SUSTAINABLE SCHOOLS
saving our energy for education

Ventilation System Management for Schools - Discussion between Ontario School Boards and ASHRAE

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Moderator

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CLIMATE CHALLENGE NETWORK

Agenda

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   a. COVID, Climate and the Economy
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2. Ventilation operating periods
3. Outside air volumes
   a. Effect on relative humidity
4. Air filtration
5. Schools without mechanical supply ventilation
   a. Use of windows
6. Testing, inspection and maintenance
7. Upgrading ventilation systems
8. Communications with stakeholders
9. Next steps

ASRAE Panelists

Kyle Hasenkox

ASHRAE Epidemic Task Force Principal, Senior Project Manager, Rocky Point Engineering Ltd.

Doug Cochrane

ASHRAE Distinguished Lecturer, Regional Vice Chair, former ASHRAE Toronto Chapter President

David Underwood

ASHRAE Fellow

2015-16 ASHRAE President

ASHRAE's position is that "Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning [HVAC] systems, can reduce airborne exposures."

School Board Panelists

Mark Twardowski

Manager of Maintenance & Environmental Services, Simcoe County District School Board

Norm Vezina

Senior Manager, Environmental Services, York Catholic District School Board

Context – COVID, Climate and the Economy

Graeme MacKay, Hamilton Spectator
March 11, 2020

Evidence just beginning to emerge

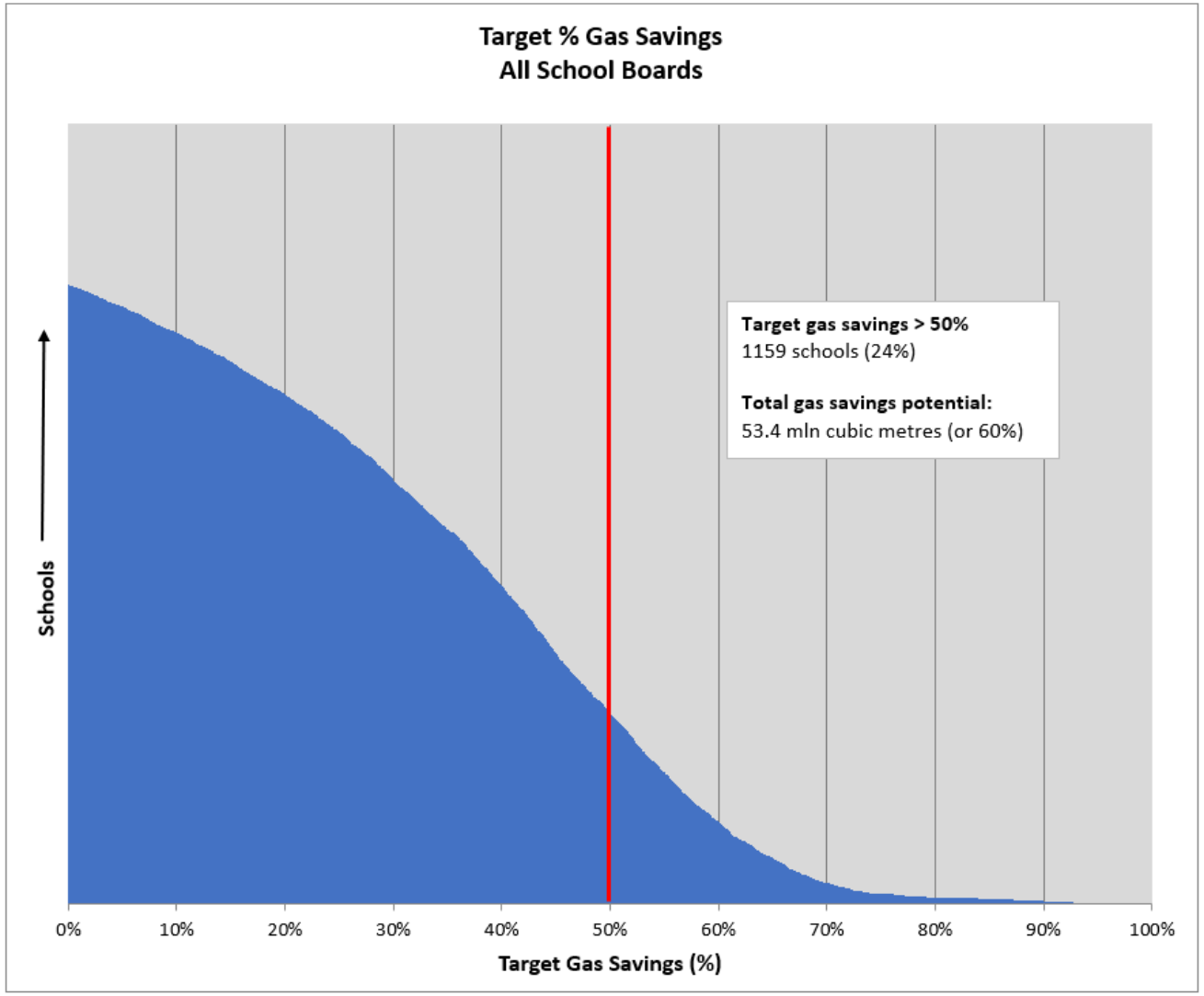
More to COVID than ventilation:

