### OREGON HOUSING & COMMUNITY SERVICES Multifamily Energy Program

# Effective Ventilation Strategies for Multifamily

Date: September 13, 2018

Presenter: Matt Christie

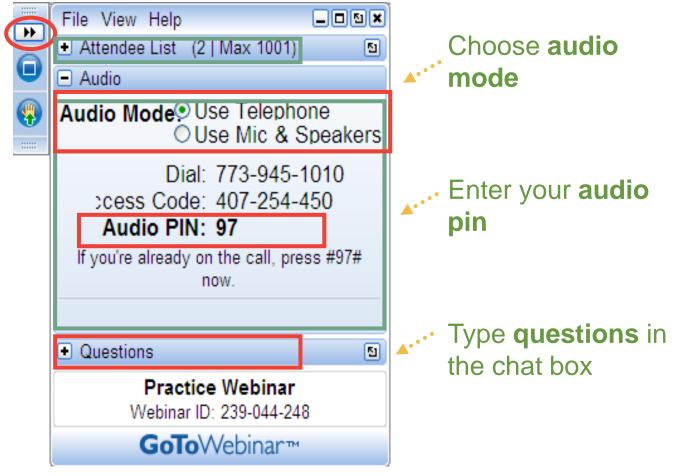




# **USING GOTOWEBINAR**

Open and close ....\* your **control panel** 

Questions will be taken at the end of the presentation.







### **REGISTER FOR UPCOMING TRAININGS**

Thursday, September 27, 2018, 12pm:

Planning for Energy Efficiency Upgrades | REGISTER NOW

• Thursday, October 11, 2018, 12pm:

Optimizing Multifamily Building Operations | REGISTER NOW



### AGENDA

- Ventilation Basics
- Ventilation Strategies & Value Proposition
- Ventilation Standards & Guides
- Business Case for Prioritizing Systems
- Questions Call to Arms





# **VENTILATION BASICS**

- Why Ventilate?
- Natural vs Mechanical Ventilation
- Build Tight & Ventilate Right

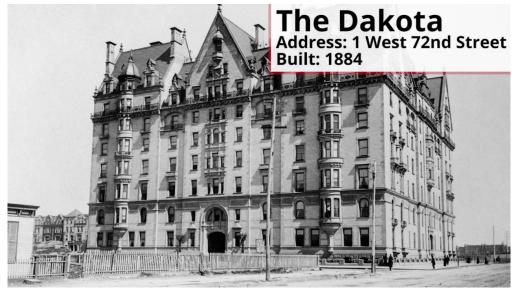




## WHY DO WE VENTILATE?

### Buildings have changed

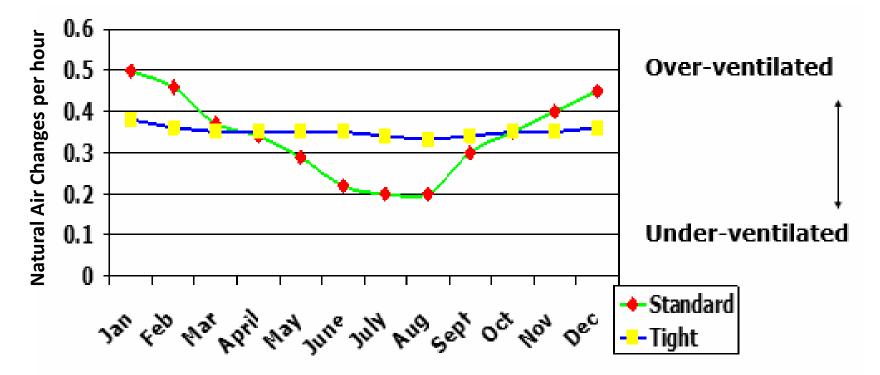
- New materials
- Codes and standards
- Tighter buildings
- Siting and land development has changed







