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VIEWPOINT

National Engineering Month, Covid-19, and Our Professional Obligation Towards Public Health

Niss Feiner, C.Tech, CHD
ASHRAE Certified HVAC Designer, Mechanical consultant, Instructor

March in Canada was National Engineering Month and the purpose was to help foster an interest in STEM (Science Technology Engineering and Math) in the next generation that will help shape our society. It is the safety of that society that I would like to discuss.

For those of us in the engineering community, the public good of society is held paramount. We incorporate and adopt ever changing codes and standards with the interest of improving public safety, and the environment.

In Canada engineering graduates take part in a ceremony known as the Ritual Calling of the Engineer (also known as the Iron Ring ceremony). This ceremony instills in these future engineers the importance and gravity of their work with regards to the public trust. There is an oath, written by Rudyard Kipling, that each member swears which includes the phrase "I will not henceforward suffer or pass, or be privy to the passing of, Bad Workmanship or Faulty Material in aught that concerns my works before mankind as an Engineer...". This ceremony was brought about by the collapse of the same bridge twice (1907 and 1916) in Quebec City. These collapses were attributed to poor engineering and resulted in the deaths of 75 and 13 workers respectively.

From that moment on, it was recognized that engineers must understand the very real cost that can result from their negligence and swear to hold paramount the public safety.

Coming back to the present, March saw the declaration by the World Health Organization of a pandemic of Covid-19 (Coronavirus), and the growth has been exponential. I would like everyone to reflect on how we in the engineering community (as well as the architectural community) design our buildings. Not just with regards to sound structural practices, but also with regards to public health and the spreading of disease.

We have the ability to influence our customers and design our buildings to minimize the spread of contagions at every level. For those in the architectural community you can pay special attention to how the public interact with building elements and finishes. Do we really need doors on public bathrooms, when we can design privacy barriers at the entrance? If the doors are absolutely required, do we need people to open them with their hands? Plenty of buildings have doors that are automatic or can be operated with a person's foot.

For mechanical engineers who specify plumbing fixtures, automatic-flushing fixtures, as well as automatic faucets should be specified. While there are additional costs for these fixtures, it should be discussed with the client to balance these costs against the loss of productivity due to the spread of illness in the workplace, as well as the potential shut down of non-essential business like we are seeing in Italy when an endemic is left to spread uncontained.

For ventilation engineers we should be looking at increasing ventilation rates, and increasing the effectiveness of filtration before we recirculate the air. We should also heavily consider technologies that kill pathogens in our ductwork prior to distributing the air to the breathing space.

We all need to understand the impact to the public health when pathogens spread without control, as well as where we as a profession can apply our skill and knowledge to help reduce the spread. When people start experiencing symptoms, it's too late, they've already spread the same illness to others.

For more information I would encourage everyone to read this article on the spread of Covid-19: https://medium.com/@tomaspueyo/coronavirus-act-today-or-people-will-die-f4d3d9cd99ca?fbclid=IwAR0hXjUhaLyQYZ5bg4We8oBQ6kJY3d3a8gLl0iibg2RZTqz9ialh1J29Xi4

It does an excellent job of explaining how the disease spread, how many people actually likely have it, and how big of an impact social distancing and other precautions can drastically help to flatten the growth curve.

Another useful link I've found, is this video.https://www.youtube.com/watch?v=Kas0tIxDvrg&fbclid=IwAR0uUDo-iSRRhtzxQqWWAQiFENOGlBeE8AOMRoN_has7kH1kdGAhDTSQ9EI

While most of us in the engineering community understand exponential, and logarithmic growth, it can be very difficult for many people to grasp just how big the numbers can get, and how quickly. This does a great job of visualizing the impact. It also does an excellent job at illustrating just how little we need to reduce the exposure rate by to yield incredible results.

For the most part, the danger does not come from the virus itself. In the case of Covid-19, the effects in most of the population will be benign. It is a more serious concern for the elderly, and those with a compromised immune system. The danger lies in the exponential growth and the effect it has on our healthcare system. We simply cannot handle the amount of people when (in the case of Covid-19 as per the above video), the affected population increases tenfold in approximately sixteen days.

While many National Engineering Month events were likely cancelled due to the pressure to enact social distancing measures, I'd still like everyone to embrace the spirit of it, and really reflect on our ability and obligation to protect the public health where our work is related.

Wash your hands, cough or sneeze into your elbow; and if you have the ability, work from home. We all have a responsibility to do what we can to protect those whose immune systems may not be up for the challenge.

All the best!

Niss Feiner, C.Tech, CHD

Covid-19 Letter from ASHRAE Toronto Chapter

To: Toronto Chapter Membership and Volunteers

I would like to start by thanking everyone for their hard work and effort to keep themselves and everyone around them safe. I would also like to thank all front-line workers who put themselves at risk every day to ensure we have what we need to survive this pandemic.

These times have created an unprecedented situation for our Chapter and our Society, and in response we are offering a brand-new slate of technical Webinars to our membership.
We are working in concert with the other chapters in Region II to bring you a world class array of technical presentations.

A quick update on our Chapter activities

- Golf in June, after long discussions and looking at potential re-scheduling we are cancelling the Tournament this year.
- We will be having our first ever June technical meeting, a Webinar on June 1st. It is filling fast, so log onto our website and register.

On Behalf of the Board of Governors, we thank everyone for doing their part to keep us all safe.

Thank you,

Antonio Figueiredo

ASHRAE Toronto Chapter President

ASHRAE Society Covid-19 Preparedness and Resources
https://www.ashrae.org/technical-resources/resources

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JANUARY MEETING & PANEL DISCUSSION SUMMARY

Building Indoor Air Quality, Health Impacts, and Benefits to Occupants

Panelists: Dr. Jeffrey Siegel, Alex Crandall, Charles Waddell.
Moderator: Amy Li

January's ASHRAE meeting and panel discussion on Building Indoor Air Quality (IAQ), allowed us to discuss with experts in the field, the important factors that affect a building's IAQ, the health implications of IAQ, and the benefits that occupants can receive from a buildings with good IAQ. Our panelists for the evening Dr. Jeffrey Siegel, Alex Crandall, Charles Waddell and Amy Li as our moderator, helped answer many of our members most pressing questions regarding building IAQ. Dr. Jeffrey Siegel is a Professor of Civil Engineering at the University of Toronto and a member of the university's Building Engineering Research Group. His research interest includes healthy and sustainable buildings, ventilation and indoor air quality in residential and commercial buildings, and control of indoor particulate matter. Alex Crandall is a Commissioning Manager at the HIDI Group with over 10 years of experience dedicated toquality focused building commissioning process. As part of the commissioning process, Alex has taken a hands-on approach to evaluating indoor environmental quality and has worked with building teams to develop corrective action where needed. Charles Waddell is the founder and CTO of Global Plasma Solutions, with a demonstrated history of working in the electrical and electronic manufacturing industry. Charles is strongly skilled in engineering, sales, construction, start-ups and product development having 30 patents granted with 27 patents pending. Amy Li is a Ph.D. Candidate at the University of Toronto, under the supervision of Dr. Jeffrey Siegel. Amy has recently completed an ASHRAE research project that examined the IAQ and energy impacts of high-efficiency filters in residential buildings.

Disclaimer: The information stated in this article is the author's interpretation of the discussion held by panelist and moderator, and does not represent an absolute consensus of the panel.

To start with the panelists were asked how good indoor air quality could be defined?

The panelists drew from personal experience, common ASHRAE standards, and future hopes to try and define what good indoor air quality is. Even if 80% of occupants have no harmful health reactions such as asthma or allergies, that doesn't necessarily mean that the indoor air is acceptable. Many harmful particulates, VOCs, and other pollutants that are detrimental to occupant health can not be easily felt by occupants. In order to obtain a more accurate definition of what a good IAQ is, more research must be conducted into what pollutants found in the environment can be harmful to occupants. By understanding what can be harmful, better IAQ systems can be put into place that address these factors. The hope of these panelists is that not only will we produce systems that remove contaminants from the air, but also produce air that makes you healthier.

What is harming us and what should a good IAQ system contain?

By learning from countries where the outdoor air quality has not been ideal due to increasing industrialization, such as China and India, or from countries that have experienced large wildfires, such as Australia, a more detailed understanding of the effects of particulates on humans can be obtained. It is important to understand how these particulates can affect the bloodstream, lungs and how they trigger allergies, in order to address these issues during the design process of new projects. In general, the panelist highlighted the need to address three major pollutant categories that degrade the IAQ of a building and can have chronic and/or acute health impacts:

- Fine particulate matter (PM2.5)
- Harmful organic gases (e.g., formaldehyde, acrolein)
- Harmful inorganic gases (e.g., carbon monoxide, ozone)

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With more buildings being designed to standards that achieve a green certification, is there a correlation to better IAQ in that building?

In order to obtain a better IAQ, the panelists argue that more than just measuring carbon dioxide needs to be monitored and that solutions such as just increasing the outdoor air intake are not enough to deal with these issues. This is especially true in areas where the outdoor air might have a larger concentration of pollutants. One of the prominent issues when designing for IAQ in a green building is the trade off between energy and the quality of the indoor air. Systems that produce better indoor air, sometimes also utilize more energy and because of this designers may opt out of using better systems in order to meet an energy quota.

