Energy Efficient Indoor Air Quality (IAQ) Studies

Preliminary Monthly Reports Summary

for September 2020

Table of Contents

1.0 Introduction

This report is intended to summarize the monthly reports submitted in September by the FlexTech consultants whom have been tasked with evaluating energy efficient COVID-safe building upgrades and operational adjustments for customers who are seeking recommendations for re-occupying their spaces safely while maintaining the pursuit of energy efficiency. The following sections will present each consultants' project progress, IAQ solutions considered in the projects, and a summary of conclusions, key findings, and commonalities found across all projects.

The consultants discussed in this report are presented in the table below, along with the enrolled customers and the regional location and market sectors of the buildings chosen to participate in the study.

New or updated information within this month's report is presented in blue text.

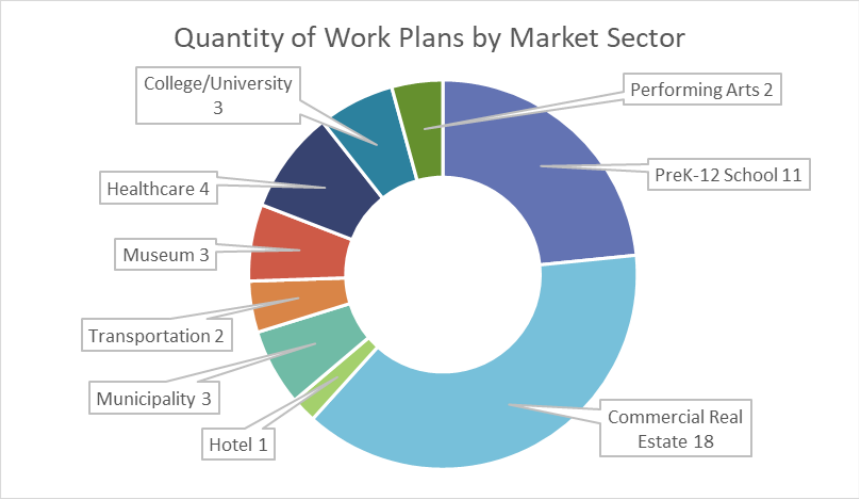
Consultant Conducting Study	Customer	Regional Building Location	Market Sector
AKF Engineers, LLP	Tishman Speyer	New York City	Commercial Real Estate
	Commercial Office Building	New York City	Commercial Real Estate
	L&L Holdings – 222 Broadway	New York City	Commercial Real Estate
	L&L Holdings – 114 5th Avenue	New York City	Commercial Real Estate
	RXR Realty	New York City	Commercial Real Estate
Bergmann Associates	The Harley School	Finger Lakes	PreK-12 School
	St. John Fisher College	Finger Lakes	College/University
Edison Energy, LLC	Memorial Sloan Kettering Cancer Center – Breast & Imaging Center*	New York City	Healthcare
	Memorial Sloan Kettering Cancer Center – Josie Robertson Surgery Center*	New York City	Healthcare
	Lincoln Center for the Performing Arts*	New York City	Performing Arts
	Lincoln Center for the Performing Arts*	New York City	Performing Arts
	Northwell Health*	New York City	Healthcare
	Empire State Realty Trust*	New York City	Commercial Real Estate
EMCOR Services Betlem	Rochester Museum and Science Center*	Finger Lakes	Museum
	Finger Lakes Community College*	Finger Lakes	College/University
	Genesee Community Charter School*	Finger Lakes	PreK-12 School
	Webster Ice Arena*	Finger Lakes	Municipality

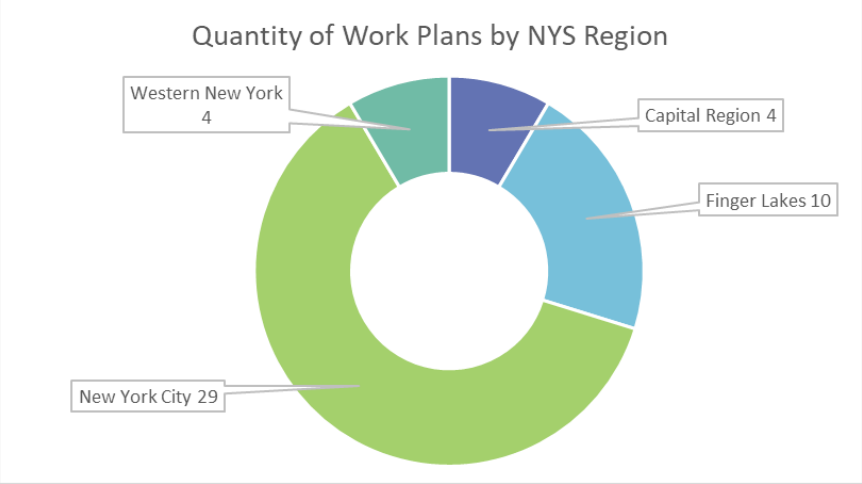
* Data from this preliminary findings report is not included in Sections 3-5 of this summary report

