Fast + Epp Head Office – Reaching Net Zero GHGs & Optimizing Thermal Comfort Case Study

Prepared By: IMPACT ENGINEERING

Building Name/Address	Fast + Epp Head Office
Building's Asset Class	Office (with Concept Lab)
Building Size	16,000 ft² (1,450 m²)
Year Built	2021
Building Owner & Manager	Fast + Epp
Mechanical / Energy Engineering Consultant	Impact Engineering

BOMA BRITISH COLUMBIA Impact ENGINEERING Fast + Epp

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PROJECT INTRODUCTION

Fast + Epp is a structural engineering firm that designed and constructed a 4-storey office headquarters in Vancouver showcasing their values, elegance in design, and purpose. The building's design intentions included high-quality, sustainable materials that allowed for a strong and flexible structural design to withstand an earthquake, connect the employees with the outside environment, and provide optimal thermal comfort. The building also includes a concept lab where engineering staff can explore new ideas, conduct research, and perform tests.

Fast + Epp placed a strategic focus on achieving an all-electric, low carbon project. Critical design decisions were made to reduce energy consumption and to employ high efficiency equipment.

This case study will highlight the four (4) main design concepts that the Fast + Epp building employed that can also be used in a retrofit application to achieve optimal thermal comfort and reduce carbon emissions in operation.

1. Dynamic Glass
2. Heat Recovery Variable Refrigerant Flow System (HR VRF)
3. Heat Recovery Ventilation
4. Electric Domestic Water Heaters

Dynamic Glass

Dynamic Glass by View was selected for the Fast + Epp building as the most cost-effective and elegant solution to reduce building cooling loads. As the sun moves around the building throughout the day, the View intelligence control software dynamically optimizes the tint of each window. Transition between the four different tint levels helps these windows control glare and solar heat gain while maximizing natural light and views to eliminate the need for blinds or other shade structures.

View systems are composed of regular glass with a series of thin, nano-coatings that react to a small electrical charge creating different levels of tint. The glazing system uses AI, considering building orientation, arc of the sun, and real-time local weather patterns to optimize the amount of light throughout the day.

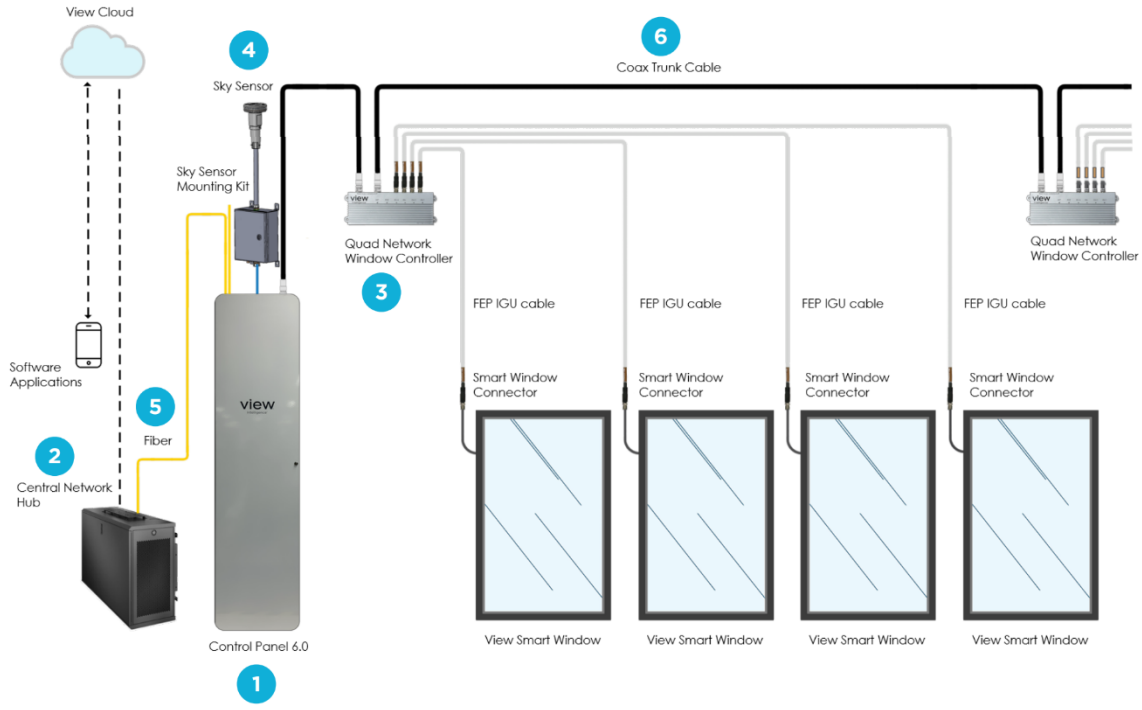
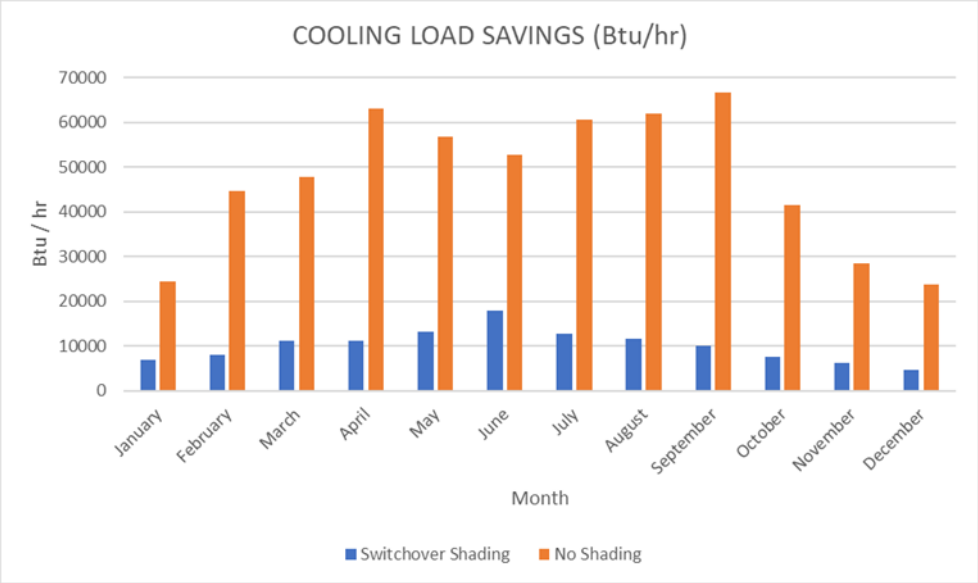


