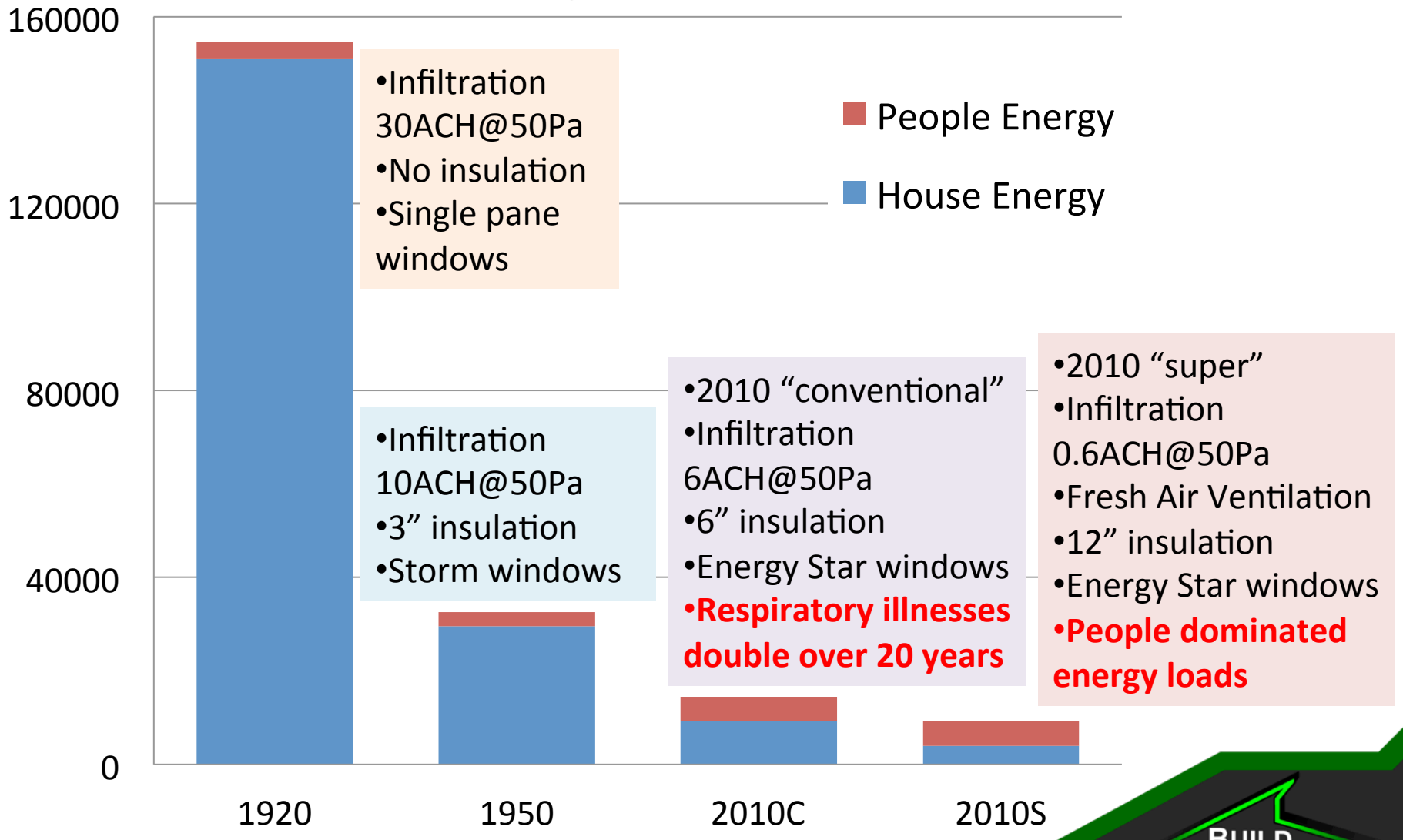
Solutions for a Healthy, Comfortable, and Sustainable Lifestyle

History of House Energy

Annual House Energy (kWh) Requirements



What Do We Want in a House?

Comfort

Healthy Comfort

Sustainable Healthy Comfort

Zero Energy Chicken House at our Lab

- Building a “zero energy” house is easy

- A comfortable indoor environment with healthy, fresh air **is more important (and more valuable)** than energy

Active Control for Passive Living??

1935 GE Globe Top Refrigerator:

- Manual "on-off" switch
  - 10 minutes per day checking and switching = 8 workdays per year (~$1600 labor value)
  - Poor control = poor food quality and poor energy efficiency
  - Food spoilage, sickness, loss nutritional value
  - Modern refrigerator uses $30-40/yr energy for storing $4000-$8000/yr of food

Other Examples:

- Manual laundry vs automatic
- Manual dishwashing vs automatic
- Manual hot water vs automatic hot water
- Manual house comfort vs automatic

Our goal is to automatically maintain a high quality indoor air environment in an energy efficient manner

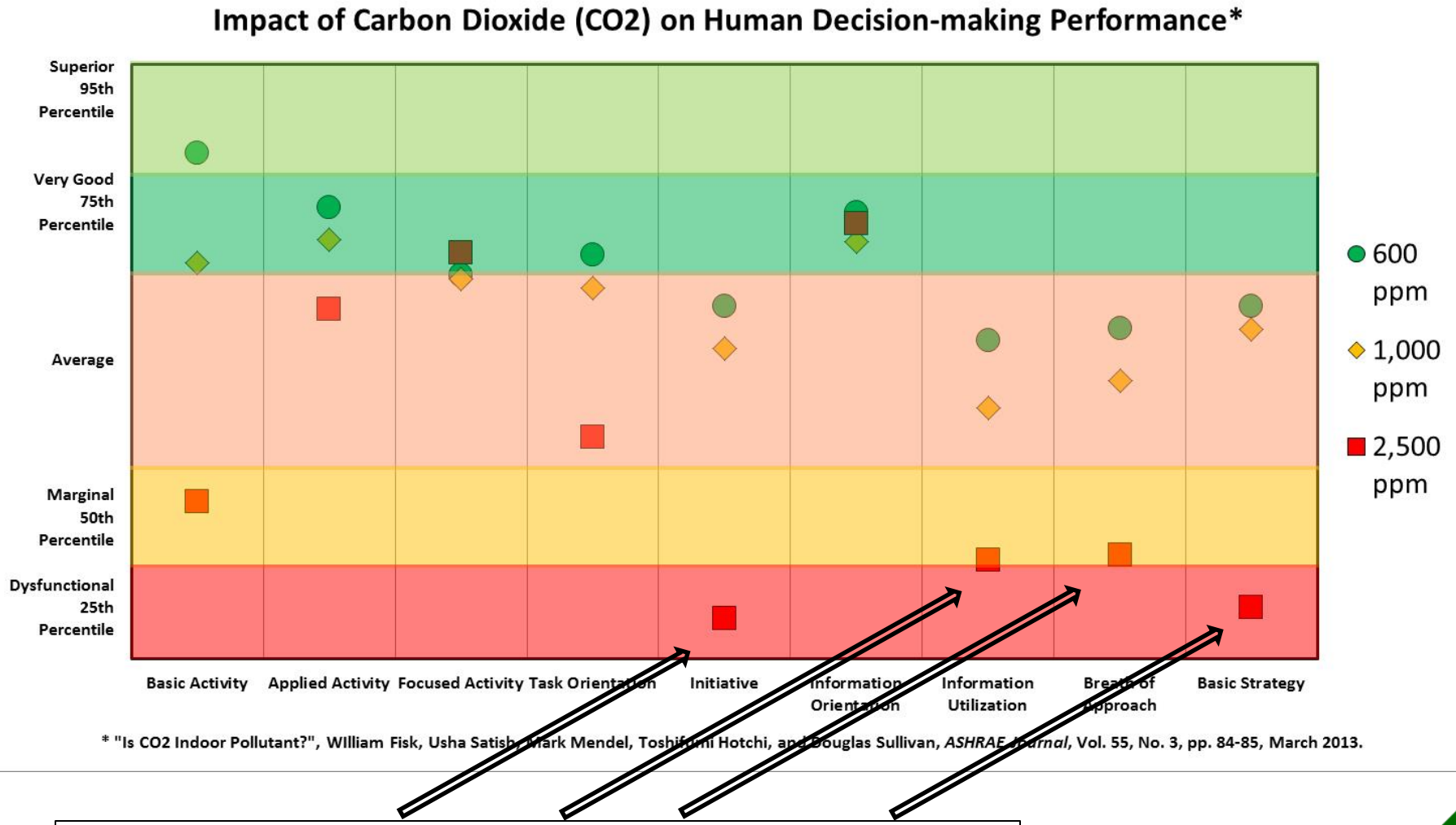
2013-2014 ASHRAE* Presidential theme
Shaping the Next

"…..a critical shift in thinking from a goal of indoor environments that are acceptable to the occupants to those that are truly healthy and productive…"