Consultant Conducting Study	Customer	Regional Building Location	Market Sector
Goldman Copeland Associates, P.C.	Large Midtown Manhattan Commercial Office Building #1	New York City	Commercial Real Estate
	Large Midtown Manhattan Commercial Office Building #2	New York City	Commercial Real Estate
	Large Midtown Manhattan Commercial Office Building #3	New York City	Commercial Real Estate
Guth DeConzo Consulting Engineers, P.C.	Albany Medical Center	Capital Region	Healthcare
	North Colonie Central School District	Capital Region	PreK-12 School
	Higher Education Institution*	New York City	College/University
Jaros, Baum & Bolles Consulting Engineers, LLP (JB&B)	Museum of Modern Art – Main Campus	New York City	Museum
	Museum of Modern Art – Queens Campus	New York City	Museum
	Rudin Management Company – 80 Pine	New York City	Commercial Real Estate
	Rudin Management Company – 3 Times Square	New York City	Commercial Real Estate
	Rudin Management Company – 345 Park	New York City	Commercial Real Estate
	New Water Street Corporation	New York City	Commercial Real Estate
	Horace Mann School – Aquatics Center	New York City	PreK-12 School
	Horace Mann School - Pforzheimer Hal	New York City	PreK-12 School
	Horace Mann School – Science Center	New York City	PreK-12 School
	Horace Mann School - Tillinghast Hall	New York City	PreK-12 School
LaBella Associates, D.P.C.	Niagara Frontier Transportation Authority – Buffalo Niagara International Airport	Western New York	Transportation
	Niagara Frontier Transportation Authority – Metro Transportation Center	Western New York	Transportation
	City of Rochester – Blue Cross Arena	Finger Lakes	Municipality
	City of Rochester – Rundel Public Library	Finger Lakes	Municipality
	Rosenblum Companies	Capital Region	Commercial Real Estate
	Webster Central School District – Dewitt Elementary	Finger Lakes	PreK-12 School
	299 Old Niskayuna Road, LLC	Capital Region	Commercial Real Estate
	North Tonawanda School District – Intermediate School	Western New York	PreK-12 School

* Data from this preliminary findings report is not included in Sections 3-5 of this summary report

Consultant Conducting Study	Customer	Regional Building Location	Market Sector
Syska Hennessy Group	Manhattan Commercial Office Tenant	New York City	Commercial Real Estate
	Westchester Commercial Office Facility	Mid-Hudson	Commercial Real Estate
Vidaris, Inc.	Mark Hotel	New York City	Hotel
	Tishman Speyer	New York City	Commercial Real Estate
Wendel Energy Services, LLC	School District	Finger Lakes	PreK-12 School
	Williamsville Central School District	Western New York	PreK-12 School





2.0 Consultant Progress Overview

The following table summarizes the progress made by each of the consultants on their work plans (i.e. the defined study scope). Typically, each work plan represents one building study, however in some cases there are multiple buildings represented in a work plan.

For each milestone listed below, the number of work plans that have completed a milestone are indicated.

Consultant	**# of Work Plans**	**# of Buildings Represented**	**Data Collection Completed** (# of Work Plans)	**Onsite Work Completed** (# of Work Plans)	**Analysis of Proposed Solutions Completed** (# of Work Plans)	**Study Report Completed** (# of Work Plans)	**Expected Report Completion Dates**
AKF	5	5	2	0	0	0	Mid-November – Early December
Bergmann	2	13	2	2	0	0	Mid-November – Late November
Edison Energy	6	7	2	0	0	0	Late September – Early December
EMCOR	4	5	0	1	0	0	Late October
Goldman Copeland	3	3	3	0	0	0	Mid November
Guth DeConzo	3	20	2	0	0	0	Mid November
JB&B	10	10	5	2	0	0	Mid-October – Mid-November
LaBella	8	8	4	1	1	1	Mid-October – Late December
Syska Hennessy	2	2	2	1	0	0	Late November
Vidaris	2	2	0	1	0	0	Late October
Wendel	2	8	0	0	0	0	Mid-December
Total	**47**	**83**	**22**	**8**	**1**	**1**	**Last Report: Late December**

3.0 Solutions Considered

Each consultant is evaluating a series of solutions intended to make each building COVID-safe while limiting the impacts on building energy efficiency. These solutions are intended to be implemented so that the buildings can run efficiently without sacrificing safe IAQ.