July 17, 2020. A study assessed the role of students and teacher in the transmission of the SARS-CoV-2 in Saxony, Germany and noted that after reopening of schools in May, only 0.6% of 2,000 school children and teachers tested positive for antibodies to COVID-19, suggesting that in low prevalence settings, social distancing strategies such as the reduction of students in different classes mixing at school, paired with symptom-based screening strategies, contact tracing, and quarantine measures, are likely as effective as full school closures.

School board questions

Are there data that substantiate that COVID-19 can be spread through an air handling system?
What lessons were learned on cruise ships? Are cruise lines implementing any additional ventilation management measures? How would you measure effectiveness?

Many schools are overventilated now



Source: 2020 Sustainable Schools Top Energy Performing School Boards analysis

Operating periods

Ministry Checklist: Consider operating mechanical systems in occupied mode for a period of one week prior to students returning under normal operating hours.

ASHRAE: Operate ventilation for 2 extra hours each school day at 100% outside air; mechanical systems should operate in occupied mode for minimum period of one week prior to students returning (may be completed at same time as teachers start returning to building) while assuring the outside air dampers are open.

OHCOW: Exhaust ventilation systems of washrooms should always be kept on 24/7; it is not recommended to switch ventilation off, but to operate continuously at reduced speed.

What's the purpose of ASHRAE's guideline recommendation of pre-occupancy flushing ? If the virus stays in the air for 3 hours what does the pre-occupancy flushing do?

Control set-points

Guidance from WHO: To reduce the number of days that the SARS-COV-2 virus can remain viable in the indoor environment, avoid setting climate control systems to low “cold” temperatures (below 70 F/ 21C) (Chin et al., 2020) and “dry” low humidity settings (below 40%) as these are optimal conditions for the virus to survive (Chan et al., 2011;Van Doremalen et al., 2020).

Baseline operation, 10 cfm/person, 0 degC OAT

		OA 65%			OA 80%		
		RAT (F)			RAT (F)		
		68	72	74	68	72	74
OA RH%	40%	22.90%	20.86%	19.85%	19.78%	18.98%	18.21%
	60%	26.17%	23.87%	22.83%	25.67%	22.93%	21.69%
	80%	29.79%	26.84%	25.52%	30.26%	26.90%	25.09%

What will be our space temperature setpoints?