Bill Bahnfleth
2013-2014 ASHRAE President

*American Society of Heating, Refrigeration and Air Conditioning Engineers

Carbon Dioxide (CO2) Impairs Cognitive Performance

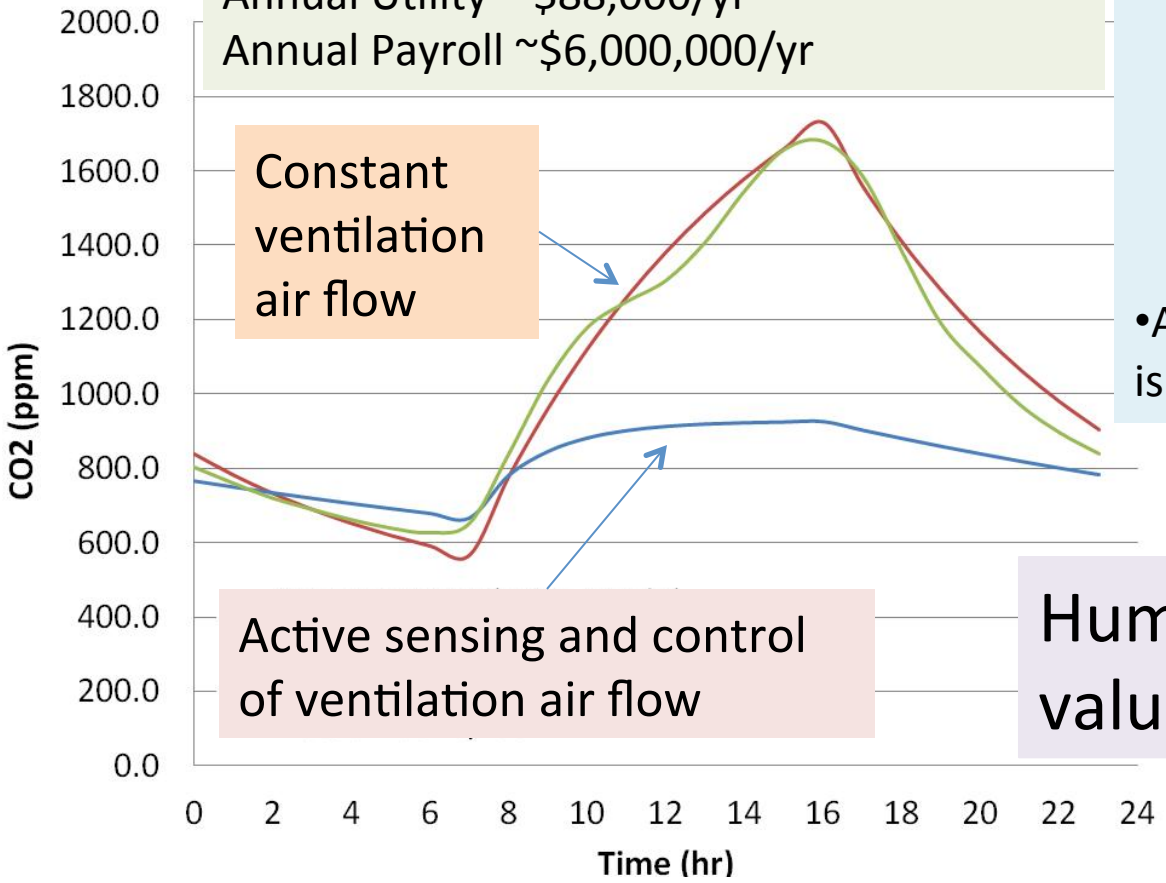


* "Is CO2 Indoor Pollutant?", WIlliam Fisk, Usha Satish, Mark Mendel, Toshifumi Hotchi, and Douglas Sullivan, *ASHRAE Journal*, Vol. 55, No. 3, pp. 84-85, March 2013.

Strongly impairs: Initiative, Information Utilization, Breath of Approach, and Basic Strategy

Value of Fresh Air

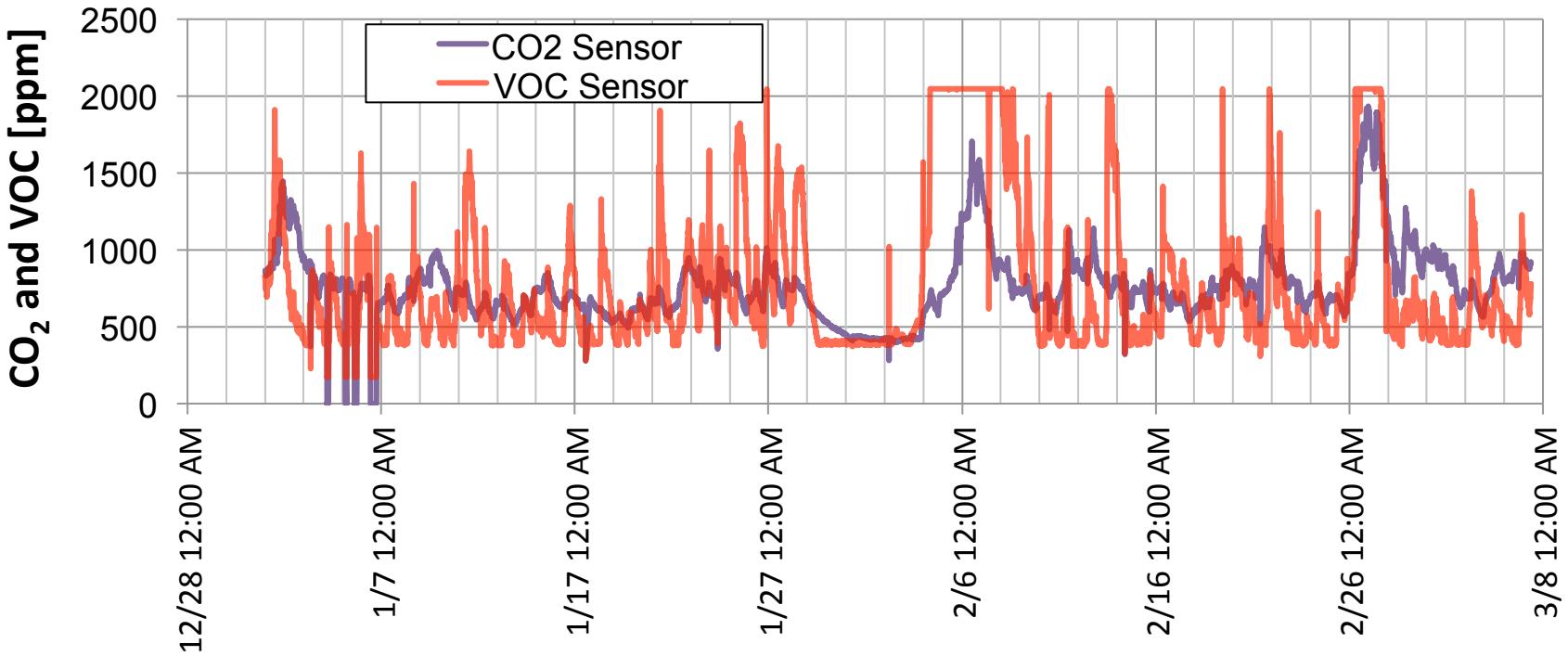
25,000 sqft facility with constant ventilation
120 Employees
Annual Utility ~ $88,000/yr
Annual Payroll ~$6,000,000/yr



- Fresh air control would increase employee productivity by $750,000/year by reducing CO2
  - 1% drop in productivity ~ $60,000 per year
  - Additional benefit through reduced sick days not included
- Annual utility cost ($88,000/yr) is unaffected

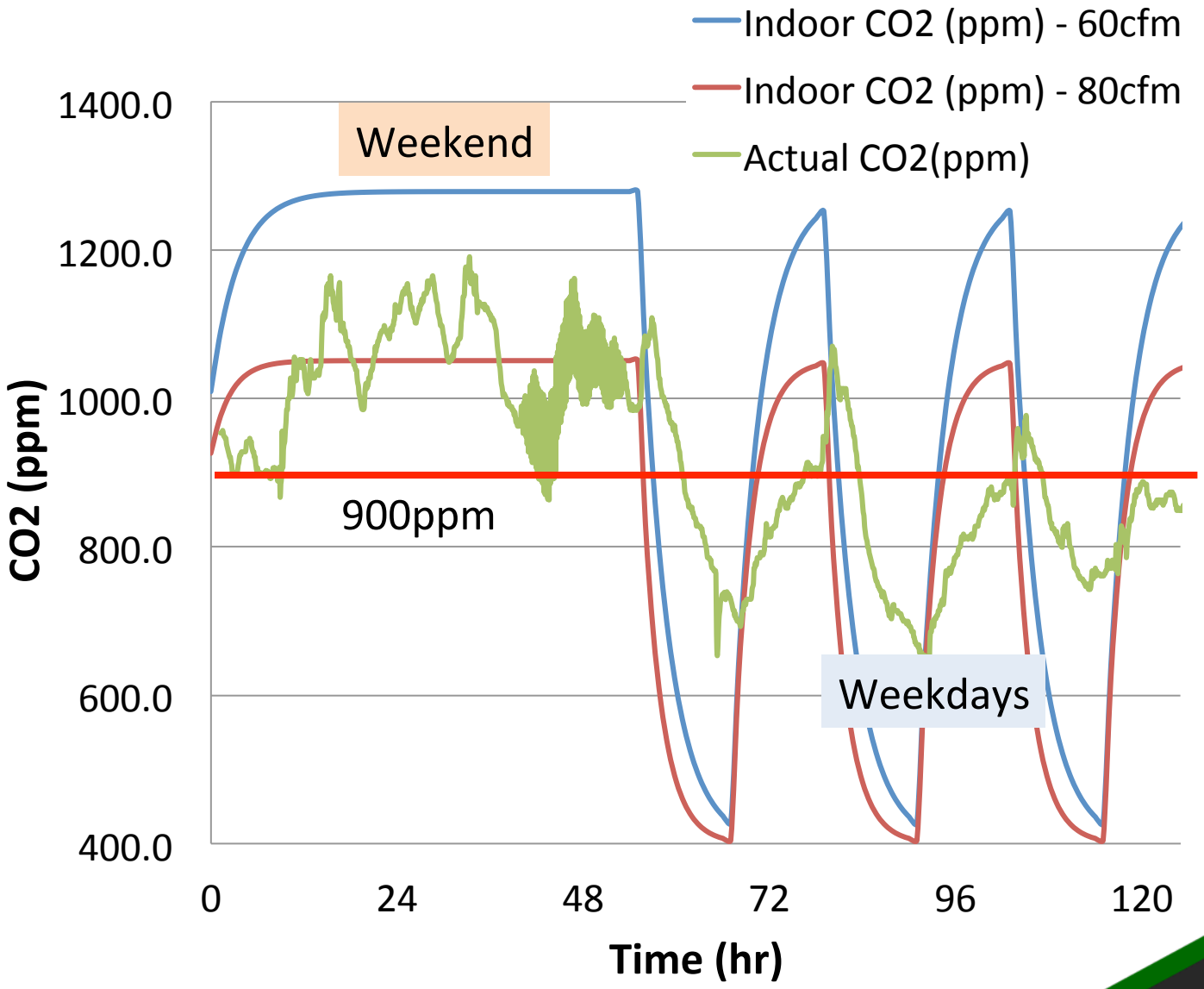
Humans are more valuable than energy!