The number of studies for which each solution is being considered within each market sector is presented in the graph below. Note that solutions covered under the "Other Solutions" category may be broken out into their own categories in future reports if there is an apparent widespread evaluation of any of these specific solutions across multiple work plans.

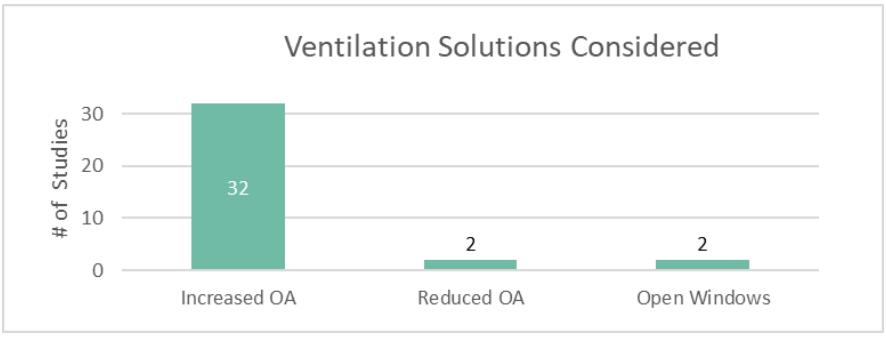
Solutions being explored by the consultants are described below:

<u>Ventilation</u>

Improved ventilation strategies are intended to remove contaminated air from occupant spaces and provide fresh outdoor air to occupant spaces such that safe IAQ can be achieved while optimizing energy use. Ventilation options under consideration include:

- Increased outdoor airflow (OA)
    - Greater amounts of fresh outdoor air are supplied to the space, decreasing the concentration of contaminated air
- Reduced outdoor airflow (OA)
    - Some spaces provide greater outdoor airflows than is necessary to maintain safe IAQ. Outdoor airflows can be reduced to maintain safe IAQ while reducing energy use
- Open Windows

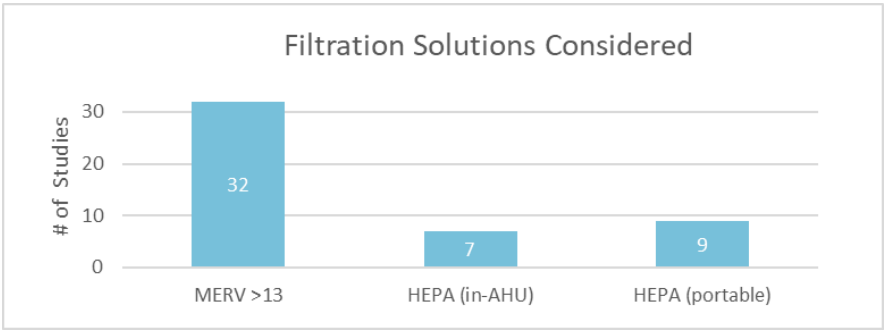
- Opening windows in spaces not served by central ventilation systems is a low/no-cost method of providing increase outdoor air to occupant spaces



Filtration

Improving filtration limits the size and amount of harmful particulates entering the occupant space via air handling units. Filtration options under consideration include:

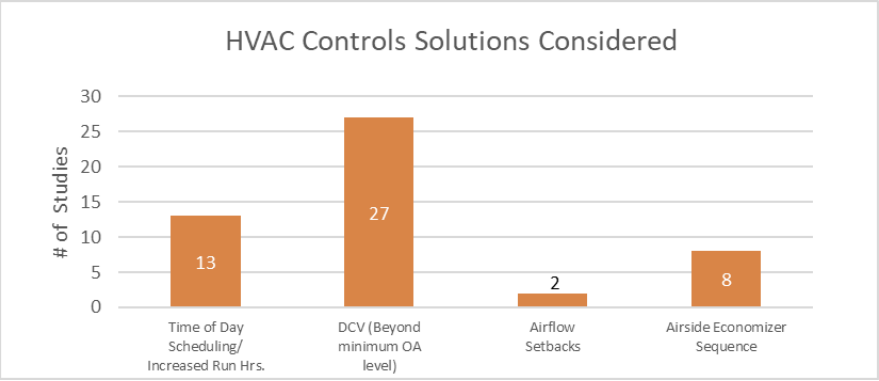
- MERV 13+ filters
  - A MERV (Minimum Efficiency Reporting Value) corresponds to the minimum particulate size a filter can capture. Higher MERV values correspond to lower minimum particulate sizes. MERV filters rated at 13 and above capture smaller particulate sizes than standard commercial MERV 8 filters
- HEPA filters (in-AHU)
  - HEPA (High Efficiency Particulate Air) filters capture smaller and more numerous particulates than MERV 13+ filters. In-AHU HEPA filters can be installed in air handling units in place of existing, less effective filters
- HEPA filters (portable)
  - Portable HEPA filters are installed in small, portable air circulation units and provide local, room-level air filtration