### WHY NOT NATURAL VENTILATION?



Natural Ventilation Rates vs Average Outdoor Temperatures





### WHY NOT NATURAL VENTILATION?



# Stack effect in the real world.





# **BUILD TIGHT AND VENTILATE RIGHT**

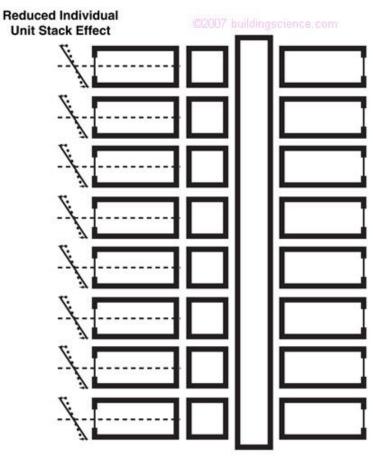


# Standard packages vs high value targets

Image courtesy Aeroseal







Compartmentalized air sealing = top priority

### **VENTILATION STRATEGIES** & VALUE PROPOSITION

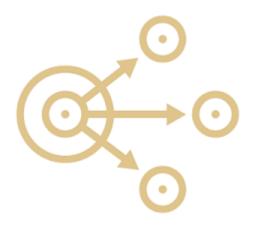
- Exhaust Ventilation
- Supply Ventilation
- Balanced Ventilation





## **GREAT VENTILATION PROVIDES...**

### DISTRIBUTION



FILTRATION



BALANCE



Distributed air into each living space. Filtration of fresh air and/or room air. Balanced pressures that discourage strong pressures in rooms/units.





## **EXHAUST ONLY**

- Advantages
  - Inexpensive

### Disadvantages

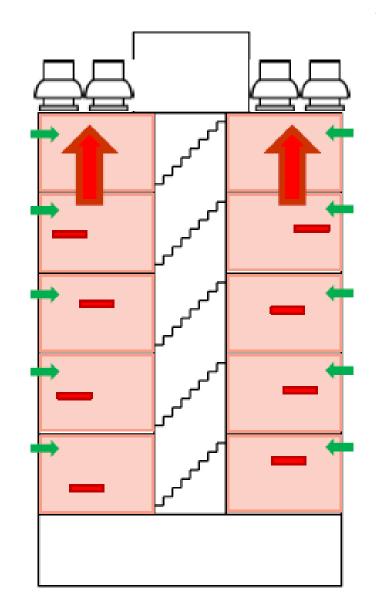
- May not provide adequate ventilation
- May add to energy consumption
- May pull odors from neighbors
- Not balanced
- Not filtered
- Not distributed

### Best Application

 Exhaust fan efficiency is > 4.0 cfm/Watt, continuous run, paired with + pressure hallways



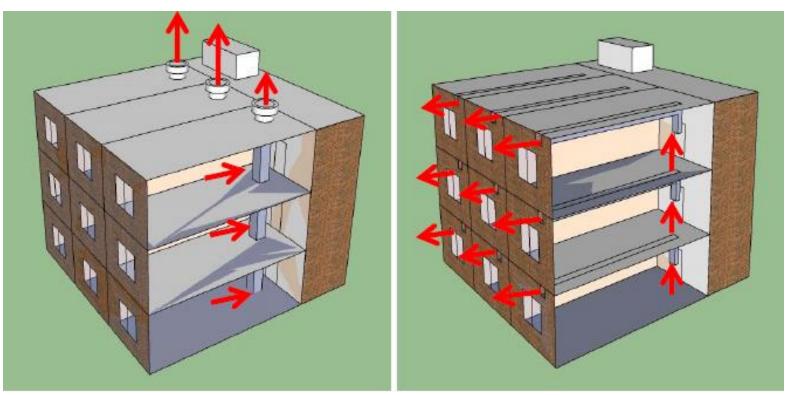




### **EXHAUST VENTILATION**

### **Central Exhaust**

### **Unitized Exhaust**







# **SUPPLY ONLY**

- Advantages
  - Relatively inexpensive
  - Potentially good air distribution
  - Potential to add filtration