Pollutant Variation in Homes is Complex

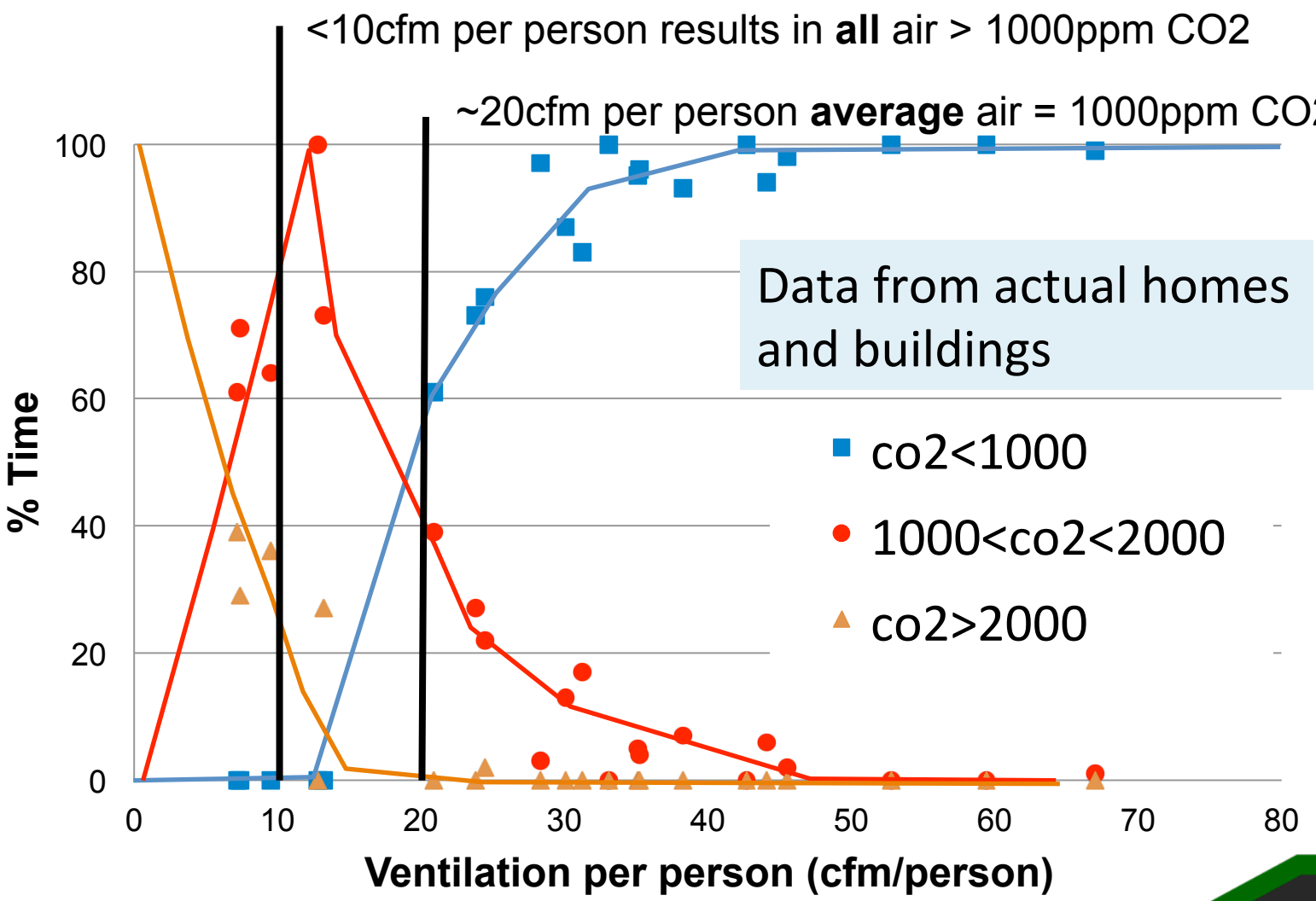


- Either CO2 or VOCs may dominate a home's pollutants
- Constant ventilation flow = too much or too little air
- Even "good" VOCs (chicken soup) should be flushed to avoid odor absorption

Constant Ventilation Flow CO2 in Home



CO2 Concentration - Constant Flow Venting

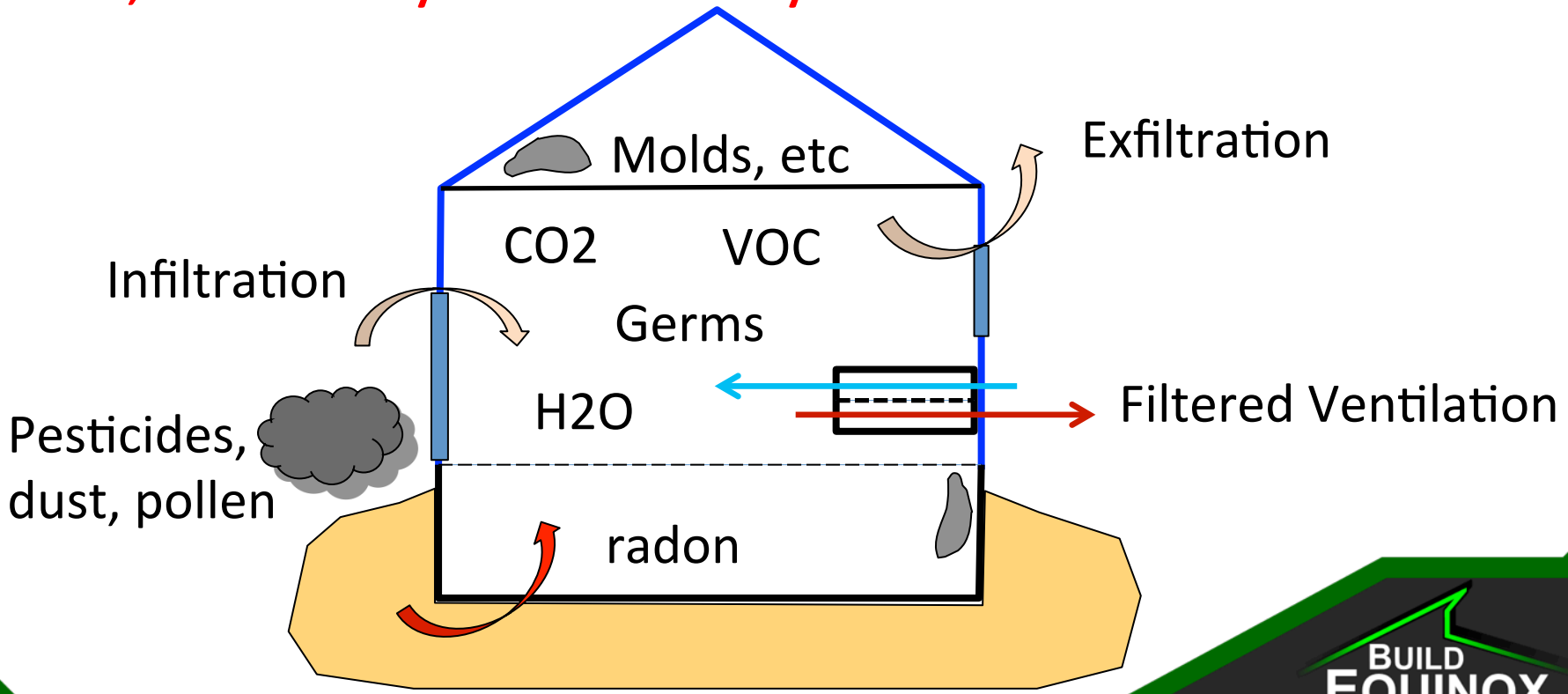


Indoor Air Quality

Poor indoor air quality impacts:

- Health
- Human Performance

But, how do you know if your air stinks?



Air Quality

You can wait until others tell you it stinks….