HVAC Controls Improvements

Improving the operation of HVAC controls systems allows for automated, reliable responses to changes in IAQ demands while limiting the amount of building energy use. Controls improvements under consideration include:

- Time of day scheduling
  - Air handling units are operated based on occupancy schedules, so that they use the most energy to ventilate a space when it is occupied and save energy when a space is unoccupied
- Demand controlled ventilation
  - Air handling units increase or decrease ventilation rates based on sensed occupancy or air quality of a space. To ensure COVID-safe air quality, AHUs can be controlled to provide ventilation beyond the minimum recommended rate when a space is occupied or air quality exceeds ideal thresholds.
- Airflow setbacks
  - Variable air volume (VAV) units limit the amount of airflow provided to a space when it is unoccupied, based on either sensed occupancy or a pre-programmed schedule
- Airside economizer sequence
  - Outdoor airflow is increased beyond its minimum safe level when doing so would result in decreased energy use (used for cooling and typically based on outdoor air temperature)

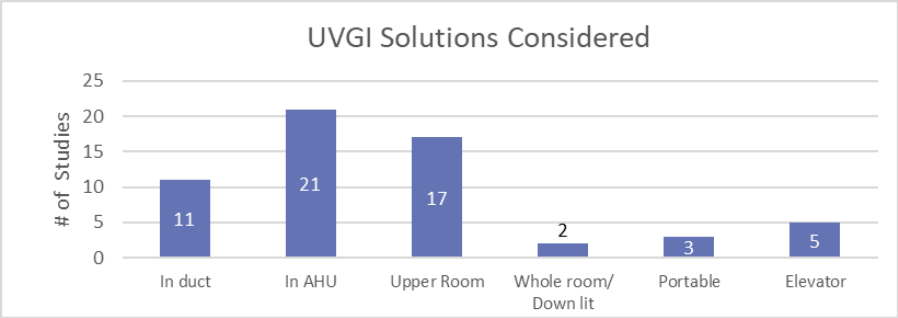


<u>UVGI</u>

Ultraviolet germicidal irradiation (UVGI) technologies are intended to destroy germ particles and microbes by applying an ultraviolet light to a surface or airstream. UVGI systems being evaluated include:

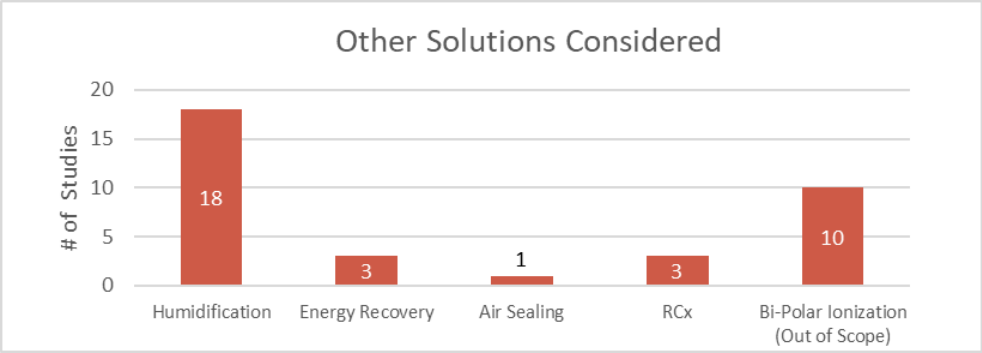
- In Duct
  - UV source located within ductwork
- In AHU
  - UV source located within air handling unit (at filter or coil)
- Upper Room
  - UV source located in the upper (typically above 8 feet) part of a room
    - avoids UV contact with occupants, allowing the system to be in use during occupied hours
- Whole Room
  - UV source located within occupant's level