Is Duct cleaning important?

Like any other system in the building or home it is important to carry out proper maintenance of the systems. The panelists outline two essential scenarios where duct cleaning would need to be mandatory:

1. Cleaning out construction debris.
2. Cleaning after any moisture related problem.

This will prevent any further spread of harmful particulates or bacteria. It is also important to select proper ducts to limit the build up of contaminants in the system. The panelists suggest against the use of inside insulated ducts, as debris and other contaminants can much easily build up with in the walls of the duct.

What are some of the best practices for improving IAQ?

In order to prevent the accumulation of harmful contaminants within the building, our panelists suggest that the following factors need to be addressed during the design process of any project:

- Source Control - determining where harmful contaminants are being produced, such as from cooking or smoking, can allow for design of effective ventilation within those designated areas.

- Ventilation - ensuring that spaces within the building have a proper amounts of outdoor air and air circulation. In some locations, it is also important to ensure that the outdoor air is treated to help minimize the number of contaminants that enter building.

- Air Cleaning - determining what technology can be implemented to deal with anticipated odors, ozone and other VOCs. Typically, a filtration system such as activated carbon, needlepoint bipolar ionization, or high efficiency filters will need to be installed to deal with such issues.

How to address the issue of Initial Cost, General Cost, and providing Alternative Recommendations?

Acknowledging that filtration systems, and more efficient HVAC systems carry a large initial cost and operating cost, our group of panelists argue that the health benefits from a better IAQ is much greater than the cost. This is due to the fact that employees will have a more comfortable workspace and can be more productive when they are not dealing with health issues such as asthma and allergies as well as cognitive impacts.

How will new smart technology affect the industry?

With new technology allowing users to instantly observe data about the IAQ of their buildings, through the use of mobile applications, the panelists see potential for this technology to help develop better monitoring systems that can allow owners and users to react quickly to any issues that arise in the system. It also helps users to understand how they are using their space, and what actions correlate to an increase in harmful contaminants. However, it is important to address the issues of cyber security and invasion of privacy. As new smart technology is implemented, a new range of data about the occupants is obtained.

Summary of January's Panel Discussion by:

Andy Valencia

Electronic Communications and Gazette Committee

[ASHRAE's advice from the position document on air cleaning]

JANUARY TECHNICAL SESSION SUMMARY

Controls 101

Abhishek Khurana, CEO of Voyager Buildings

Fig 1. Abhishek Khurana, March 2020

On March 9th 2020 at Ryerson University, the Vice President of ASHRAE Toronto Chapter, Mr. Abhishek Khurana, gave a presentation on the topic of building controls. Abhishek has more than seven years of experience in the Automation Industry and owns Voyager Buildings, a BAS Contracting firm in Toronto. The presentation was attended by several ASHRAE members consisting of Consulting Engineers, Manufacturers Reps, Sustainability Professionals and University/College students.

In the past, buildings were controlled pneumatically. Some of the components of the pneumatic system, such as air dryers to prevent pipes from getting clogged, air filters to remove the dirt from the tubes so that pressure doesn't drop were essential for proper functioning of the system. The system later evolved into the DDC or Electronic System. All the issues which had been faced by pneumatic systems were solved overtime. Moreover, BACnet has become a new industry standard for communication protocol, an improvement from every manufacturer following its own protocol.

There are four types of control points on a controller: Binary Input (BI), Binary Output (BO), Analog Input (AI), and Analog Output (AO). An example of a binary signal would be the controller sending or receiving a signal of the on/off position of a pump. An example of an analog signal would be the controller sending or receiving a signal of closing or opening a control valve at a certain position.

Following is the typical hierarchy in building controls: Enterprise Level - System Level - Unit Level Control. A single computer workstation provides data to the user of all HVAC equipment and is connected to the supervisory controller. Supervisory controllers are connected to application specific controllers and then to sensors and actuators in the field.

Unit Level Control is standalone control capable of controlling the unit it comes with. For example, the control units of VAV boxes, chillers, pumps, etc. are standalone controls but can be manufactured in a way to communicate with the building BACnet system.

The picture below of a control loop was further explained during the presentation.

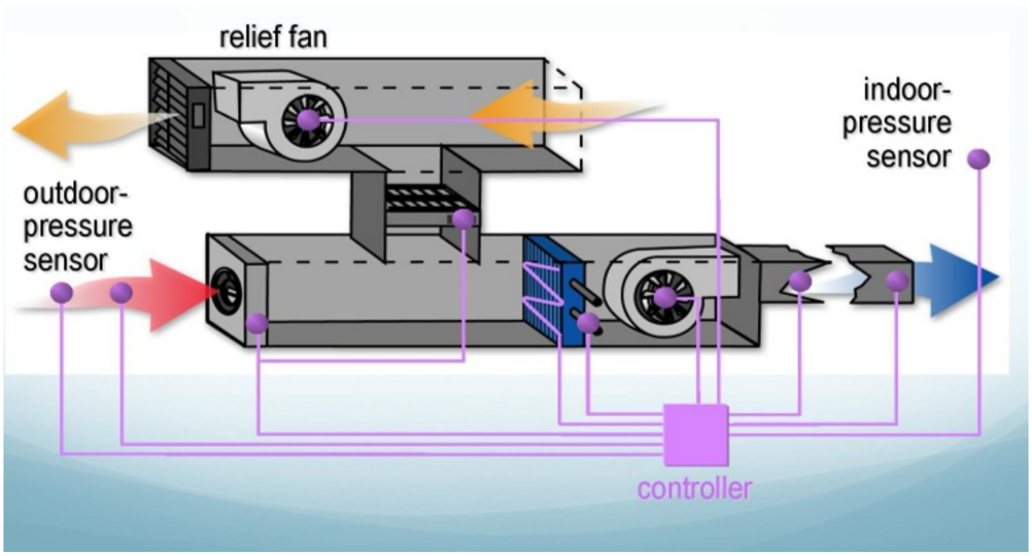


Fig. 2. Abhishek Khurana, Building Pressure Control Loop, March 2020

Fig. 2 above shows an example of how the controller connects and controls various parts of a roof top unit. For example, the controller will control the amount of water flowing through the coil based on the temperature reading it receives from the discharge air temp sensor. It controls the outdoor air damper and return air damper to control the temperature of the air in the mixing chamber. It receives data from the indoor pressure sensor and outdoor pressure sensor to make sure the exit or entrance door to the building is not partially open when the space is positively pressured or too difficult to open when the space is negatively pressurized.

There are two system level operating modes, occupied mode and unoccupied mode.

During occupied mode:

- Terminal units maintain the "occupied" setpoint.
- Outdoor air damper delivers proper amount of ventilation air.
- Air is cooled or heated to the desired set point.
- Supply air fan operates continuously, modulating to maintain the static pressure point.

During unoccupied mode:

- Terminal units maintain "unoccupied" setpoint.
- Outdoor air damper is closed.
- Supply fan, cooling coil, and heating coil operate as needed.

The control system optimizes the equipment running time for morning warm up. For example, if the equipment can do warm up in two hours and the occupied hours start at 8 am then the equipment will begin warming up at 6 am instead of 5 am or earlier, hence saving energy.

The system level controller also saves energy for chillers using chilled water reset. As shown in the picture below, a system level controller can increase the leaving water temperature if that temperature is enough to meet the requirement of the space.

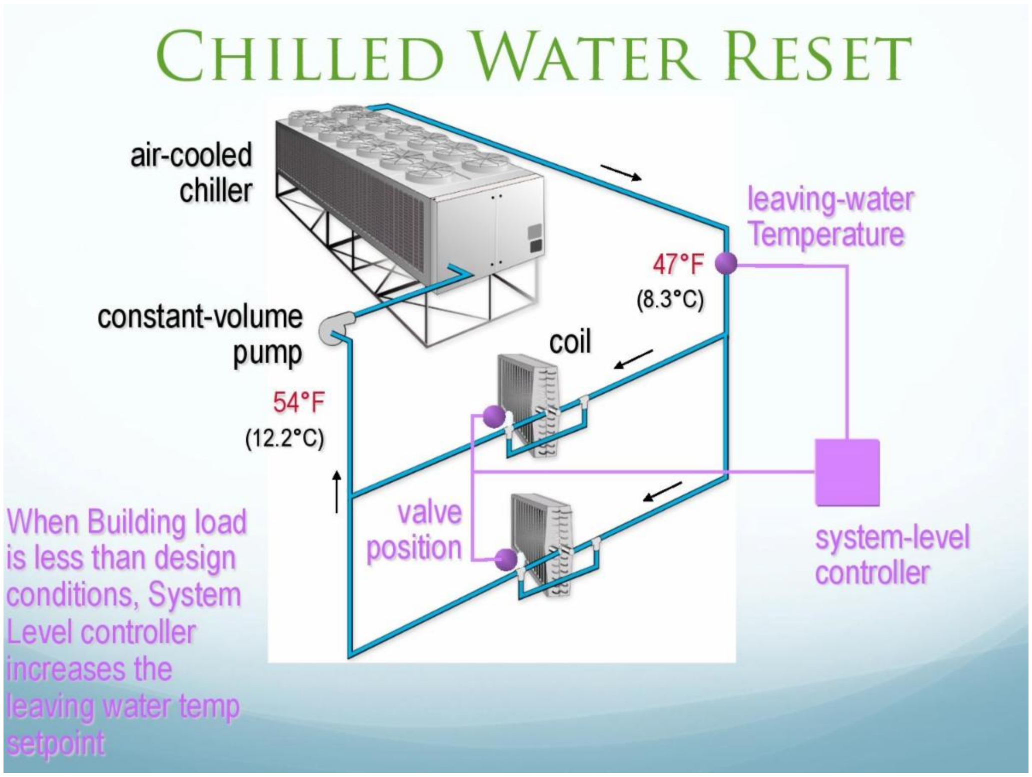


Fig. 3 Abhishek Khurana, Chilled Water Reset, March 2020

Failure recovery:

The control system can switch between the chillers in case the currently running chiller has failed or is unable to meet the cooling requirement of the building. Moreover, if the System Level Controller loses connection with the equipment (for e.g., wires being accidentally cut during construction), the unitary control on the equipment will reset itself to its default settings to keep the equipment running.

