Whole-House Ventilation Systems: Providing Healthy, Comfortable, & Energy Efficient Indoor Solutions

Zehnder America

John Rockwell

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Learning Objectives

At the end of this program, participants will be able to:

1. Understand the advantages and weaknesses of supply-only, exhaust-only, and balanced ventilation systems
2. Learn how heat recovery ventilation enables a comfortable and healthy environment
3. Understand HRV/ERV's role in building an energy efficient home
4. Learn how to evaluate and choose the most effective HRV/ERV system

Why has Mechanical Ventilation Become Increasingly Important?

- Houses have become increasingly tight in the last 20 years due to energy cost concerns
- Previous air infiltration and exfiltration rates have been significantly reduced
- Thousand of chemicals enter the home through building materials, cleaners, furniture, carpets, and other products.
- Need for better ventilation in conjunction with increasingly energy efficient construction

2012 Building Codes & Standards

- 2012 ICC Residential Building Code
- N1102.4.1.2 (R402.4.1.2) Testing - The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour in zones 1 & 2, and 3 air changes per hour in zones 3 to 8. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals)

- Energy Star Qualified Homes – Version 3 (2012)
- 6 ACH50 in CZs 1,2
- 5 ACH50 in CZs 3,4
- **4 ACH50 in CZs 5,6,7**
- 3 ACH50 in CZ 8

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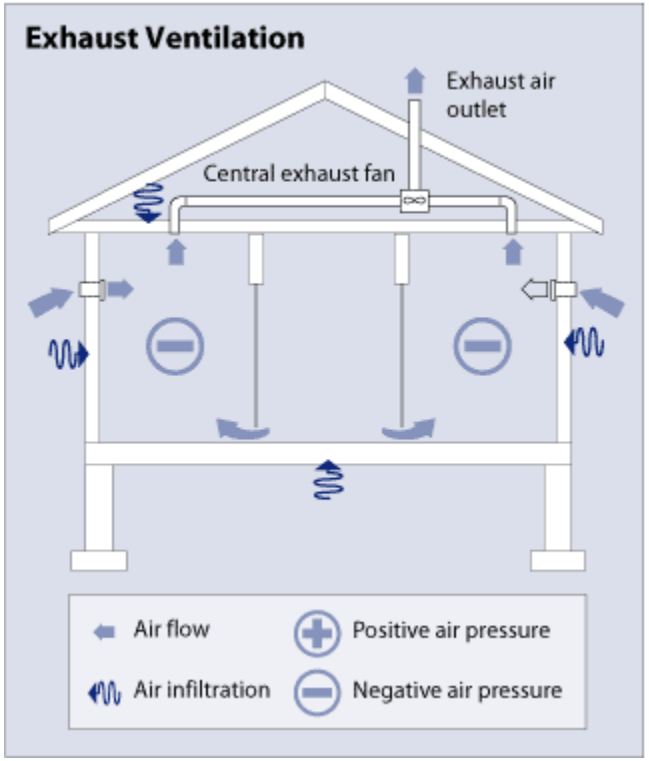
Ventilation Options

- Exhaust Ventilation
- Supply Ventilation
- Balanced Ventilation
- Heat Recovery Ventilation

- ASHRAE 62.2-2010 establishes 1 cfm of mechanical ventilation for every 100 square feet of occupiable space and an additional 7.5 cfm per person.
- Passive House establishes 0.3 air changes an hour of the occupiable volume.

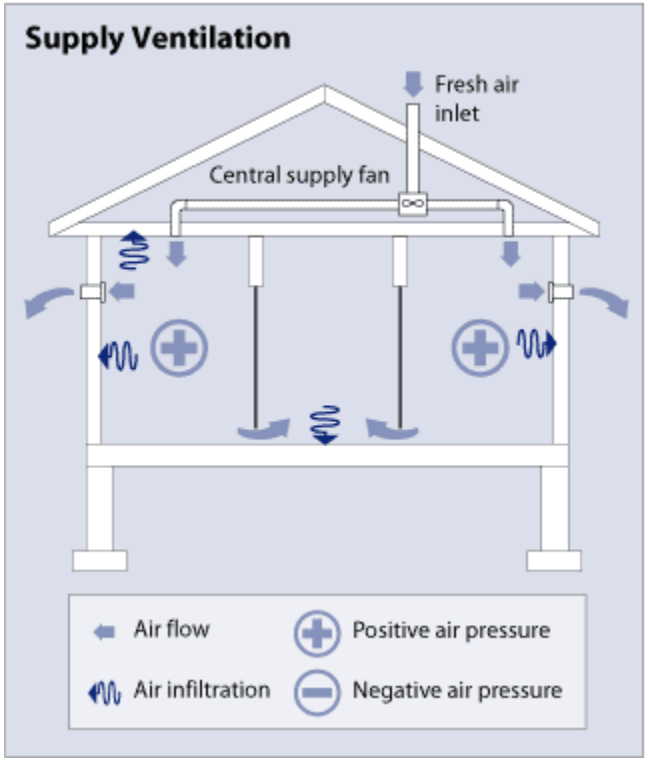
Exhaust Ventilation

- Stale air exhausted from kitchen and bathroom
- Outdoor air enters through random leaks in the building envelope



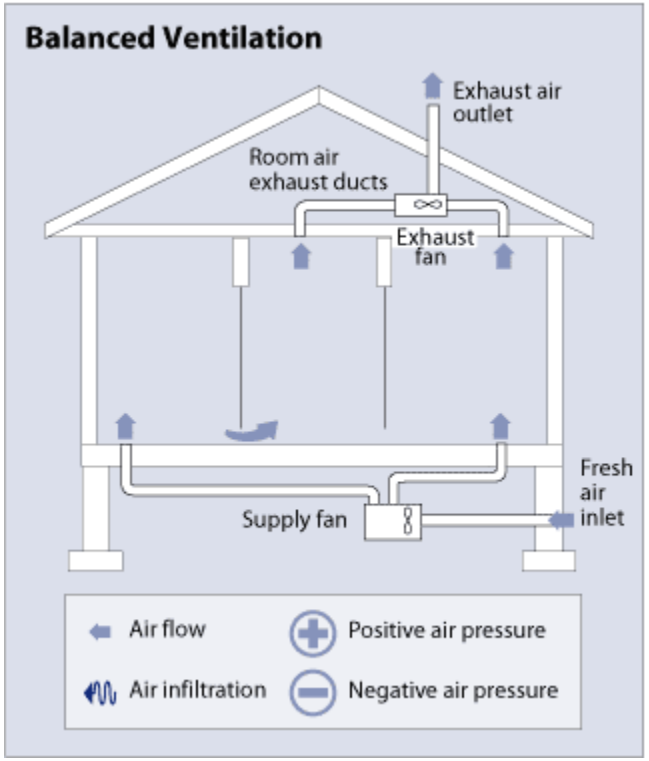
Supply Ventilation

- Outside air pulled into the home
- Stale air exits the home through random leaks in the building envelope

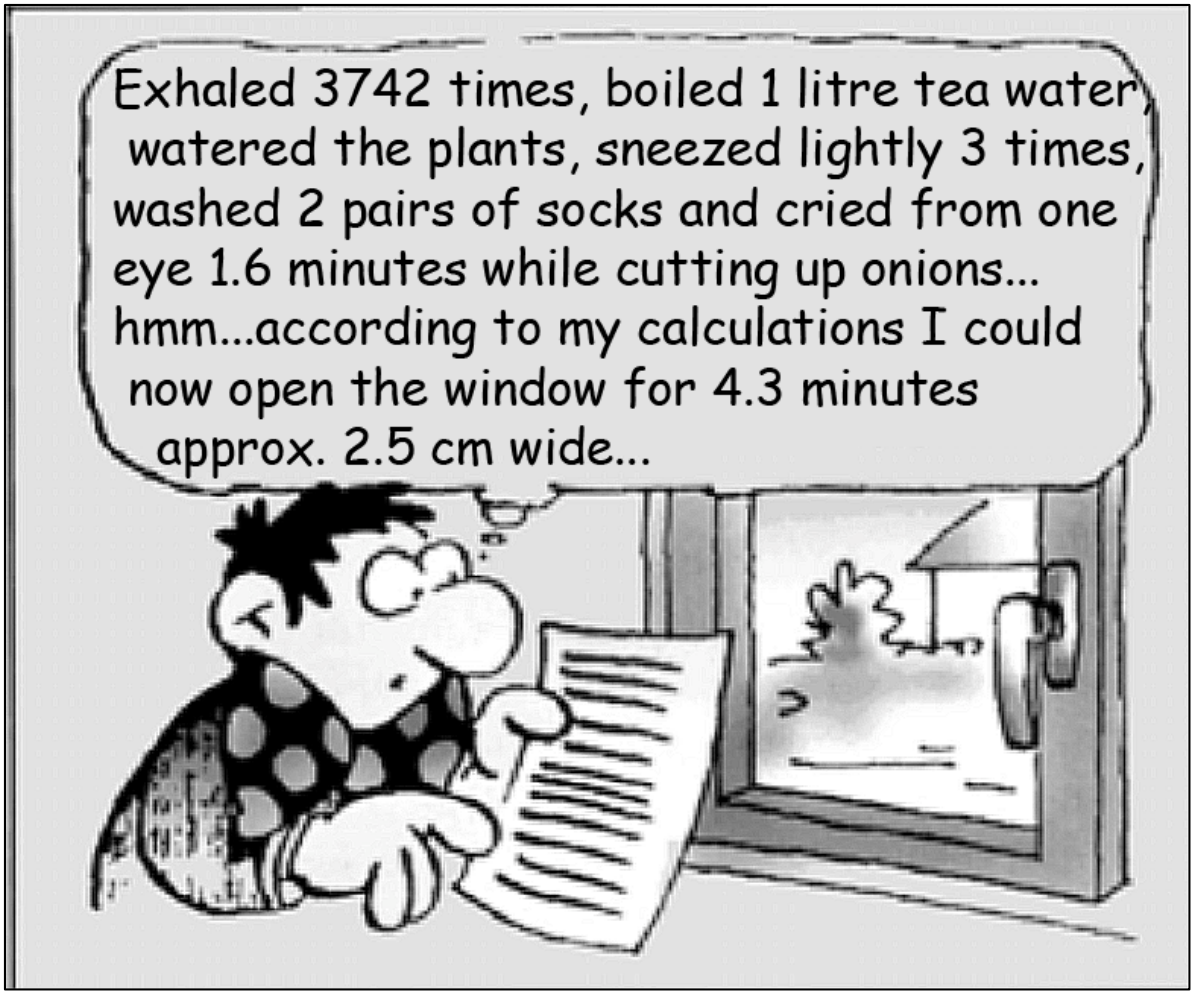


Balanced Ventilation

- Stale air exhausted from the kitchen and bathroom
- Fresh air is supplied to bedrooms and living spaces