        - UV light contacts occupant spaces, restricting operation to unoccupied hours
- Portable
    - Portable UV source located within occupant's level
        - UV light contacts occupant spaces, restricting operation to unoccupied hours
- Elevator
    - UV source located in elevator car
        - activated when elevator car is not occupied



<u>Other Solutions</u>
Other solutions considered include the following:

- Humidification
    - Maintaining relatively humidity levels of 40-60% has been found to be the optimal humidity range to limit the transmission of most disease-causing particles
- Energy or heat recovery
    - Heat taken from exhaust air is transferred to incoming outdoor air in order to limit the additional heat energy needed to condition greater amounts of outdoor air
- Air Sealing
    - A seal that prevents air or vapor passage
- Retro-commissioning
    - Existing systems are tested, inspected, and repaired or replaced to ensure they are operating optimally
- Bi-polar ionization (not included as part of the NYSERDA-funded study)
    - Reactive ions are introduced into the airstream in order to neutralize bacteria, viruses, and other particles
    - Effectiveness of this technology is not widely verified and has therefore been excluded from the NYSERDA-funded scope of these studies until independent, unbiased, 3rd party evidence of the technology's ability to inactivate the SARS-CoV-2 virus and operate safely becomes available

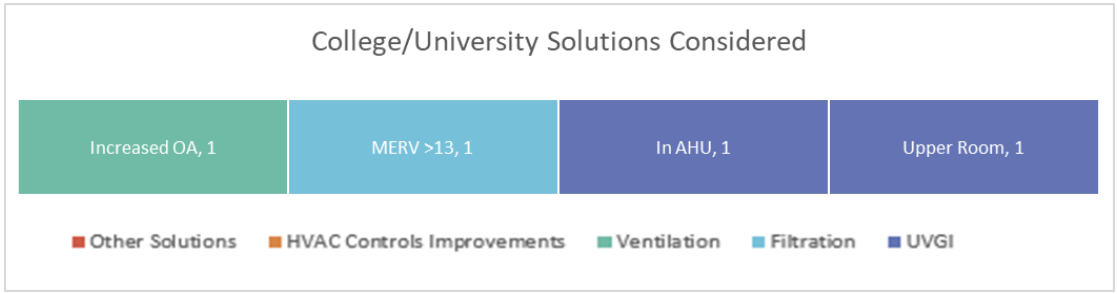

Other Solutions Considered
# of Studies
20
15
10
5
0
18
3
1
3
10
Humidification
Energy Recovery
Air Sealing
RCx
Bi-Polar Ionization (Out of Scope)

4.0 Issues Encountered and Common Observations

A summary of relevant issues encountered and observations that have been identified are presented below, categorized by market sector.

College and University – One (1) study

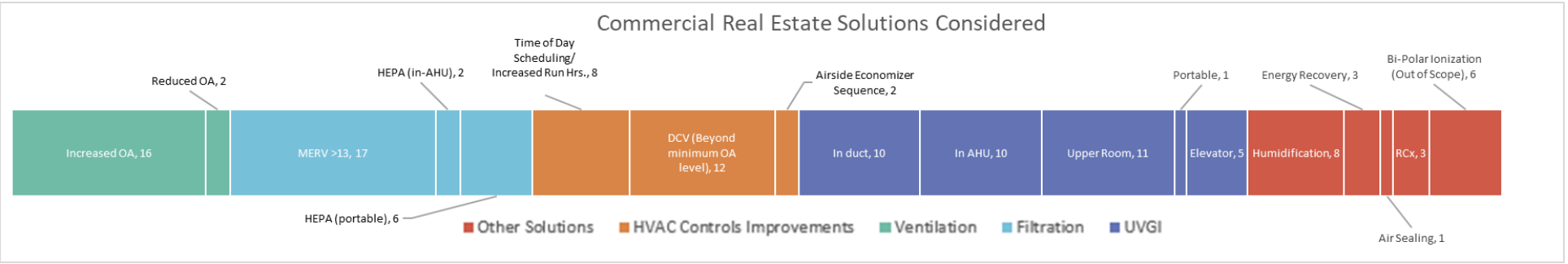
- The AHUs in one (1) study are old and due for replacement. This makes UVGI application in these units unfeasible as a long-term solution



