ASHRAE Level II Energy and Water Management Review

1665 West Broadway
Prepared for Doctors of BC c/o
Warrington PCI Properties

April 2021

Energy Profiles Limited

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Executive Summary

This report details the results of an ASHRAE Level II Energy and Water Management Review at 1665 West Broadway, a 45,505 ft² commercial office building in Vancouver, British Columbia.

Utility costs at the property are on the order of $110k/year ($2.43/ft²/year).

Opportunities identified in this analysis that were used to develop the target performance, savings, and payback analysis fall into one of the following categories:

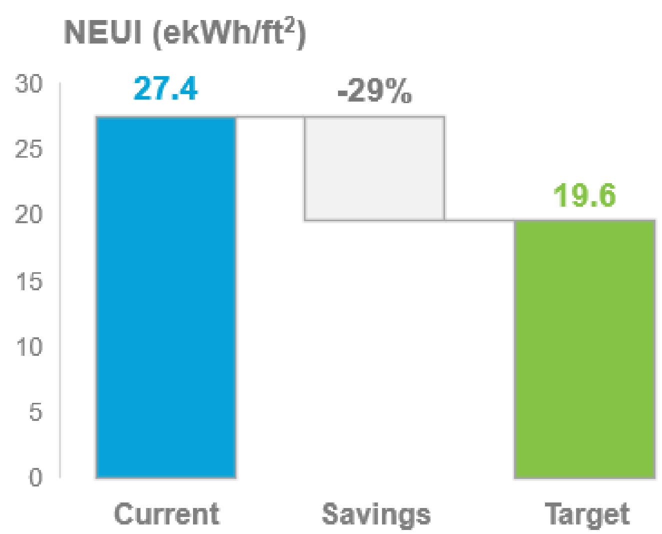
1. Metering Upgrades (2 measures)
2. Operational Optimization & Tenant Engagement (8 measures)
3. System Retrofit Measures (8 measures)

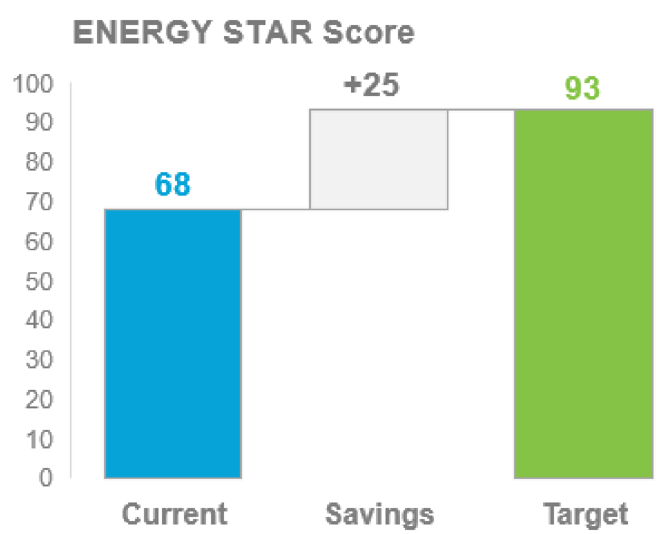
Combined, these opportunities yield the following potential savings and target performance:

Key Findings:

$28k /yr (25%)	$85k	3.1 yrs	42.4 kgCO2e/yr (29%)
Cost Savings	Implementation Cost	Simple Payback	Carbon Savings

Current and Target Performance





*NEUI = Normalized Energy Use Intensity
*NEUI & ENERGY STAR Scores as of Year Ending February 2020

Opportunities with longer paybacks, or geared towards carbon savings, have been included for your consideration, but are not included in the development of the Target Performance. These measures could be considered as part of the long-term energy, water, and carbon conservation strategy for the property.

1.0 Introduction

1665 West Broadway is a six-storey office tower with three levels of underground parking. The property was constructed in 1972 and has a gross leasable area of 45,505 ft^2 (gross floor area of 58,074 ft^2).

Energy Profiles Limited (EPL) was retained to prepare an ASHRAE Level II Energy and Water Management Review of the property, including the identification and technical/economic evaluation of possible energy, water, and carbon reduction measures.

1.1 Methodology

A review of energy and water consumption history was performed, including a benchmarking analysis with similar sized office buildings in the Metro Vancouver area over the same 12-month period (from EPL's database of properties).

This set the direction for the investigation, which included a general overview of the existing facilities and an assessment of the following building systems:

- Building envelope
- Lighting systems
- HVAC systems
- Control systems
- Domestic hot and cold-water systems.

Through discussions with on-site staff, assumptions were made with respect to the current operation of the building and building systems to establish a reasonable baseline for evaluation of energy and carbon savings measures.

1.2 Limitations and Use of Report

This report was prepared for the exclusive use of Doctors of BC and Warrington PCI Management (Warrington) and is intended to provide an independent assessment of the energy performance of this building.

The report is based on data and information gathered at the property that reflects conditions and operations during the site visit in December 2020. It is assumed that information received for this report was provided in good faith by Warrington and other individuals or companies noted in the report and is both factual and accurate.

Recommendations made herein are based on EPL's interpretation and understanding of operational conditions in the building and should be considered as such. Cost savings and feasibility of recommended projects are subject to a range of variables; recommendations may change over time, and further study may be required to verify the feasibility of a project at the time of implementation.

Any use which a third party makes of the report is at the sole responsibility of the third party.

2.0 Utility Consumption History

The utility consumption pattern for a building is influenced by a number of variables, including:

- Weather
- Thermal resistance and air tightness of walls, roofs, and windows
- Volume of outside air for ventilation
- Design and operating schedule of the building HVAC systems
- How the HVAC systems are operated and controlled
- Design and operating schedule of lighting systems
- Building occupancy level and hours of operation
- Tenant use of the space and heating/cooling needs.