<u>High levels of carbon dioxide correlate with</u>

- Increased spread of contagious diseases
- Drowsiness
- Headaches
- Inability to concentrate

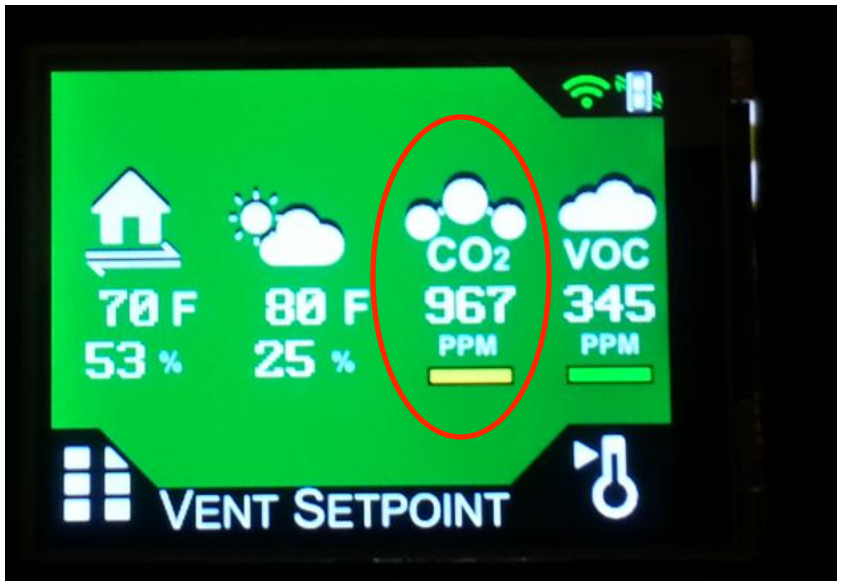
Or, You Can Measure and Control It

Two Factors Affect Air Quality

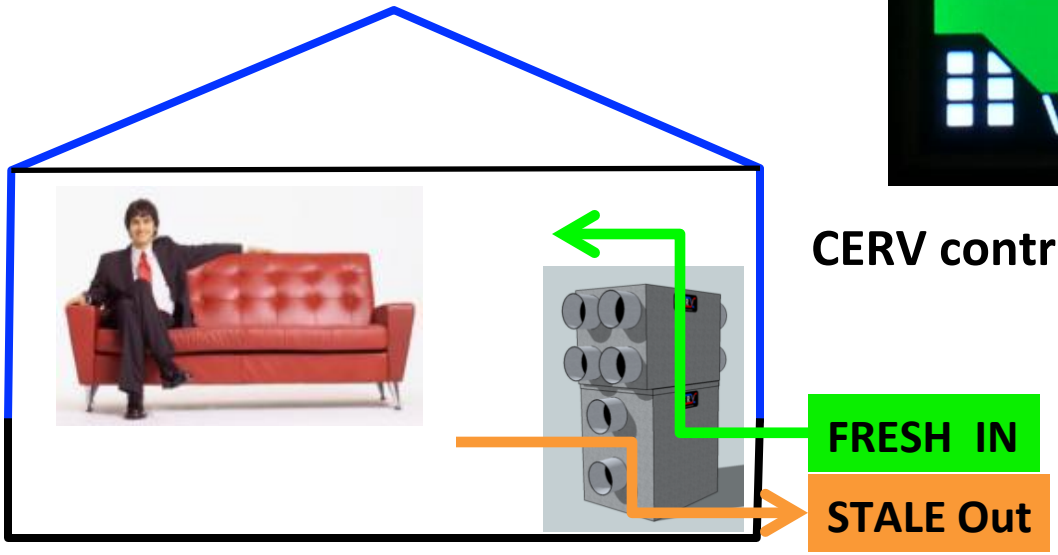
Pollution generation rates

Fresh air flow rate

CERV =
Conditioning **E**nergy **R**ecovery **V**entilator
Pronounced “serve”



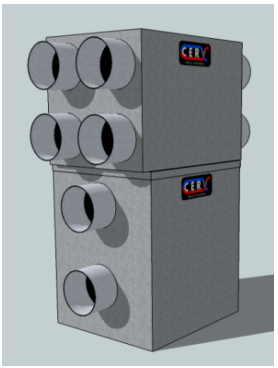
CERV control screen photo from Denver PH



CERV Development

Concept and initial results presented at 2008 Passive House Conference (Duluth MN)

Laboratory and Field Tests
2008 to current



UL Certification 2012

NEWELL INSTRUMENTS
CERV CONDITIONING MODULE
MODEL NO CERV-001-PARTB
SERIAL NO

VOLTS AC	120	PH Φ	1
AMPS	2.5	Hz	60

MIN CIRCUIT AMPACITY 2.5
MAX FUSE SIZE (AMPS) 15
BLOWER 1 OUTPUT MAX (FLA) 1.1
BLOWER 2 OUTPUT MAX (FLA) 1.1
MAX AIR FLOW (CFM) 300

c UL us LISTED
ACCESSORY FOR DUCTED HEAT RECOVERY VENTILATOR
4VN8

WARNING: RISK OF ELECTRIC SHOCK. CAN CAUSE INJURY OR DEATH: DISCONNECT ALL REMOTE ELECTRIC POWER SUPPLIES BEFORE SERVICING.

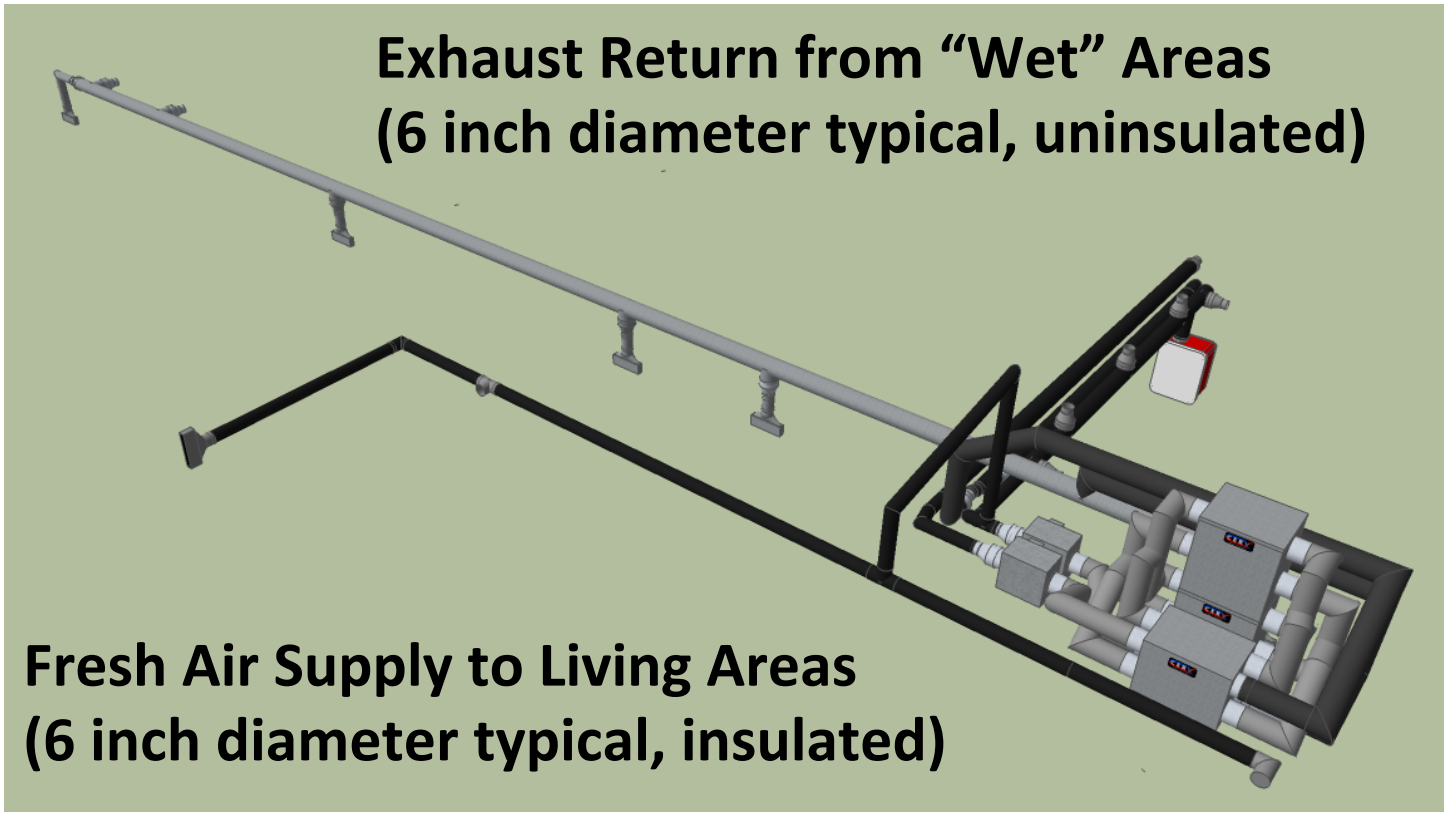
NOT FOR OUTDOOR USE
For use with CERV-001-PARTA

Three UL certifications:

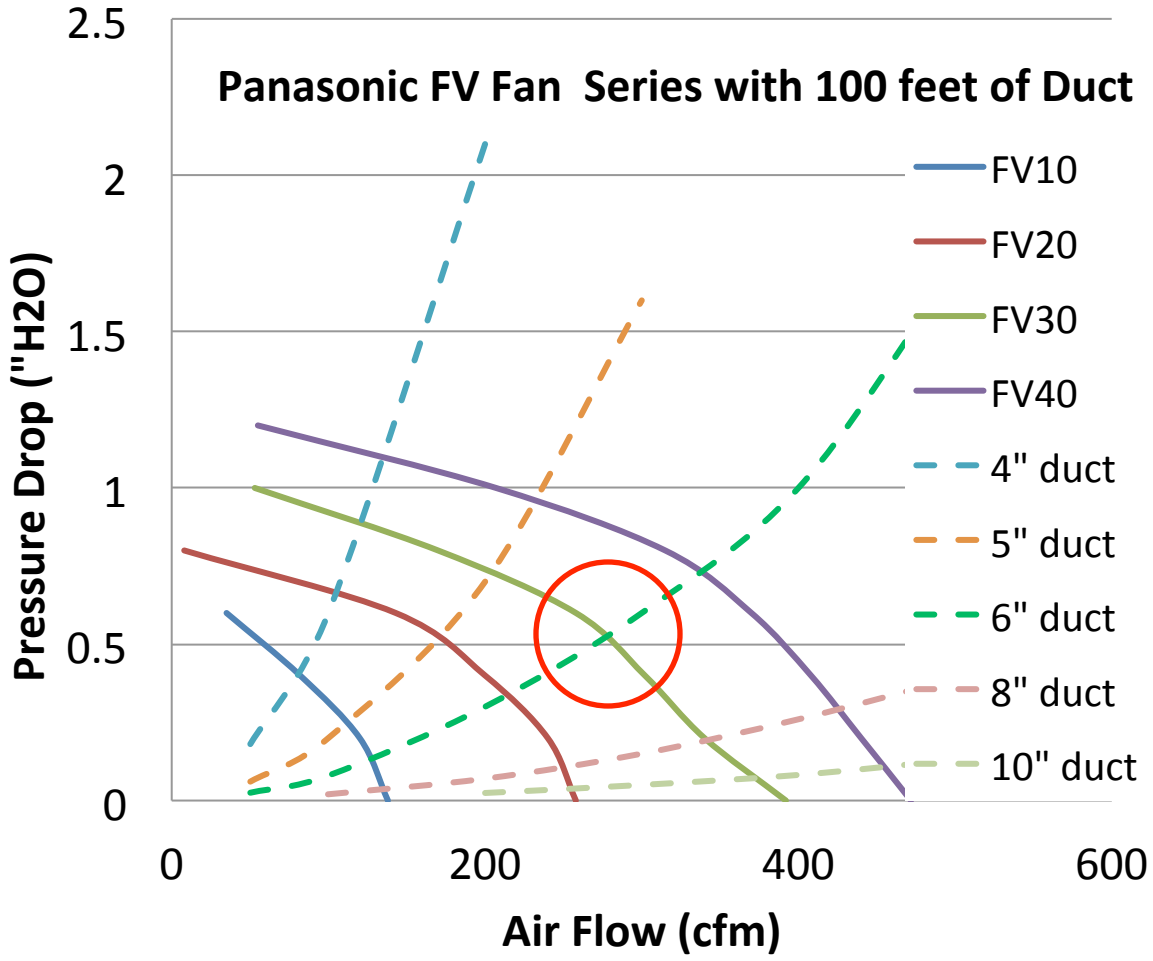
-Energy Recovery
-Heat Pump
-Power electronics component

CERV

Fresh Air Supply/Exhaust Air Preferred Duct Design



Panasonic “WhisperLine™” Fans

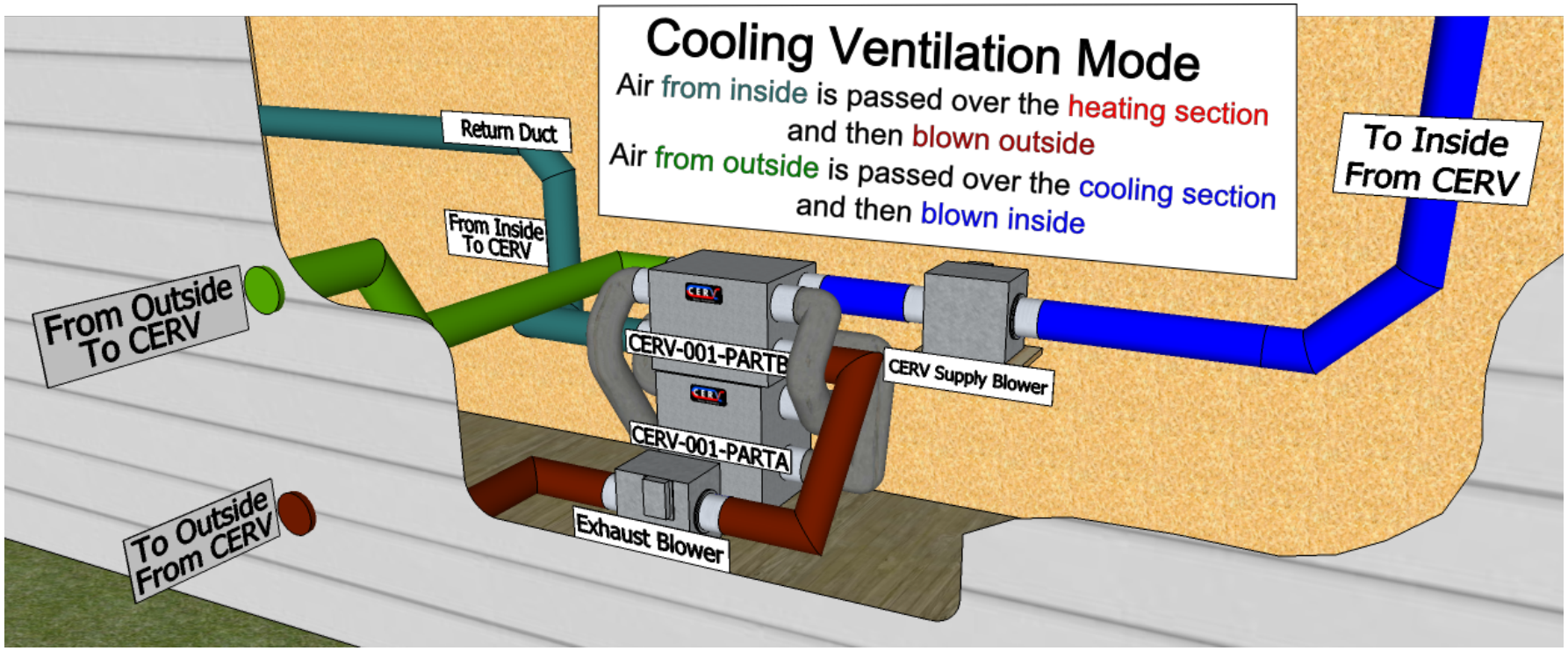


- 0.5 Watts per cfm (total fan power)
- Balanced ventilation

- Annual fan energy depends on occupancy
- 1 person* vent ~ 80kWh/yr
- 2 persons vent ~ 160kWh/yr
- 4 persons vent ~ 320kWh/yr

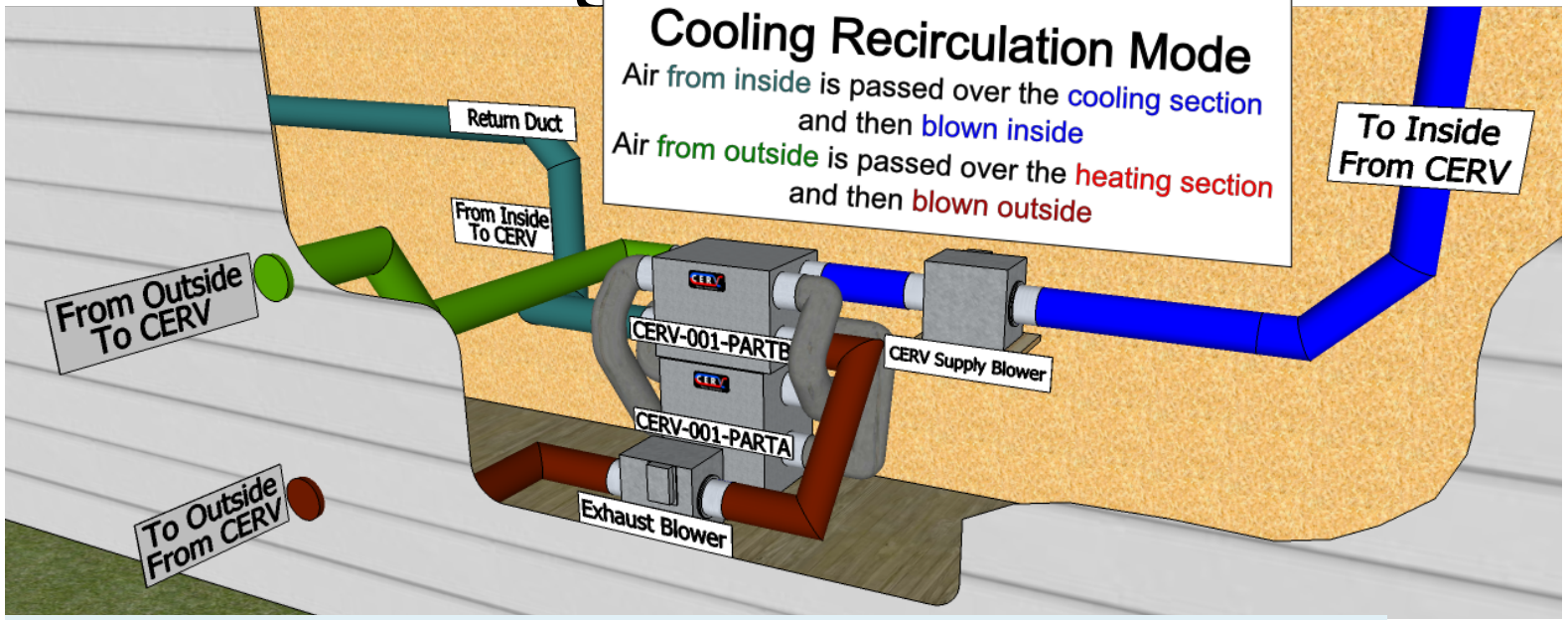
* 12 hours/day occupancy per occupant assumed