Commercial Real Estate – Seventeen (17) studies

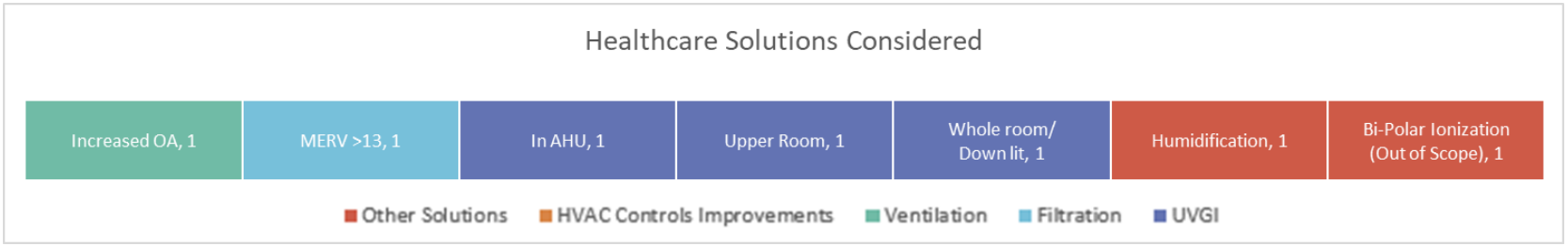
- Ventilation controls in one (1) study are being overridden in order to correct a humidity control issue. Humidity control issue found to be due to inappropriate occupancy modes.
- The fan power of the AHUs in one (1) study may be too low for feasible implementation of filter upgrades
- The design characteristics of the AHUs in one (1) study only allows the use of MERV 8 filters
- The AHUs in five (5) studies are too large or too small of a size for practical application of in-unit UVGI
- The site conditions in two (2) studies limit adequate access for installation of in-duct UVGI.
- Excessive envelope renovation would be required to implement negative pressurization in two (2) studies
- The AHUs in one (1) study are too large for practical implementation of energy recovery

- The tenant under consideration in one (1) study does not have control over solutions implemented at central AHUs (i.e. ventilation rates, in-AHU UVGI, central AHU filter upgrade), therefore solutions considered are only applicable at zone level
- Previously considered solutions:
  - One (1) study previously considered increasing ventilation rates, but excluded it due to lack of tenant control over solutions implemented at central AHUs
  - One (1) study previously considered in-AHU UVGI, but excluded it due to lack of tenant control over solutions implemented at central AHUs
  - One (1) study previously considered upper room UVGI, but excluded it as there were no spaces large enough for practical application of the solution
  - Three (3) studies were previously not considering in-duct UVGI, but have now begun considering it
    - Two (2) of these are considering in-duct UVGI as an alternative to unfeasible in-AHU UVGI
  - One (1) study previously did not consider in-AHU UVGI, but is now considering it after obtaining additional site data



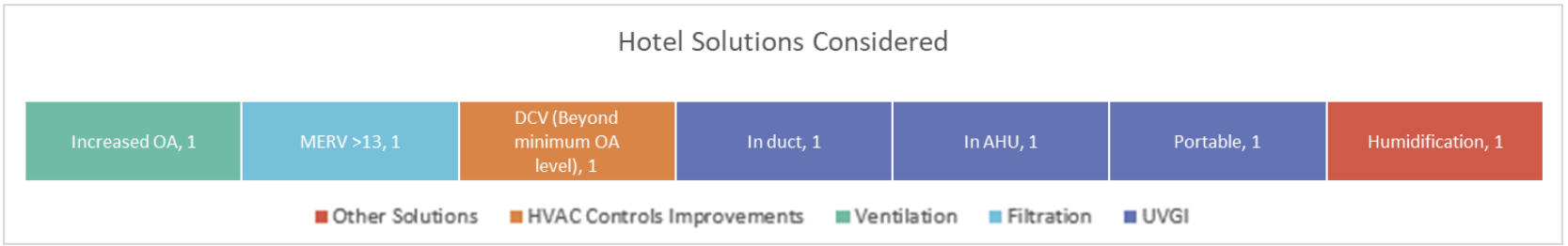
Healthcare – One (1) study

- One (1) AHU in one (1) study is due for replacement in the near future, making any long-term IAQ solutions impractical



