seventhwave

Demand control ventilation:
maximize savings with practical approaches

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Acknowledgement

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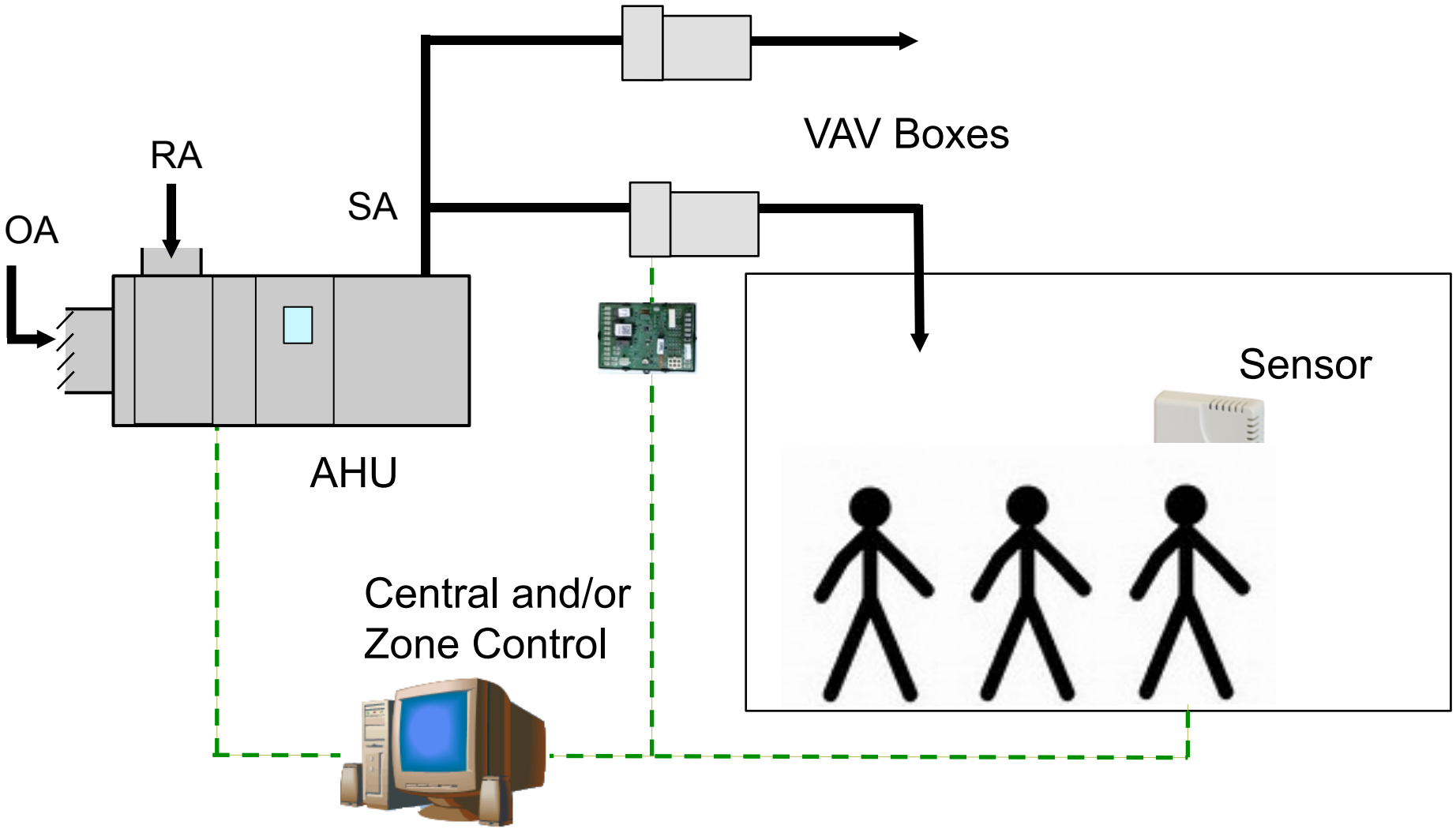
Today's topics

- Quality DCV design
- Field study results
- (Re)commissioning

Background on DCV



Source: http://i.stack.imgur.com/4WKDC.jpg

Quality DCV design

Be thorough

Choose responsible party

- Mechanical engineer
- Controls contractor
- Other (vendor, …)

Be complete:

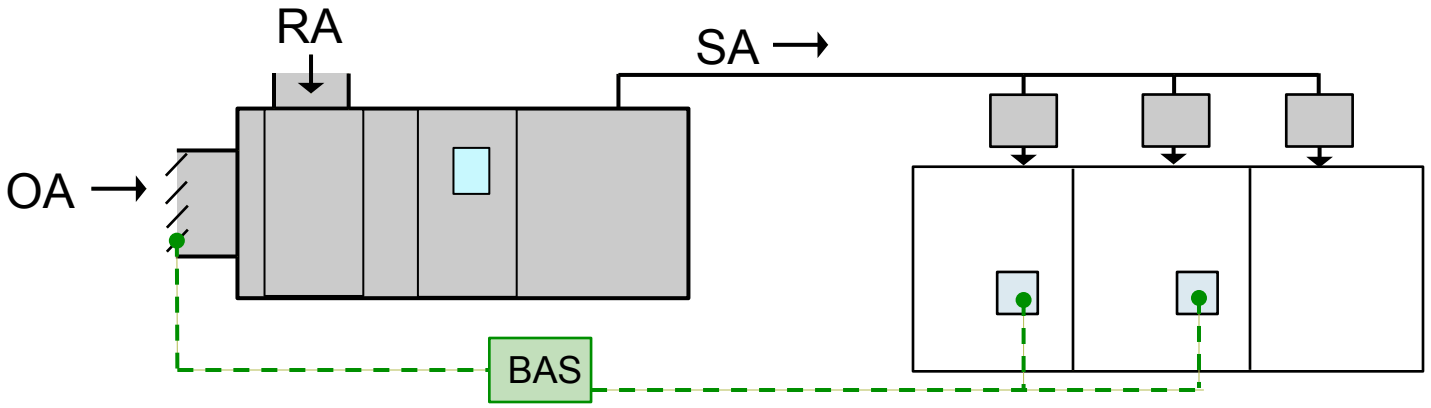
- Specific sequence
  - CO_2 setpoint
  - Outside airflow lower limit
- CO_2 sensor location
- Airflow measurement req.