Other functionality of the control system includes: time of day scheduling, centralized alarm and diagnostics, remote access, reports, preventive maintenance, and integration with other systems.

Abhishek then provided a sample project to help understand how a controls project would come together. An office space building consists of following equipment (wired solution):

a) Rooftop units:

2 x C/W Bacnet controller: Typically, a RTU comes with a MSTP link and it can be connected and integrated with the system controller. If not, then a controller will need to be wired to the terminal strip allowing the programmer to program the sequence of operation as per the Design Engineer.

2 x existing RTU C/W legacy controller: Is access to the terminal strip possible if there is no way to integrate the controller with the system controller or is there a gateway provided by the manufacturer which can be

translated into BACnet and hence integrated with the system controller? The contractor would resolve the issue of an existing legacy controller by answering these questions.

b) VAV boxes (x15):

A VAV box comes with its own controller with a MSTP link typically. The controller is connected to a space sensor, and pressure sensors around the VAV to measure the air flow. Based on the setpoint and the space temperature, the controller determines what percentage to open the damper by so the space temperature can be satisfied. Upon satisfying the space temperature, the damper may go back to minimum position or fully closed based on programming.

c) Perimeter heating (Valves):

For the control valves, the controller will send an analog signal to control the flow through the valves. This can be used as supplementary heating with cooling only VAV boxes.

d) Boiler + pumps:

Typically, boilers come with a master-slave controller which may use proprietary protocol. Depending on the manufacturer, there may be a BACnet card available for integrating in the System Controller. Otherwise, we will look into hardwiring all points to the unitary controller and then use BACnet MSTP or IP to integrate the unitary controller into the system controller.

e) Humidifier:

If the humidifier comes with a BACnet card, the system level controller will be able to send commands to control the humidifier and receive feedback. Otherwise control may be limited depending on points we can hardwire - On/Off and Status being the basic points in that scenario.

f) Motorized valves and dampers:

Depending upon the type of valve and damper, the input and output to the device will be binary or analog. A 2 position actuator will require a Binary Signal whereas a modulating actuator will use an analog signal. It is also important to know if the power being supplied to the actuators is 24V or 120V. Spring Return vs Non-Spring Return is also something to consider. For valves we want to know the pressure drop so the valves can be sized accurately.

Summary by Eshan Patil

Electronic Communications and Gazette Committee

FEBRUARY DINNER PRESENTATION SUMMARY

Improving the Performance and Indoor Environmental Quality of Post-War Multi-Unit Residential Buildings

Lecturer: Dr. Jamie Fine, Phd. EIT, Post Doctoral Fellow

University of Toronto

February's dinner meeting focused on the topic of how to improve the performance and indoor environmental quality of post-war multi-unit residential buildings (MURBs). The topic was presented by Jamie Fine, a post-doctoral fellow at the University of Toronto. Dr. Fine has spent his career researching how to improve the performance of these type of buildings as well as energy systems since 2014 and received his PhD from

Ryerson University in 2018. Dr. Fine's lecture focused of providing new insight and understanding on three main topics:

1. Ventilation and IAQ perceptions in two post-war MURBs.
2. A new retrofit method for post-war MURB heating systems.
3. Strategies for testing the air tightness of multi-unit buildings

Ventilation and IAQ perceptions

The motivation of this study is to develop a more comprehensive understanding of the performance of pressurized corridor systems in many high-rise buildings and perceptions of indoor environmental quality. The study considered how occupant-driven effects, such as opened windows and exhaust fans, and weather-driven effects, such as wind and temperature, affected the amount of fresh air that entered the space and the accumulation of indoor pollutants. The study collected data from two different buildings. Both were located in Toronto, were owned by the same owner, had recently replaced their air handling units, and had rectangular floor plates. Air flow measurements were taken at supply grills on each floor, and in-person surveys were carried out by a sub-contracted professional survey company. This survey was carried out in February (i.e. Winter) and asked 25 occupants of their comfort levels within their space during winter and summer.

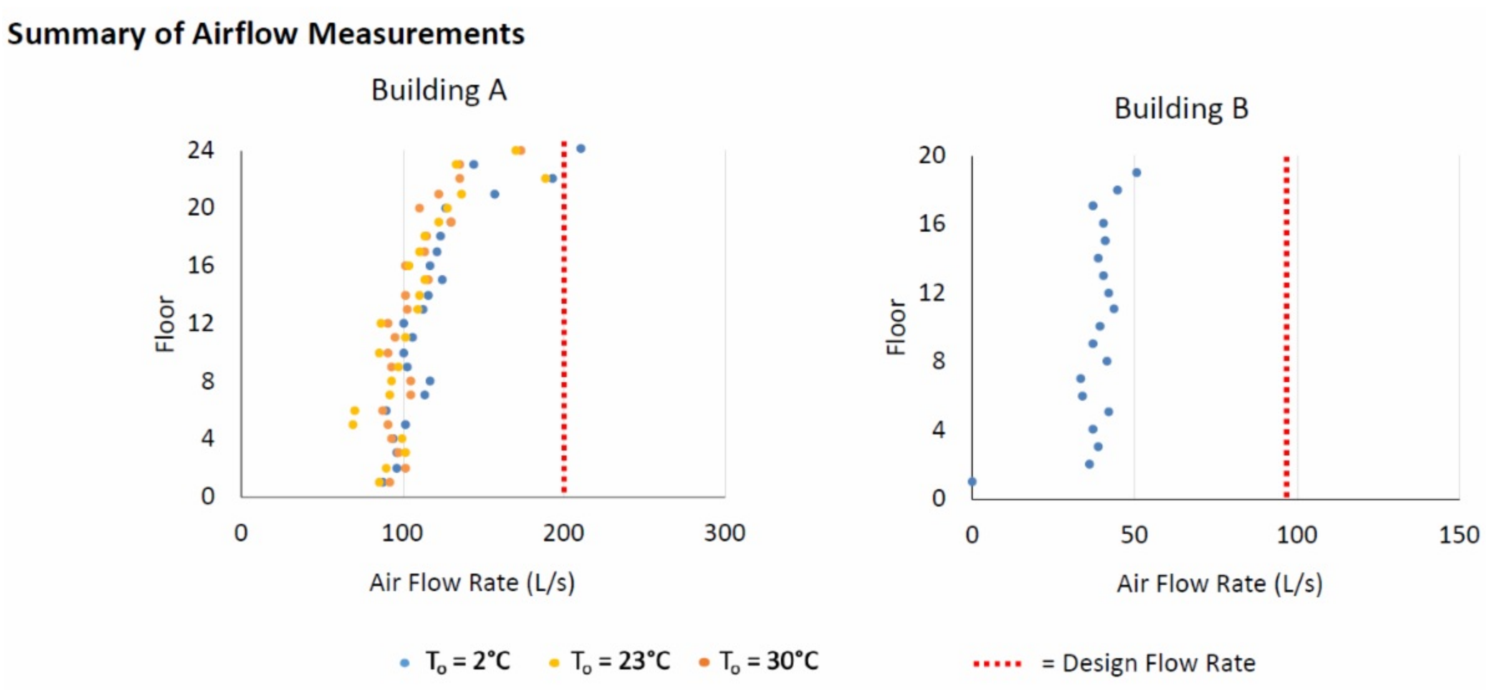


Figure1: Summary of Airflow Measurements

The air flow study yielded two conclusions:

1. No significant difference between mean airflows as a function of outdoor temperature.
2. No significant difference of the variability of air flow as a function of outdoor temperature.