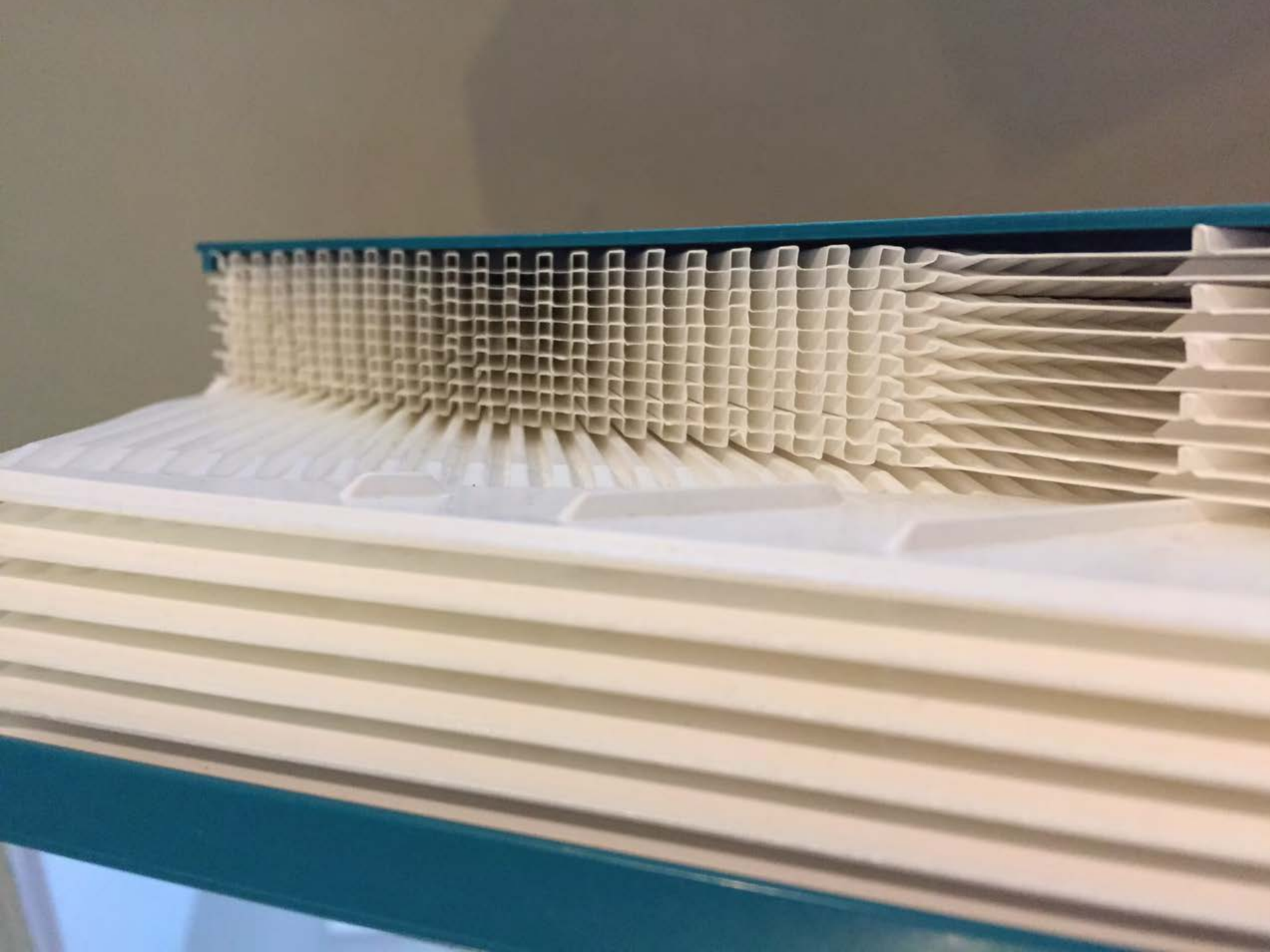
Window Ventilation?



Heat Recovery Ventilation

- A Heat Recovery Ventilator (HRV) is an energy recovery system that employs an air-to-air heat exchanger between the supply of fresh air and the extracted stale air.

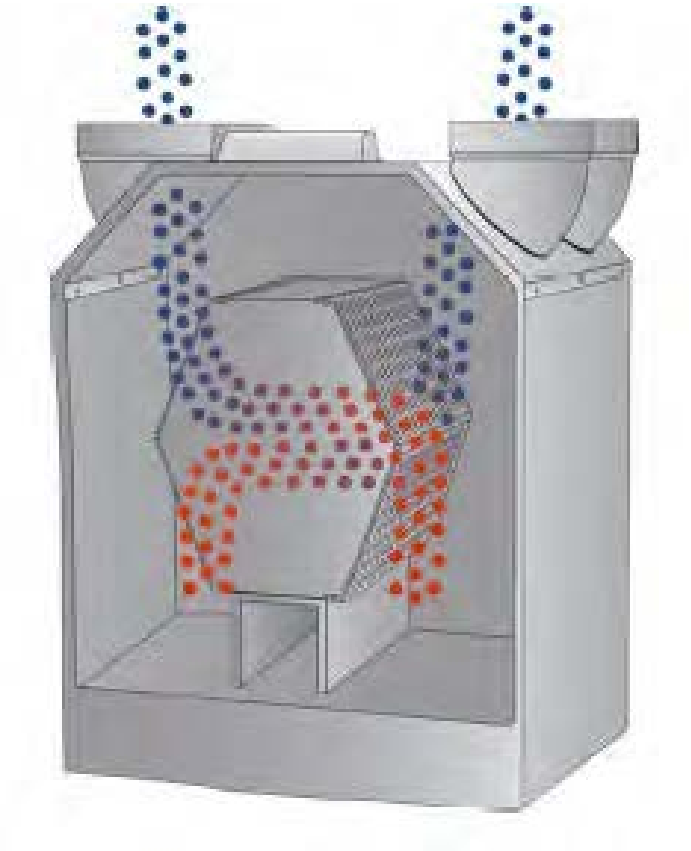
- This method of ventilation provides fresh air and an improved indoor climate while saving energy by reducing the heating (or cooling) requirements.



Enthalpy Recovery Ventilation

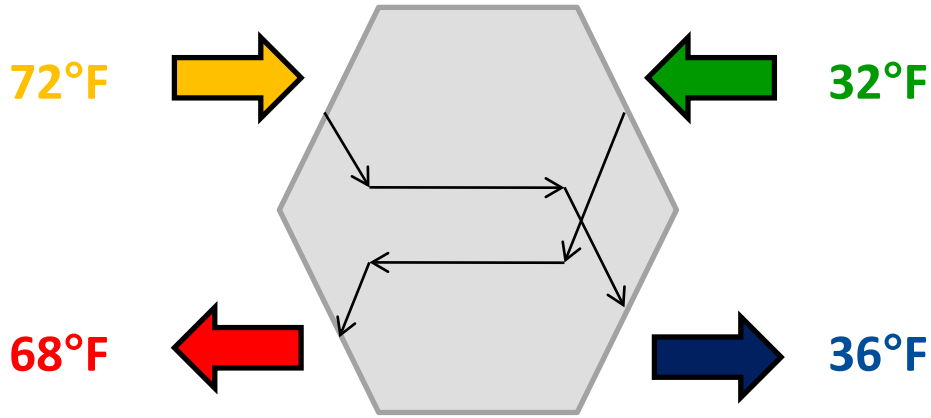
- Enthalpy recovery ventilation (ERV) is a heat recovery ventilation system that **also** passes moisture (water vapor) between the two air streams

- This method of ventilation can help to control humidity levels and reduce latent cooling loads



HRV

Counterflow heat exchanger
(winter)



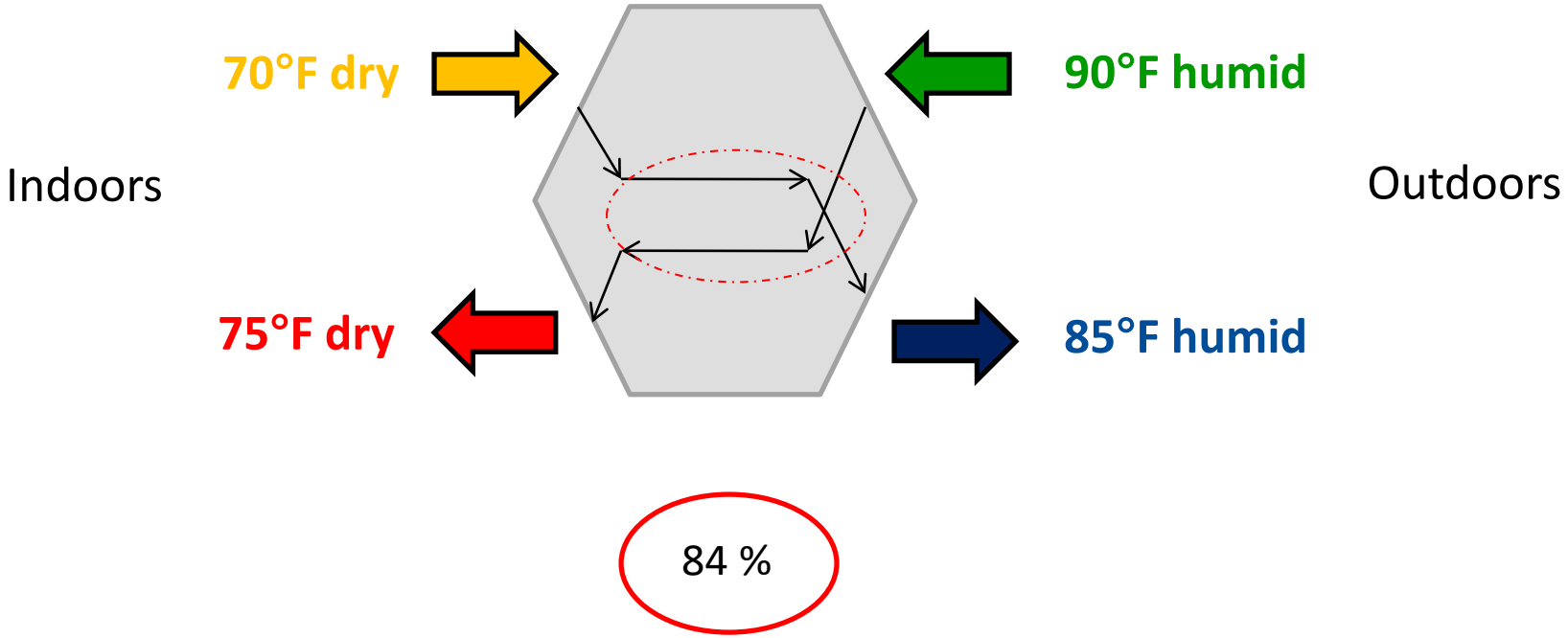
Indoors

Outdoors

90 %

ERV

Counterflow heat exchanger
(summer)



Summary

- Exhaust Ventilation
- Supply Ventilation
- Balanced Ventilation
- Heat Recovery Ventilation

Learning Objectives

At the end of this program, participants will be able to:

1. Understand the advantages and weaknesses of supply, exhaust, and balanced systems
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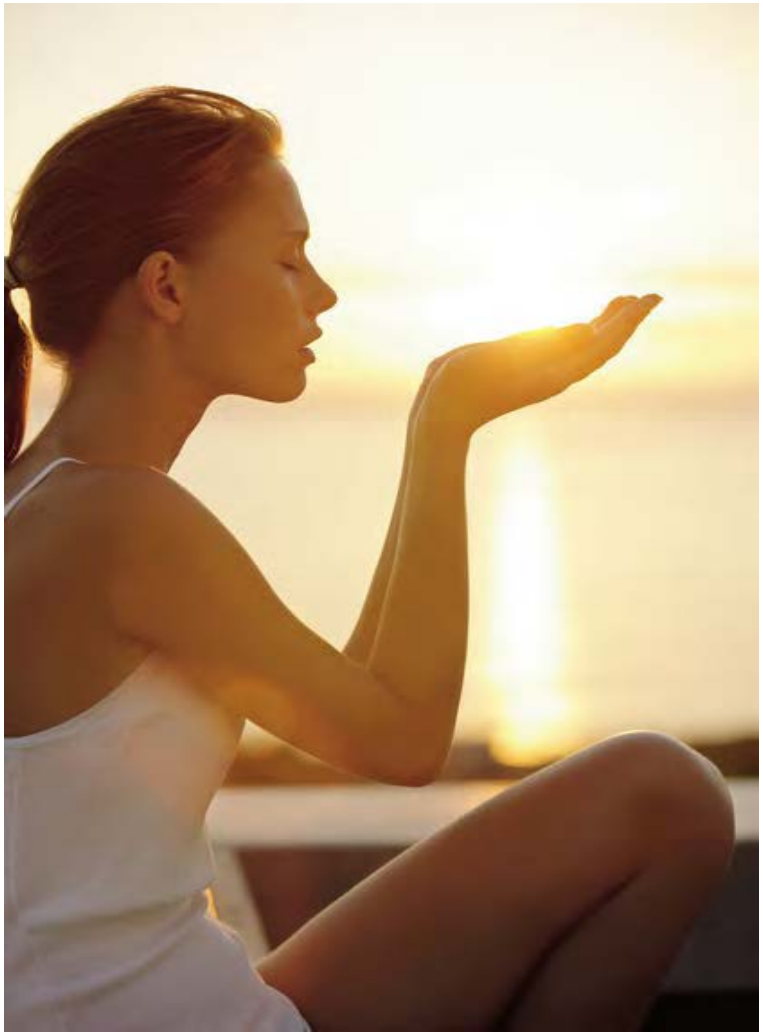
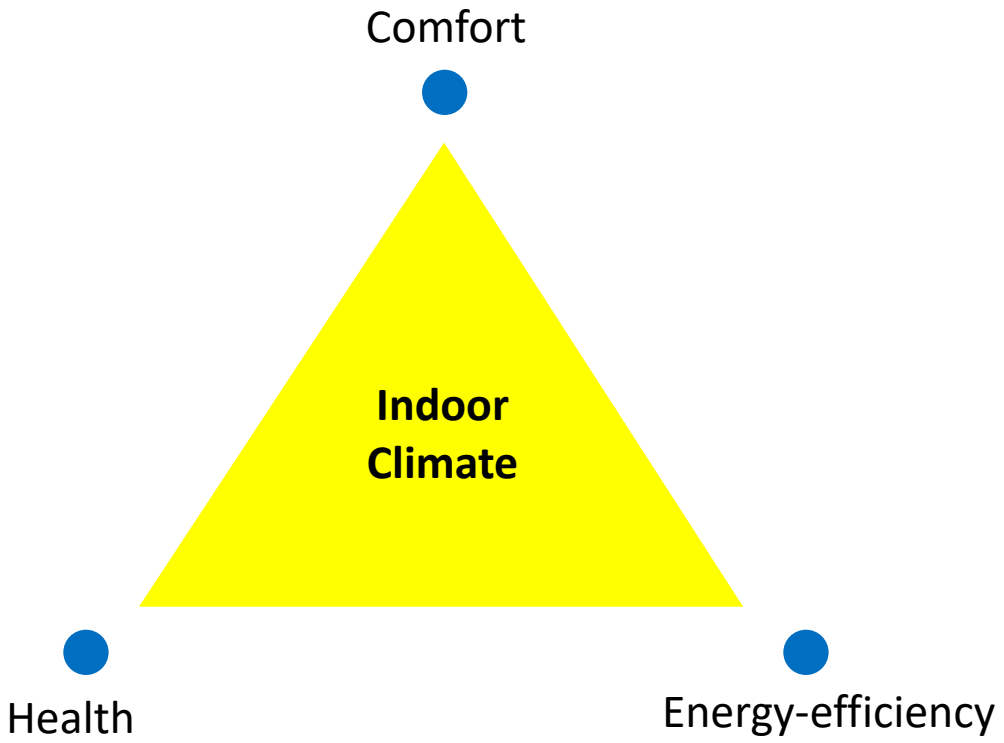
Balanced Heat Recovery Systems

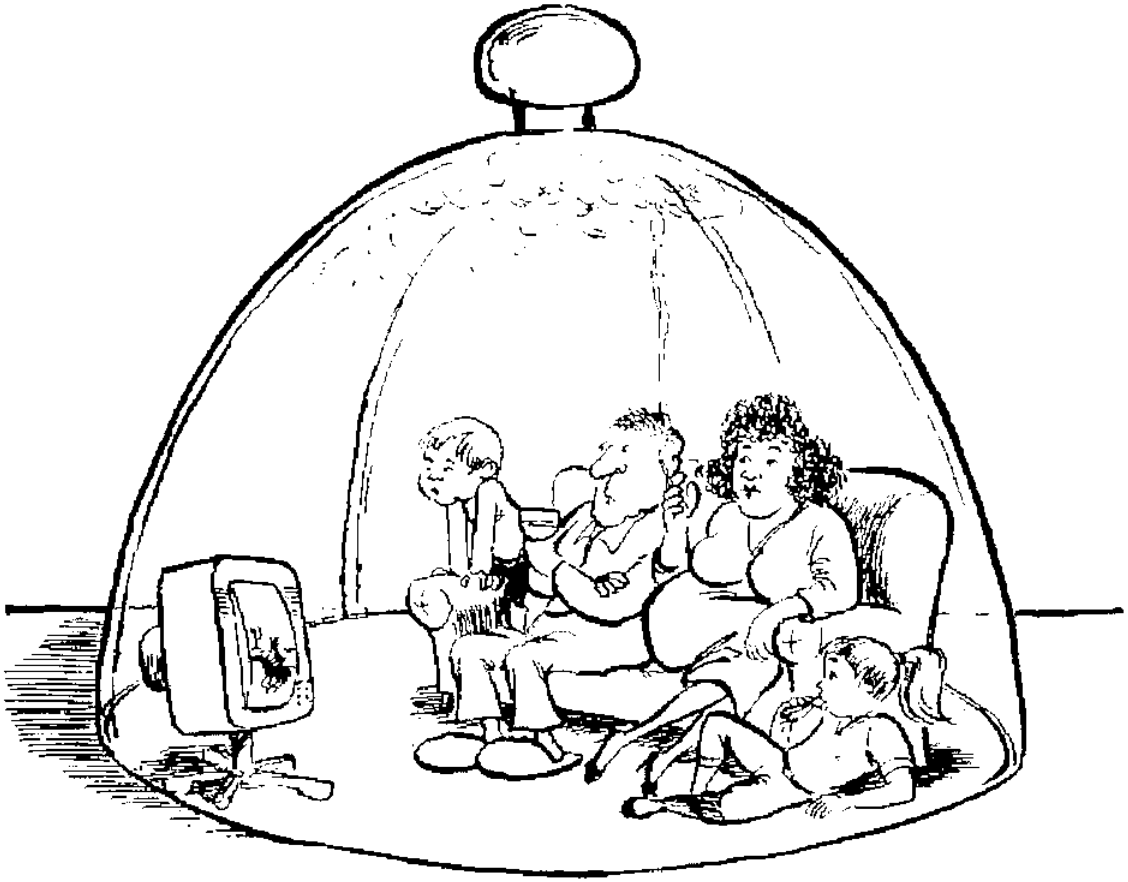


Provide energy-efficient, healthy and comfortable indoor climate solutions.



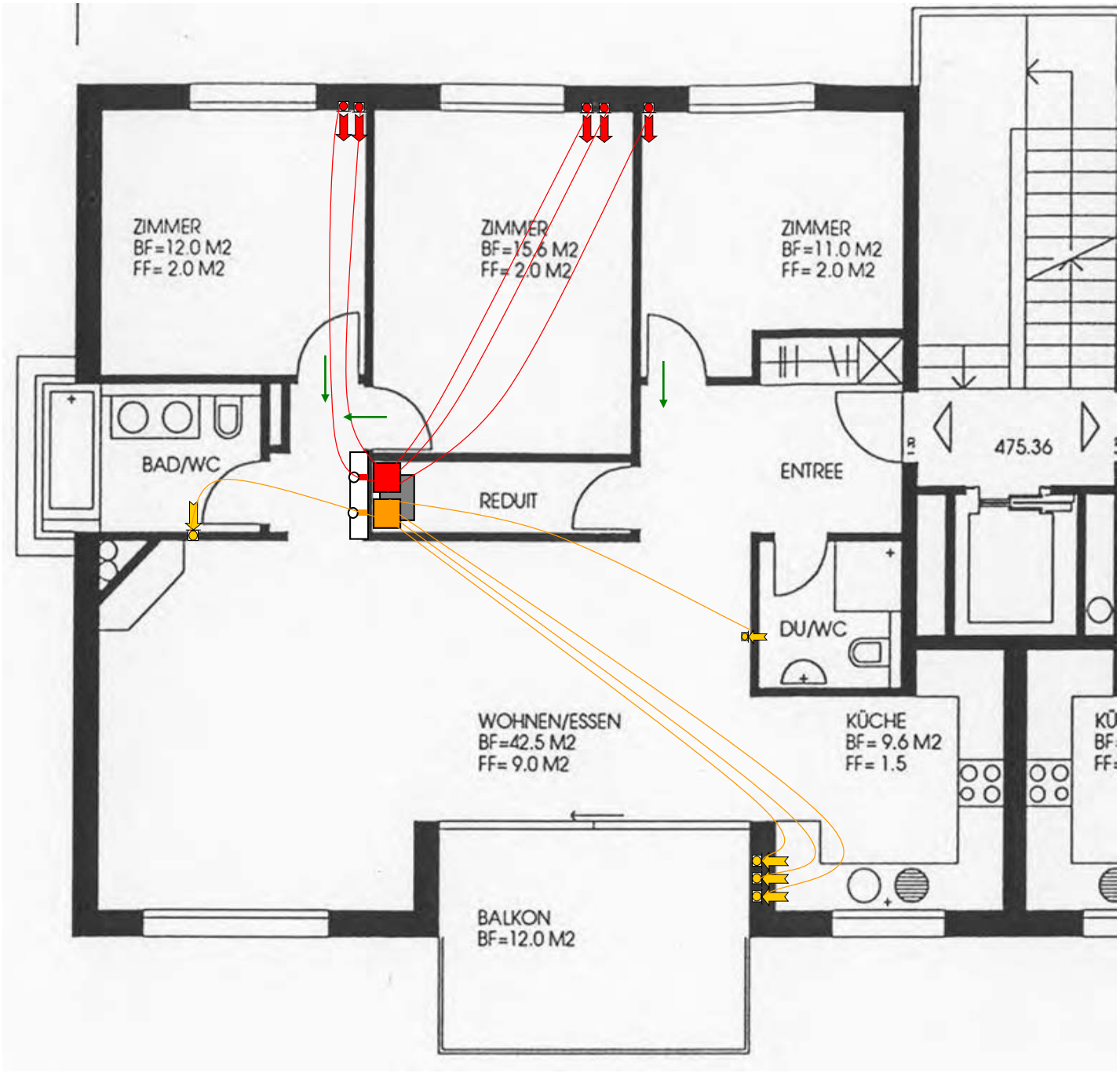
Health and Comfort Concerns

- Humidity
- Excess CO_2
- VOC's
- Odors
- Allergens
- Temperature




SUPPLY
walk-in
closet
(if existing)
bedroom/
guestroom
hallway
living/
dining
kitchen/
bathroom
RETURN

Solution With HRV/ERV Ventilation


ZIMMER
BF=12.0 M2
FF= 2.0 M2
ZIMMER
BF=15.6 M2
FF= 2.0 M2
ZIMMER
BF=11.0 M2
FF= 2.0 M2
BAD/WC
REDUIT
ENTREE
475.36
DU/WC
WOHNEN/ESSEN
BF=42.5 M2
FF= 9.0 M2
KÜCHE
BF= 9.6 M2
FF= 1.5
BALKON
BF=12.0 M2

Increased Comfort with a Ventilation System with Heat Recovery

Efficient mold protection: Fresh air is provided and excess humidity is removed automatically

Efficient noise barrier and protection against dust: Preheated and filtered air is provided draft-free at closed windows

Summary: Health and Comfort

- Heat Recovery Ventilators
  - Removal of pollutants such as odors, smoke, VOCs etc.
  - Avoidance of humidity problems and protection of the building structure
  - Protection of the inhabitants with regard to mold
  - Filtration of the outside air as protection against pollen (allergies)
  - Generally provide more uniform distribution of fresh air

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Early «Zero Energy» Homes Example