Sequence options

1. Direct OA flow control

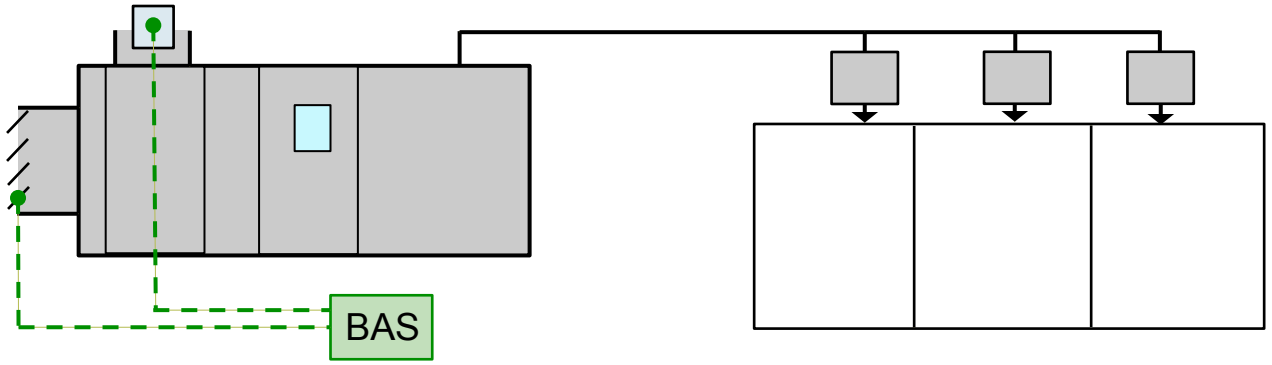
a. Zone CO_2 sensors

Slight potential for imperfect IAQ…



b. Return CO_2 sensor

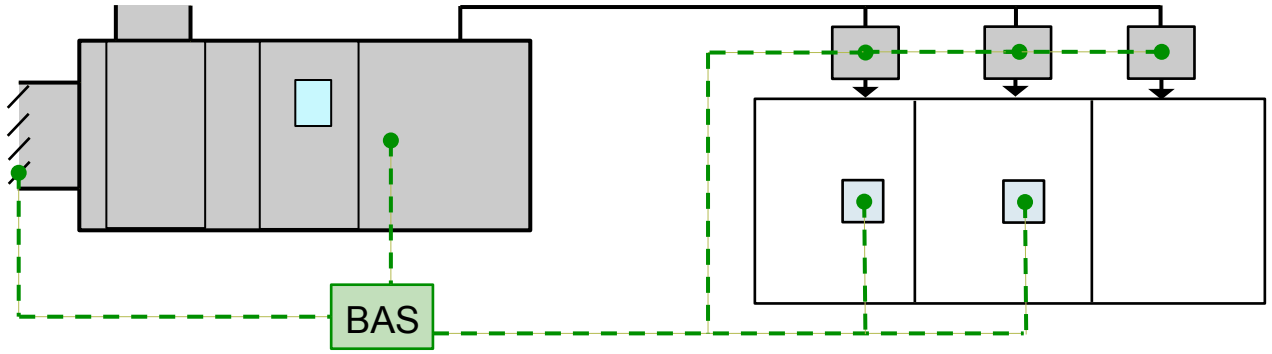
More potential for imperfect IAQ…



Sequence options

2. Ventilation reset

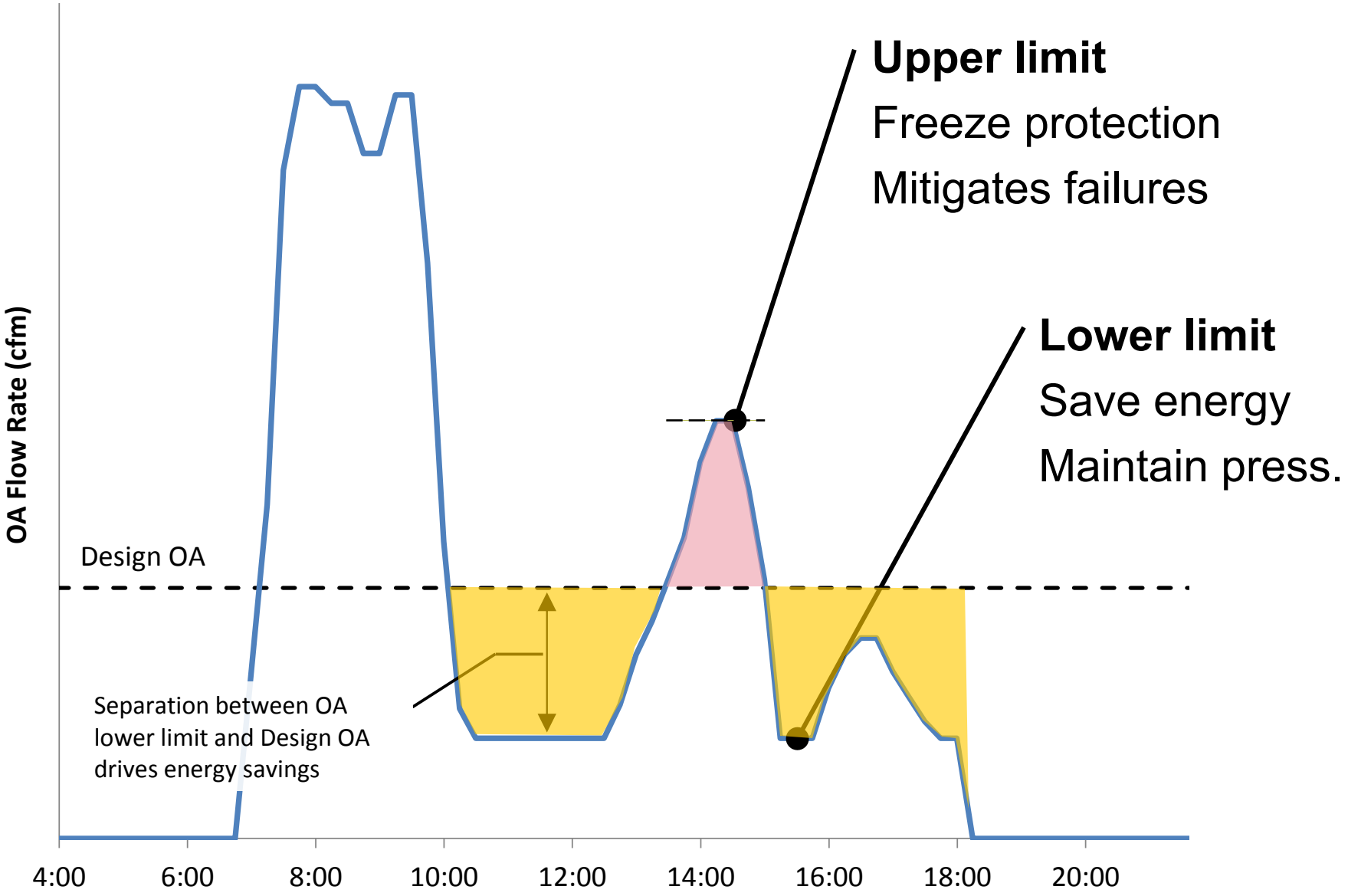
   a. OA flow reset



   b. Zone, then OA flow reset

   c. Zone, then OA flow reset, with occupancy sensors

Elements of sequence