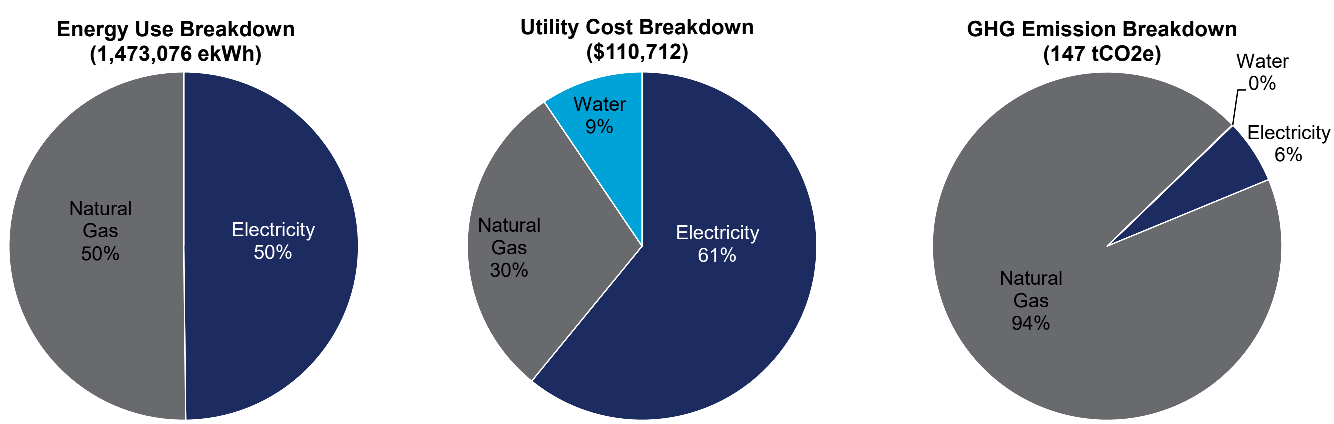
To quantify energy, water, and cost savings, the 12-month period ending February 29th, 2020 was selected as the base year. This period was chosen to provide a baseline period that is not impacted by the COVID-19 pandemic (low building occupancy etc.) on the energy and water consumption at the property.

The following table and graphs summarize the estimated energy use, utility cost, and greenhouse gas (GHG) emissions breakdown for the base year.

Table 2.0-1: Energy Use, Utility Cost & GHG Emission Breakdown
12-months ending February 29, 2020 (Pre-COVID)

Utility	Annual Consumption (ekWh/ft^2)	Annual Emissions (tCO_2e)	Annual Cost (\$/ft^2)	% of Annual Cost	Total Cost
Electricity	16.1	9	$1.48	60.9%	$67,403
Natural Gas	16.2	138	$0.72	29.7%	$32,843
Water	--	0	$0.23	9.5%	$10,467
Totals	**32.4**	**147**	**$2.43**	**100%**	**$110,712**

Figure 2.0-1: Energy Use, Utility Cost & GHG Emission Breakdown
12-months ending February 29, 2020 (Pre-COVID)



Impact of COVID-19 on Carbon Intensity

Warrington PCI and the Doctors of BC are interested in understanding the impact that the COVID-19 pandemic has had on the building's carbon emissions. The following table summarizes the carbon intensity by utility for the baseline period (12 months ending February 29, 2020) and a more current period (12 months ending September 30, 2020).

Table 2.0-2: Carbon Intensity ($kgCO_2e/m^2$) Comparison

Utility	Annual Carbon Intensity ($kgCO_2e/m^2$)		
	Baseline Period (Pre-COVID) Mar. 1, 2019 - Feb. 29, 2020	Current Period (Post-COVID) Oct. 1, 2019 - Sept. 30, 2020	Variance
Electricity	1.6 kgCO2e/m²	1.4 kgCO2e/m²	-11%
Natural Gas	25.6 kgCO2e/m²	26.3 kgCO2e/m²	3%
Water	0.0 kgCO2e/m²	0.0 kgCO2e/m²	-
Totals	**27.3 kgCO2e/m²**	**27.8 kgCO2e/m²**	**2%**

As noted in the table above: for the 12-month period ending February 29, 2020 the carbon intensity of the utility use at the property was 27.3 $kgCO_2e/m^2$ (147 tCO_2e). For the 12-month period ending September 30, 2020, the carbon intensity of the utility use at the property was 27.8 $kgCO_2e/m^2$ (150 tCO2e). Overall, the building's carbon intensity increased by 2% compared to the February 2020 baseline period.

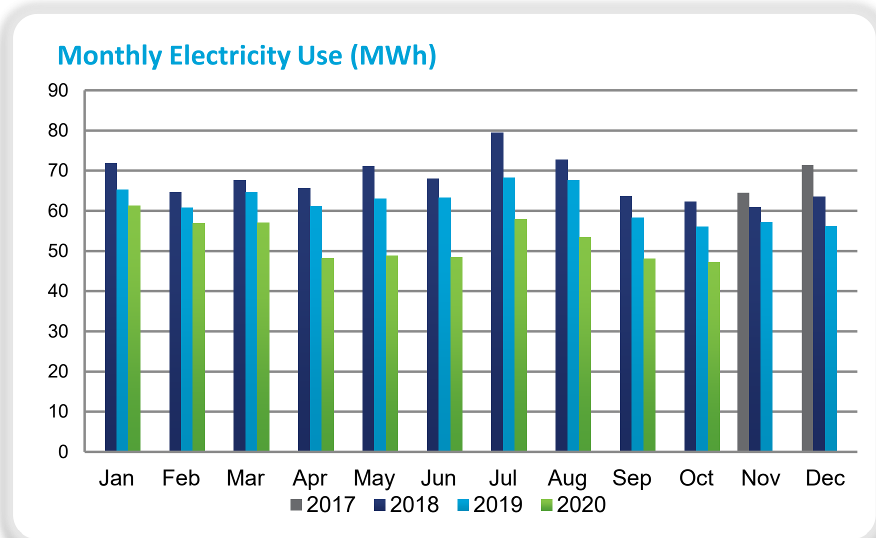
The increase in carbon is due to the increase in natural gas use during the COVID-19 period. While electricity use decreased, likely as a result of building occupants working from home (i.e., reduced plug and lighting loads), the carbon impact of natural gas is approximately ~16 times higher than electricity due to BC's clean electricity grid. As shown in the pie chart above, natural gas use represents the lions share of GHG emissions at the property (94%).

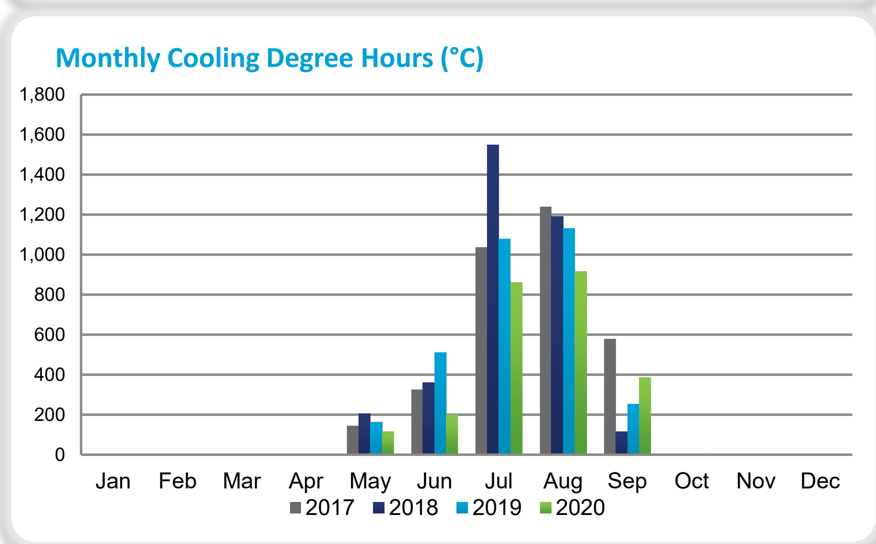
2.1 Electricity Use

Electrical power is supplied by one BC Hydro account billed via the Large General Service Rate 1611 rate class, paid by Warrington PCI Management.