Hotel – One (1) study

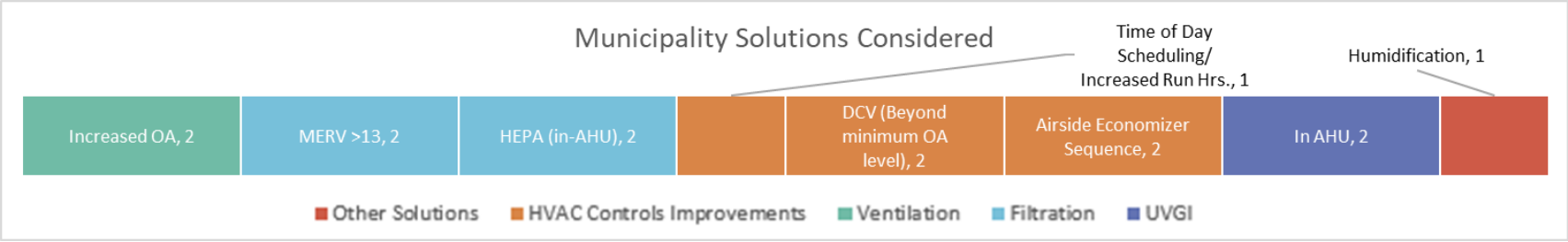
- The one (1) study in this sector is considering in-duct, in-AHU, and portable UVGI, MERV 13+ filtration, increased ventilation rates, demand control ventilation, and humidification measures
  - The site conditions in this study cause difficult access for installation of in-duct and in-AHU UVGI
- Energy recovery was previously considered in this study, but was excluded due to limited space in AHUs for energy recovery installation



Municipality – Two (2) studies

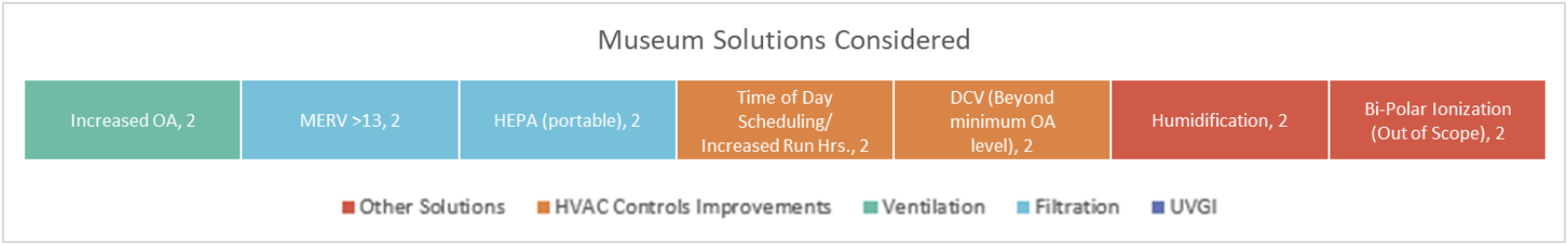
- The two (2) studies in this sector are considering in-AHU UVGI, MERV 13+ filtration, in-AHU HEPA filtration, increased ventilation rates, demand control ventilation, and changes to the airside economizer sequence
- One (1) study is considering increasing run hours of HVAC systems
- One (1) study was previously considering humidification measures, but is no longer considering this solution due to existing design characteristics of the conditioned space

  - The other study in this sector is still considering humidification measures
- The control sequence for the fan coil units (FCUs) and AHUs in one (1) study need to be repaired to allow for greater ventilation rates
- The design characteristics of some of the AHUs in one (1) study cannot accommodate the installation of improved filters nor in-unit UVGI



Museum – Four (4) studies

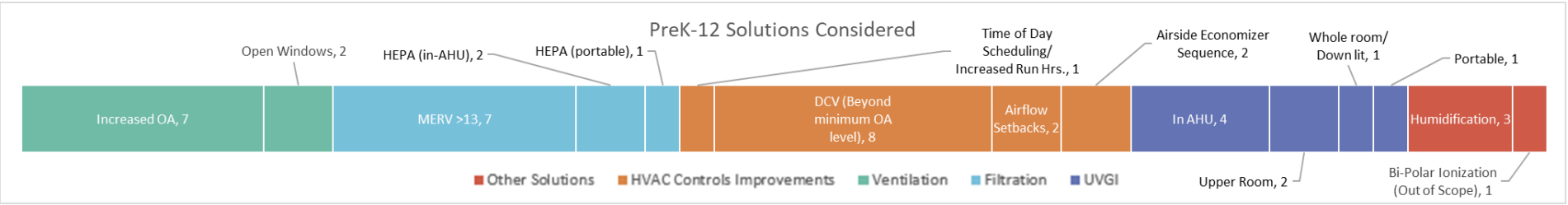
- All four (4) studies are considering increased ventilation rates
- All four (4) studies are considering MERV 13+ filtration
- Two (2) studies are considering portable HEPA filters
- Two (2) studies are considering demand control ventilation
- Two (2) studies are considering changes to airside economizer sequences
- Four (4) studies are considering increased run hours of HVAC systems
- Two (2) studies are considering in-AHU and upper room UVGI
- Two (2) studies are considering humidification measures and bi-polar ionization