#### Disadvantages

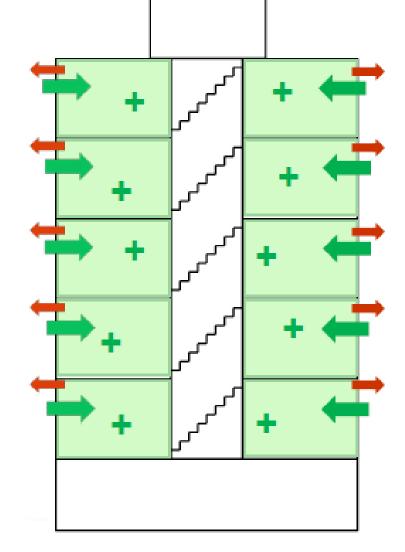
- Not common on a per unit basis
- May push pollutants/moisture into cavities/other units
- Outside air reduces the heating and cooling capacity of the H/AC system(s)
- May lead to comfort issues (outdoor temp, humidity)

#### Best Application

- Dry climates
- When spot ventilation is well controlled
- Set to run continuous with fan efficiency is > 4.0 cfm/Watt







## **BALANCED – UNIT HRV/ERV**

#### Advantages

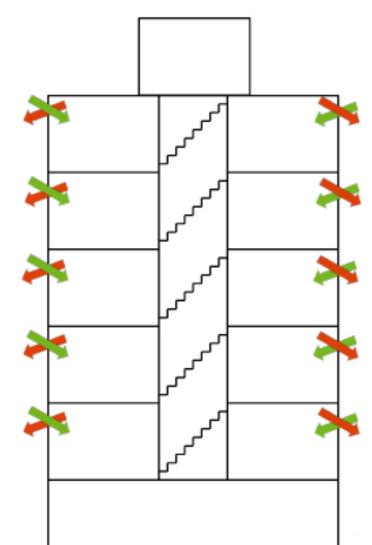
- Balanced ventilation
- Good air distribution
- Potentially saves energy (with good fan)
- Good filtration options

#### Disadvantages

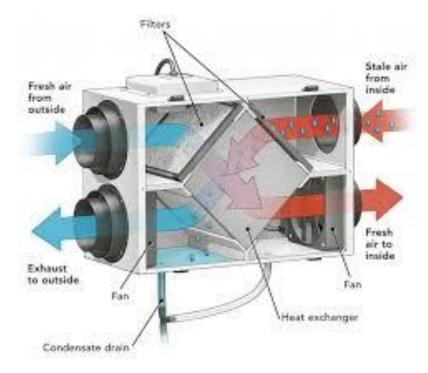
- Increased cost
- Requires running independent ducting into rooms, or multiple units
- Not all systems distribute into all rooms
- Requires commissioning and balancing
- Best Application
  - Cost of operation and moisture control are main drivers

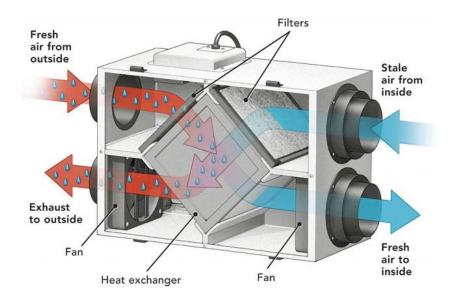






### BALANCED VENTILATION – WITH RECOVERY





#### Heat Recovery Ventilator

#### **Energy Recovery Ventilator**





### **IN-UNIT HRV/ERV**

### Package ERV

### Small Thru-wall Models

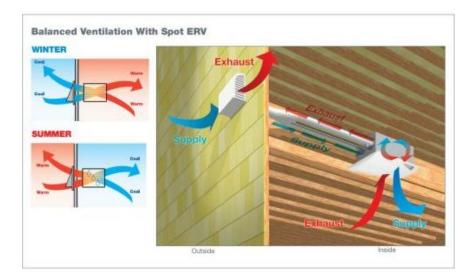




Image courtesy Lunos

#### Image courtesy Building America





### VENTILATION STANDARDS & GUIDES

- Oregon Code
- ASHRAE
- Building Science Corporation (BSC)
- International Code Council (ICC)