In general, electricity use should be consistent year to year, with summer weather being the primary factor affecting use.

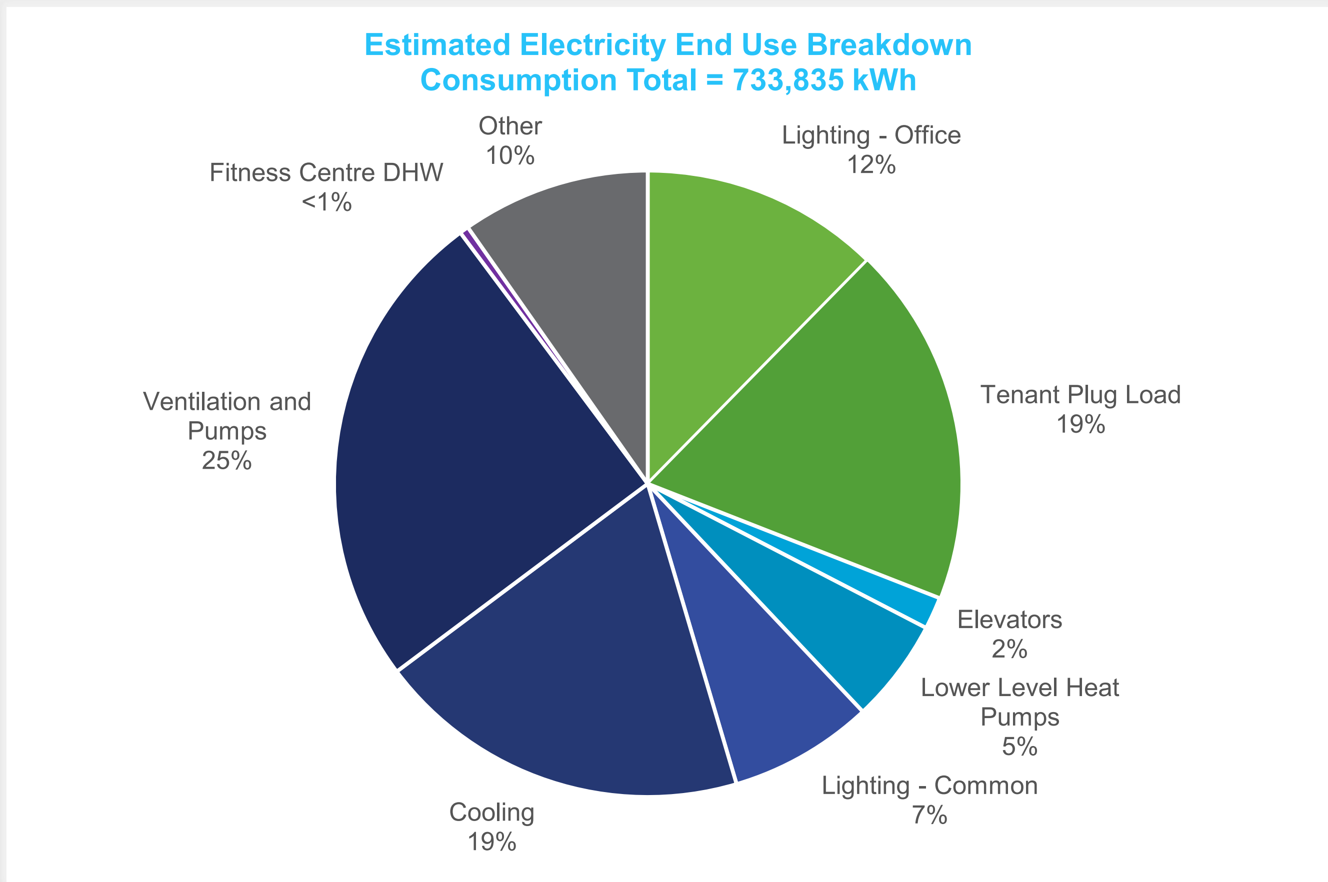
Historical electricity data and cooling degree hours are shown in the following figures.





2.1.1 Estimated Electricity End Use Breakdown

An estimated electricity end use breakdown was prepared using meter data, operational data, and scheduling for major HVAC equipment and loads, in conjunction with engineering principles.



The estimated electricity end use breakdown can be further simplified into four load types summarized in the following table.

Table 2.1.1-1: Estimated electricity end use breakdown by load type

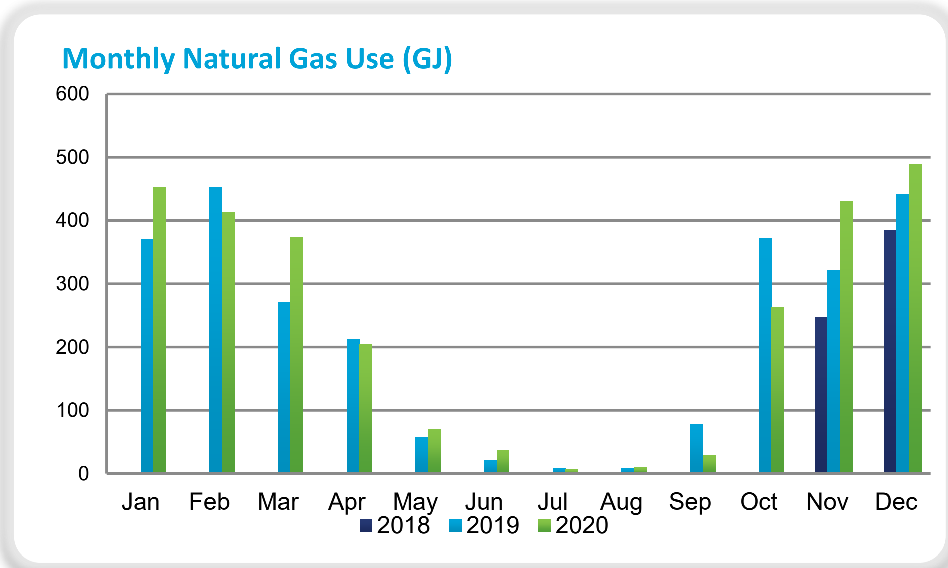
Load type	Percent of total consumption
Base building	59%
Tenant in-suite	31%
Fitness Centre DHW	<1%
Other	10%
Total	**100%**