PreK-12 Schools – Ten (10) studies

- Seven (7) studies are considering increased ventilation rates
- Two (2) studies are considering opening windows for ventilation
- Seven (7) studies are considering MERV 13+ filtration
- Two (2) studies are considering in-AHU HEPA filtration
- One (1) study is considering portable HEPA filtration
- Six (6) studies are considering demand control ventilation
- Two (2) studies are considering changes to economizer sequences
- For buildings that are reported to contain air handlers (6 studies), in-AHU UVGI is being considered for four (4) studies and no studies are considering in-duct UVGI
- Two (2) studies in this sector is considering upper room UVGI
- One (1) study is considering whole room and portable UVGI
- Three (3) studies are considering humidification measures
- One (1) study is considering bi-polar ionization and other solutions that are outside the NYSERDA-funded portion of this study

- The filter maintenance schedule in one (1) study lists inconsistent filter names and types
- The design characteristics of the AHUs in two (2) studies cannot accommodate the installation of improved filters nor in-unit UVGI
  - Thermal comfort issues were reported in one (1) study



Transportation – Two (2) studies

- Both studies are considering increased ventilation rates

- One (1) study is considering increased run hours of HVAC systems
- One (1) study is considering MERV 13+ and in-AHU HEPA filtration
- Both studies are considering demand control ventilation and changes to airside economize sequences
- Both studies in this sector are considering in-AHU UVGI and upper room UVGI
- Both studies are considering humidification measures
    - In one (1) study, humidification is unfeasible at 5/7 AHUs due to existing design characteristics of the conditioned space
- The design characteristics of the smaller AHUs in one (1) study cannot accommodate the installation of in-AHU UVGI. The AHUs in the same study are already equipped with MERV 15 filters and cannot accommodate higher efficiency filters.

Overarching

- One (1) study in the College/University sector, one (1) study in the Commercial Real Estate sector, and one (1) study in the Healthcare sector have existing UVGI systems installed
- Two (2) studies in the College/University sector, ten (10) studies in the Commercial Real Estate sector, two (2) studies in the Museum sector, one (1) study in the PreK-12 School sector, and one (1) study in the Transportation sector have existing MERV 13+ filters installed

5.0 Consultant Study Sources

The sources used by the consultants as part of these studies are cited below:

1. ASHRAE Epidemic Task Force
   https://www.ashrae.org/technical-resources/resources

2. ASHRAE Standard 62.1-2013, Ventilation for Acceptable Indoor Air Quality
   https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_62.1_2019

3. ASHRAE Standard 211-2018, Standard for Commercial Building Energy Audits https://ashrae.iwrapper.com/ASHRAE PREVIEW ONLY STANDARDS/STD 211 2018

4. Renat Manassypov, *Evaluating Virus Containment Efficiency of Air-Handling Systems*, ASHRAE Journal, July 2020
   https://www.ashrae.org/file%20library/technical%20resources/covid-19/17-23_manassypov.pdf

5. Zhen-Dong Guo et. al. *Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020*, CDC EID Journal Volume 26, Number – July 2020
   https://wwwnc.cdc.gov/eid/article/26/7/20-0885_article

6. Mahesh Jayaweera et. al. *Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy*, NIH's Elsevier Public Health Emergency Collection, June 13, 2020
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7293495/

7. Emanuel Goldman, *Exaggerated risk of transmission of COVID-19 by fomites*, The Lancet, July 30, 2020
   https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30561-2/fulltext

8. Steven Taylor, Taylor Engineering, *Covid Transmission White Paper*,
   https://taylorengineers.com/wp-content/uploads/2020/05/TE-COVID19-White-Paper.pdf

9. Mosto Technologies, Humidification White Paper

10. Steril Aire, Equipment Information and Specifications

11. RESET IAQ Sensor Accreditation Standard
    https://www.reset.build/download/RESET_Standard_v2_2_6_Monitor%20Standard%20180921.pdf

12. RESET Standard-compliant sensors: indoor, room-level sensors https://www.reset.build/monitors/type/indoor

13. RESET Standard-compliant sensors: in-duct, system-level sensors: https://www.reset.build/monitors/type/induct