Outside air volumes

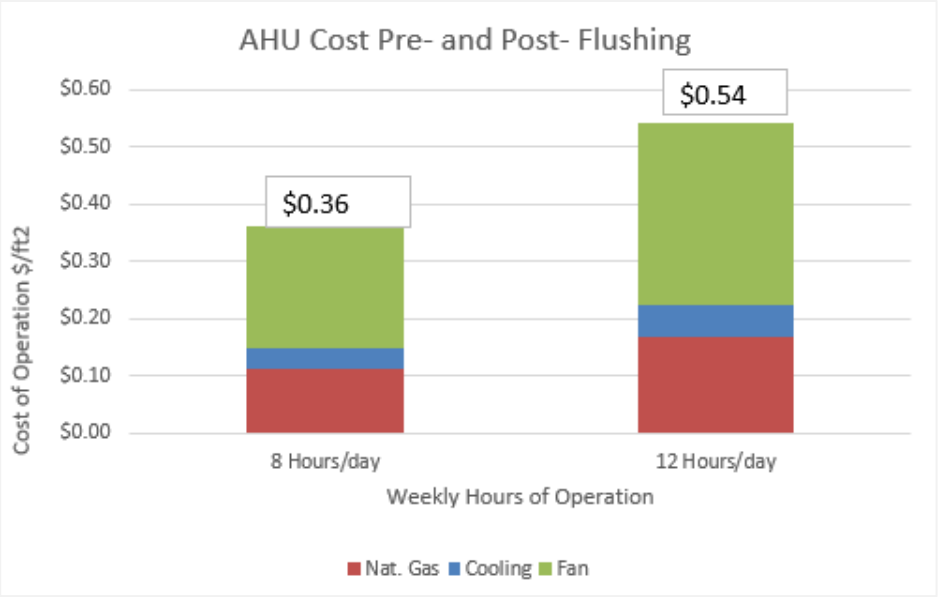
ASHRAE: The underlying effort of the designer should be to increase outside air to the spaces and treat return air

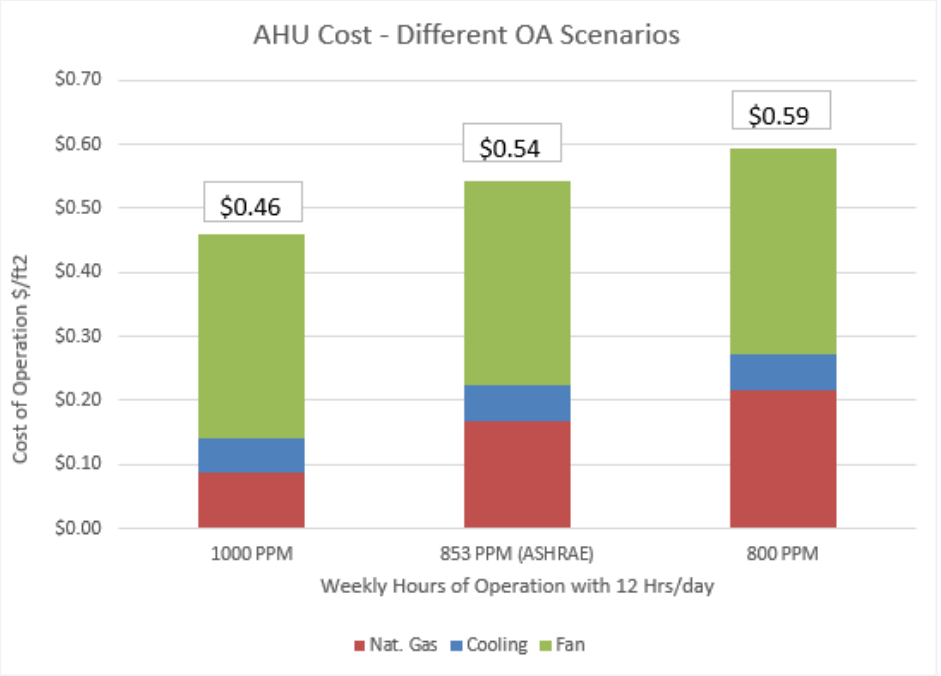
ASHRAE: During the Pandemic, disable any Demand Control Ventilation (DCV) and introduce the maximum possible OA flow 24/7 until further notice (including DOAS)

What will be our outside air volume setpoints?

OHCOW checklist: Where in-demand ventilation systems cannot be converted: change CO2 set point to lower, 400 ppm value, in order to assure the operation at nominal speed (where applicable).