Cooling Ventilation Mode



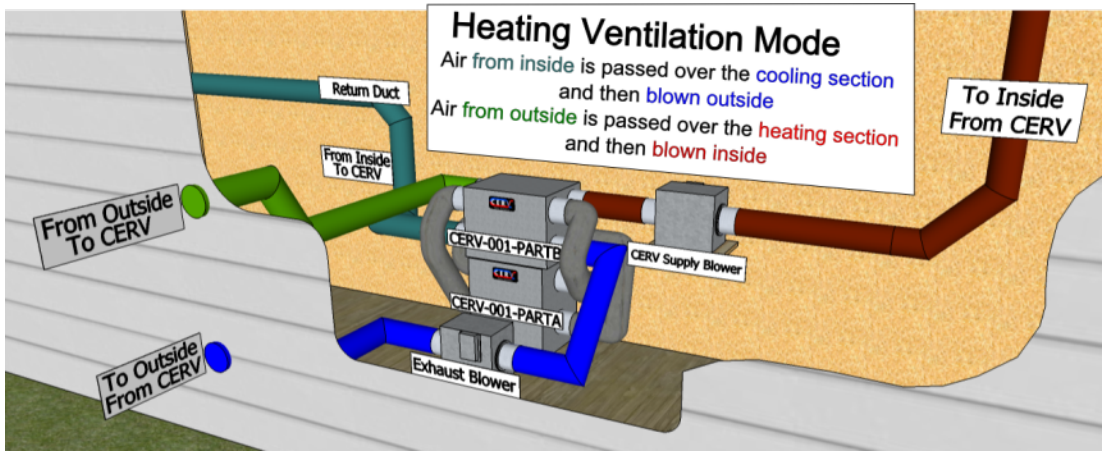
- Cools and dehumidifies when beneficial, exchanging energy between fresh air stream and exhaust air stream
- When "fresh air" is nicer than indoor air, maximizes fresh air similar to opening the windows….except it knows to close them when it isn't so nice
- Unlike an open window, the air is filtered as desired

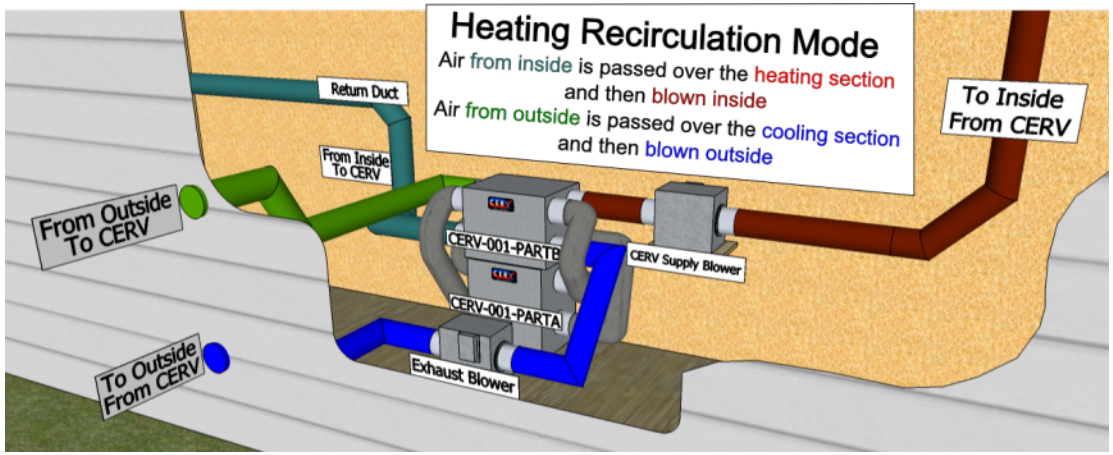
Cooling Recirculation Mode



- Additional cooling and dehumidification capacity when desired through recirculation mode….helps maintain uniform air quality and comfort conditions
- Can decide whether the CERV™ provides as much as it can, or whether it operates only at a level of treating the fresh air
  - Equinox House uses CERV ™ and 1 ton mini-split combo
  - Mini-split AC primarily needed for high occupancy time and exceptionally warm/humid weather

Heating Ventilation/Recirculation Modes





Similar to cooling:

- Heats fresh air when beneficial
- Can provide additional heat if desired through recirculation unifying air quality and comfort
- Energy recovery from frost (during cold weather, 30% of energy exchange is latent)

CERV Control

Master Controller
-secure wireless (non-internet)
-color touchscreen

Remote Vent Switch (battery free)
- Optional – kitchen, baths, etc

Smith House-DCV Control of CO2 & VOC

DCV CO2 and VOC setpoints

CO2
VOC
Recirc Cool
Vent Cool
Recirc Heat
Vent Heat
off

1800
1600
1400
1200
1000
800
600
400
200
0

8/22/2012
8/22/2012
8/23/2012
8/23/2012
8/24/2012
8/24/2012
8/25/2012
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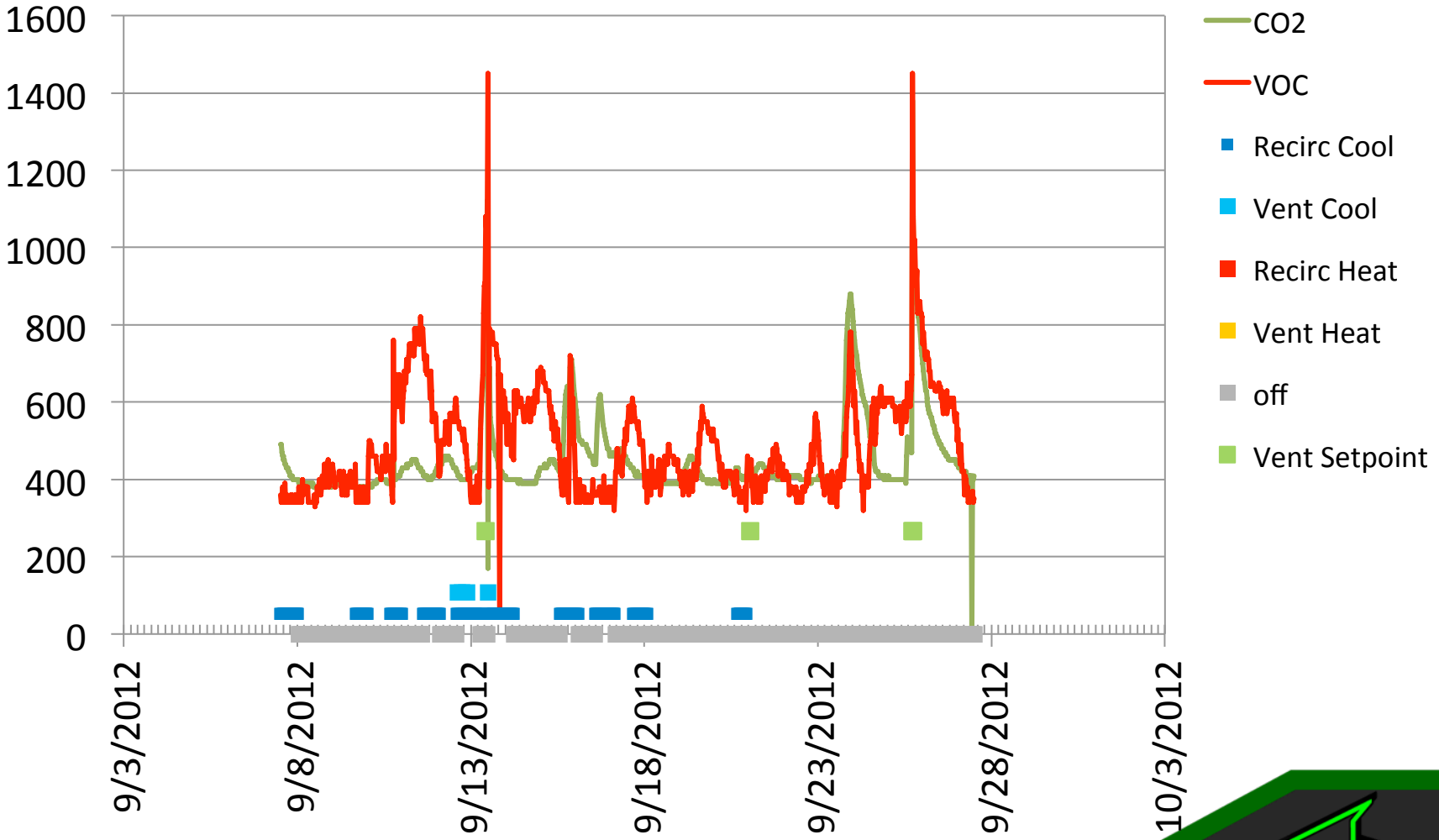
8/26/2012
8/26/2012

Gable House CO2 & VOC (ppm)

(Warm and Neutral Weather)



Energy Impacts

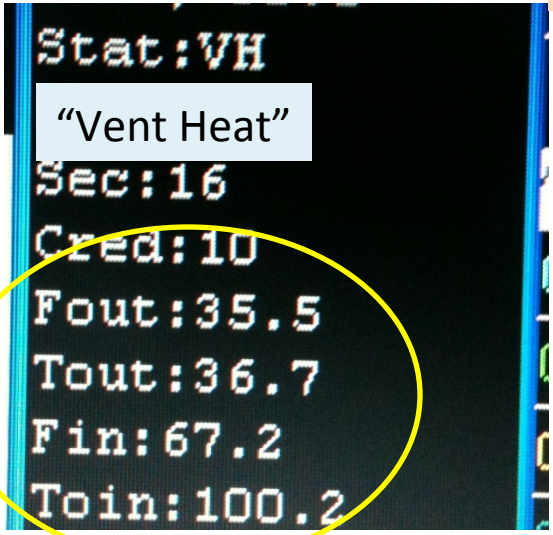
What are the CERV's energy characteristics and how does it compare to basic HRV and ERV systems?