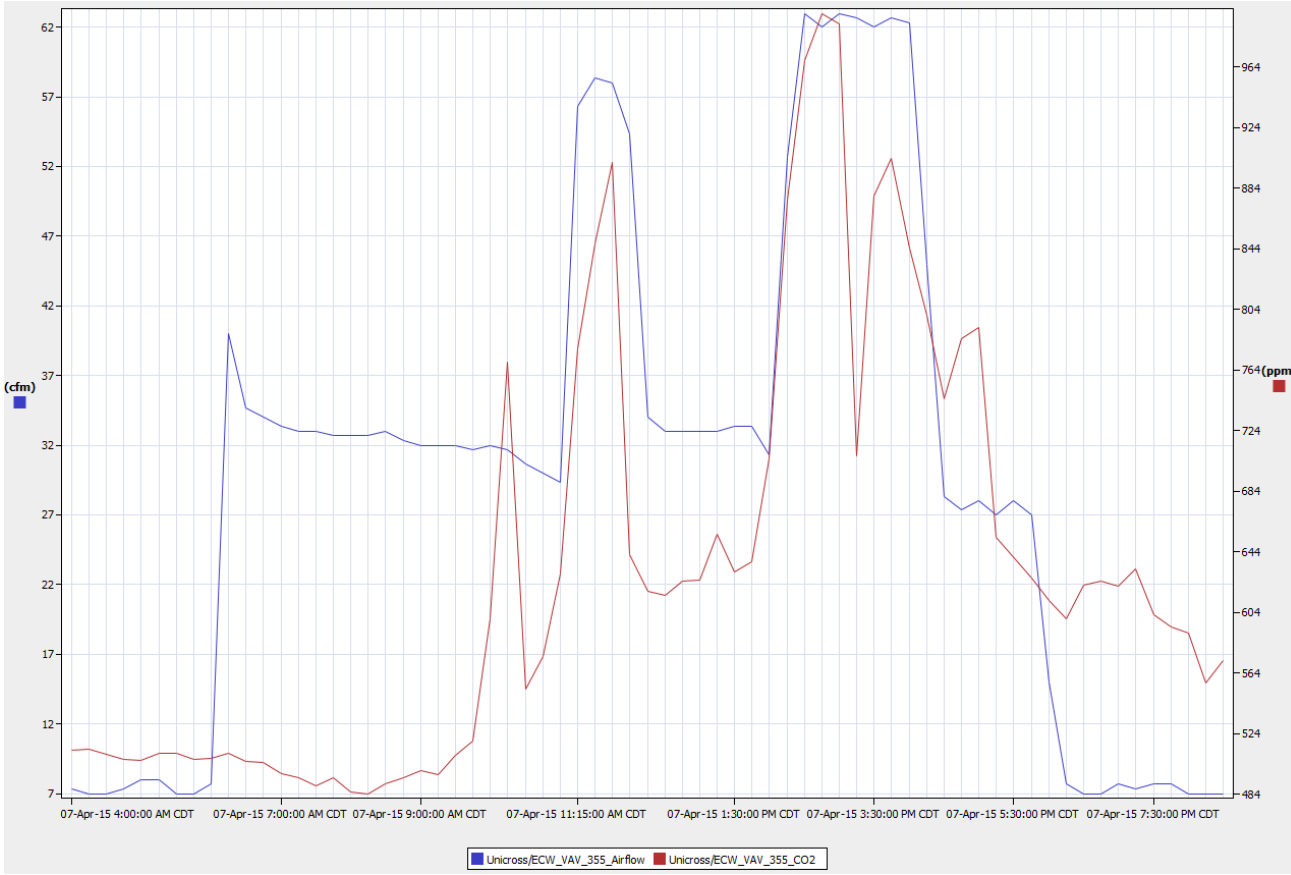


Elements of sequence

CO_2 setpoint

Setpoint(s) per: $C\downarrow R = C\downarrow OA + 8400 E\downarrow Z \times met/R\downarrow P + R\downarrow a \times (sf/p)$

Proportional or single setpoint



CO_2 sensor location

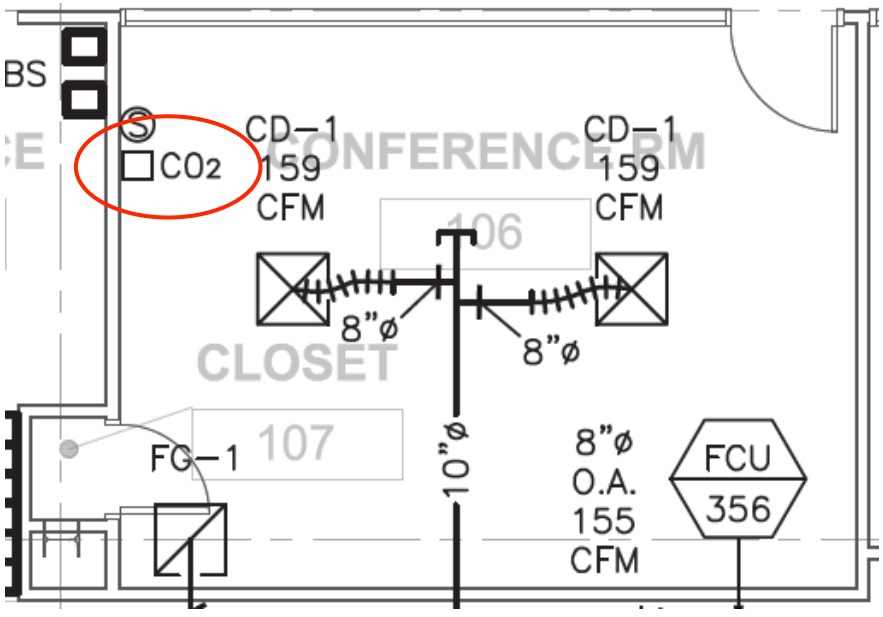
Ideally in zone

- At breathing height (3-6 ft.)
- Not below a thermostat

Common return

- Limited situations

Show on drawings!



Other considerations

Use occupancy sensors!