What will be our CO2 setpoints?





Elec. Cost $/kWh	$ 0.15

Outside air volumes – school board questions

What should be the typical outdoor air damper minimum setting? We can't get air flows tested in every building in time.

Does demand ventilation make sense when we have predictable occupancy levels in schools?

Effects of lower relative humidity

Leipzig, 20.08.2020: Indian-German research team recommends at least 40 percent humidity in public buildings: The airborne transmission of the coronavirus SARS-CoV-2 via aerosol particles in indoor environment seems to be strongly influenced by relative humidity. They recommend controlling the indoor air in addition to the usual measures such as social distancing and masks. A relative humidity of 40 to 60 percent could reduce the spread of the viruses and their absorption through the nasal mucous membrane. To contain the COVID-19 pandemic, it is therefore extremely important to implement standards for indoor air humidity in rooms with many people

"Transmission is greater in dry air, infectivity is higher in dry air, and the ability of a human being to fight infection is impaired," said Dr. Stephanie Taylor, a graduate of and lecturer at Harvard Medical School.

Outside air impact on relative humidity

Assumptions

No. of students=	30
Area of classroom (ft2)=	700
height (ft) =	9
CO2 generation (L/s) =	0.0031

ASHRAE 62.1	
cfm/person=	10
cfm/ft2=	0.06
Outside air conditions	
Temp (F)=	32

Winter

OA (cfm) =	342
initial OA %=	65%
Total Air (cfm)=	525
cfm/ft2=	0.75
air changes/hr =	5

		OA 65%*			OA 80%		
		RAT (F)			RAT (F)		
	OA RH% Scenarios	68	72	74	68	72	74
Space RH%	40%	22.90%	20.86%	19.85%	19.78%	18.98%	18.21%
	60%	26.17%	23.87%	22.83%	25.67%	22.93%	21.69%
	80%	29.79%	26.84%	25.52%	30.26%	26.90%	25.09%

*As per ASHRAE sample classroom

ASHRAE: Install Portable humidifiers in each classroom for local humidity control.

What will we do about relative humidity?

School board questions

Are there any plans or recommendations to improve humidity levels?

Humidity control is not mentioned in the “Optimizing Air Quality in Schools” guidelines. Do you feel that portable humidifiers could be a viable short-term option to improve air quality?

Humidification is a long-term challenge. What is being done to improve reliability and cost effectiveness of the equipment?

Air filtration

	MERV-10	MERV-13
Total SP ("w.g.)	2.75	2.92
kWh/ft2	0.98	1.04
$/ft2	$ 0.15	$ 0.16

Increase	6%

Ministry checklist: review and update existing standards for frequency of filter replacement & type of filters to be utilized
ASHRAE: Select filtration levels (MERV ratings) that are maximized for equipment capabilities, use MERV 13 if equipment allows, while assuring the pressure drop is less than the fans' capability.

What will we do about air filtration?

a. Pre- and secondary filter MERV standards.
    a. Applications to different ventilation system types (central, ERV/MUA units, unit ventilators and fan powered terminal units).
b. Frequency of filter changes, disposal of used filters.
c. Use of portable air filters.

School board questions

Can viruses captured in HEPA filters survive and be released when the unit/fan is OFF?

Are there situations when air purification units are most beneficial, like kindergarten rooms? Are there types of purifiers that work better than others?

A HEPA filter with 212 CFM capability has air flows through the top of the appliance so air currents would be head high. Would this violate the tenet that placement should ensure air does not flow from one person to another?

Is ASHRAE aware of the use of UV in HVAC for killing COVID-19 virus and other viruses?

Schools without mechanical supply ventilation

ASHRAE: Ensure airflow patterns in classrooms are adjusted to minimize occupant exposure to particles.

What will we do about spaces without central mechanical ventilation?

- Use of operable windows
- Operation of exhaust fans

Testing, inspection, maintenance and monitoring

Ministry, ASHRAE checklists: lots of recommendations.

What are our immediate priorities?