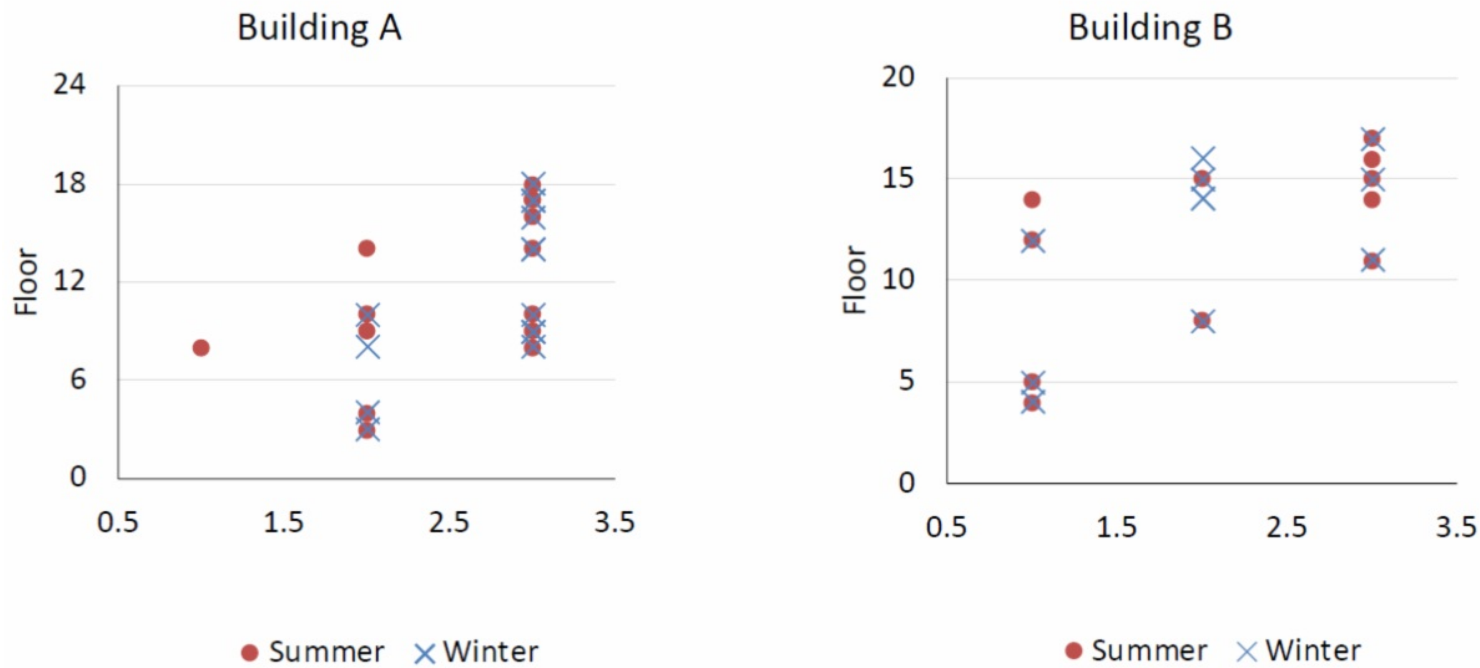


Figure 2: Outdoor Odour Results

The survey on comfort level and air quality perception concluded the following results:

Correlating perceptions to floor

1. The only significant result with correlating perceptions to floor, was that perception of outdoor odours changes as a function of floor.

Correlating perception to season

2. Season had little effect on thermal comfort, and it was consistently too warm.
3. Windows were left open in both seasons, which supports the thermal comfort finding.
4. IAQ was consistently poor, possibly as a result of the low measured ventilation rates.

In conclusion the strong anecdotal evidence that was initially expected of a temperature dependent ventilation changes were not observed. Airflow rates near the top of the building were higher than the bottom. Residents near the bottom of the building reported issues with outdoor odours, even though the system was newly commissioned. The perceived IAQ of these buildings was consistently poor, supporting that pressurized corridors were not working as intended.

A new retrofit method for post-war MURB heating systems

In southern Ontario, there are 1200 post-war MURBs that have been constructed between 1960-1970, and most do not have functional in-suite temperature control equipment. The choice of HVAC equipment, such as hydronic baseboards for heating, and lack of temperature regulators, has resulted in overheating and constant need of open windows by occupants. Owners are beginning to investigate the installation of TRVs in apartments to help reduce overheating. This retrofit strategy haves been shown to reduce overheating by 17% to 27%, however the cost of installation can range from $745 to $1,400 per valve. The high initial cost of installation of this equipment can be barrier for owners.

Figure 3: Installed TRV

In order to decrease the capital cost associated with improving comfort, energy performance and operational savings, an alternative retrofit strategy needs to be developed. The proposed retrofit strategy should focus on the following key features:

1. Wireless temperature sensors installed in each suite
2. Grouping suites such that the flow rate to a group of suites can be controlled by a single valve.
3. The coldest suite in a group is maintained at a setpoint.

It is important to determine the limitation imposed on this system when used in existing buildings. This limitation typically stems from grouping constrains imposed by existing riser layouts. A simulation case study on a student residence building in Toronto was carried out to test a variety of layouts to determine trends in effectiveness for the retrofit. A total of eight different grouping configurations were tested. As expected, the case study showed that the most effective grouping strategy was one group per suite, with a space heating energy saving of 26% and "too warm" signal reduction of 93%. However, this configuration would be expensive, and the energy savings and comfort increase would not be much greater than a one floor per group with north-south split configuration (21% and 92% respectively). This proposed strategy is therefore the recommend configuration for the case study buildings, as it also improves payback periods by up to 70%.

Grouping Strategy	Total Number of Groups	Space Heating Energy Savings	"Too Warm" Signal Reduction
Base Case Operation	0	0%	0%
One Group for Building	1	6%	24%
North-South Split	2	7%	31%
Five Floors per Group	4	14%	68%
Five Floors per Group with North-South Split	8	17%	82%
One Group per Vertical Suite Stack	16	9%	42%
One Floor per Group	20	17%	80%
One Floor per Group with North-South Split	40	21%	92%
One Group per Suite	320	26%	93%

Figure4: Data Results From Simulation Case Study

Strategies for testing the air tightness of multi-unit buildings

Many buildings rely on uncontrolled air leakage for one portion of their ventilation calculation. In particular, older homes rely on uncontrolled air leakage for almost all ventilation purposes, and in MURBs buildings, it has been shown to account for up to 50% of heating loads. Currently the most common test used to quantify this leakage, is a blower door test. However, this test requires that the entire building is at the same interior pressure, which can be difficult to achieve for large buildings.

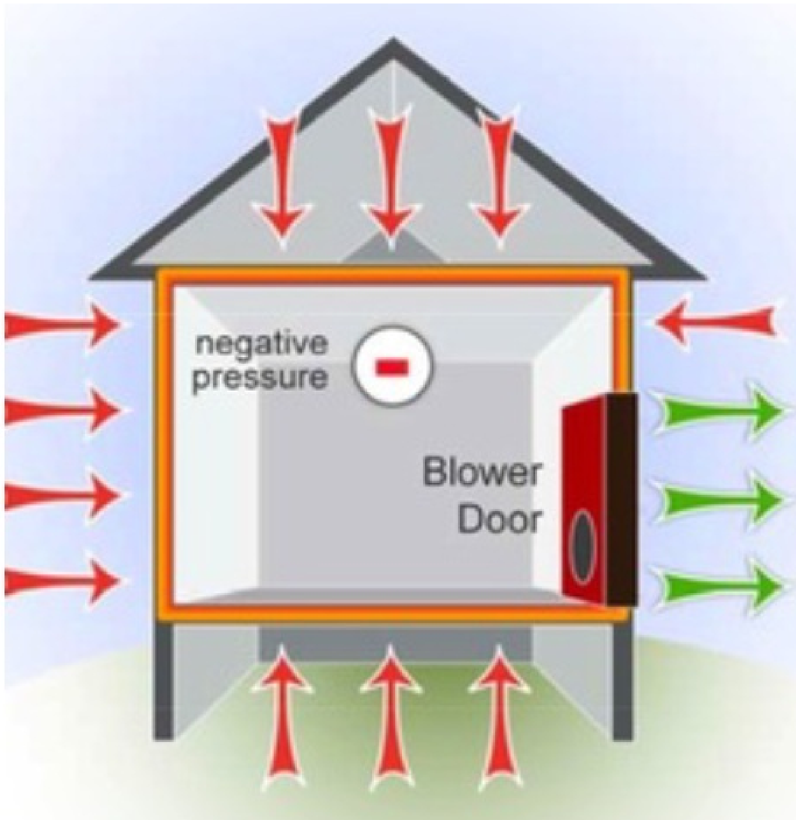


Figure 5: Blower Door Test

To deal with this issue in MURBs, a Whole Suite Test is more often used, but can result in poor quantification of the exterior suite boundary when applied. An alternative method for MURB buildings is the Pressure Neutralization Test. This test requires all adjacent zones be at the same pressure as the test suite, requiring multiple fans. Most technicians avoid this method as it is complex, time consuming, and expensive. The issues with all these tests are that;

1. There is a lack of verification of exterior boundary air tightness because the existing test is difficult.
2. There is no information about alternative methods that can access the exterior boundary air tightness in multi-unit buildings.

To obtain more accurate results for the air tightness of MURBs, it is necessary to determine and compare the effectiveness of alternative air tightness test methods.

Two different methods were considered for possible alternative air leakage tests, the Lstiburek method and the Love and Passmore method. The process for each test is as follows:

Lstiburek Method

- A typical whole-suite test is carried out first
- The fan is removed from the test suite and fans are installed in all adjacent zones

Love and Passmore Method

- A typical whole-suite test is carried out
- Windows in adjacent zones are closed and brought to the same air tightness configuration as

- The pressure of the test suite is monitored while the adjacent zones are brought to different pressures

the test suite

- The test suite is pressurized and the pressures in the adjacent zones are monitored

These methods have not been used in high-rise MURBs before, as originally both of these methods were used in single-family homes or row houses. To compare these tests, an on-site sequential pressure neutralization test was completed. Using the test data, an air flow model in CONTAM that represents the tested suite was built, and simulations of each alternative method was carried out to determine the effectiveness of each method.