CERV Fresh Air Heating Data

~200cfm air flow
-Gross heat = 4.1kW
(35.5F to 100.2F)
-Net heat = 2.1kW
(67.2F to 100.2F)

Total CERV Power

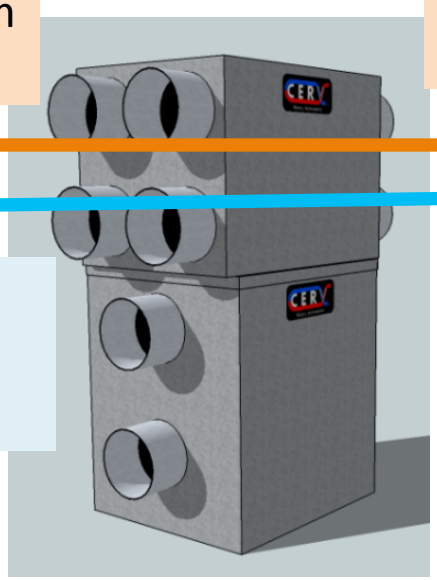
Room Temperature & Humidity (21C = 70F)



"Vent Heat"

Exhaust Air from Inside, 67.2F

Exhaust Air to Outside, 36.7F



Conditioned Fresh Air to Inside, 100.2F

Fresh Air from Outside, 35.5F

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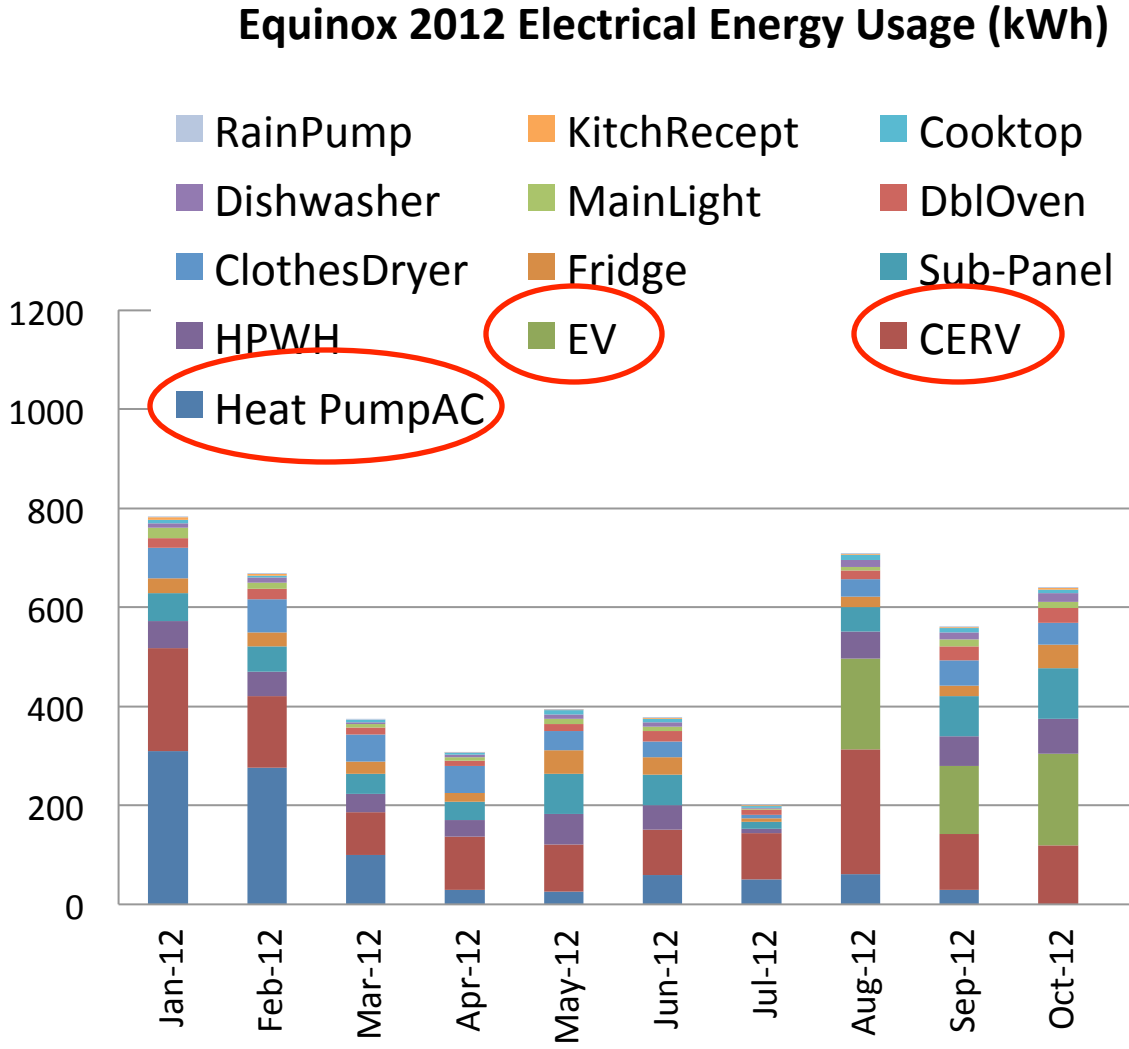
Equinox House Monthly Energy (kWh)

Jan 2012 – Dec 2012

Equinox House



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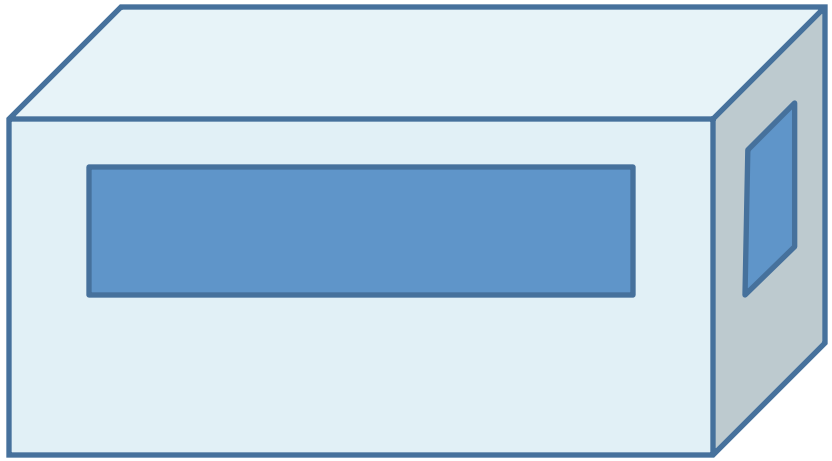
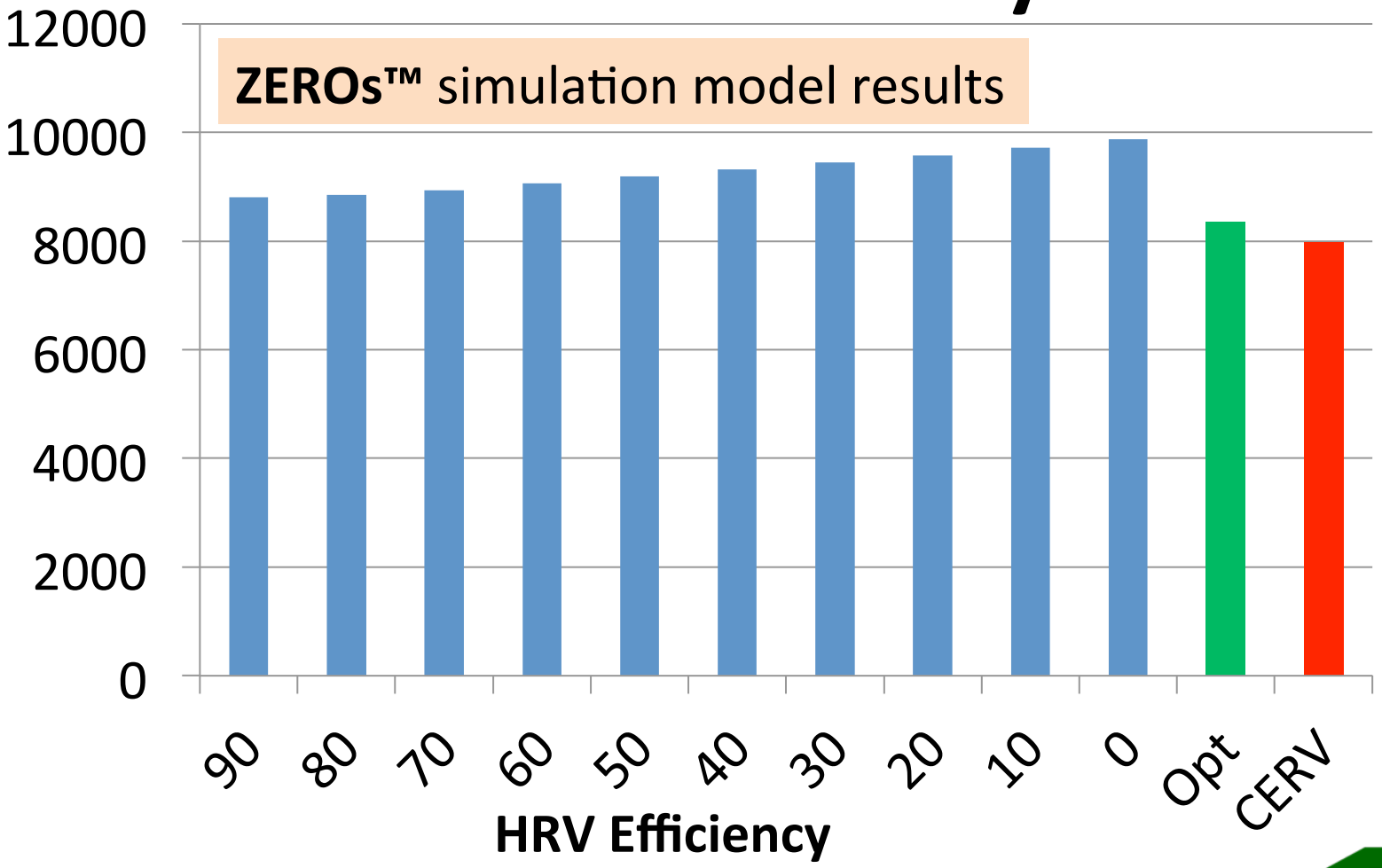
Is the Highest HRV Efficiency Always Best?