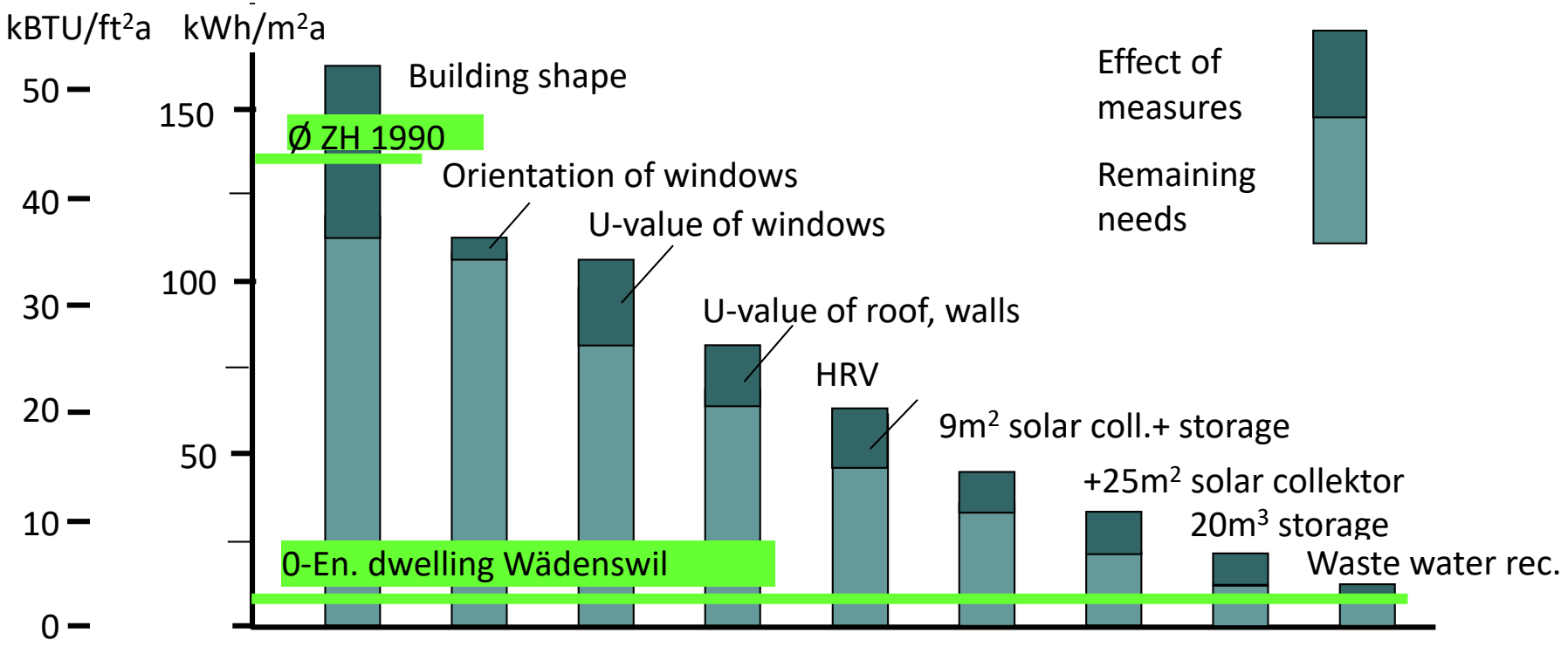
Experience with cutting edge energy efficiency with Zero-Heating-Energy-dwellings Wädenswil, 1990

Comprehensive measures to reduce consumption and to use solar heat

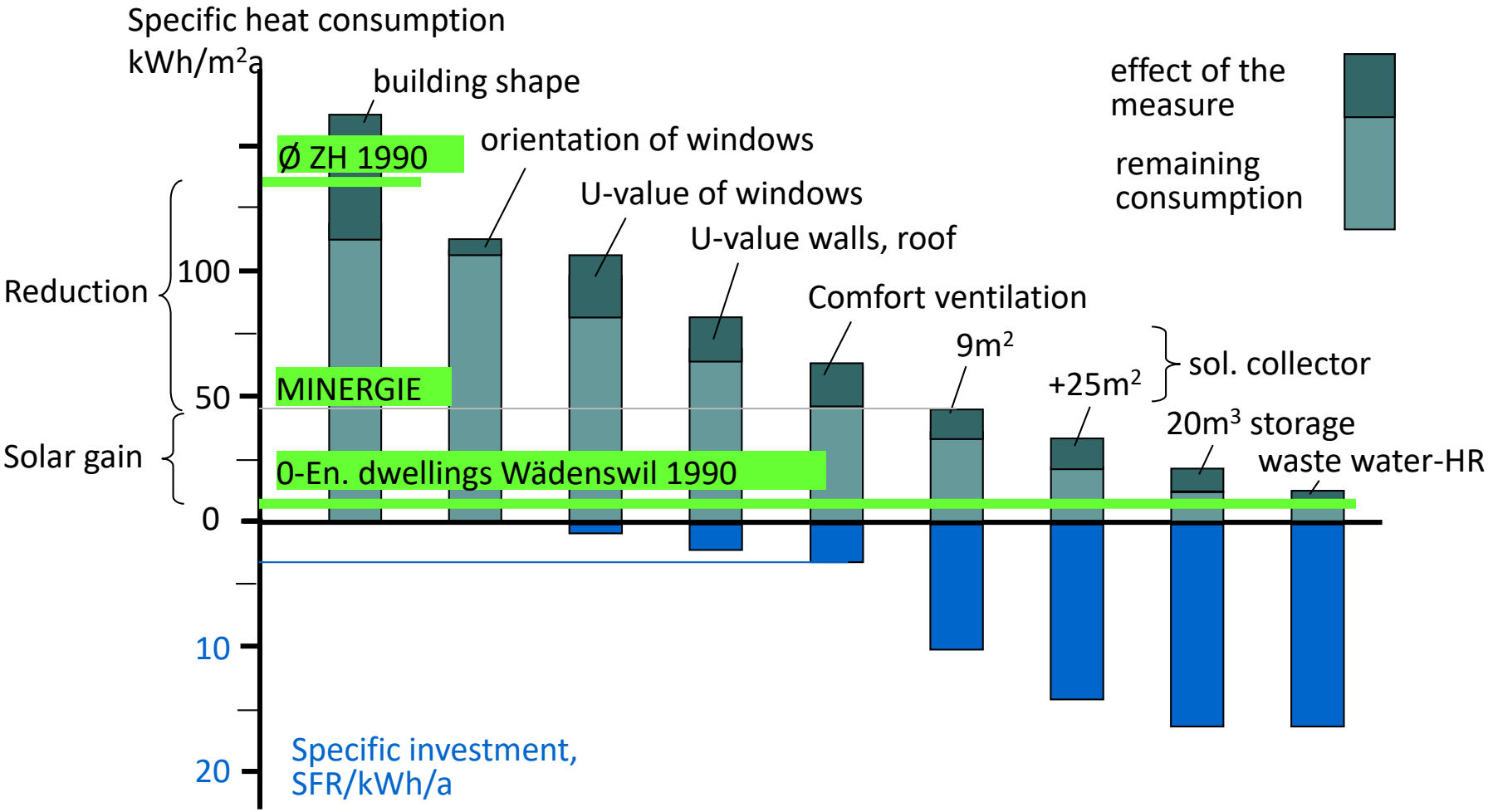
600 pounds of wood/year for space heating & DHW

Determining Factors for Energy Use in Zero Energy Homes

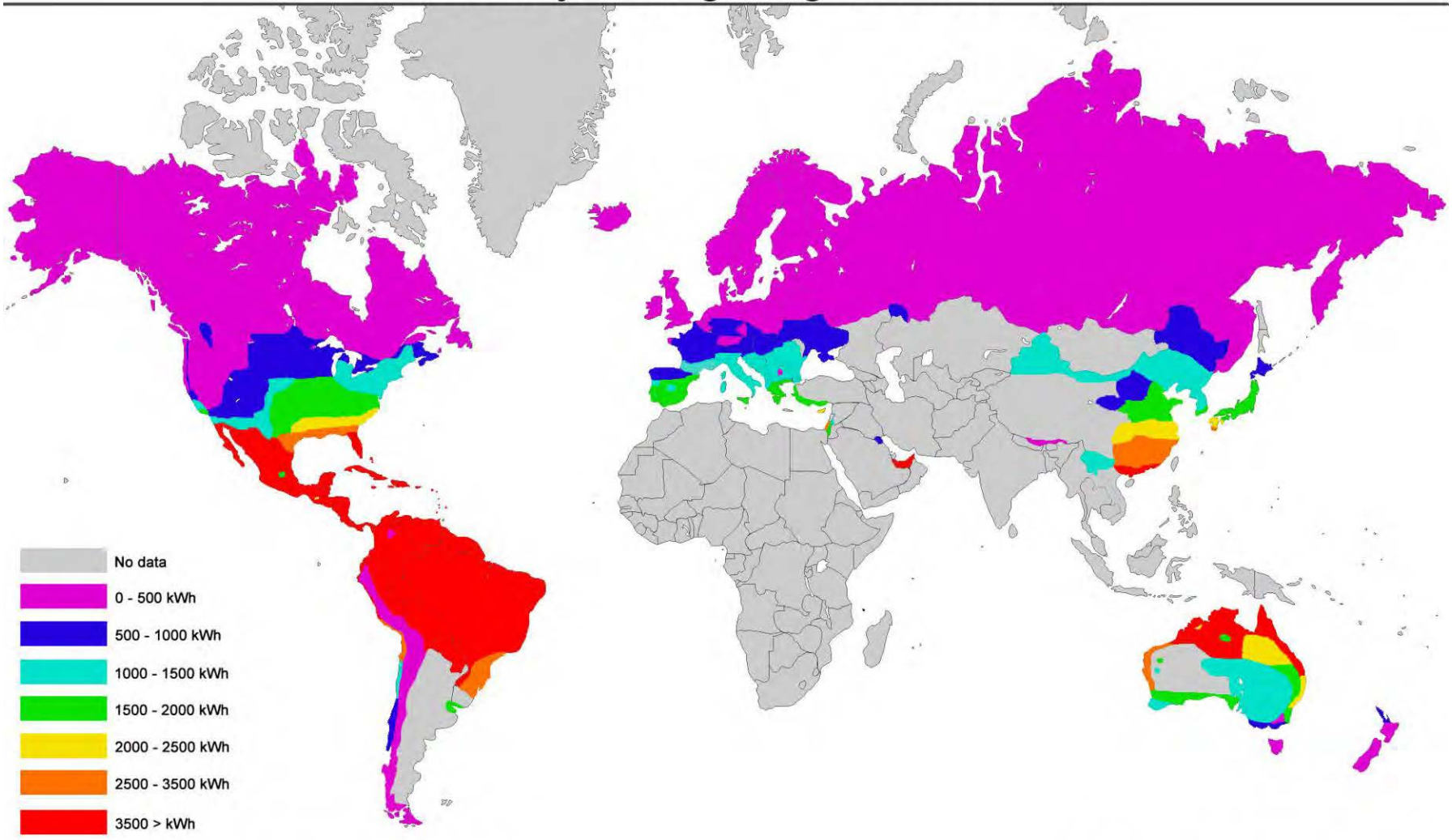
- Important reduction compared to average by shape, insulation, HRV
- First 9m^2 of solar collectors with equal gain as next 25m^2
- Solar heat storage 20m^3 with little effect



Specific Investment: Low for Reduction, High for Solar System



Yearly savings regenerator



Local variations in altitude may affect yearly savings.