- Occ. sensor = VAV savings, aside from DCV

AFMS on drawings

Consider OA diversity in sizing

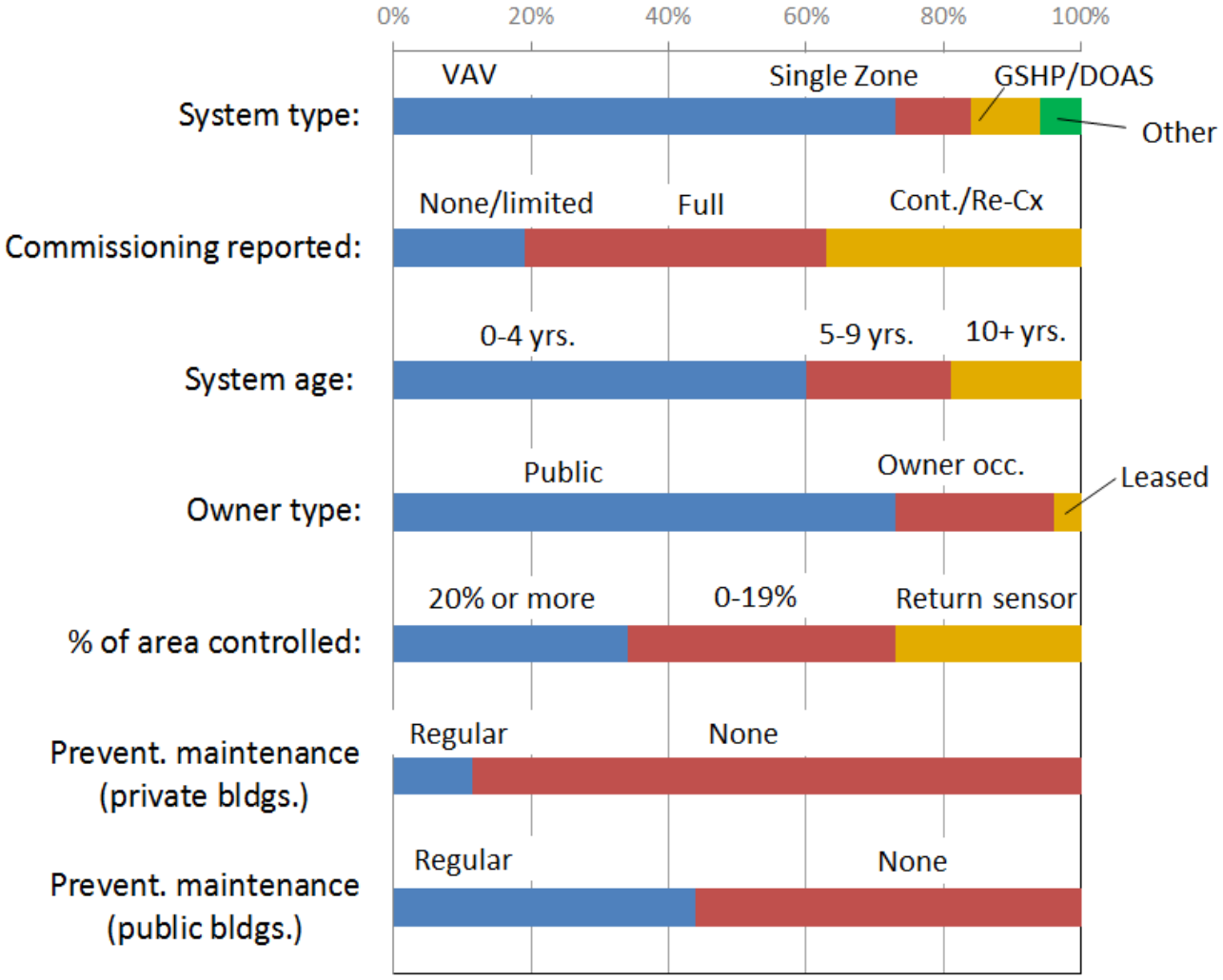
DCV: not just a 'Yes / No' choice

- Control portion of zones
- Strategically use common return
- Use 2-way dampers
- Mix approaches

Field study results

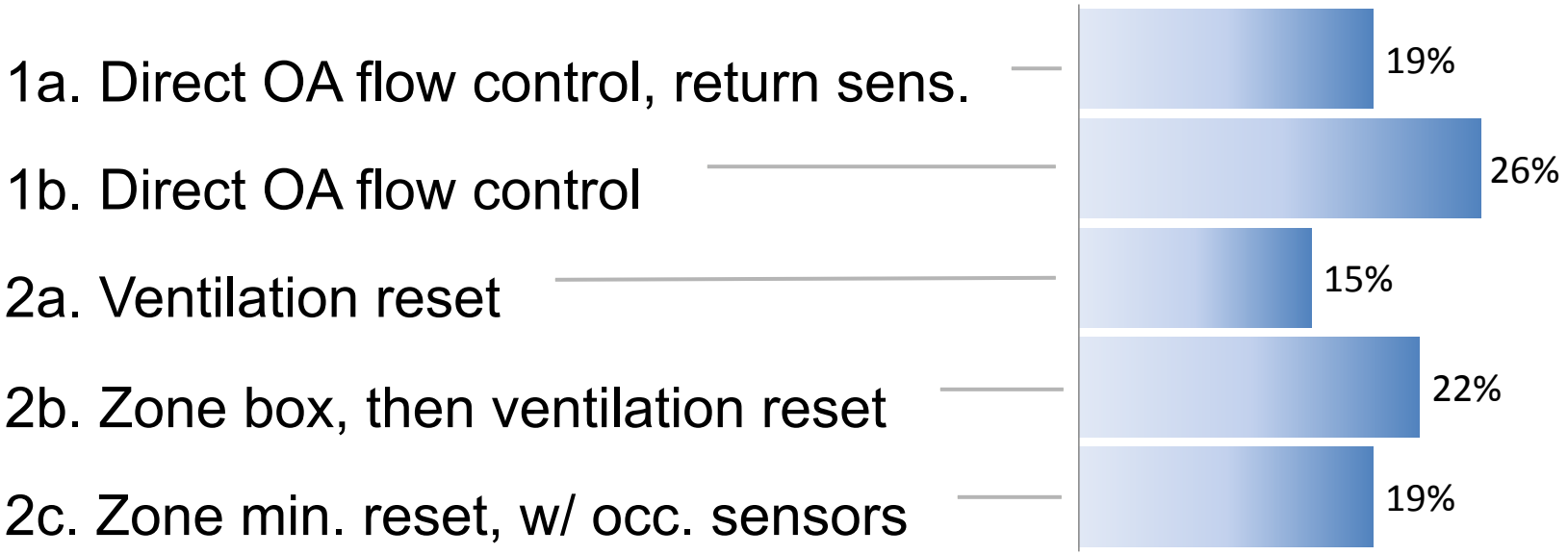
Characterization of approaches

96 systems around Minnesota:

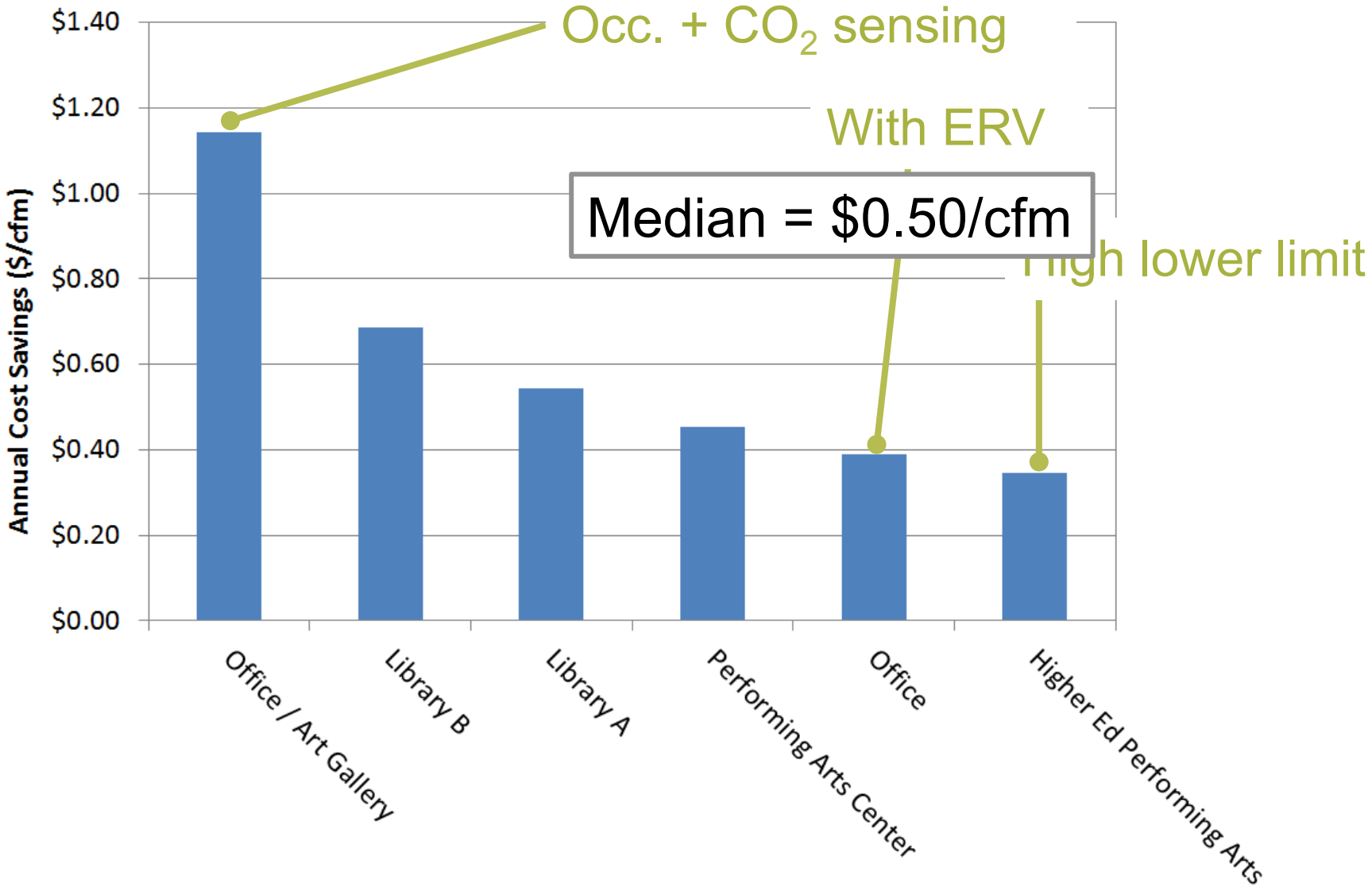


Characterization of approaches

Approaches (sequences):



Measured savings per design OA rate (cfm)



Results

We also scaled the results to a Duluth climate

	Savings per Design OA Flow		
	therms/cfm	kWh/cfm	$/cfm
Median	**0.80**	**0.64**	**0.59**
Change from MSP results	27%	-34%	18%