Using the Lstiburek method the results showed that while the test can estimate exterior boundary leakage, it has similar complexities and equipment drawbacks as compared to the pressure neutralization method. In addition, it did show that the sensitivity of this method to measurement noise is greater than the pressure neutralization test. As such, it is not recommended for use in a high-rise MURB.

Test Pressure (Pa)	Estimated Flow Rate (L/s)	Actual Flow Rate (L/s)	Error
65	35.5	35.4	0.2%
70	37.8	37.8	0.2%
75	40.2	40.1	0.2%
80	42.4	42.4	0.2%

Figure6: Lstiburek Method Results

The results obtained from the Love and Passmore method showed a high percentage of error (108% error). The main cause of error in this method is its dependence on pressures being generated in adjacent zones. Corridors in multi-unit buildings can have strong leakage pathways, resulting in it being difficult to build up interior air pressure. In addition, flow from adjacent suites is typically small and is not enough to build up sufficient pressure either.

Test Suite Pressure (Pa)	Exterior Flow Estimate (L/s)	Actual Exterior Flow (L/s)	Error
65	73.8	35.4	108%
70	78.6	37.8	108%
75	83.4	40.1	108%
80	88.1	42.4	108%

Figure7: Love and Passmore Method Results

Currently there are no easy-to-use methods for testing the air leakage of MURBs, and high air-leakage rates in multi-unit buildings can cause significant impact on the energy usage. Both methods tested, the Lstiburek and Love and Passmore, are not recommended as replacements for the pressure neutralization method based on the construction of the test suite. More work is still needed to determine the sensitivity of methods to construction techniques and to develop new methods.

Summary of February's Dinner Meeting by:

Andy Valencia

Electronic Communications and Gazette Committee

PHOTO - PAST PRESIDENTS

March 11th 2020, Past Presidents Night and Dinner Meeting

MARCH DINNER PRESENTATION SUMMARY

Integrating Renewable Energy Systems in Buildings

Sheila J. Hayter PE, FASHRAE, Society President 2018-19
National Renewable Energy Laboratory
Golden, Colorado USA

Presentation for ASHRAE Toronto Chapter, March 11, 2020

In March, Sheila J. Hayter, a distinguished lecturer and ASHRAE Presidential Member, gave a presentation about integrating renewable energy systems in building design. Sheila shared her knowledge and experience with these technologies, explained the considerations when choosing renewable energy systems, and described the Research Support Facility building project as a case study for the various strategies to achieve net zero energy.

Reasons to integrate renewable energy systems:

1. Buildings consume approximately 40% of all worldwide annual energy consumption, with over 60% of it in the form of electricity. In Ontario, emissions from buildings are a slightly lower (about 20%) due to a clean source energy mix from hydro and renewables.
2. About 75-80% of all building stock that will exist in the next decade will be buildings which already exist today. Our design decisions today will have a long-lasting impact on our future energy consumption
3. Energy policies and building codes are moving towards requiring clean energy design solutions

There are many types of renewable energy systems which can be considered for building projects, including solar, wind, geothermal, and biomass. In general, the following should be considered when choosing the renewable energy system (RES):

- Know your loads - Determine the building's energy consumption profile
- Evaluate access to resource - Is there enough to meet demand? Is there area to install it?
- Check codes and regulations - Are there government mandates that affect the RES?
- Verify acceptance by utilities - can they accept putting energy back into grid? If not, bring them into the design discussion.
- Find Incentives - Are financial incentives available to offset first costs?

The following table summarizes the further points to consider when choosing between the various types of renewable energy systems (RES):

RES	Pros	Cons	Considerations
Solar	• Cost has been reducing over the past decade • Solar technologies are simple to install and maintain • Thermal systems can provide good service hot water	• Although the cost of solar has decreased significantly in recent years, it may still be considered expensive in some cases. It is important to understand what incentives are available to offset the initial investment costs and to investigate alternatives for financing solar system investments.	• Need a suitable location to install solar array, such as unshaded roof or land area • Need to allocate space in the building for the balance of system components (e.g., inverter, hot water storage tanks, etc.) • Need good solar availability (can check using solar resource map [1]) • If the array is shaded, need to calculate how system performance will be impacted • Often, solar array tilt and orientation are impacted by architectural

			requirements. Need to understand how the solar system performance will be impacted. • Make building solar ready by planning wiring, pipe routing, and storage systems [2]
Wind	• Good solution if there is a good wind resource at the site where the turbine may be installed • Low-maintenance 20-year life span • The cost to run is often equal to the local utility rate	• Very site specific • Need wind speed >8 m/s (can check using Canadian Wind Energy Atlas [3] • Highly recommended to measure the actual wind resource at the site where the turbine may be installed	• Use wind anemometer to measure wind source over months (preferably 1 year)
Geothermal	• Both ground-source heat pumps and direct geothermal systems are considered to be renewable energy technologies • Ground-source heat pumps are effective for mixed climates	• Challenge for direct geothermal systems is access to a good resource - direct geothermal resources are very site specific	• Would it be cost-effective and consistent for the site? (check using geothermal map of Canada [4]
Biomass	• Biomass resources are available in many sources (Lumber yards, Solid waste, Wood Chips etc.) • Logging residues map show there are lots available in Ontario • Mature market for equipment	• Limited by proximity to a permanent steady waste stream (can check using BIMAT [5]) • Limited by delivery logistics	• Is it available when needed (throughout all winter) • Is there enough quantities of the resource? • How many truck deliveries/week are needed to fuel boiler? • Where to manage the biomass dumps on site?

Table 1. Types of renewable energy systems (RES)

Case Study - Research Support Facility Phase I and II

Research Support Facility building is a zero energy building near Denver, Colorado.

According to the US Department of Energy, a zero energy building is defined as an energy-efficient building where, on a source energy basis, the annual delivered energy is less than or equal to the on-site renewable exported energy.

It was built in two phases (RSF I and RSF II) through a design/build process with the goal to achieve less than 25 kBtu/ft2 in energy use intensity (35 kBtu/ft2 including the datacenter), at least 50% energy savings compared to ASHRAE 90.1-2004, and LEED Platinum certification. The facility was built to accommodate over 1300 occupants, with both phases totaling 358,000 ft2. The RSF I was contracted at a firmed fixed price of $259/ft2 construction cost, not including the $29/ft2 for photovoltaics. RSF I was occupied in June 2010, while RSF II opened the follow year in November 2011.