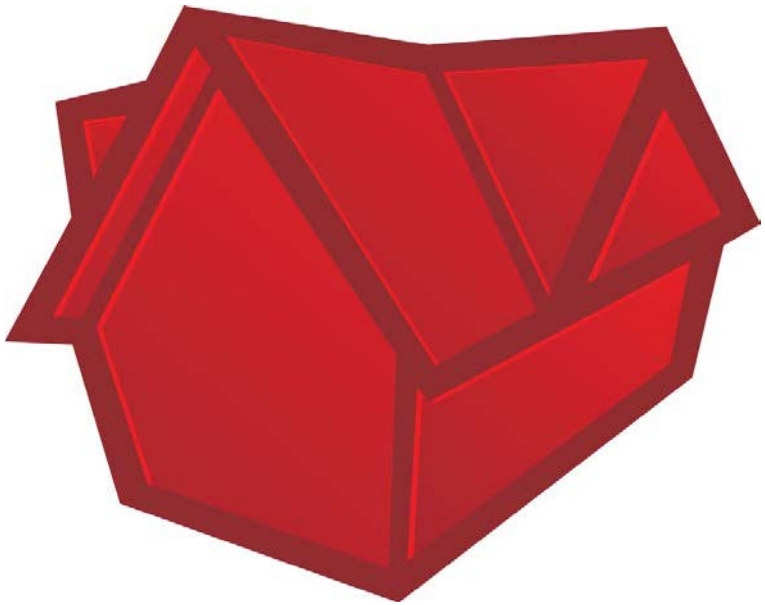
J.E. StorkAir, J.H. Halfwerk, Sept. 2008

Bath Fan vs. HRV Energy Usage

Assumptions:

- 3 Bedroom/1 bath home
- 1,500 s.f.
- 8’-0” ceiling height
- Passive House Ventilation

  0.3 ACH = 60 CFM
- Outside Air: 30°F
- Inside Air: 70°F



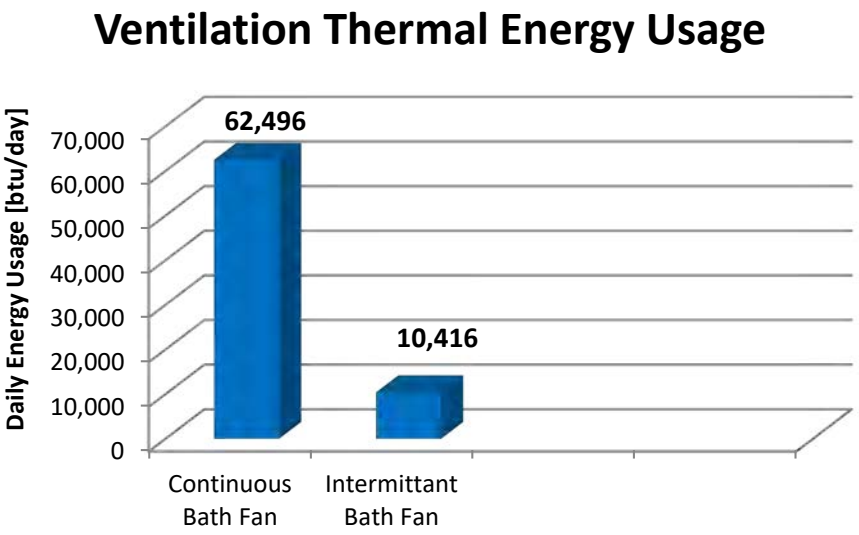
Bath Fan vs. HRV Energy Usage

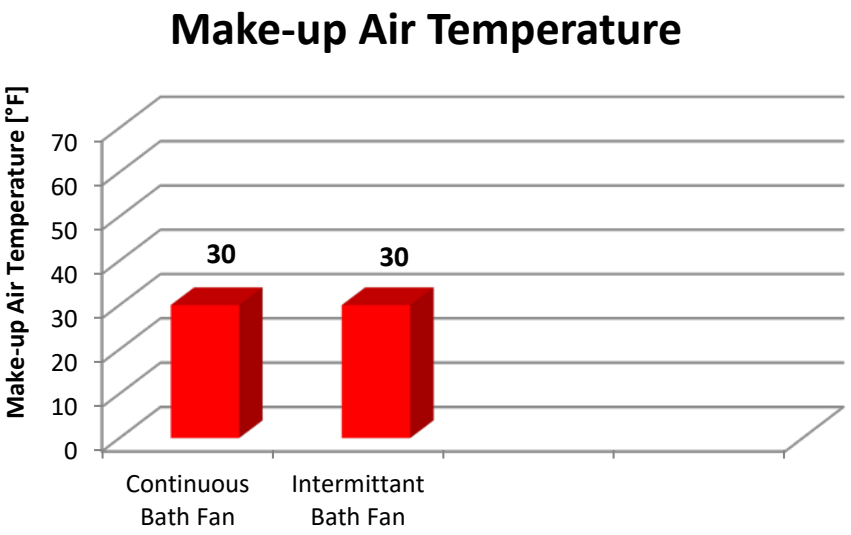
Bath Fan case, 60 CFM continuous operation:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours) = **62,496 Btu/Day**

Bath Fan Case, 120 CFM intermittent (2 hours per day):

Energy Usage = (1.085)(120 CFM)(70°F - 30°F)(2 hours) = **10,416 Btu/Day**



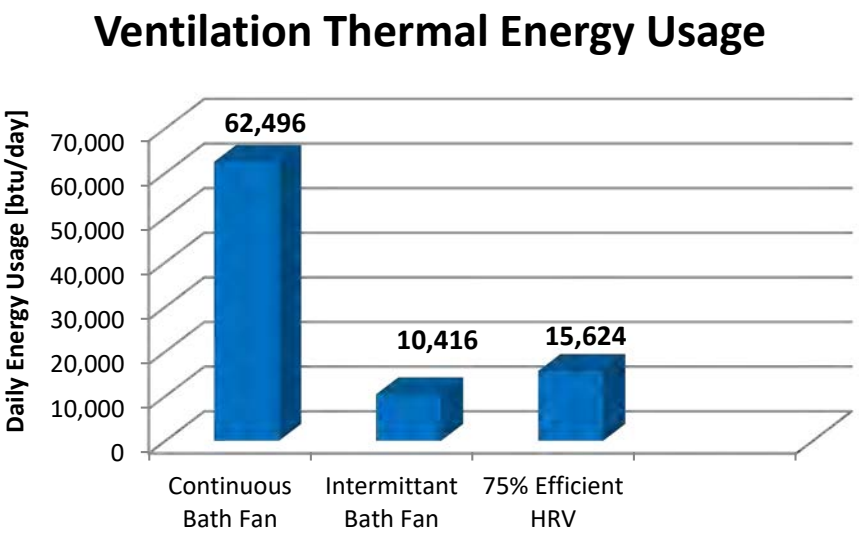


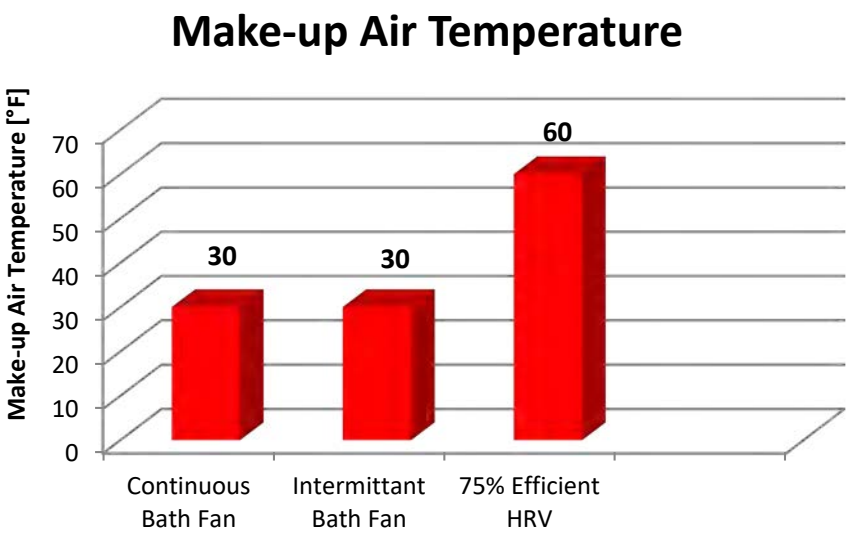
Bath Fan vs. HRV Energy Usage

75% Efficient HRV case, 60 CFM continuous:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.75) = **15,624 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.75) = **60°F**



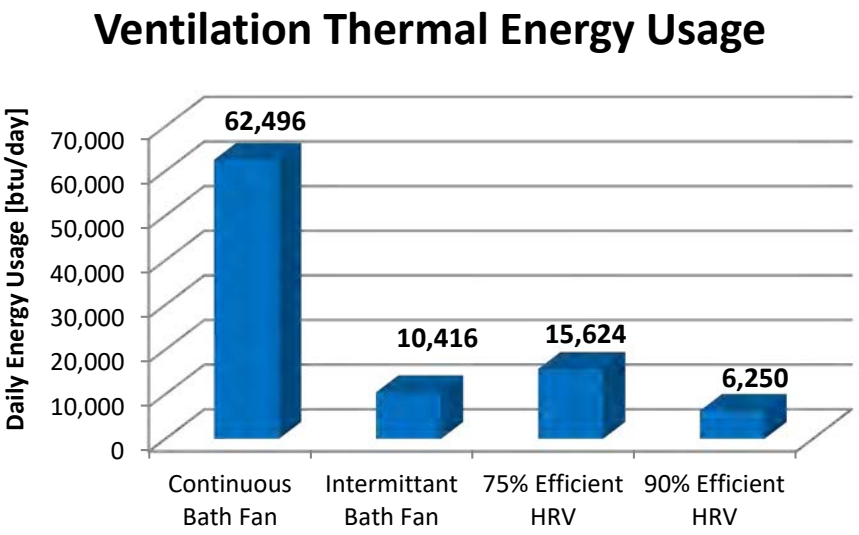


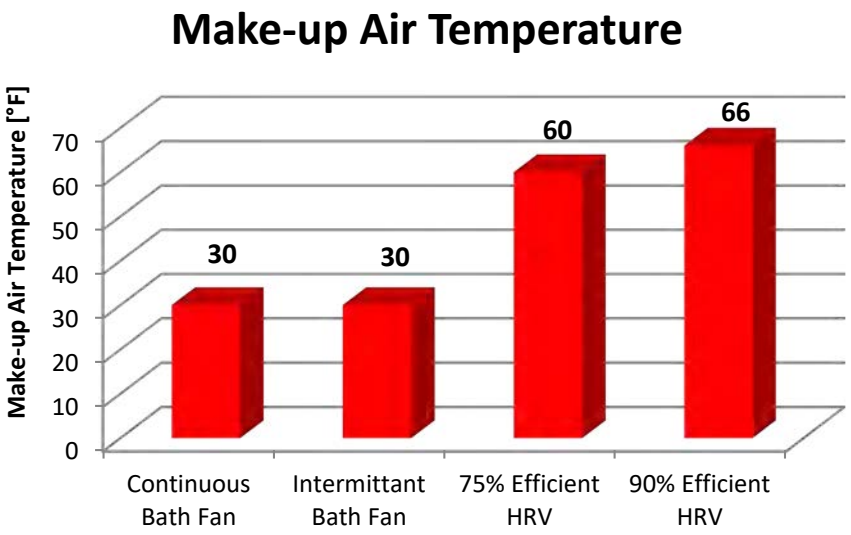
Bath Fan vs. HRV Energy Usage

90% Efficient HRV case, 60 CFM continuous:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.90) = **6,250 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.90) = **66°F**