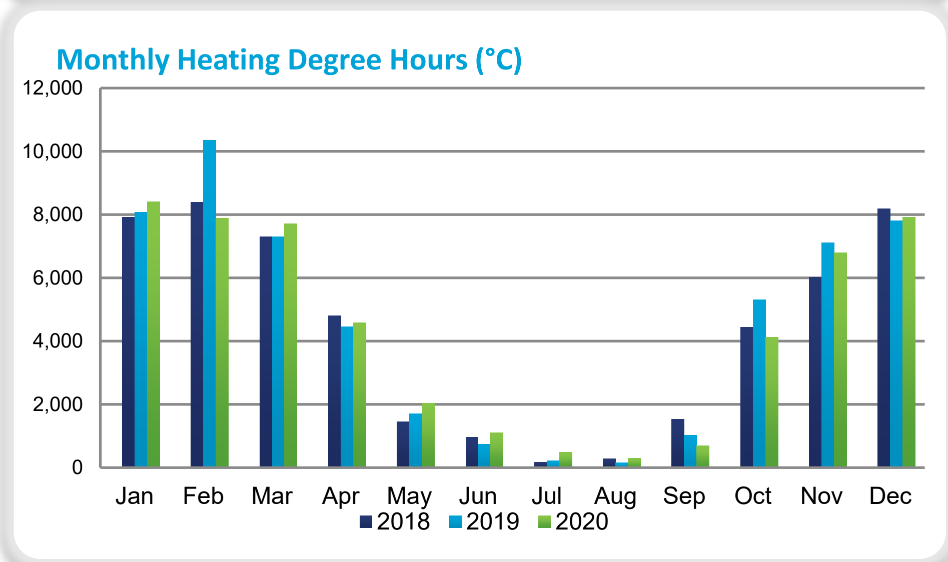
2.2 Natural Gas Use

Natural gas is supplied by FortisBC under a delivery contract with Direct Energy paid by Warrington PCI Management.

In general, natural gas use should be consistent from year to year, with winter weather being the primary factor affecting use.

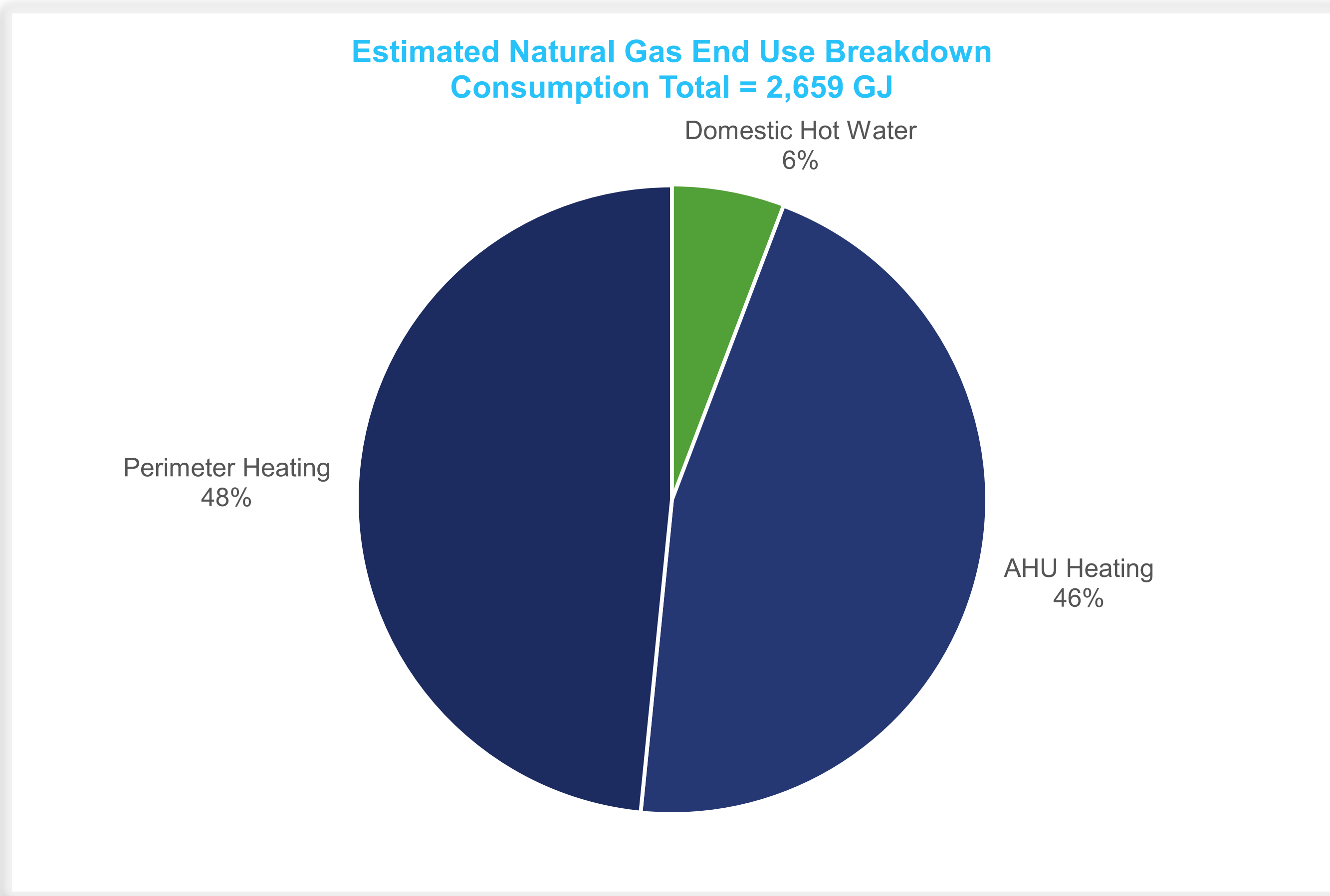
The combined historical natural gas data and heating degree hours are shown in the following figures.





2.2.1 Estimated Natural Gas End Use Breakdown

An estimated natural gas end use breakdown was prepared using meter data, operational data, and scheduling for major HVAC equipment and loads, in conjunction with engineering principles.