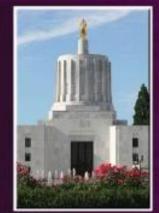
### **OREGON CODE**

#### 2014 OR Mech Specialty Code

Baseline for ventilation in new and existing multifamily buildings and to confirm compliance in regulatory and non-regulatory settings. Based on the 2012 International Mechanical Code

http://ecodes.biz/ecodes\_support/free\_resources/Oregon/1 4\_Mechanical/14\_ORMech\_main.html





#### 2014 Oregon Mechanical Specialty Code

Based on the 2012 International Mechanical Code<sup>1</sup> and the 2012 International Fuel Gas Code<sup>1</sup>





### ASHRAE



ANSI/ASHRAE Standard 62.2-2013 (Supersedes ANSI/ASHRAE Standard 62.2-2010) Includes ANSI/ASHRAE addenda listed in Appendix C

#### Ventilation and Acceptable **Indoor Air Quality** in Low-Rise **Residential Buildings**

See Appendix C for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the Ame National Standards Institute.

This standard is under continuous mantenance by a Standard Standard Project Committee (SPC) for which the Standards Committee has exabilited a documented program for regular publication of addends or reveales, including procedures for many, of documented, commands and non reveales to reduce is only and for the standard. The change shared for the standard in distances form the normal K-SPA website (swwaarhard and get an

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Used as a standard for **multifamily** building dwelling units

#### **ASHRAE 62.1**

See Appendix J for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

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ANSI/ASHRAE Standard 62.1-2013

Ventilation

(Supersedes ANSI/ASHRAE Standard 62.1-2010)

ANSI/ASHRAF addenda listed in A

for Acceptable

**Indoor Air Quality** 

Used for low-rise multifamily corridors and common areas



ANSI/ASHRAE/IES Standard 90.1-2013 (Supersedes ANSI/ASHRAE/IES Standard 90.1-2010) Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

**Energy Standard** for **Buildings Except Low-Rise Residential Buildings** (I-P Edition)

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This standard is valet concisions maintenance by Alonday Standard Payser Commission (SIC) for which the Standards Com-ments In statistical exclosement program (nor genergiz production of station or revisions, reading production for integra-documented, comments action on respect for charge is any part of the standard. The denge substitute from, instruction, and allocations may be obtained in electronic time from the AMARK 14 bias (station action action action action action stations). The station action acti a.orgip

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#### **ASHRAE 90.1**

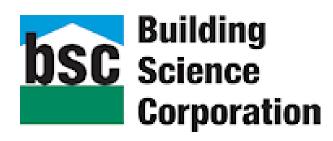
Used as a standard for high-rise multifamily buildings

https://www.ashrae.org/technical-resources/standards-and-guidelines





# **BUILDING SCIENCE CORPORATION & INTERNATIONAL MECHANICAL CODE**





#### BSC GM-1501 Ventilation Guide

Provides mechanical ventilation requirements of occupied spaces in new low-rise residential buildings

https://buildingscience.com/documents/special /ventilation-new-low-rise-residential-buildings





#### ICC International Mechanical Code

Baseline for ventilation in new and existing multifamily buildings and to confirm compliance in regulatory and non-regulatory settings.

https://codes.iccsafe.org/public/document/yc7 355qxk7/chapter-4-ventilation

# **DWELLING-UNIT VENTILATION**

#### **Minimum Ventilation Rate for Dwelling Units**

- OR MSC: Ventilation Rate (CFM) = 15 cfm x (Number of Bedrooms + 1)
- ASHRAE: Ventilation Rate (CFM) = 0.03 X Unit Floor Area (ft<sup>2</sup>) X (Number of Bedrooms + 1)
- ICC & BSC: Ventilation Rate (CFM) = 0.01 X Floor Area (ft<sup>2</sup>) + 7.5 X (Number of Bedrooms + 1)