Summary: Energy Efficiency

Heat Recovery Ventilators

- Reduce energy penalty associated with mechanical ventilation

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Components of an HRV Device

ECM motors

Lowest energy consumption

Heat recovery unit

Counter flow heat exchanger

High heat recovery > 90%

Filters

High MERV rating filters available

Ease of filter change

Control unit /display

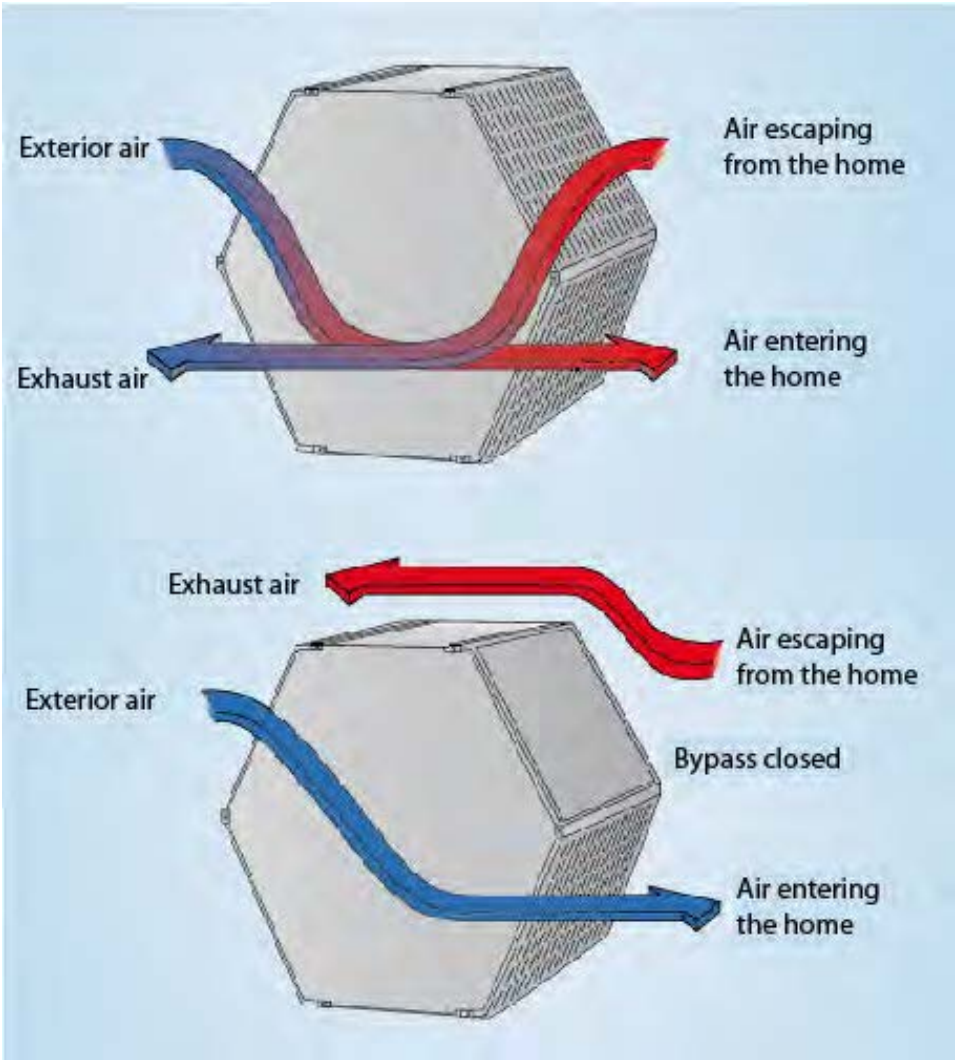
Highest functionality

Components of Heat Recovery

Heat Exchangers
- Cross counter flow
- Heat recovered > 90%

Summer bypass
- automatic
- temperature adjustable
- heat exchange

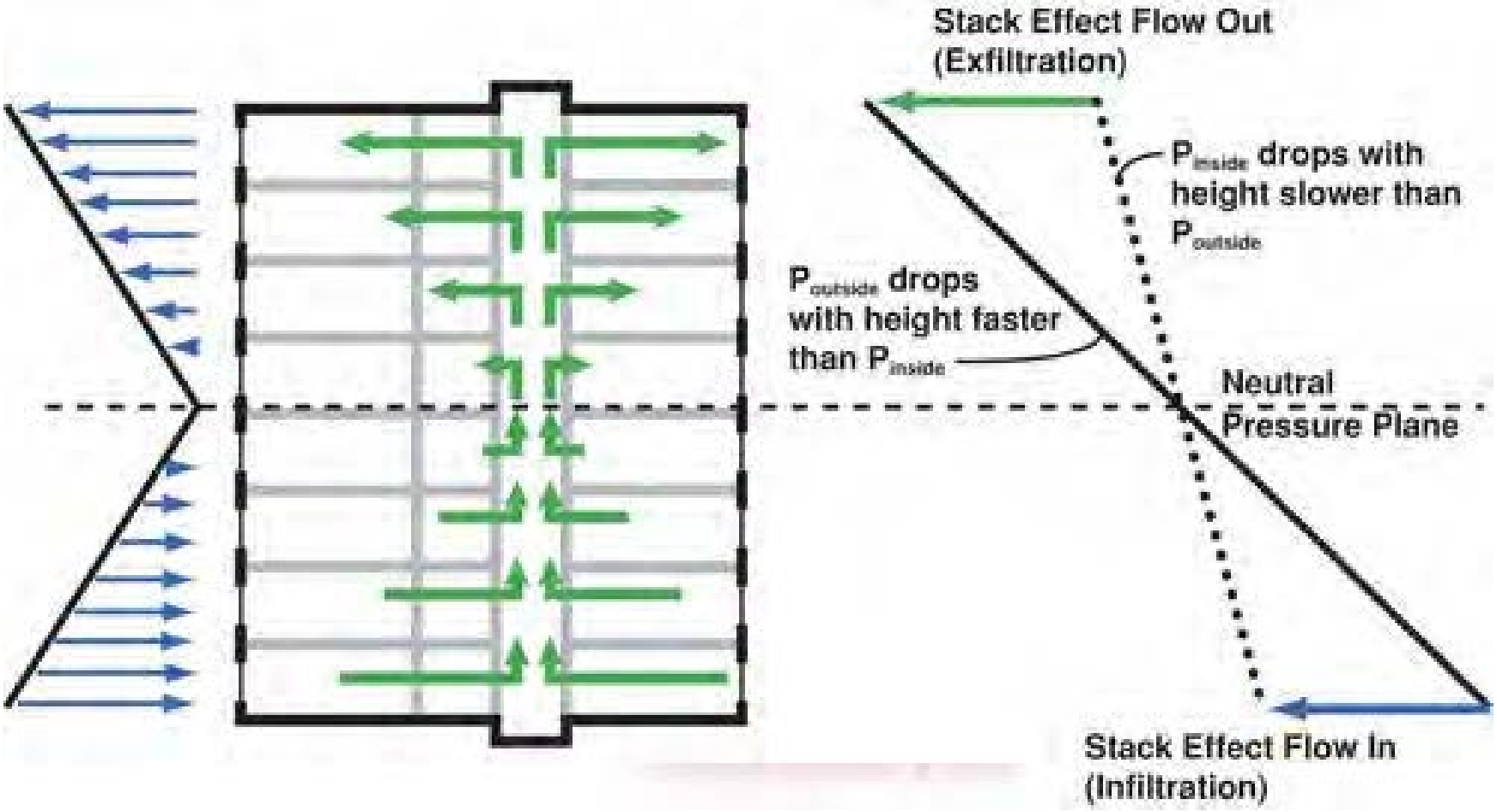
Ventilators
- efficient ECM motor
- continuously variable
- quiet operation



HRV or ERV

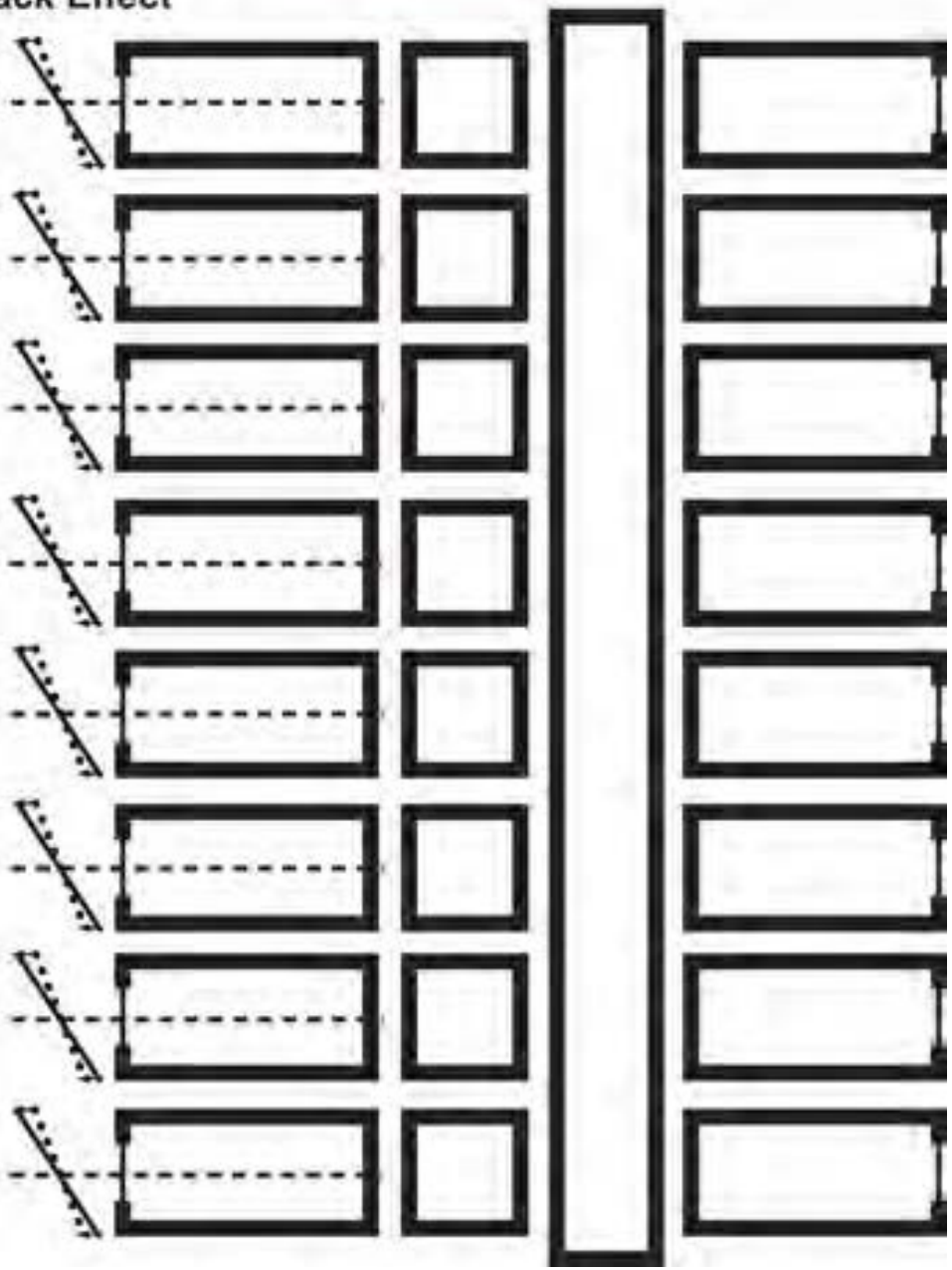
Driven by:

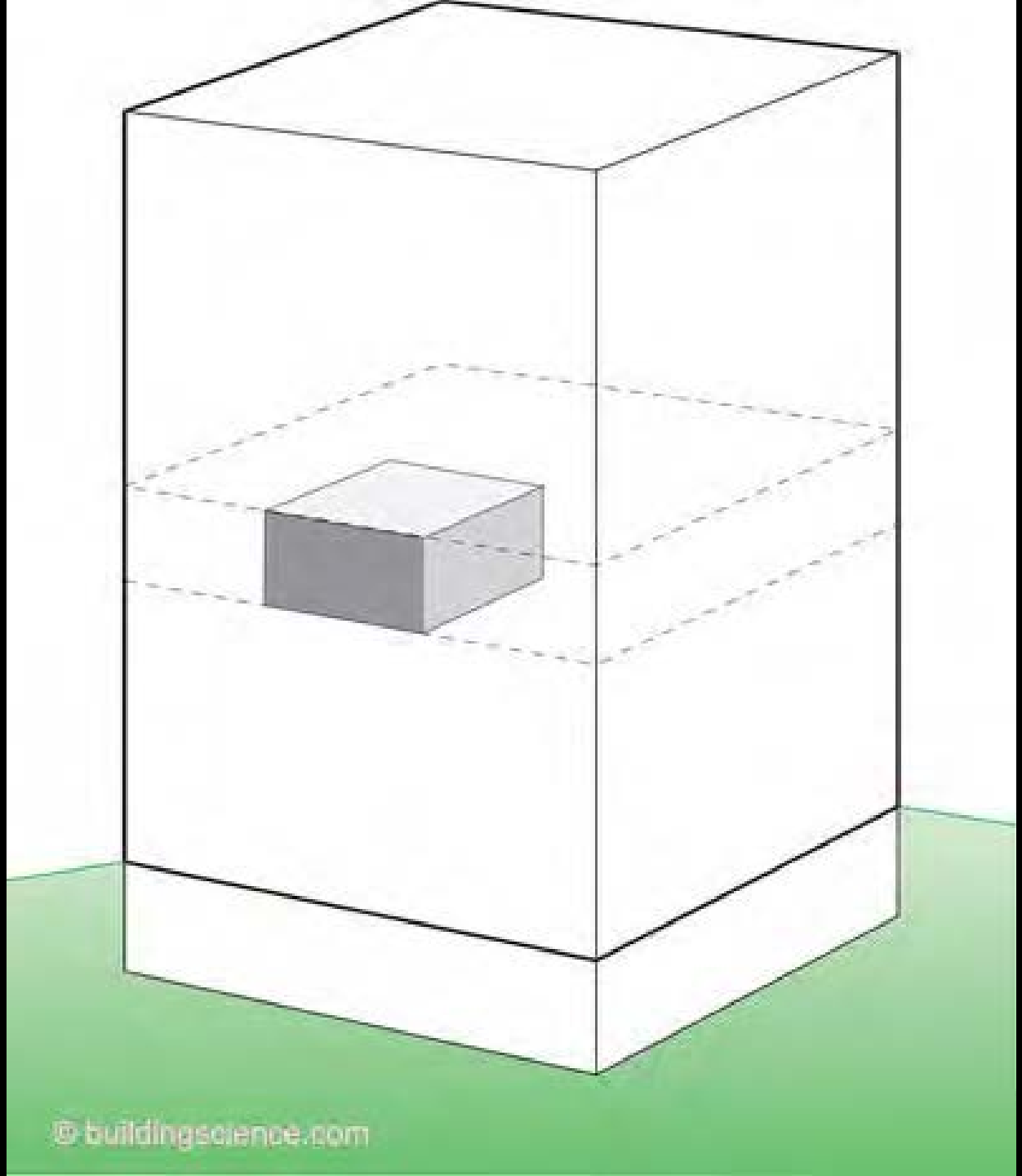
- Occupancy
- Climate
- Efficiency
- Dehumidification


Stack Effect Flow Out
(Exfiltration)
P_{inside} drops with
height slower than
$P_{outside}$
$P_{outside}$ drops
with height faster
than P_{inside}
Neutral
Pressure Plane
Stack Effect Flow In
(Infiltration)


SCBC Bank

Reduced Individual
Unit Stack Effect

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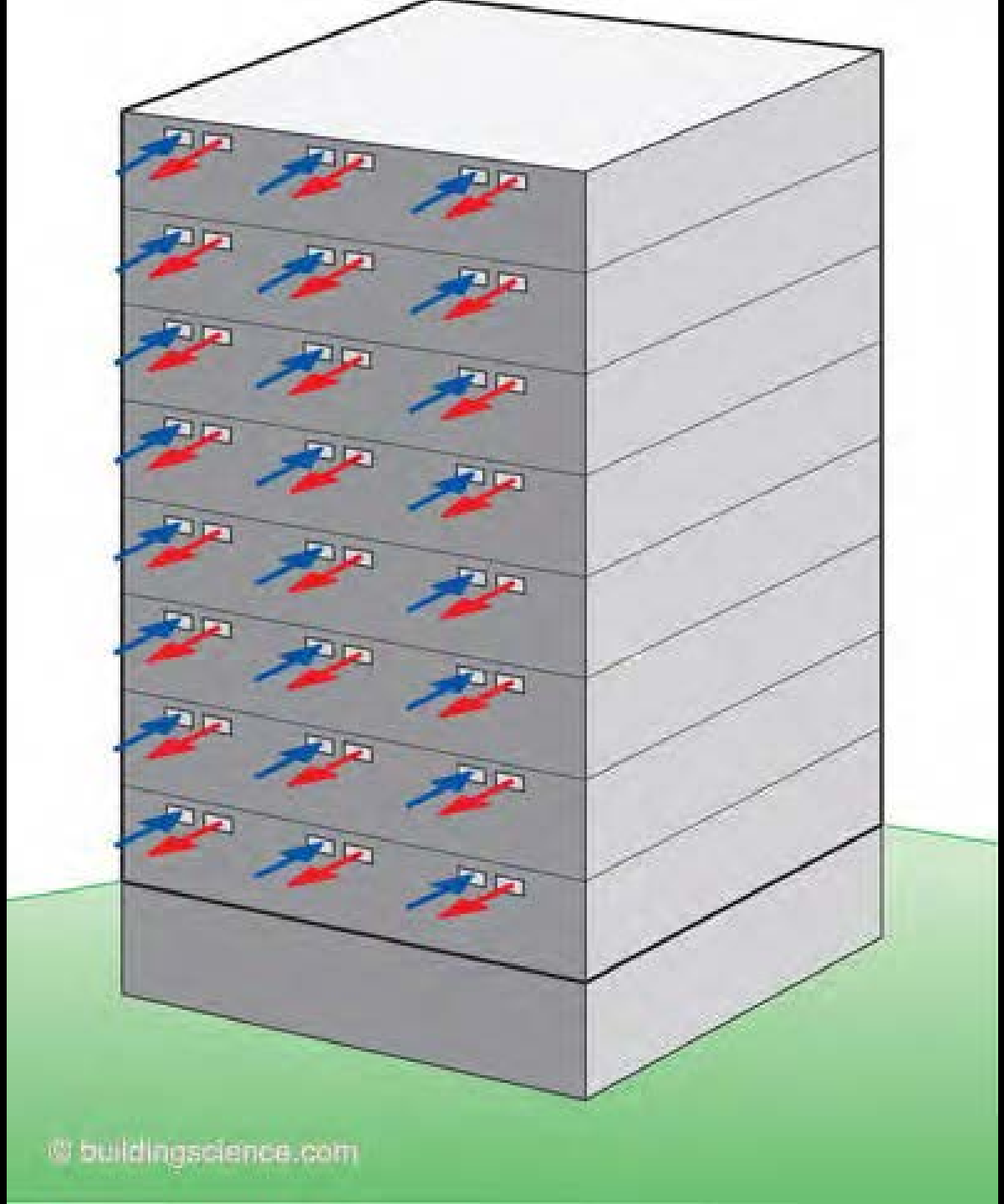
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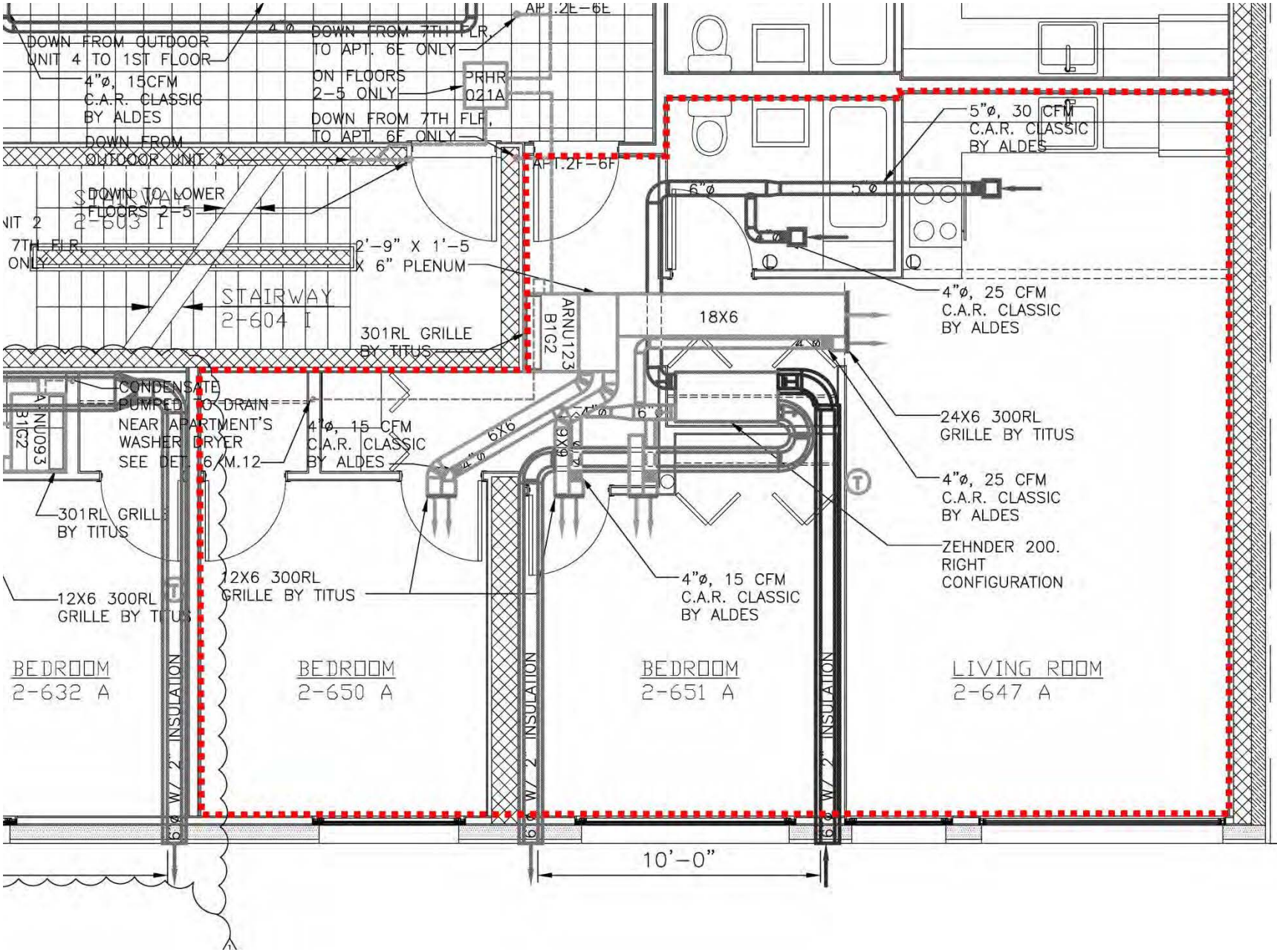
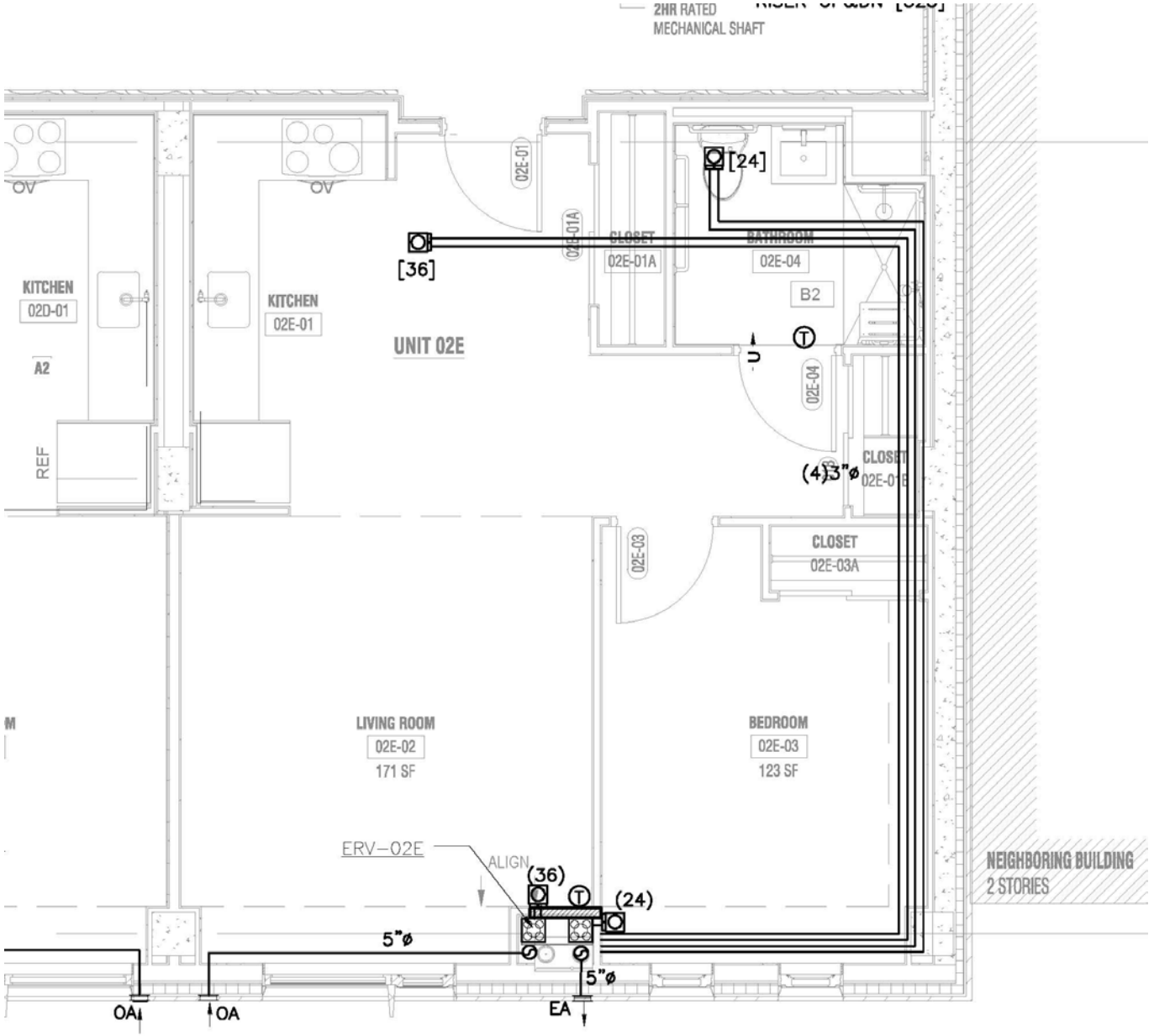
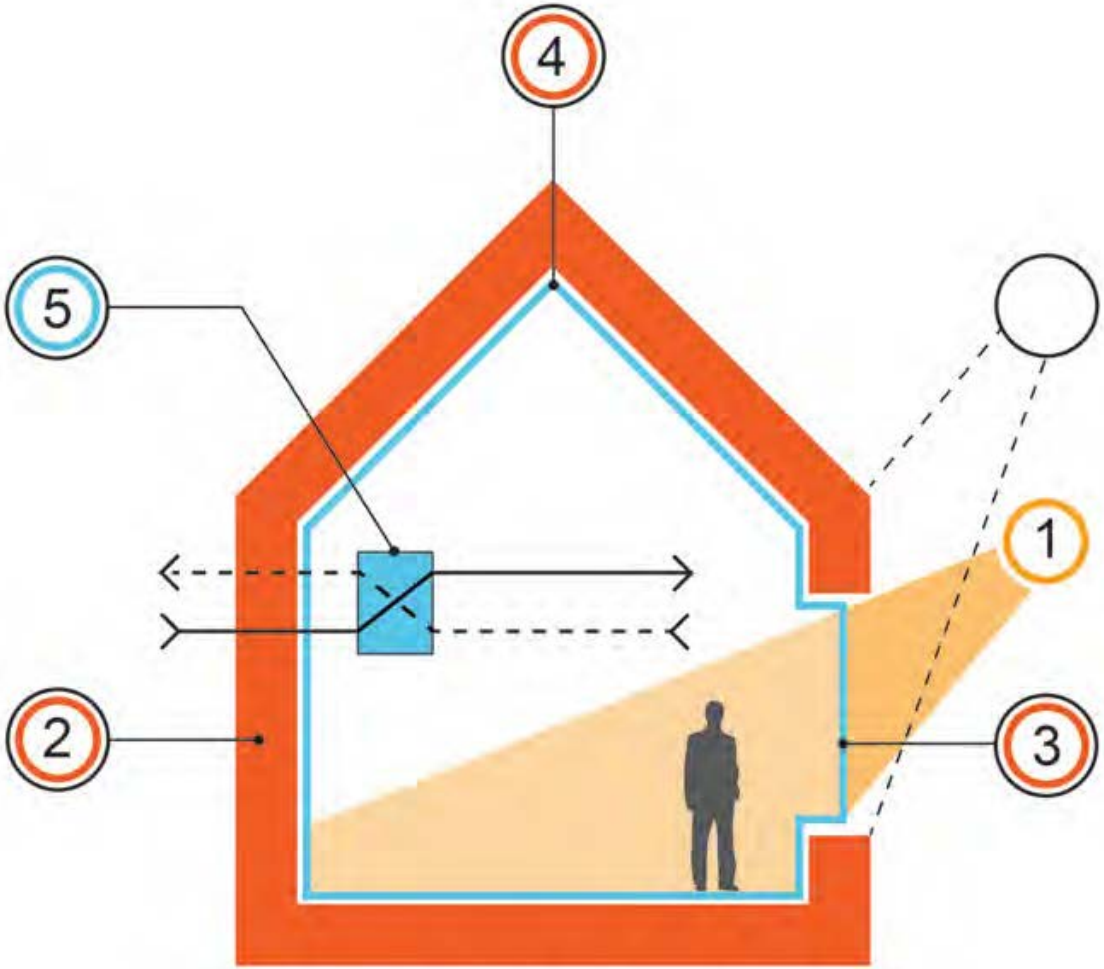
ONE WAY