The estimated natural gas end use breakdown can be further simplified into three load types summarized in the following table.

Table 2.2.1-1: Estimated electricity end use breakdown by load type

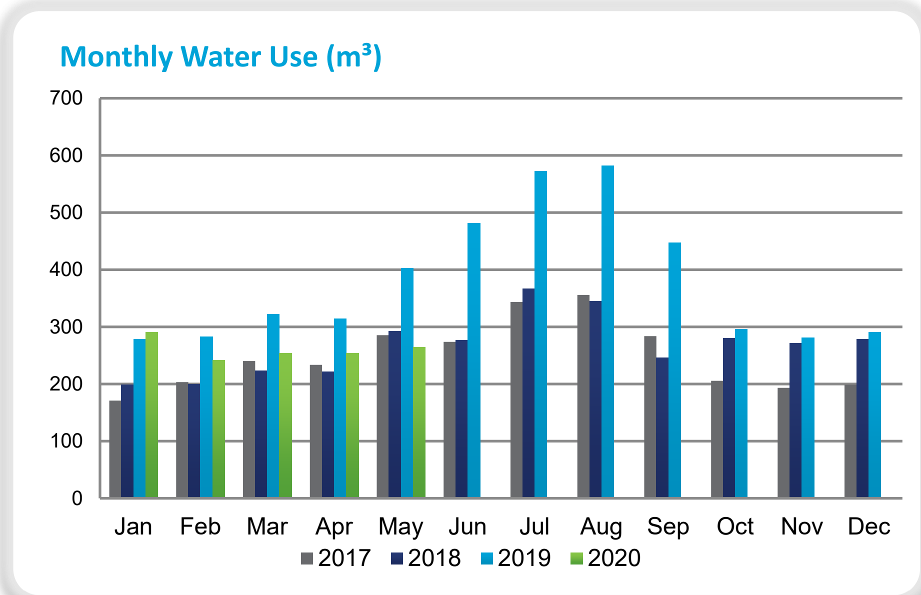
Load type	Percent of total consumption
Domestic Hot Water	6%
AHU Heating	46%
Perimeter Heating	48%
Total	**100%**

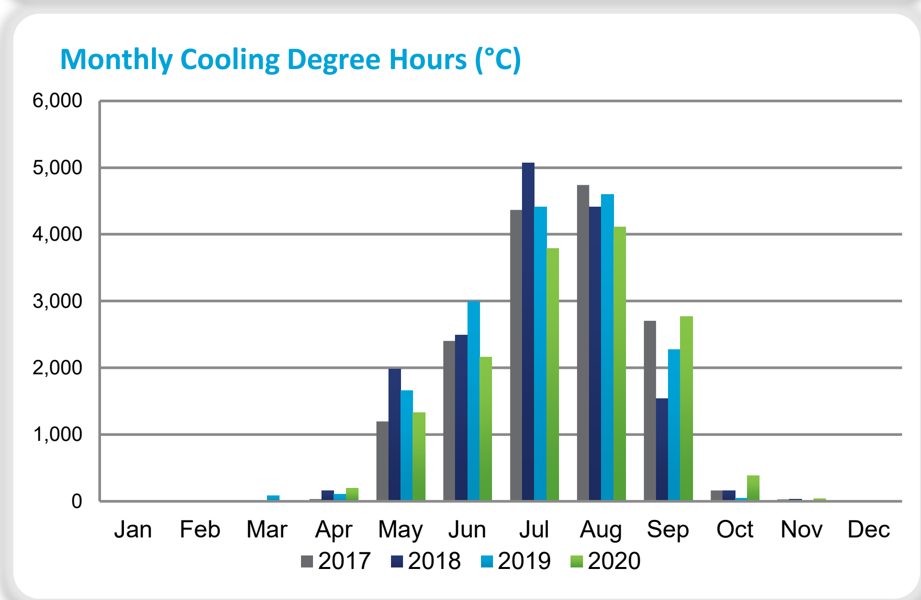
2.3 Water Use

Water is supplied to by one City of Vancouver account billed according to the metered 75mm rate class, paid by Warrington PCI Management.

In general, water use should be consistent from year to year, with summer weather and building occupancy being the primary factors affecting use.

Historical water data and cooling degree hours is shown in the following figures.

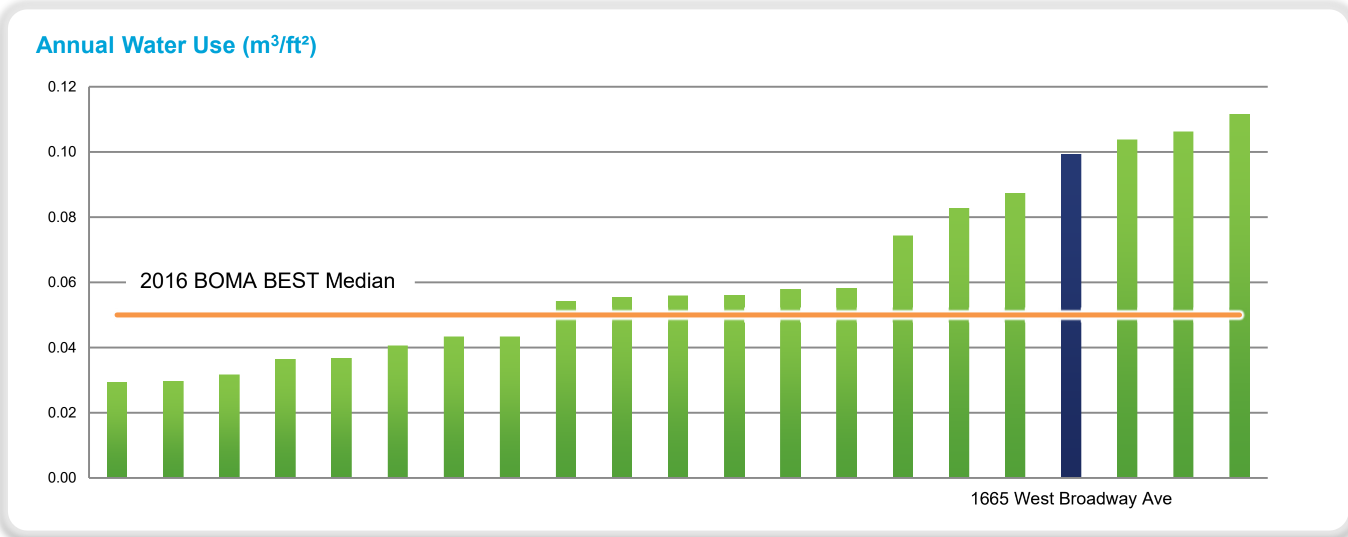




Building Operations was unable to confirm the reason for the high water use in the summer of 2019.