Image: View Net Brochure

As a result of installing View Dynamic Glass, the project was able to avoid the installation of **5 tons of cooling** at the central plant level (HR VRF rooftop condensing units). More importantly, downstream indoor VRF fan coil units serving the building perimeter were able to be reduced in size. In doing so, a significant HVAC capital savings was realized which also includes savings on smaller sizes of sheet metal ductwork, reduced overall requirement for diffusers as well as refrigerant piping and electrical cabling.

Achievements beyond the capital and energy savings include: occupant comfort via reduction in glare and improved indoor air quality, reduction in airflow volumes, reduction in indoor temperature differential, as well as maintenance savings associated with reduced cleaning of items like blinds and external shades.

Expected savings as modelled during construction (39,000 kWh cooling energy)



Dynamic Glass as a Retrofit

View glass technology has also been implemented successfully for existing building envelope upgrades and tenant improvement projects.

Dynamic Glass can be installed in existing framing or as a full window replacement. When provided with details on the existing framing and any limitations, a profile of the gasket can be taken to have a die cut for adaptation.

The design also allows for flexibility with installation phases and includes innovative solutions to conceal added wiring. Commonly, wiring can be incorporated with the existing radiators behind the casing.

The Dynamic Glass system also enhances the efficiency of existing mechanical cooling systems and may extend their useful life. By effectively reducing solar heat gain load, existing mechanical

cooling systems needn't work as hard to provide adequate cooling, even as summer temperatures rise over future years due to climate change.

Heat Recovery Variable Refrigerant Flow System (HR VRF)

An all-electric Heat Recovery (HR) Variable Refrigerant Flow (VRF) system was chosen as an energy efficient and highly responsive method of heating & cooling the Fast + Epp building with multiple zones and demands.

VRF systems provide heating and cooling by cycling refrigerant between an outdoor unit and each zone's ductless or ducted indoor unit(s). Zones will have individual demand based on usage, occupancy, changing solar loads and user preferences. Air-source VRF systems exchange heat with outdoor ambient air using heat pump technology to provide more energy as heat than the system uses as electricity. This ability is measured using a term called coefficient of performance.