Recommissioning

Deficiencies

Sequence change to reflect design

OA damper schedule

Use of damper position

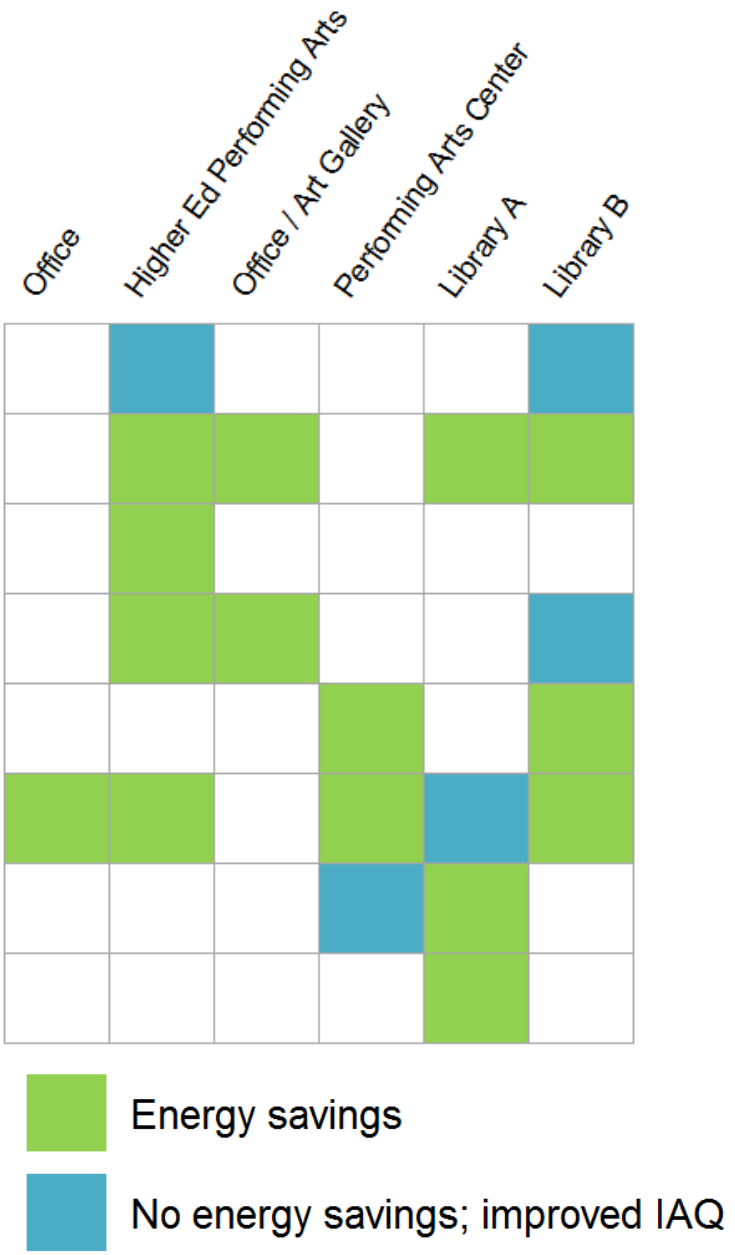
OA lower limit

OA upper limit

CO_2 setpoint

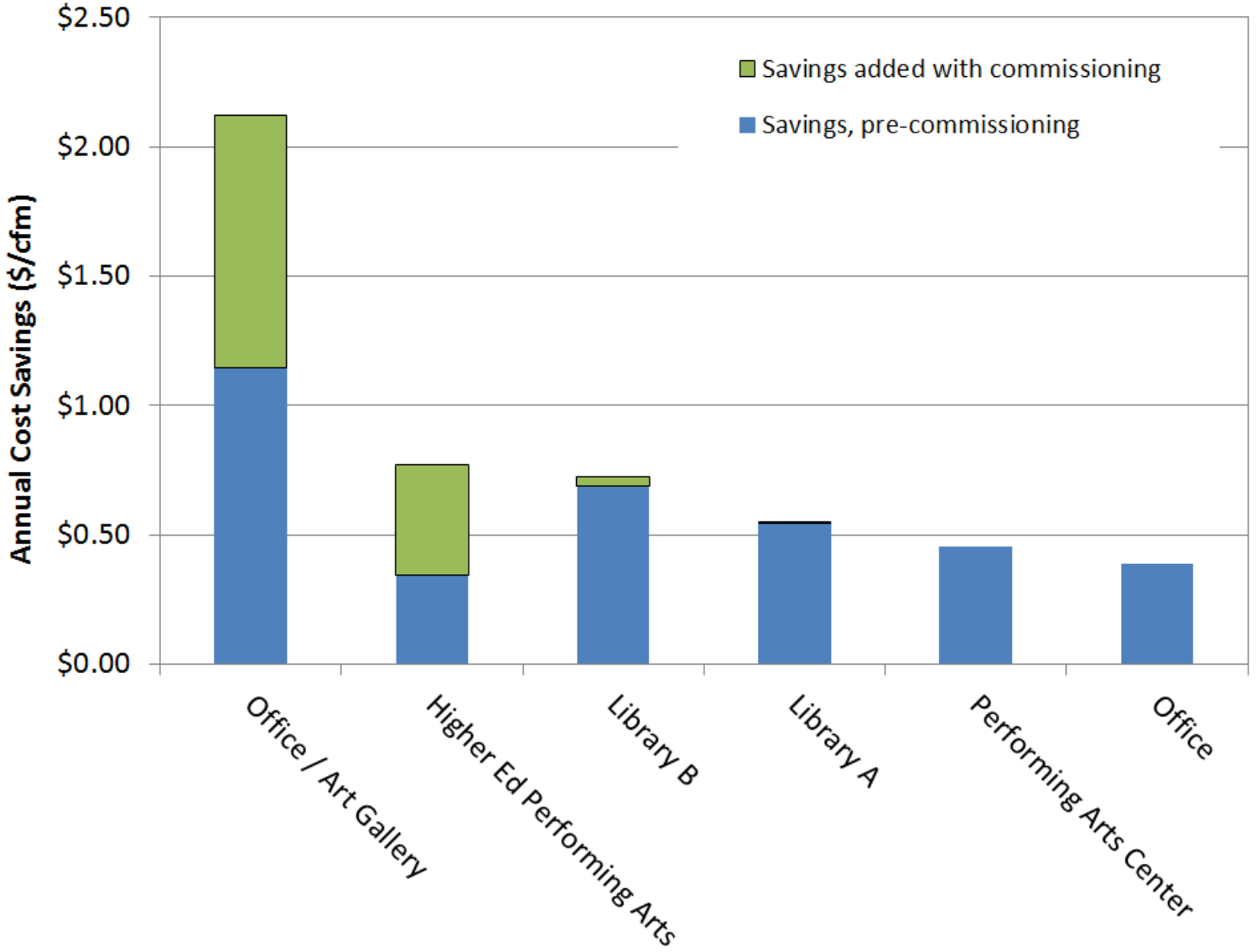
CO_2 sensor calibration

Inaccurate airflow measurement



Recommissioning results

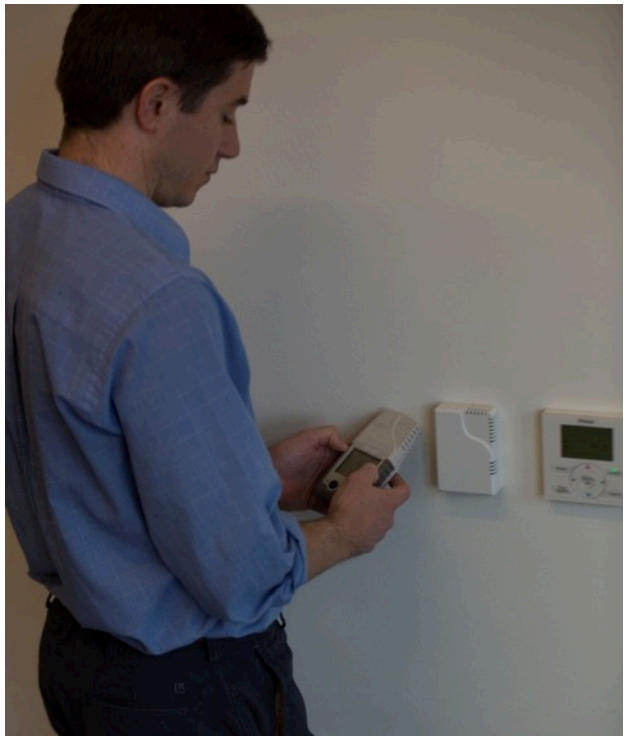
Half the systems saved more, an average of 54%



