



## Rethinking Occupancy-Based Ventilation Controls

39th AIVC Conference 2018

#### Iain Walker and Brennan Less iswalker@lbl.gov





Traditionally:

- 1. Sense occupancy
- 2. Turn ventilation off (or low setting) if no occupancy

Assumes occupants (and their activities) are the only source

What if we account for other contaminants that are continuously emitted?

- VOCs (e.g., formaldehyde)
- Left over from occupant activities: moisture, odors, particles, etc.



## Method

Use simulation software (REGCAP) to calculate relative exposure compared to a continuously operating ventilation system (baseline).

Assumption #1: contaminants emitted continuously.

Assumption #2: contaminants emitted at half rate when unoccupied

Use a real-time control to optimize control strategies

Include infiltration – DOE "Zero energy ready" airtightness 1.5 – 3 ACH50

15 US climate zones

200 m<sup>2</sup>, three bedrooms, four occupants

Include operation of kitchen/bath exhaust and clothes dryer

Balanced & unbalanced fans- higher capacity to allow for recovery after occupants return







## **Occupancy patterns**

- 1<sup>st</sup> shift: unoccupied 08 17 hr. weekdays
- 1<sup>st</sup> extended: unoccupied 8 22 hr. weekdays + 2 two hour periods each weekend day
- 3<sup>rd</sup> shift (night shift): unoccupied 21 06 hr. weekdays



## **Smart Ventilation Control**

- Real time calculation of exposure and "dose" (24 hour moving average exposure) for ALL times
- Make a decision every 10 minutes to turn fan on or off
   Fan on if dose or exposure > 1
- During occupied time operate fan to meet target: maintain average relative exposure less than or equal to one
- Unoccupied: maintain average relative exposure less
  than or equal to five
  - To avoid acute exposure based on ratio of acute to chronic particle exposure levels.



## **"Traditional" Occupancy Ventilation Control**

IAQ Fan Sized to Standard (62.2-2016), Turned Off When Unoccupied





#### **"Traditional" Occupancy Ventilation Control**

IAQ Fan Sized to Standard (62.2-2016), Turned Off When Unoccupied



# Real time controller results- recovery nearly as long as "off"





# Real time controller results- recovery nearly as long as "off"





Table 1: Median values for annual average air exchange rate and relative exposure.

Case	Fan Type	Unoccupied	Air Exchange	Relative Exposure
		Emissions	(ACH)	
No IAQ fan	None	Full	0.102	4.959
Continuous fan	Exhaust	Full	0.340	1.005
	Balanced	Full	0.358	0.999
Occupancy Controlled	Exhaust	Full	0.326	1.001
	Exhaust	Half	0.298	0.996
	Balanced	Full	0.328	1.007



## **Results**



#### Why low savings?

1. Recovery period increases ventilation rate when occupants return home

2. In most locations, this shifts ventilation to colder times of day

3. Over-sized fan that is cycled on/off leads to increased mean airflow



## **Results**

- accounting for pollutants emitted during unoccupied periods drastically limited the reductions in average ventilation rate to between 4 and 12%, compared with the 24% reduction not accounting for non-occupied emissions.
- scenarios that assumed pollutant emissions were cut in half during unoccupied times had increased energy savings to an average of 11% for a typical occupancy pattern.



## **Future work**

• Lets figure out this ratio:

## occupied emissions

## total emissions