1. Ventilation testing.
2. Inspection for leaks and losses.
3. Filter replacement and leaks around filter banks.
4. Rooftop units, unit ventilators (including portables) and terminal devices.
5. Enhanced BAS monitoring and fault detection.

Potential impact

	Nat. Gas	Cooling	Fan	Total	ekWh/ft2	GHG emissions (kg eCO2/ft2)
Base Case 8 hrs/day @ 65%OA	$0.11	$0.04	$0.21	$0.36	6.30	0.88
Addition due to:						
Additional 4 hrs/day	$0.06	$0.02	$0.11	$0.18	3.15	0.44
Flushing + 800 PPM	$0.05	$0.00	$0.00	$0.05	2.04	0.36
MERV-10 to MERV-13	$0.00	$0.00	$0.01	$0.01	0.13	0.00
Total Additions	**$0.10**	**$0.02**	**$0.12**	**$0.24**	**5.32**	**0.80**

	Total Floor Area (sf)	# of buildings	Total Incremental Cost ($)	Total Incremental ekWh	Total Incremental GHG Emissions (kg eCO2)
Elementary	169,574,520	3,792	$ 40,840,352	902,132,528	135,659,616
Secondary	113,623,108	759	$ 27,365,006	604,472,309	90,898,486
Total	**283,197,628**	**4,551**	**$ 68,205,358**	**1,506,604,837**	**226,558,102**

Upgrading ventilation systems

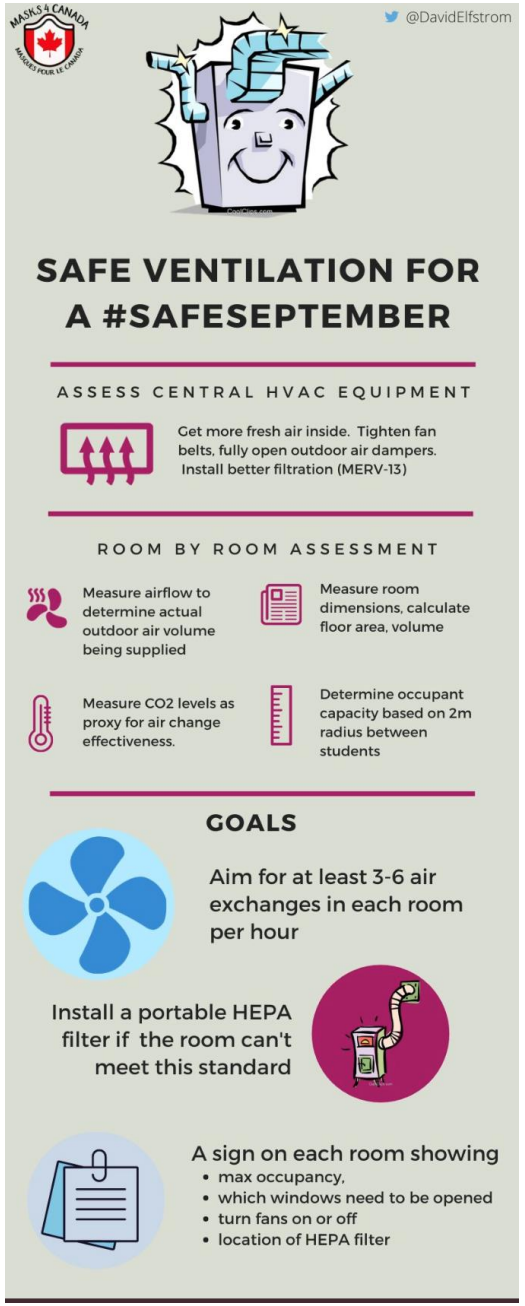
Use the current and forthcoming government funding to work towards fully adaptable ventilation systems in all mechanically ventilated schools:

1. Testing and rebalancing
2. Variable total and outside air (VFDs)
3. Enhanced monitoring and control
    a. CO2 and RH monitoring
    b. Fault detection and response

Communications with stakeholders

Managing the messaging:

1. proactive communication
2. response to questions and concerns
3. attention to every school
4. evidence-based answers to FAQs



Thank you!

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