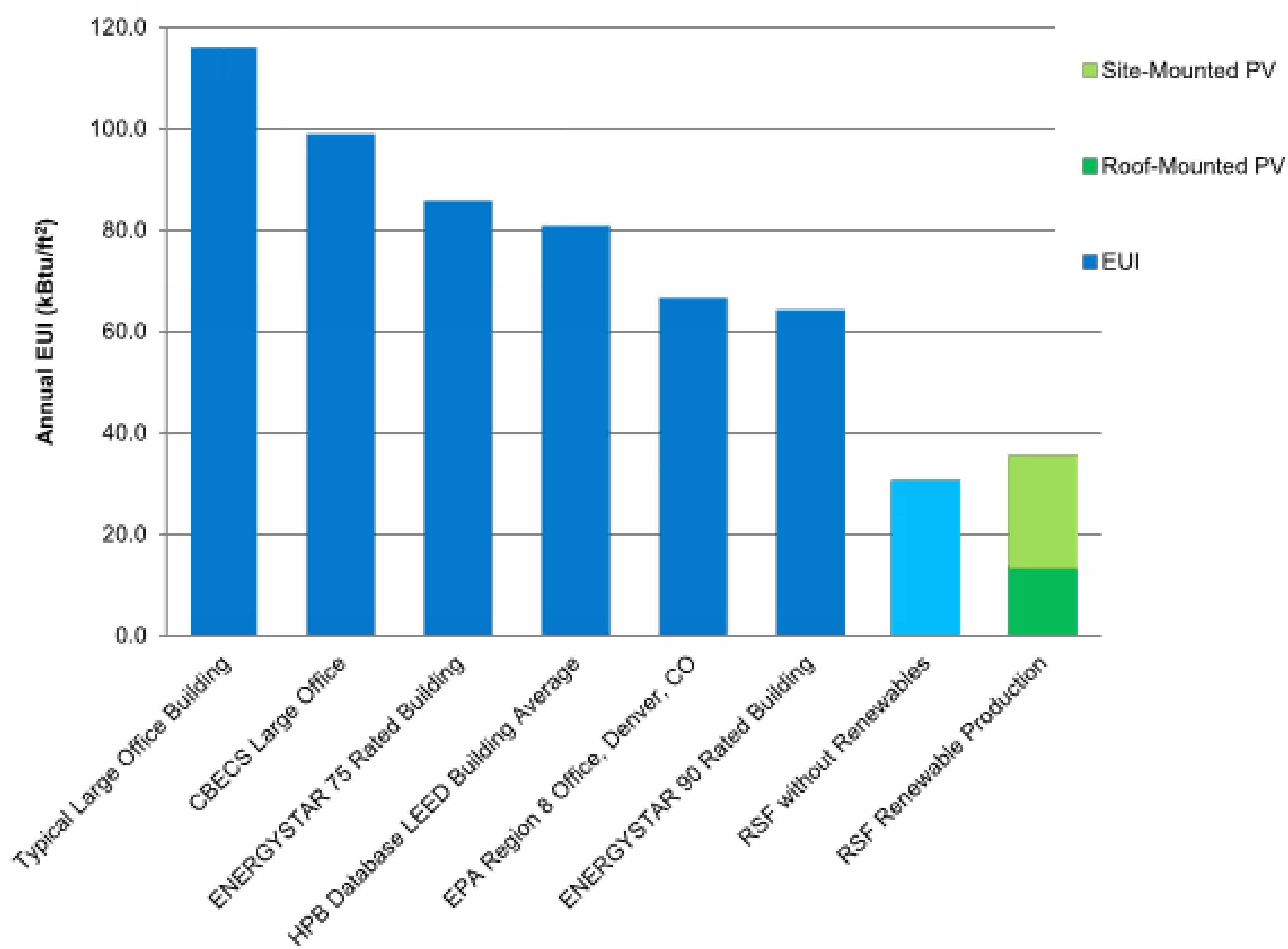


Figure 1: Annual Energy Use Intensity (EUI) target vs typical offices in the databases

The main energy conservation measures of the project include:

- Lighting load reduction
- High efficiency data centre
- Plug load reduction
- Thermal mass
- Natural ventilation
- HVAC System selection
- Control optimization

Lighting load reduction was achieved by designing the narrow architectural form for each wing of the building, which allows for great daylight penetration. Though the increased surface area increased the thermal losses from the envelope, they were offset by the savings on energy provided by daylighting and continuous dimming lighting system control.

A lesson learned after occupancy was that the lighting schedules assumed during design were oversimplified. The design (shown as energy model lighting power in Figure 2) assumed that most occupants leave the facility after 6pm. However, this was not the case in reality and it became an additional source of energy consumption that overshoots the design consumption estimates. Luckily the building still achieved net zero energy performance from additional savings in other areas.

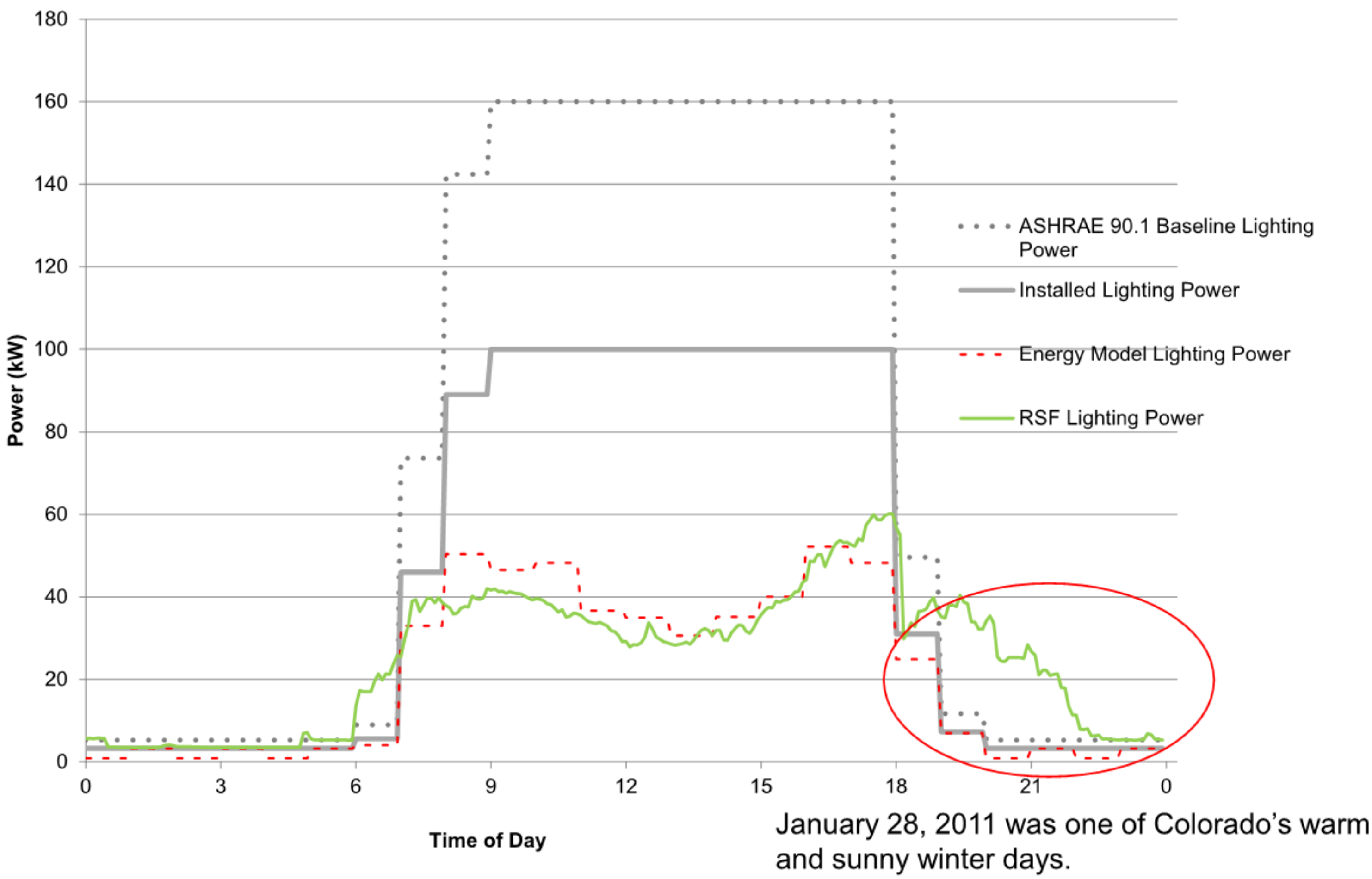


Figure 2: Building lighting profile, discrepancy between energy model and measured is circled in red

When considering plug load reduction, it should be noted that the occupants have the largest influence on the plug loads (about 44.7% of total loads). The power density assumed for plug loads would influence the size and type of the renewable energy system which needed to be designed.