#### **How to Supply Minimum Ventilation**

- OR MSC: Occupied space ventilated by mechanical means, unless ACH is greater than 5
- ASHRAE & BSC: Mechanical exhaust system, supply system, or combination thereof supplying outdoor air
- ICC: Occupied space ventilated by mechanical means, unless ACH is greater than 5

#### **Controls and Operation**

• ASHRAE, OR, ICC & BSC: Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied





# **DWELLING-UNIT VENTILATION**

#### **Airflow Testing**

- ASHRAE: Ventilation devices and equipment serving individual dwelling units shall be tested<sup>1</sup>
- OR & ICC: Indoor air exhausted measured using a flow hood, flow grid, or other airflow measuring device

#### **Minimum Filtration**

- ASHRAE: MERV 6 or better<sup>2</sup> or equivalent in effectiveness
- BSC: MERV 9 or better<sup>3</sup>

#### **Adjacent Spaces**

• ASHRAE & BSC: Minimize air movement across envelope components to dwelling units from adjacent spaces

<sup>1</sup> *in accordance with ANSI/ASHRAE Standard 51/AMCA 210, or ANSI/RESNET 380-2016* <sup>2</sup> when tested in accordance with ANSI/ASHRAE Standard 52.2 <sup>3</sup> when tested in accordance with ANSI/ASHRAE Criterion 52.2





### **INTAKE & EXHAUST**

#### **Intake Air**

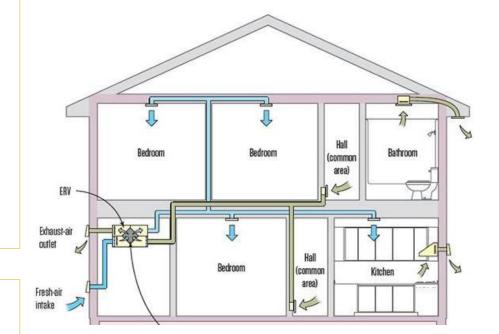
- ASHRAE, ICC, & BSC: Inlets located a minimum of 10 ft. from contaminant sources
- OR, ICC & BSC: When10 ft from intake, opening must be 3 ft below exiting contaminant sources
- ASHRAE & ICC: Openings not obstructed and protected with screen

#### **Exhaust Air**

- ASHRAE, OR, ICC, & BSC: Kitchen & bathrooms must be provided with a local exhaust
- BSC: Kitchen hood and bathroom fan Energy Star compliant & supplied with back-draft damper







### **INTAKE & EXHAUST**

#### **Exhaust Air Rate**

- ICC: Table 403.3.2.3
- OR: Table 403.3
- BSC: Similar to ICC
- ASHRAE: 62.2 Tables 5.1 & 5.2

	ST RATES FOR GROUP R-2, R-3, AND R	
AREA TO BE EXHAUSTED	EXHAUST RATE CAPACITY	
Kitchens	100 cfm intermittent or 25 cfm continuous	
Bathrooms and toilet rooms	50 cfm intermittent or 20 cfm continuous	

Application	Airflow
Enclosed Kitchen	<ul> <li>Vented range hood (including appliance-range hood combinations): 100 cfm (50 L/s)</li> <li>Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s) or a capacity of 5 acl</li> </ul>
Nonenclosed Kitchen	<ul> <li>Vented range hood (including appliance-range hood combinations): 100 cfm (50 L/s)</li> <li>Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s)</li> </ul>
Bathroom	50 cfm (25 L/s)

#### TABLE 5.2 Continuous Local Ventilation Exhaust Airflow Rates

Application	n Airflow	
Enclosed Kitchen	5 ach, based on kitchen volume	
Bathroom	20 cfm (10 L/s)	