Economics

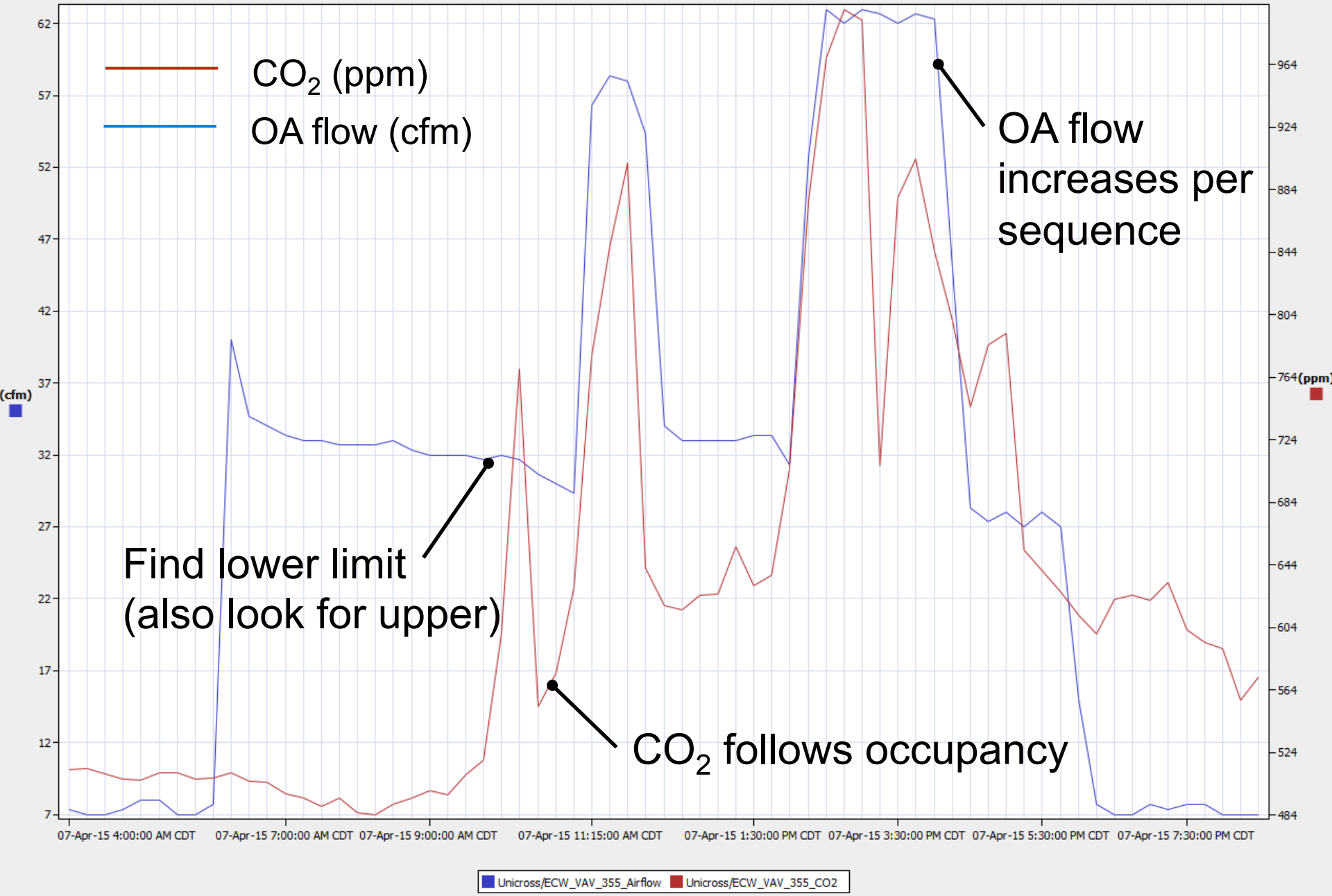
Economics per 1000 cfm of design OA

	CO_2 and Occupancy Control	Typical CO_2 Control	Typical CO_2, Partial Control	Recommissioning
Break-even cost	$16,412	$6,658	$1,643	$2,900
Simple payback		4 - 5 years	7 - 8 years	<1 - 2.5 years



(Re)commissioning

Virtual performance checks



Virtual performance checks

- Determine control: 1) OA damper position vs. 2) OA flow measurement (if available)
- Check for rogue DCV zones
- Check CO_2 sensor reading at unoccupied
- Determine OA damper schedule
- Recognize that savings is from heating (gas)
  - Economizer negates cooling savings
- Verify economizer operation

Spot checks

Meet the operator on-site; discuss system operation

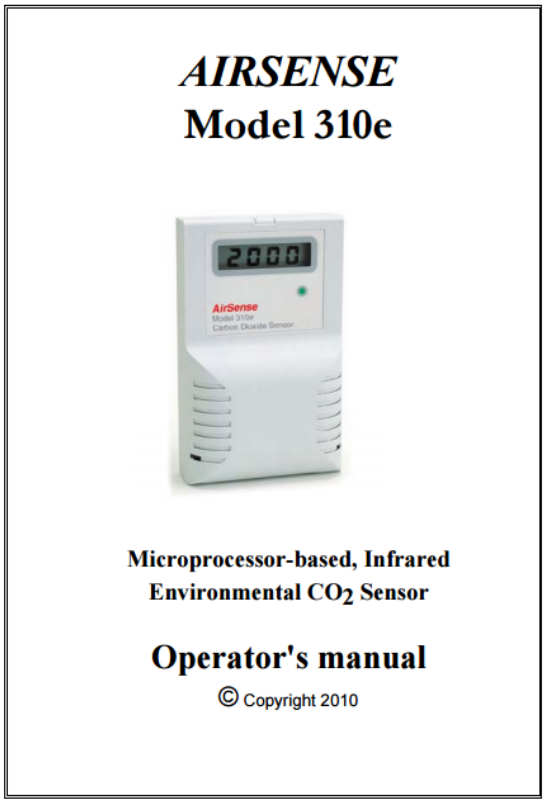
Validate measured points:

- Temperatures: SA, MA, RA, OA (brief traverse)
- Valve positions (visual, temp)
- OA damper position (visual)
- Supply fan speed (VFD)