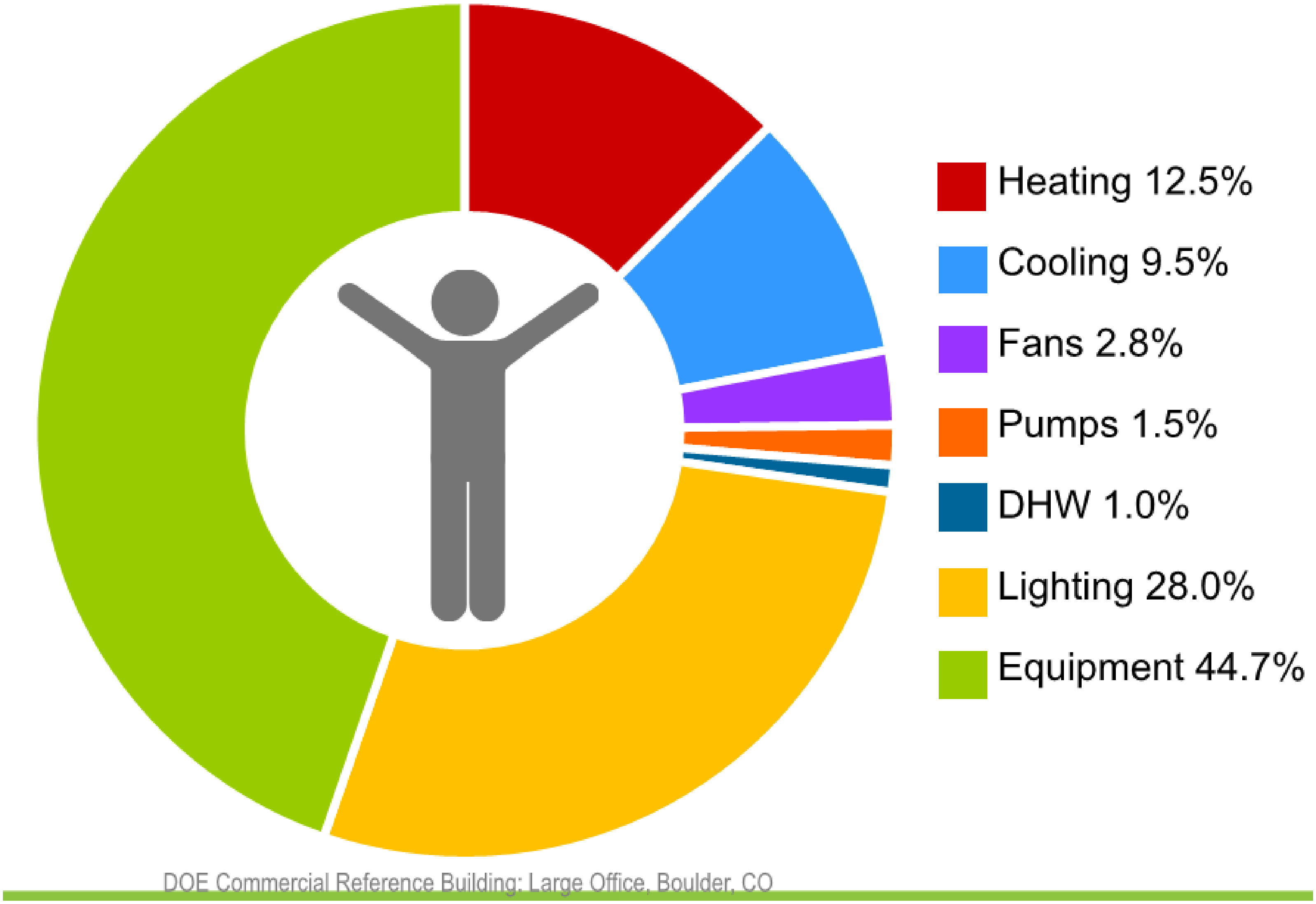


Figure 3: The occupant's influence on the building loads

For example, significant plug load reduction was achieved by changing the nearly 2000 phones required for the building, which typically consume 13W each, to Voice over IP phone systems which only consume 2W each. Combined with switching other types of plug equipment (printers, desk lamps etc.) to low energy options, the building reduced the equipment load in the building's office areas by 48% as shown in Figure 4.

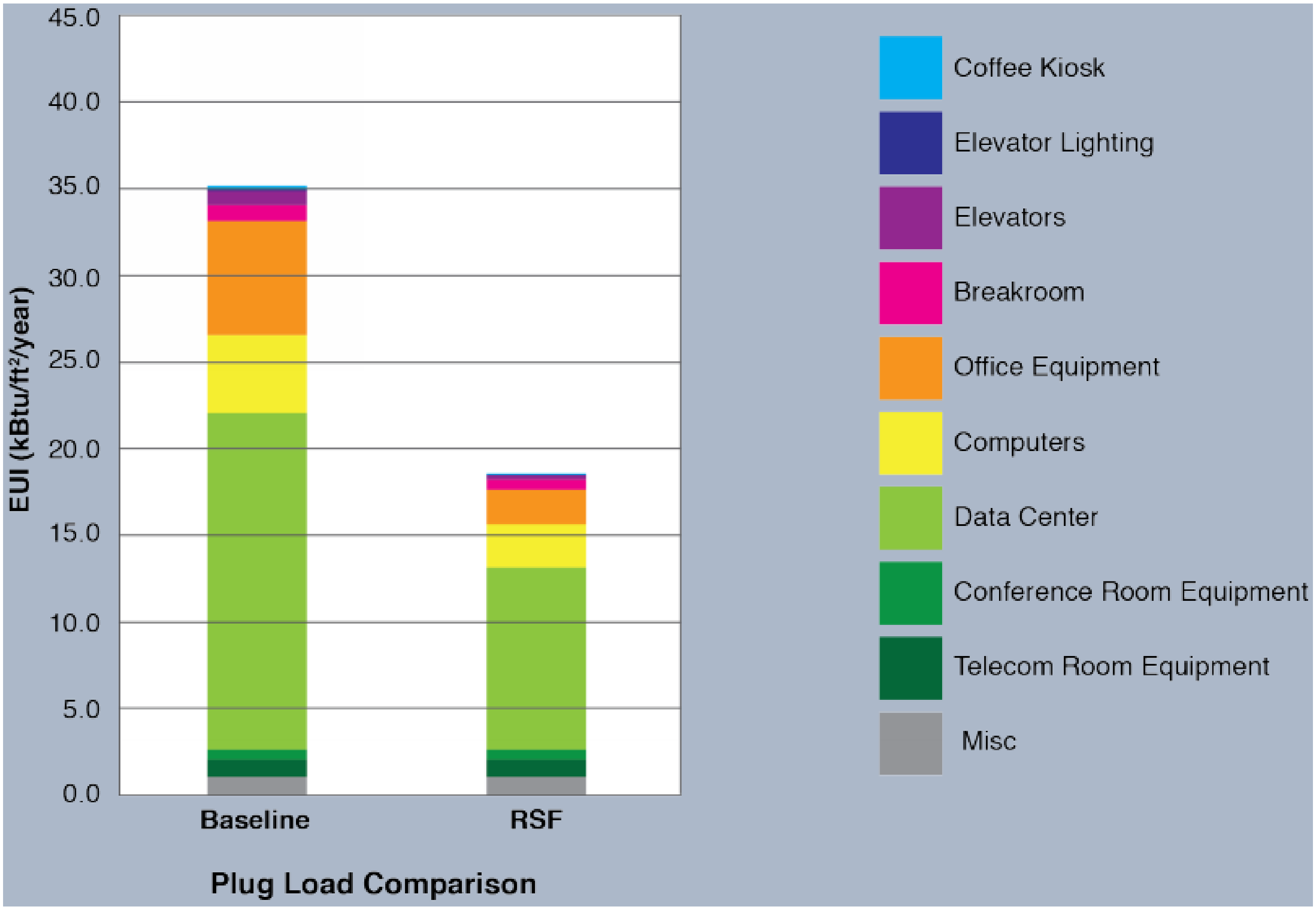


Figure 4: RSF's reduced plug loads compared to the baseline design.

The data center of the building used a hybrid cooling system which uses free cooling first, and were installed with the state-of-the-art power systems and energy efficient equipment at the time. The data center design was able to achieve PUE of 1.35-1.36 in 2010.

Thermal mass in the form of 6" thick lightweight concrete on the interior walls was used to the design's advantage. Nighttime purging during summer stored coolness inside at night, which helped keep temperatures comfortable in daytime. This strategy also helped during the heating season by capturing solar heat gains to offset heating loads and improve comfort. A solar ventilation preheat system was implemented on the south-facing walls of the south and north wings of the building, as shown in Figure 5. The solar heated air was drawn through the system down into the crawl space using fans. This heat was then stored in the concrete labyrinth that was constructed in the crawlspace. At night, the ventilation air was then drawn through this crawlspace to preheat the air before delivering it to the building.

Figure 5: Southern wing of RSF, the panels in black are the solar ventilation preheat system

Natural ventilation was used in the office areas to reduce the cooling load of the building during occupied periods during the swing seasons. Automatic windows were controlled and operated to support nighttime cooling and daytime natural ventilation, while notifications were given to the occupants to open the manual windows when outdoor conditions were favorable.

The HVAC system consisted of underfloor DOAS with CO2 demand-controlled ventilation in the office areas. Radiant in-floor heating and cooling served the typical office zones while VAV and displacement ventilation served the conference rooms. Hot and chilled water was provided by the campus central plant, which included a wood chip boiler that meets approximately 50% of the heating load and high efficiency water cooled chillers. The system provided cooling at 1000ft2/ton compared to the typical 300-400ft2/ton.

During the first month of operation, the measured consumption was noticeably higher than expected from the design. Investigating and correcting various sources of minor errors such as the control sequence, damper installation, and valve operations allowed the system to achieve the expected performance (cumulative demand side annual EUI of 35.1 kBtu/ft2) from the design energy model.

By applying the lessons learned in the first phase of the project, the design and construction of RSF II, which commenced about a year and a half after RSF I, achieved of cost savings of 5%. Despite adding over 1/3 to the area of the project, RSF II was 17% more efficient than RSF I. The difference in performance came from the cumulative effect of small improvements. The following are some highlights of these improvements:

- Higher efficiency solar panels
- Less window area while maintaining full daylighting
- Minimizing thermal bridges
- Coupling indirect evaporative cooling with exhaust air energy recovery
- Daylighting controls & passive cooling in stairwells
- Increased flexibility in lighting controls
- Cooling IT and electrical rooms with heat pumps, using heat rejection for service hot water

Aside from the building design and construction, Sheila highlighted the importance of energy management. For example, the building automation dashboard could display building performance information on indicators within a range, so that it would be easier for the building operations team to confirm normal operation at a glance and diagnose any unexpected energy consumption in the building.

The onsite renewable energy system for RSF I & II consisted of several rooftop and parking PV systems.

Three arrays were on the roofs of the RSF, one at the front parking area, and one at the parking garage building serving the RSF. Figure 6 shows the locations and capacities of these systems.

Figure 6: PV arrays which are part of the RSF project

While the parking garage provided additional area for PV arrays, it could also consume a lot of ventilation fan and lighting energy (a typical parking garage can consume up to 15-20% of the total energy load of the building it serves). To minimize the parking garage loads, the team designed the parking garage building to have ample openings for natural cross ventilation and used efficient lighting with occupant controls.

A random sample of LEED certified buildings is shown in Figure 7. Comparisons of cost of the RSF project with and without the PV system (shown in blue) demonstrates that meeting aggressive energy and sustainability goals (net zero energy in this case) for building projects does not necessarily mean that the building must come at a higher cost.