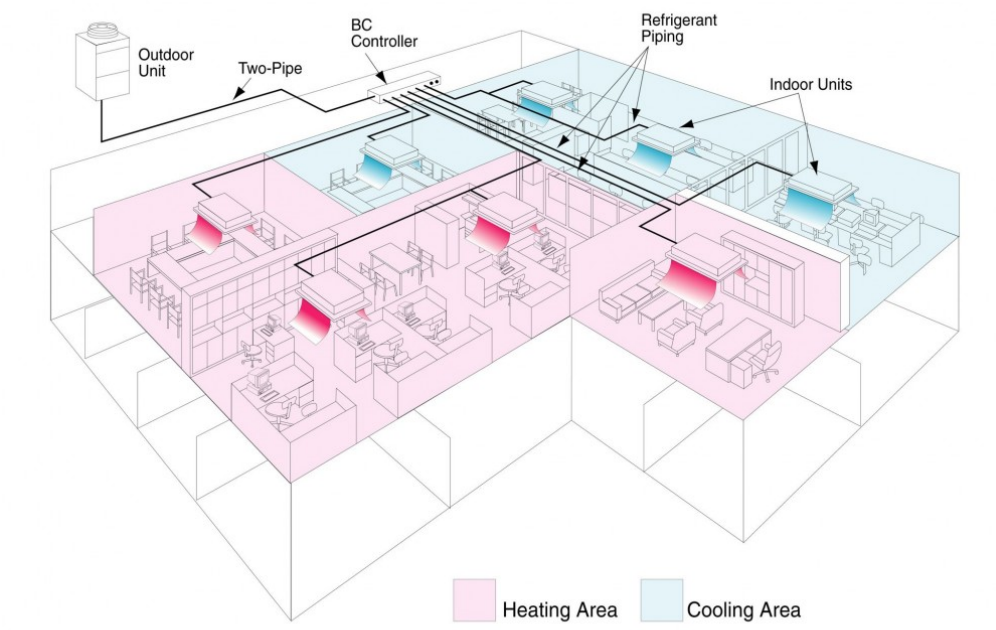


Image: Mitsibishi Electric

A typical high efficiency gas boiler has a coefficient of performance of 90%, meaning that for every 1 unit of natural gas energy input, 90% of that energy input is converted to useable heat. HR VRF can have a coefficient of performance upwards of **500%** and heat recovery effectiveness of **77%** based on manufacturer's data.[i]

The VRF system's ability to provide both heating and cooling eliminates the need for separate air conditioners and heating systems. A significant benefit of this system is that each interior zone will have individual temperature control allowing occupants to customize comfort in their zones while retaining the ability to optimize heating and cooling energy with centralized equipment control.

HR VRF as a Retrofit

Heat Recovery VRF systems can be applied to virtually any scale of project with variations in strategy, however typically these systems are employed for office retrofits or low to mid-rise buildings that require cooling and multiple zones of control. VRF systems are limited by maximum pipe lengths and therefore placement of outdoor units should be carefully considered.

HR VRF systems are easier to retrofit than hydronic systems for the provision of cooling and heating due to much smaller distribution piping which can be more easily concealed.

Central or DDC control systems are not required for a VRF retrofit as these systems come with their own centralized control systems. In addition, the modular nature of the construction lends itself to a phased installation that can reduce disruption to occupants.

Heat Recovery Ventilation

The heat recovery ventilator (HRV) in the Fast + Epp building provides fresh air while simultaneously recovering heat from the exhaust air. Fresh air gets ducted into the return duct on each fan coil and exhaust air is pulled out via grilles on the back wall (East wall) of the office as well as washrooms, storage rooms, etc. Separating the fresh air from the heating and cooling system reduced the overall infrastructure and allowed for a single air handling unit to provide the required ventilation to each office floor.

HRV heat recovery effectiveness for the technology implemented offered **78%** efficient AHRI rated wheel efficiency.[ii]

HRV as a Retrofit

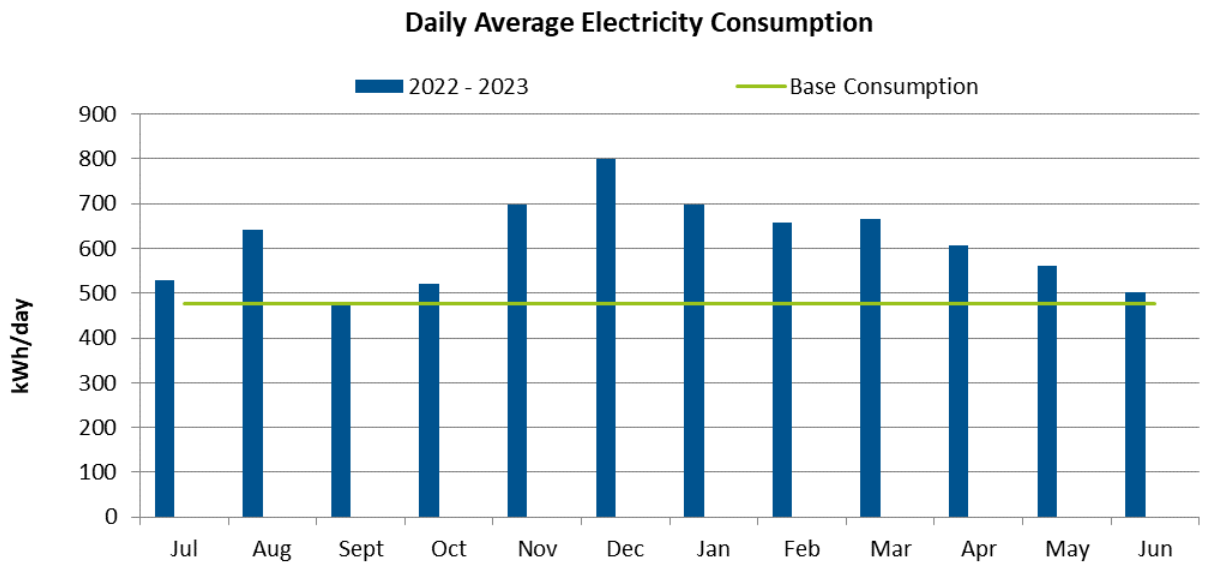
HRV systems have good retrofit applications, particularly when makeup air systems and associated building exhaust fans are in proximity. Heating and cooling can be added directly to an HRV as needed.