Sensors

CO_2 sensors

- Calibrate or replace



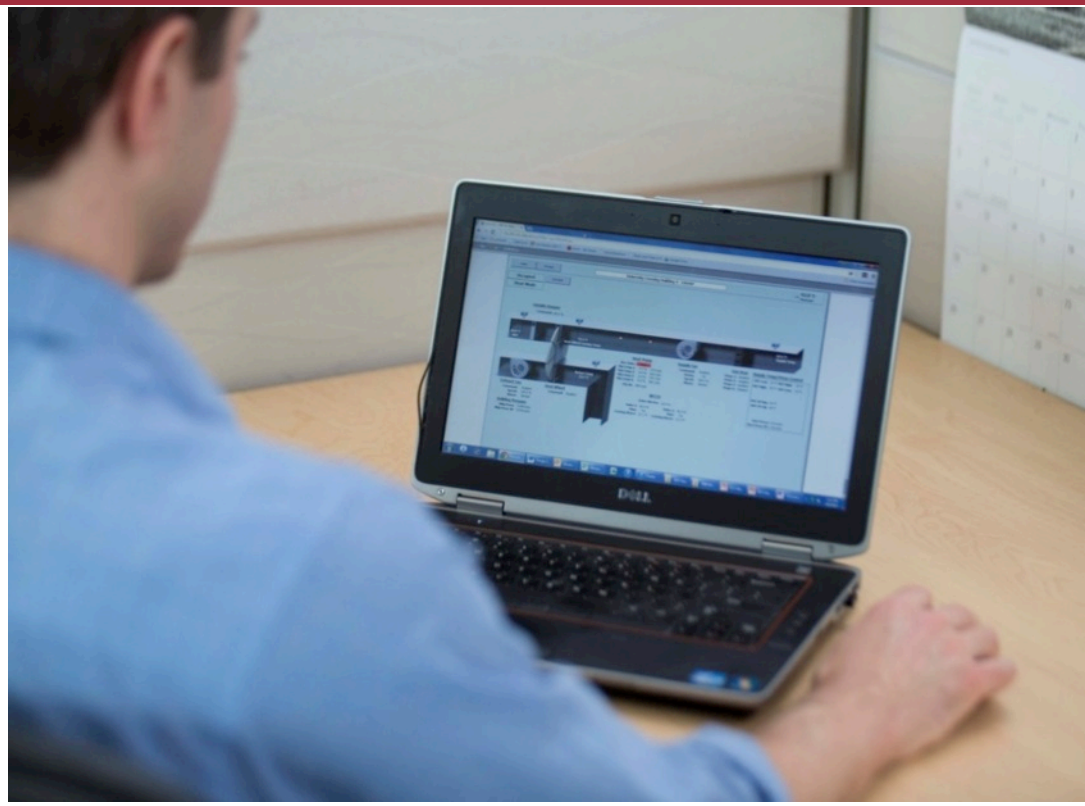
- Recalculate setpoint per Standard 62.1
- Auto calibration valid?

SPT and Sequence Optimization

Perform basic system performance tests

- AHU
- Key VAV boxes

Correct deficiencies found in tests



Optimize:

→ OA upper / lower limit, CO_2 setpoint, OA schedule

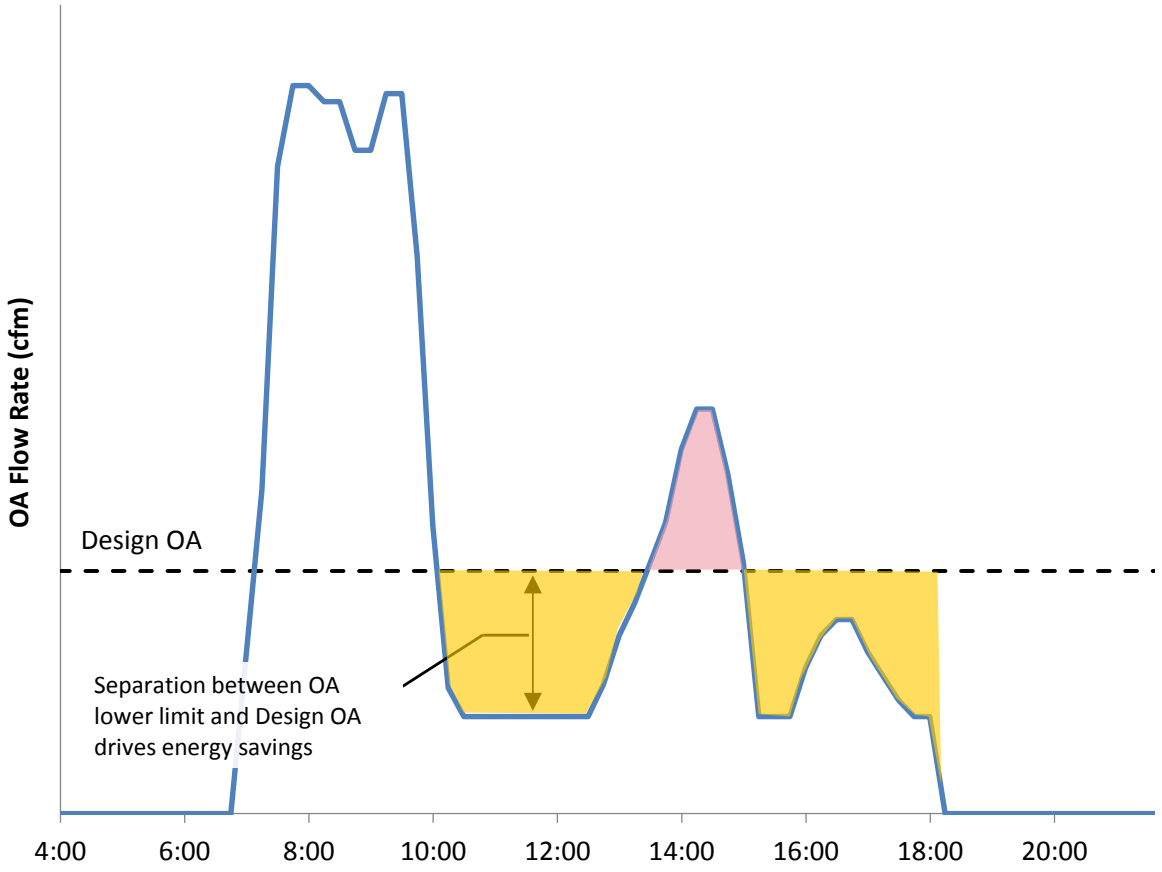
Hand over to operators

Report any changes made

Add any needed trending

Complete handover missed at install

- Document the sequence
- Plan for future monitoring



For more information

Sequences

- Basic: EDR 2007
- Ventilation reset: Trane 2005
- With occupancy sensors: Taylor 2014. *Demand control ventilation for multiple zone VAV systems – problem solved*
  (from ASHRAE Annual Meeting, Seattle 2014; seminar available for a fee)

Code requirements

Code Notes 2012 IECC Demand Control Ventilation

AFMS: Fisk 2009

CO_2 sensor performance: Shrestha 2009

Resources

Download the study

Stay tuned for a fact sheet and the full report:
seventhwave.org/dcv

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