### BUSINESS CASE FOR PRIORITIZING SYSTEMS

- Odor Control
- Moisture Control
- Cost to Operate
- Maintenance
- First Cost
- Winning Cases





# ODOR CONTROL

#### **Controlling Odors Generated In-Unit**

• Meeting both spot and whole-unit ventilation

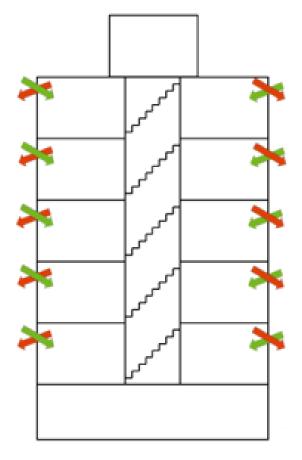
**Controlling Odors from Neighboring Units** 

- Compartmentalized air sealing PLUS
  - Balanced ventilation top option
  - Alternatively, + pressure ventilation, running continuous, with efficient fans

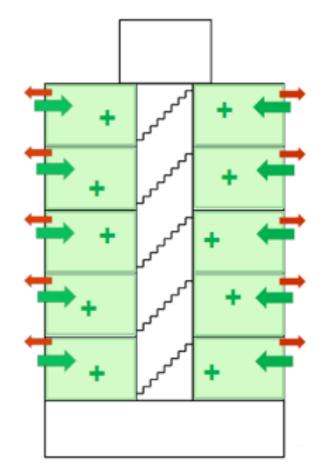




### **ODOR CONTROL**



#### **Balanced Ventilation**



**Supply Only Ventilation** 





# **MOISTURE CONTROL**

### **Controlling Relative Humidity**

- Meet both spot and whole-unit ventilation
- Exhaust whole house and exhaust spot
- Balanced system
  - HRV/ERV
  - Separate supply fan and exhaust fans (range hood or bathroom fan)

Reduce comfort complaints

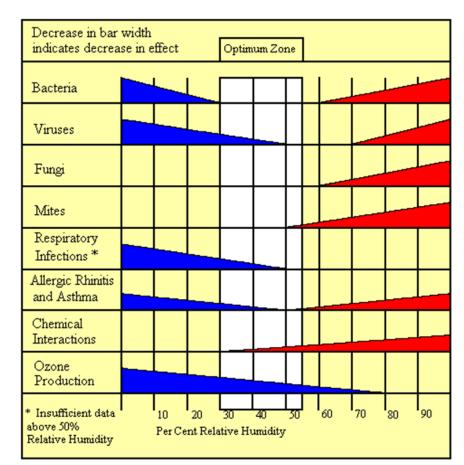
> Reduce chances of building rot

Reduce instances of mold/mildew





### **MOISTURE CONTROL**



Unmanaged moisture can lead to poor Indoor Air Quality







Unmanaged moisture can lead to build durability issues

## **COST TO OPERATE**

Cost to Heat/Cool or Dehumidify Fresh Air

• Avoid direct supplied outdoor air

#### **Cost of Fan Energy Used**

- Balanced with heat/energy recovery, preferably with low energy fan
- Exhaust strategy with efficient fan (moves >4 cfm/watt)





### **COST TO OPERATE**

#### **Balanced Ventilation with HRV**

#### ANNUAL VENTILATION COST CALCULATOR

Interested in knowing how much it might cost you to operate an AirCycler® ventilation system? Check out our Ventilation Cost Calculator for an estimated range of your annual energy cost. The range covers homes that are old and leaky (nading very life ventilation) to homes that are new and airtight (neading very more ventilation).

	Powered by Residential Energy	Dynamica, LLC 62018
Ventilation System®	Average Stand-alone HRV	~
ZIP Code 0	97701	
Floor Area	690	ft#
Bedrooms 0	1	~
Stories 0	1	~
Heating Fuel®	Electricity with heat pump	~
Electricity Price	¢ 10.8	per kWh
Anne Low-end Estimate® - Older home - Leaky (7 ACH <sub>in</sub> ) - 15 CPM ventilation		
High-end Estimate • • Newer home • Built to IECC-2012 • Air tight (3 ACH <sub>m</sub> ) • 27 CFM ventilation	or IECC-2015	
<ul> <li>Use of this web app im</li> <li>See Background and A</li> </ul>	piles acceptance of Disclaimer. Issumptions.	