DOWN FROM OUTDOOR UNIT 4 TO 1ST FLOOR
4"ø, 15CFM C.A.R. CLASSIC BY ALDES
4"ø
DOWN FROM 7TH FLR. TO APT. 6E ONLY
ON FLOORS 2-5 ONLY
PRHR 021A
DOWN FROM 7TH FLR. TO APT. 6F ONLY
APT.2E-6E
APT.2F-6F
DOWN FROM OUTDOOR UNIT 3
DOWN TO LOWER FLOORS 2-5
UNIT 2
2-603 I
7TH FLR. ONLY
2'-9" X 1'-5 X 6" PLENUM
STAIRWAY
2-604 I
301RL GRILLE BY TITUS
ARNU123 B1G2
18X6
5"ø, 30 CFM C.A.R. CLASSIC BY ALDES
6"ø
5"ø
4"ø, 25 CFM C.A.R. CLASSIC BY ALDES
24X6 300RL GRILLE BY TITUS
4"ø, 25 CFM C.A.R. CLASSIC BY ALDES
ZEHNDER 200. RIGHT CONFIGURATION
ARNU093 B1G2
CONDENSATE PUMPED TO DRAIN NEAR APARTMENT'S WASHER DRYER SEE DET. 6/M.12
4"ø, 15 CFM C.A.R. CLASSIC BY ALDES
6X6
4"ø
7"ø
6"ø
9X9
4"ø, 15 CFM C.A.R. CLASSIC BY ALDES
301RL GRILLE BY TITUS
12X6 300RL GRILLE BY TITUS
12X6 300RL GRILLE BY TITUS
BEDROOM 2-632 A
BEDROOM 2-650 A
BEDROOM 2-651 A
LIVING ROOM 2-647 A
6"ø W/ 2" INSULATION
6"ø W/ 2" INSULATION
6"ø W/ 2" INSULATION
10'-0"


2HR RATED
MECHANICAL SHAFT
KITCHEN
02D-01
A2
REF
KITCHEN
02E-01
UNIT 02E
02E-01
02E-01A
CLOSET
02E-01A
[36]
[24]
BATHROOM
02E-04
B2
02E-04
(4)3"ø
CLOSET
02E-03
CLOSET
02E-03A
LIVING ROOM
02E-02
171 SF
BEDROOM
02E-03
123 SF
ERV–02E
ALIGN
(36)
(24)
5"ø
5"ø
OA
OA
EA
NEIGHBORING BUILDING
2 STORIES

V–R–2



PASSIVE HOUSE PRINCIPLES

1. SOLAR ORIENTATION
2. HIGH INSULATION
3. HIGH PERFORMANCE WINDOWS
4. AIR TIGHT ENCLOSURE
5. BALANCED VENTILATION WITH HEAT RECOVERY

RPA
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This concludes

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Thank you for your time.

Any questions?

John H. Rockwell

Technical Sales Engineer

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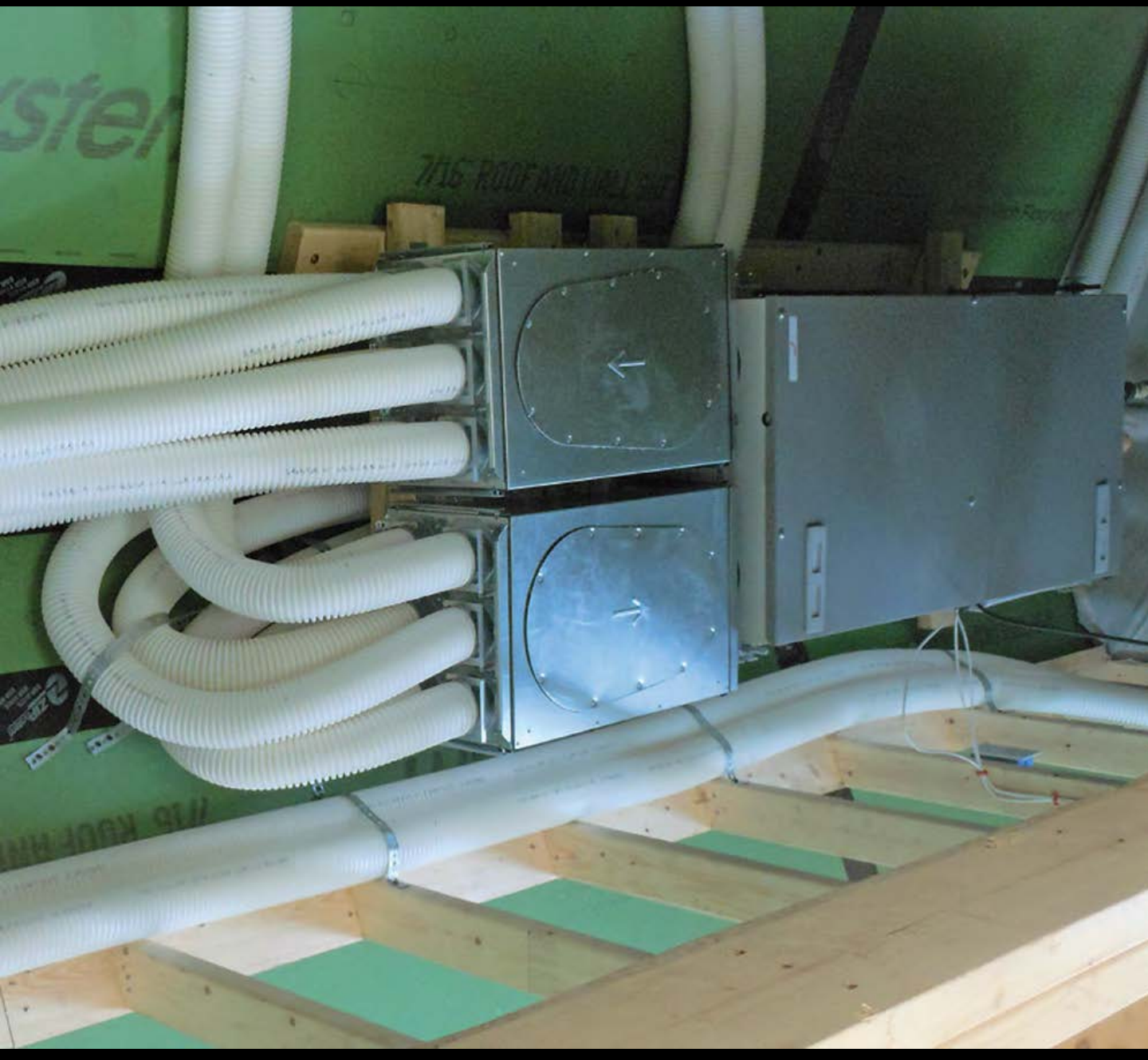


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