2.3.1 Comparison with Other Buildings – Water Use

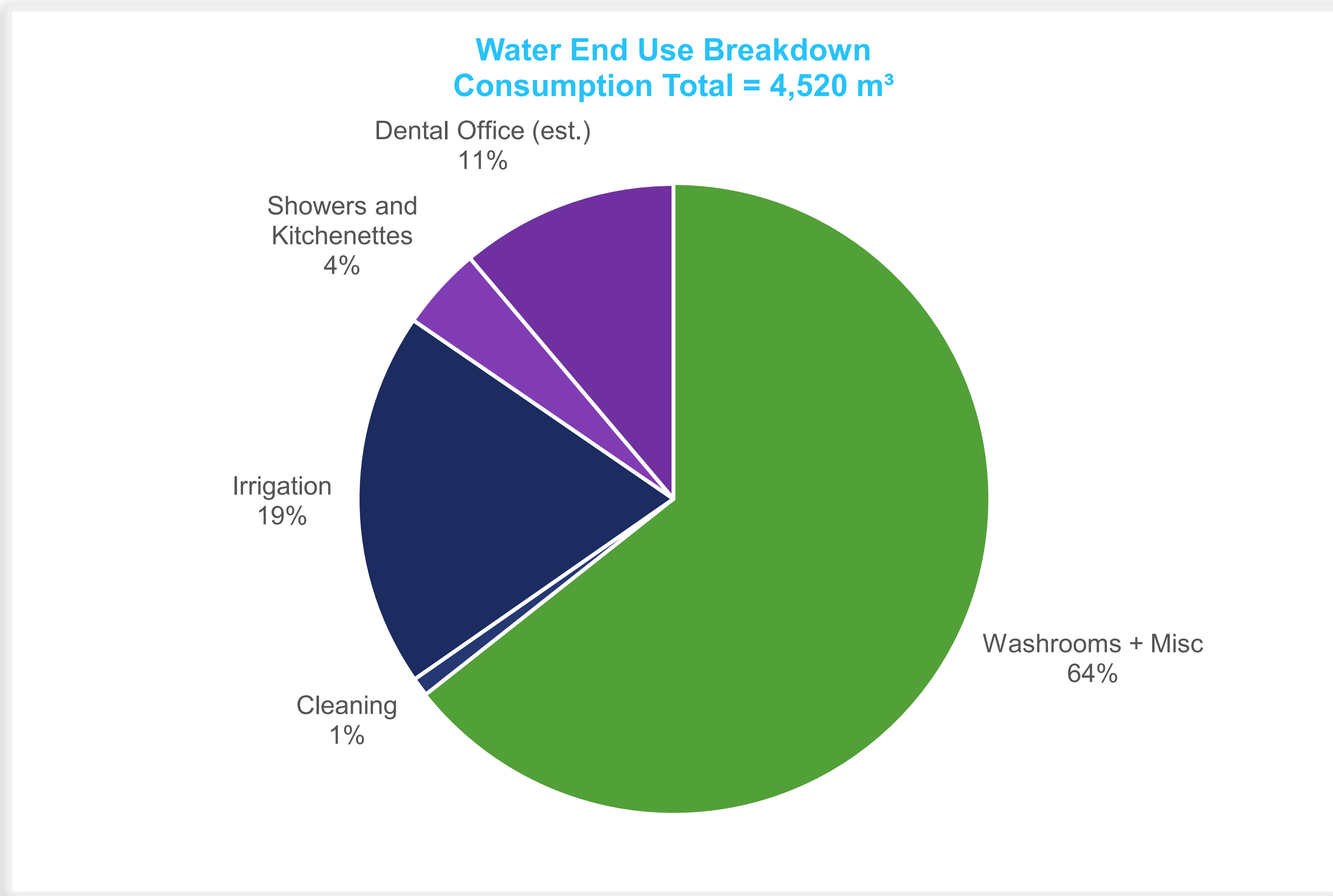
Results from benchmarking 1665 West Broadway against offices in the Metro Vancouver area (from EPL's database of properties) indicates that the annual water use intensity at 0.10 m^3/ft^2, based on the 12-month period ending February 2020, is above (worse than) average.



1665 West Broadway water use is also higher than the median water use intensity of 0.05 m^3/ft^2 for a 2016 BOMA BEST Office building, as reported in the BOMA BEST National Green Building Report (released in 2018).

2.3.2 Estimated Water End Use Breakdown

An estimated water end use breakdown was prepared using water bill data, and plumbing fixture loads, in conjunction with engineering principles.

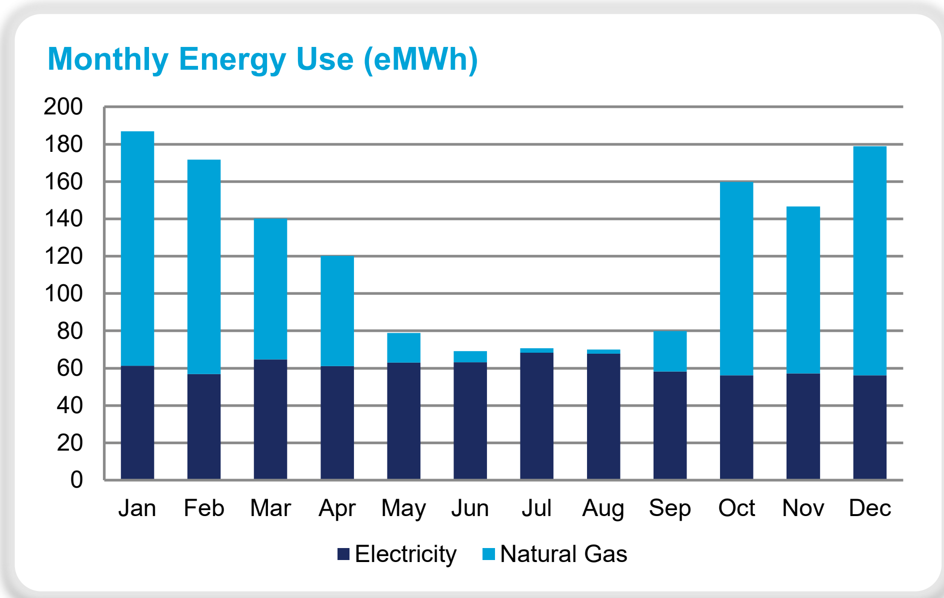


The 64% “Washrooms + Misc.” is comprised of all water use that was not accounted for after estimating the other specified primary water users shown in the diagram above. It is recommended that a leak-check be performed as this unaccounted consumption is higher than typically observed in office buildings.