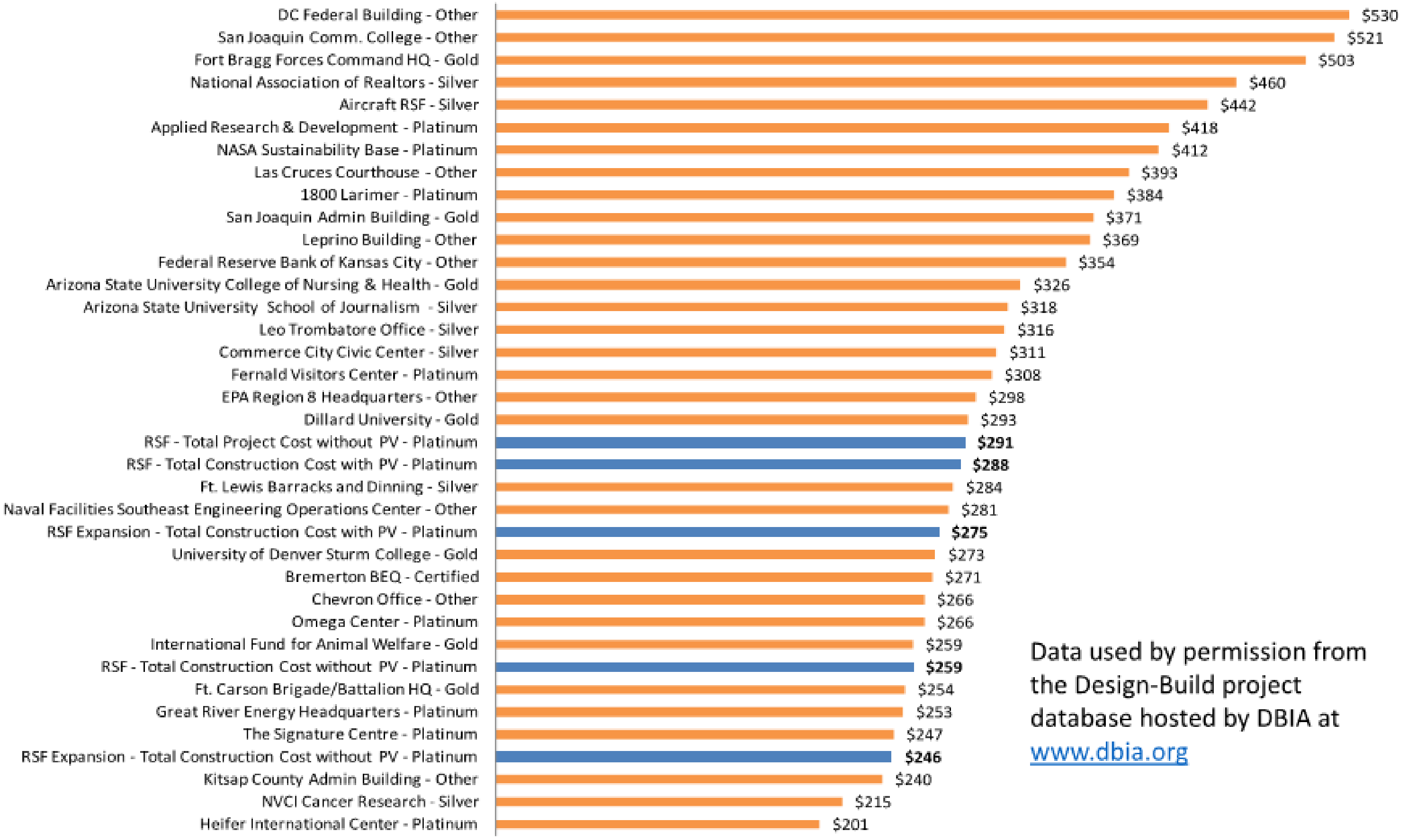


Figure 7: Random sample of the cost ($/ft) of LEED certified projects compared to the RSF

References

[1] energyhub.org. Solar Energy Maps Canada. Available : https://energyhub.org/solar-energy-maps-canada/

[2] National Renewable Energy Laboratory. Solar Ready Buildings Planning Guide. Available: http://www.nrel.gov/docs/fy10osti/46078.pdf

[3] Environment Canada.Canadian Wind Energy Atlas. Available: http://www.windatlas.ca

[4] Natural Resources Canada. Geological Survey of Canada Open File 6167. Available: ftp://ftp.geogratis.gc.ca/pub/nrcan_rncan/publications/ess_sst/247/247765/of_6167.pdf

[5] Agriculture and Agri-Food Canada. Biomass Inventory Mapping and Analysis Tool. Available: http://www.agr.gc.ca/atlas/bimat

Summary by **Kai Ye**

Website & Gazette Committee

Badri Patel (left), YEA Co-Chair for 2019-20 from ASHRAE Toronto Chapter participated in 'Leadership U' program during 2020 ASHRAE Winter Conference held in Orlando, FL during Feb 1-5, 2020.

LEADERSHIP U program for Young Engineers in ASHRAE (YEA)

Have you wondered what ASHRAE Officers do at the ASHRAE Winter and Annual Conferences? Through Leadership U, four YEA members are selected for each conference to be matched up with Society Officers and participate in all of their events and board meetings, including social activities. Leadership U not only allows you to experience a conference like an Officer, but it is also a great opportunity to network and form connections with those active in ASHRAE.

If you have any questions about Leadership U or application process, please reach out to ASHRAE Toronto Chapter YEA Committee:

YEA Chair, AlekhyaKaianathbhatta at alekhya_k@rogers.com

YEA Co-Chair, Badri Patel at badri.patel@mail.ashrae.org

JOB POSTINGS

Please click on the link below to be redirected to the ASHRAE Toronto Chapter job postings section.

Job Postings

UPCOMING EVENTS

New ASHRAE certification!

HVAC Designers

Why is earning the ASHRAE Certified HVAC Designer (CHD) credential the best way to gain a competitive edge? In a recent "Industry Need" survey, ASHRAE Member respondents who influence the HVAC Designer hiring decision had this to say:

- HVAC Designer certification is a tool to identify competent new hire prospects (74%)
- It is a worthwhile professional development goal (82%)

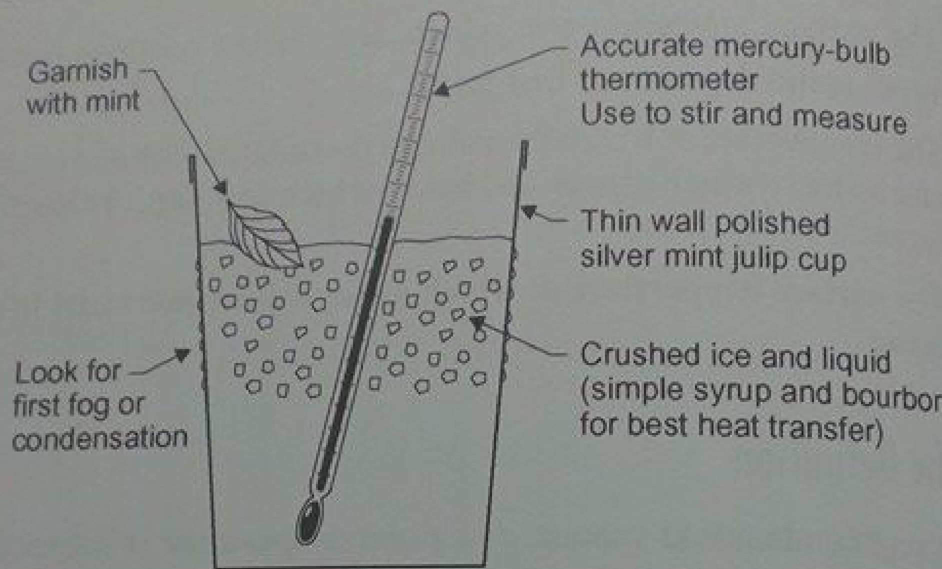
HVAC Designers themselves agree that earning an HVAC Designer certification would be a "worthwhile professional development goal" (75%) and "help differentiate practitioners from their peers" (70%). Earning the Certified HVAC Designer (CHD) certification will let your employer, peers and customers know that you have the knowledge, skills and abilities needed to get the job done, and position you for continued recognition and success.

For more information on this and other available certifications follow thelink below
https://www.ashrae.org/professional-development/ashrae-certification

FUNNY SECTION

to prepare these data, which ... form in *ASHRAE Handbook—Fundamentals*.

A dew-point hygrometer utilizes a temperature-controlled, highly polished observable surface. In the instrument's simplest form, crushed ice is slowly added to a liquid in a thin-walled silver container such as a mint julep cup (Figure 12-1). An accurate mercury bulb thermometer is used to constantly stir the liquid in the cup. When the first sign of condensation (dew) is observed on the outside of the cup, the temperature of the liquid in the cup is read as the dew-point temperature. This method requires that the temperature of the outside surface of the silver cup and the temperature of the liquid in the cup be essentially the same. In actual practice, the temperature of the liquid in the cup will be slightly lower than the outside surface temperature of the cup.



Instructions

1. Slowly add ice, stir and observe temperature and evidence of condensation.
2. Dew-point is thermometer reading when fog or condensation first appears.
3. Dispose of contents of cup in compliance with all regulations.

Figure 12-1—Dew-point temperature apparatus.

Funny Section provided by Niss Feiner, C.Tech, CHD, from ASHRAE publication

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