Example House

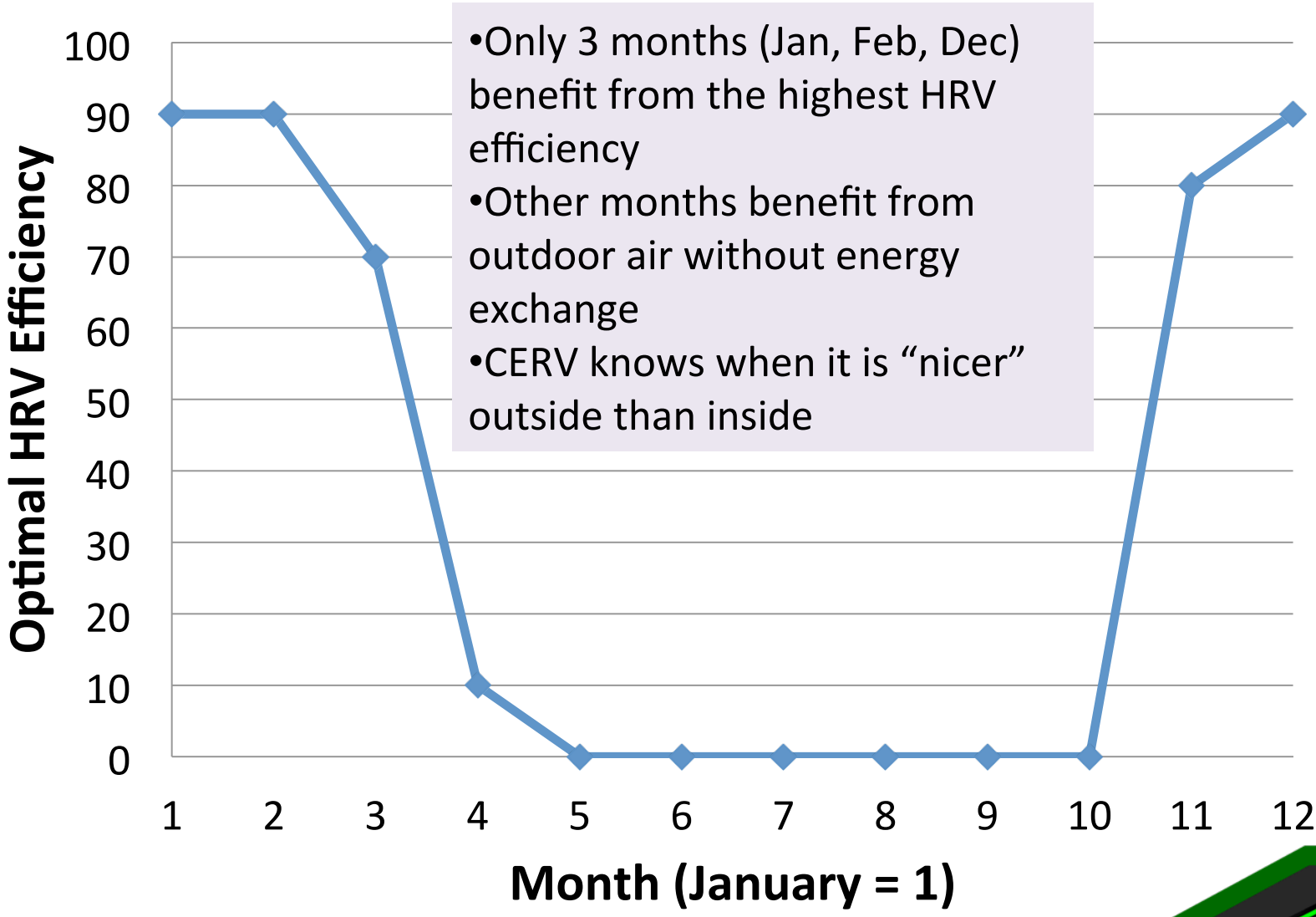
- 4 Occupants
- Denver
- 2000sqft
- R48 walls and roof
- Heat pump & AC
- 200W base electric
- 50W/person electric
- Heat Pump Water Heater
- 200sqft S window
- 50sqft E & W windows

Annual Electric (kWh) vs HRV Efficiency



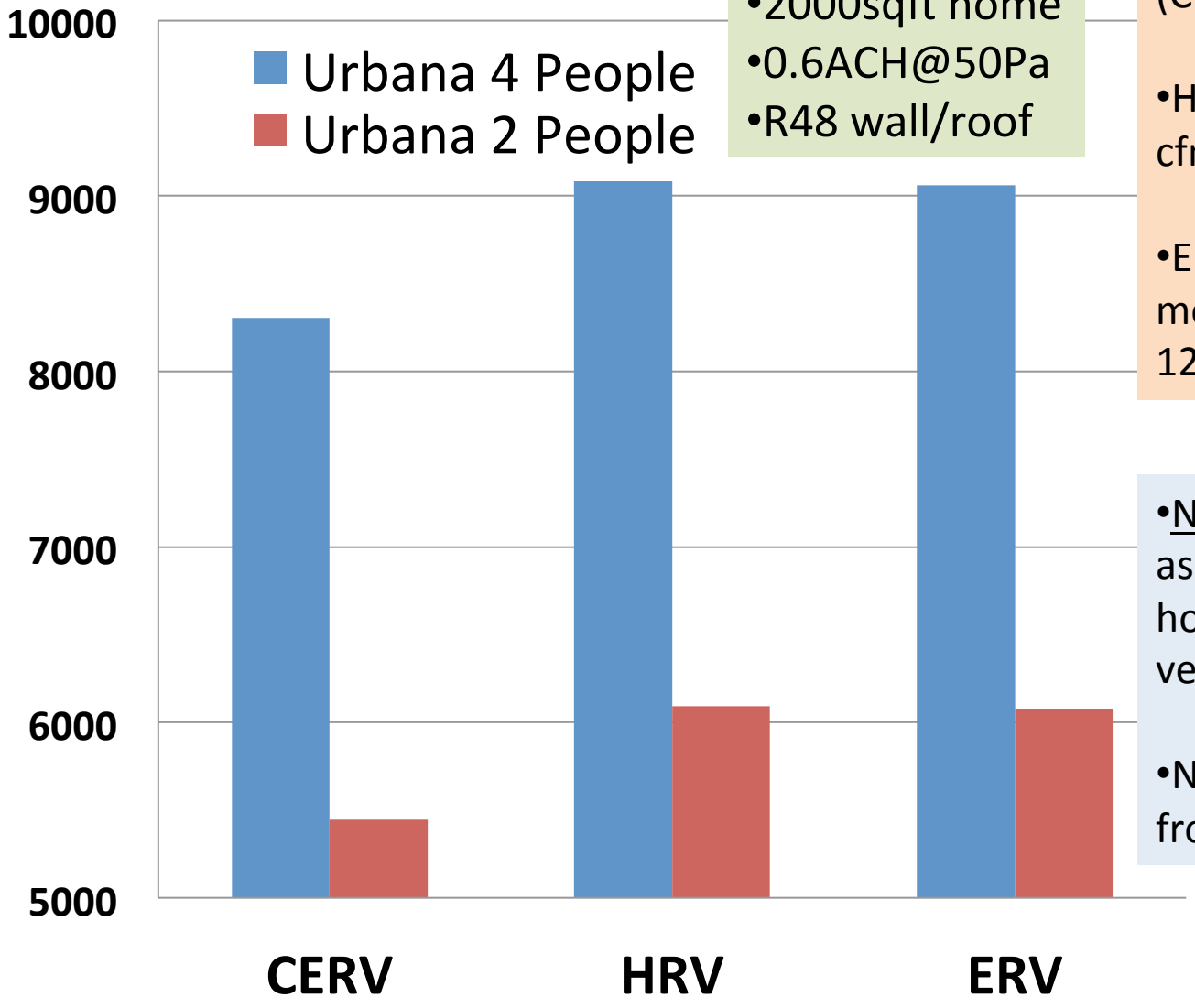
CERV controls know when it is “nicer” outside than inside and knows when it is more energy efficient to ventilate

Optimal HRV Efficiency



- Only 3 months (Jan, Feb, Dec) benefit from the highest HRV efficiency
- Other months benefit from outdoor air without energy exchange
- CERV knows when it is "nicer" outside than inside

CERV/HRV/ERV



- 2000sqft home
- 0.6ACH@50Pa
- R48 wall/roof

- CERV pollution setpoints (CO2 and VOC) = 900ppm
- HRV = 90% with 0.7W/cfm; 120cfm
- ERV = 80% heat and 60% moisture with 0.7W/cfm, 120cfm

- NOTE: HRV & ERV results assume someone knows how to properly control ventilation air flow
- No HRV/ERV pre-heat frost prevention assumed

Annual Energy Trends – CERV/HRV/ERV

Each case will vary by house design, occupancy and location

Thank you!

•CERV fresh air conditioning technology provides an energy efficient means to ensure a healthy indoor environment under the highly varying conditions in a home

- •Automated monitoring frees occupants from continual adjustment and programming of a home's ventilation schedule
- •Active sensing and control of carbon dioxide and VOCs maintains excellent indoor air quality in an energy efficient manner
- •Conditioned air delivered throughout a home improves overall house comfort

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