2.4 Overall Energy Performance

2.4.1 Energy Use Summary

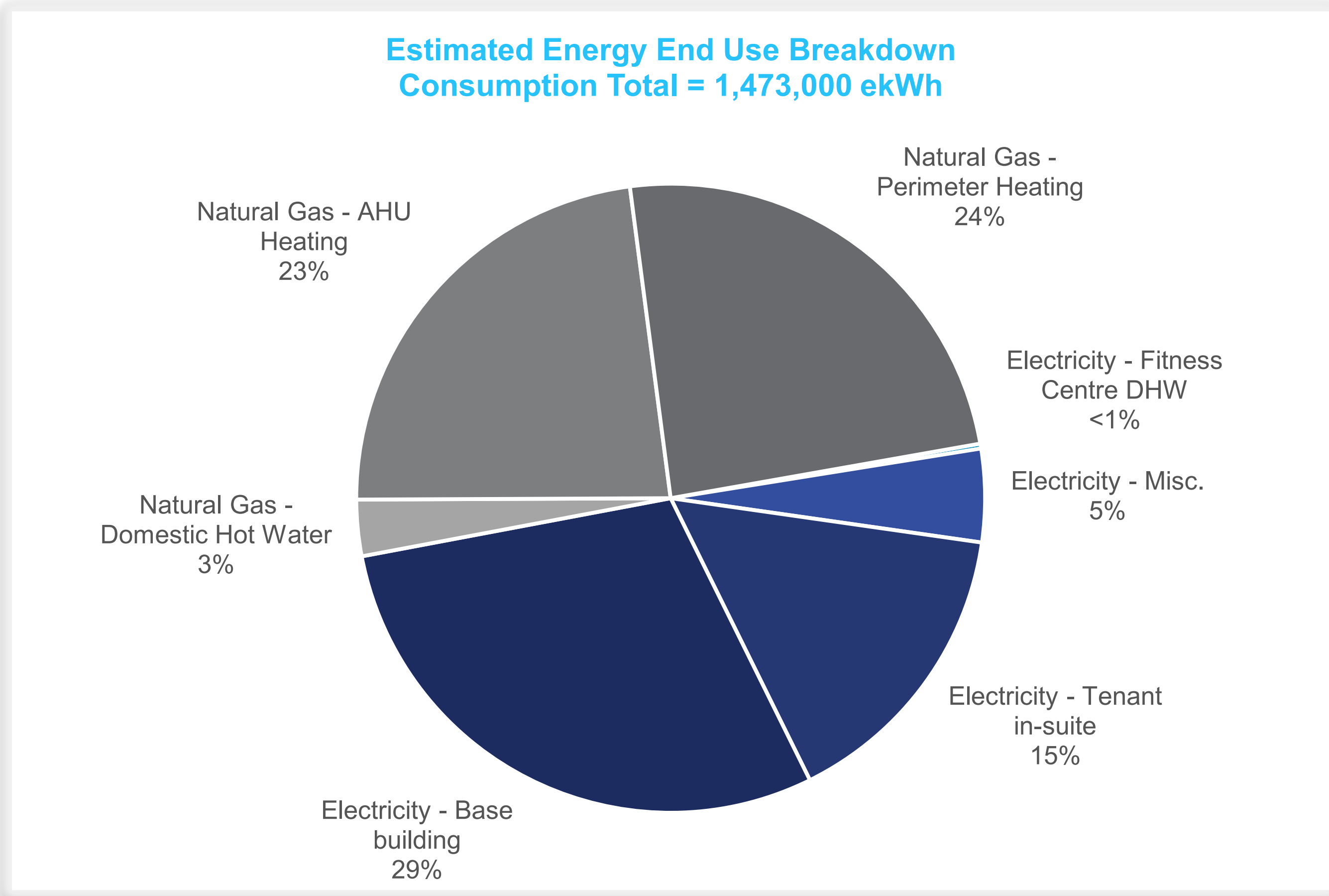
Monthly energy use for the baseline period (March 1, 2019 to February 29, 2020) is illustrated below.



Billed annual energy use intensity at 1665 West Broadway for the period ending February 29, 2020 was 32.4 $ekWh/ft^2$ (unnormalized), using the building's gross leasable area (GLA).

2.4.2 Estimated Energy End Use Breakdown

An estimated total energy end use breakdown was prepared using meter data, operational data, and scheduling for major HVAC equipment and loads, in conjunction with engineering principles.



2.4.3 Normalized Energy Use Intensity (ekWh/ft^2/yr)

The Normalized Energy Use Intensity (NEUI) was developed to provide an energy performance metric to compare the performance of commercial office buildings of different sizes, occupancy, location etc. on an even playing field.

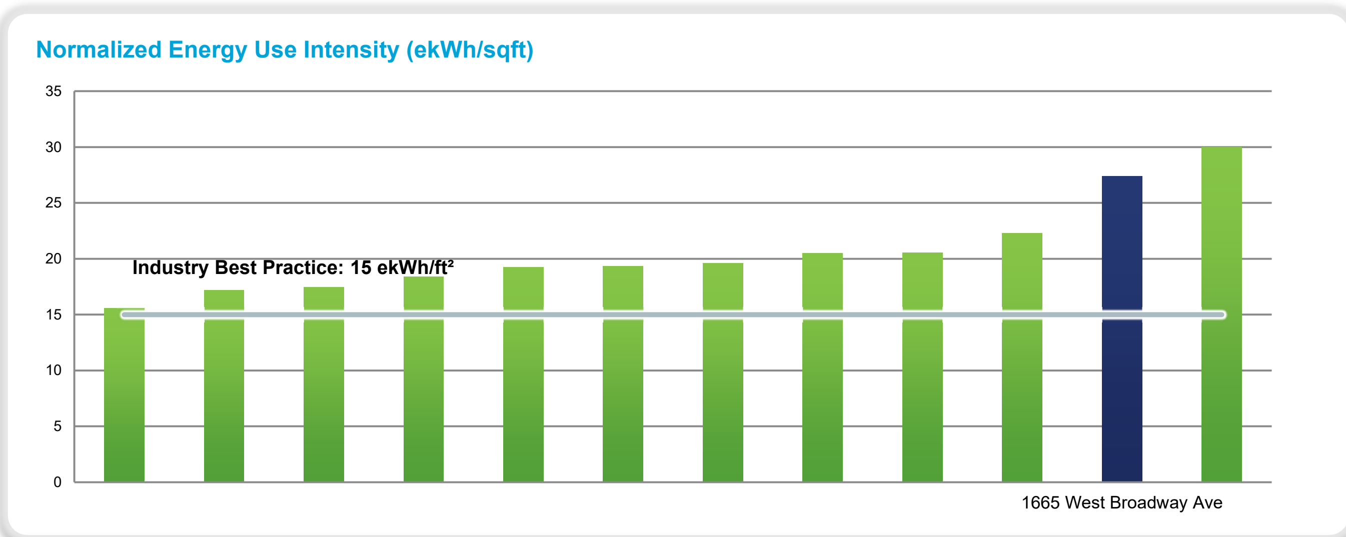
The NEUI for 1665 West Broadway for the 12-month period ending February 29, 2020 was calculated to be 27.4 ekWh/ft^2. The following table provides a comparison of the NEUI from the Baseline Period compared to the current period.