Electric Domestic Water Heaters

Commercial electric water heaters were installed on each floor of the Fast + Epp building to serve bathroom and kitchen loads. As office spaces have relatively small DHW needs, low capital cost electric resistance hot water heaters were recommended instead of a more costly heat pump (HP) solution. These electric tanks also require less space and have no requirement for outdoor equipment.

SHOW

The graph below illustrates the performance of the systems after one year of operation, representing the whole sites' energy usage, including both the office and concept lab areas of the building.



Fast + Epp Actual Energy Usage from July 2022 to June 2023

Annual energy use is approximately 223,600 kWh. At this stage, no additional recommissioning or optimization of setpoints has been completed to further reduce energy usage for this building.

The baseline energy usage of 480 kWh/ day can primarily be attributed to lighting, plug loads, elevator, and system equipment fans and pumps as cooling and heating requirements would be at their lowest, although likely still contributing to the total.

Carbon emissions from operation are 2.57 tCO^2e per year (at a rate of 11.5 tC02/GWh of electricity).

This effectively is equivalent to:

- Less than one (1) gasoline-powered passenger vehicles driven for one year.[1]
- Nearly one-third (1/3) of a typical homes' energy use for one year. [1]

COMPARE

How does the Fast + Epp office building performance compare to other office building in British Columbia?

Fast + Epp office building EUI is 0.54 GJ/m2. Note this office also has a testing lab which would increase energy use per spare foot expected in that area.

The Energy Star Portfolio Manager EUI by property type for office buildings 2019 was 0.87 GJ/m2.

The Fast + Epp office is currently over 35% less energy per square meter than the median other office buildings.

EXPERIENCE

Impact interviewed a sample of occupants varying in age, gender and location working within the space to obtain feedback on the thermal comfort of the HR VRF system and interface with the View Smart Window performance.

View Smart Window Glass Feedback

Overall, the View glass system was well received. However, this is in part due to users having direct control over the view glass tint and the ability to override parameters of the performance through the View glass app. As mentioned above, the glass offers four (4) tint options. If the user would personally like more sunlight, they are able to manually adjust their space conditions.

Heat Recovery Variable Refrigerant Flow System Feedback

Feedback on the thermal comfort conditions were similar to that expected from a standard mechanical system where comfort perspective is from personal preferences.

[1] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results

Better results could be achieved in creating a feedback mechanism to allow users to optimize setpoints on local thermostats. This final piece of adjusting and optimizing the base setpoints can be led by the building's operations staff.

HOW IT WORKS

Guidance on how to implement these strategies successfully as a retrofit.

View Smart Window Glass

- Involve experts at View Glass early to assess the best retrofit solution. A representative from View Glass can come to site and provide assistance to the energy and engineering retrofit team.
- Understand your framing system's advantages and disadvantages.
- Be clear if blinds are required for privacy and if there are any bulkheads covering the existing glazing system.
- The existing HVAC system should be rebalanced to adjust for the reduced solar heat gain.

User feedback:

- It is recommended to install View Glass on all windows (rather than only crucial heat gain directions) for consistency and to reduce afternoon or evening glare.

Heat Recovery Variable Refrigerant Flow System

- HR VRF systems have maximum allowable vertical and horizontal refrigerant pipe lengths, which change between manufacturers. Be clear your project fits these parameters.
- When using both HR VRF and View Smart Windows together, conduct cooling load analysis to expect reduced solar heat gain from the external environment.
- Ensure that occupants are educated on the system and dynamic parameters available for individual zone control.
- Plan for continual optimization post installation.

User feedback:

- Check-in with occupants to see if any adjustments are needed.

Heat Recovery Ventilation

- Retrofit application is ideal when the exiting exhaust fan and air supply unit are near each other. Returns are diminished the more decentralized the system is.
- A more attractive financial return is realized with moderate to large air volumes.

REFERENCES

i Product data sheet for equipment used for the Fast + Epp Project: LG MULTI V5 HRV Unit. https://www.lg.com/global/business/multi-v-5

ii Product data sheet for equipment used for the Fast + Epp Project: SystemAir Rooftop HRV ERV3200RT