#### **Exhaust Ventilation**

#### ANNUAL VENTILATION COST CALCULATOR

Interested in knowing how much it might cost you to operate an AirOycler® ventilation system? Check out our Ventilation Cost Calculator for an estimated range of your annual energy cost. The range covers homes that are old and leaky (neading very little ventilation) to homes that are new and airtight (neading more ventilation).

	Powered by Residential Energy Dyna	nica, LLC 62018
Ventilation System®	SmartExhaust	×
Exhaust Fan 0	Generic EnergyStar fan	~
ZIP Code®	97701	
Floor Area 0	690	ft#
Bedrooms ®	1	~
Stories 0	1	~
Heating Fuel®	Electricity with heat pump	~
Electricity Price 0	¢ 10.8	per kWh
Annu	al Ventilation Cost Range	
Low-end Estimate®	\$22	

Leaky (7 ACH<sub>III</sub>)
 15 CFM ventilation required



Use of this web app implies acceptance of Discialmer.
 See Background and Assumptions.





#### Source: https://www.aircycler.com/pages/calculator

### MAINTENANCE

#### **Staffed Building**

- Central exhaust systems
- Positive pressure central systems
  - Better access to filters that impact multiple units at once

#### **Un-Staffed Building**

- In unit exhaust
- In unit HRV/ERVs
  - Will require tenant education





### FIRST COST

#### Table 1. Overview of Whole-Building Ventilation Systems Evaluated and Considered in CCCRD Homes

System	Power	Approximate Installed Cost (\$)	Advantages	Disadvantages
Exhaust Fan Operating Continuously	6 W	400	<ul> <li>Low first cost</li> <li>Simplest installation</li> <li>Low operating cost</li> <li>Lowest maintenance</li> </ul>	<ul> <li>May draw air in from garage*</li> <li>OA not actively distributed</li> </ul>
CFIS **	Depends on AHU, 250 W minimum	650	<ul> <li>Low first cost</li> <li>Simple installation</li> <li>Distributed OA</li> </ul>	• High operating cost
Distributed ERV/HRV	Varies, at least 40 W	1,450–3,300	<ul> <li>Distributed OA</li> <li>Heat recovery</li> <li>Potential for low operating cost</li> </ul>	<ul> <li>High first cost</li> <li>More complex installation</li> <li>Highest maintenance</li> </ul>
Local ERV	23 W	750	<ul> <li>Heat recovery</li> <li>Low operating cost</li> </ul>	• OA not distributed

\*Could be neighboring unit or hallway

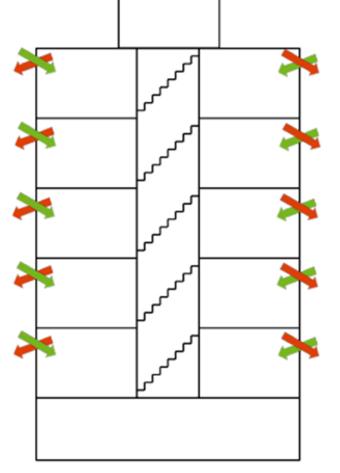
\*\*CFIS is a + pressure system integrated with a central air handler





Image courtesy of US DOE Building Technologies Program

### **OVERALL WINNERS**



**Balanced Ventilation** 





Balanced ducted systems with heat/energy recovery are a high choice for all but first cost.

1st

2nd

First cost considerations can be met with Local ERV system

Other balanced systems, or exhaust with constant flow and energy efficient fans are second best.

# QUESTION BREAK

### THANK YOU FOR ATTENDING

#### Oregon Housing and Community Services Multifamily Energy Program

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