Table 2.4.3-1: Normalized Energy Use Intensity – 1665 West Broadway

Description	1665 West Broadway	
	Baseline Period (Pre-COVID) Mar. 1, 2019 - Feb. 29, 2020	Current Period (Post-COVID) Oct. 1, 2019 - Sept. 30, 2020
Normalized Energy Use Intensity (ekWh/ft^2)	27.4	26.6

Generally speaking, a NEUI of 20 ekWh/ft² is considered to be 'good' performance. The best-performing commercial buildings in Canada now consume less than 15 ekWh/ft^2, which forms the best practice target in the NEUI. 1665 West Broadway's NEUI is higher (worse) than both metrics.

As shown in the figure below, 1665 West Broadway's performance is worse than its peers.



The current NEUI methodology, developed by REALPAC in 2009, has generally been the industry accepted normalization methodology for building performance in Canada to date.

The unprecedented situation presented by the COVID-19 pandemic, namely the extremely low building occupancy for prolonged periods, has provided new and unique information about performance normalization. As a result, EPL – in conjunction with a REALPAC lead steering committee - is in the process of rebuilding the NEUI methodology from first principles to better normalize for low occupant density (critical for assessing operation during a pandemic) and reflect the modern high-performance building. The updated methodology is currently under industry review and is expected to be available in the coming months.

In the absence of an updated NEUI metric, we have prepared a comparison of 1665 West Broadway's NEUI based on the 2009 REALPAC methodology for comparison purposes to other office buildings in the Metro Vancouver area.

2.4.4 ENERGY STAR Score

ENERGY STAR is a widely used independent benchmark that illustrates how efficiently a given building uses energy relative to similar buildings.

Like the NEUI, the ENERGY STAR scoring system normalizes a building's energy performance based on a number of factors including building size, number of occupants, and weather, and ranks it relative to similar buildings. A score between 1 and 100 is assigned to the building based on its ranking. A score of 50 indicates average energy performance.

Based on utility information available for the period ending February 29, 2020, an ENERGY STAR score of 68 was calculated for this site.

Table 2.4.4-1: ENERGY STAR Score – 1665 West Broadway

Description	Average	ENERGY STAR & LEED-EBv4 Minimum	1665 West Broadway	
			Baseline Period (Pre-COVID) Mar. 1, 2019 - Feb. 29, 2020	Current Period (Post-COVID) Oct. 1, 2019 - Sept. 30, 2020
ENERGY STAR Score	50	75	68	68

3.0 Description of the Building and Building Systems

1665 West Broadway is an office building located in Vancouver, British Columbia and consists of six floors of office space, including a medical (dentists) office, and a 3-level underground parking garage.

Table 3.0-1: Key building information

Description	Information
Property Name	BC Medical Building
Address	1665 West Broadway St, Vancouver, BC
Property Type	Office
Number of Floors	6
Gross Leasable Area - Medical Office	1,858 ft²
Gross Leasable Area - Office	43,647 ft²
Gross Leasable Area - Total	45,505 ft²
Gross Floor Area	58,074 ft²
Parking Garage Area	43,699 ft²
Lease hours	65
Site Contacts	Pamela Lima - Property Manager
Phone Number	604 - 331 - 5277

Based on discussion with building operations, cleaning typically starts at 4:00 PM and ends around 10:00 PM, Monday to Friday.

3.1 Building Envelope

The exterior of 1665 West Broadway consists of concrete cladding with single-pane windows that represent approximately 50% of the façade. The ground floor lobby consists of floor-to-ceiling single-pane windows with concrete cladding.

Figure 3.1-1: Exterior: main façade (left) and building front view (right)

The exterior vision areas along the perimeter of the building consist of single-pane glazed units original to the building. The windows are fitted with operable blinds.

Figure 3.1-2: Vision areas: operable blinds (left) and single-pane windows (right)

The main entrance to the offices is from West Broadway, on the South face of the building, and consists of two sets of glass doors that lead directly into the conditioned lobby.

Figure 3.1-3: Lobby doors (left) and lobby viewed from building exterior (right)

There are also two single door exits at the back (North face) of the building. Additional access is provided by a loading dock, as well as a metal cage door leading to the underground parkade.

3.2 Lighting Systems

Base building lighting is summarized in the following figure and table. Based on site visit observations, and conversations with building operations, the base building office lighting is controlled by a variety of control systems (outlined in the table below), but is typically ON from 7:00 AM – 6:00 PM, Monday – Friday. Some private offices and meeting rooms are controlled with wall-mounted switches and occupancy sensors. The typical lighting power density for base building office lighting is 0.7 W/ft².

Table 3.2-1: Lighting control by floor

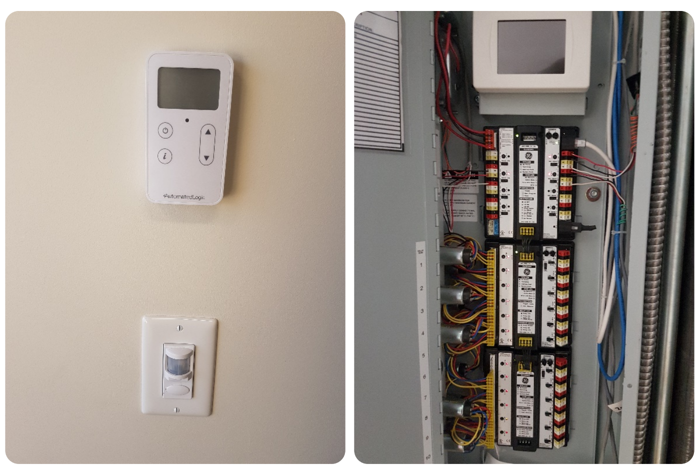
Lighting Control	Floor
Primarily motion mensors with local overrides.	1
GE Lighting Control System, swept OFF at 6:00 PM. Also has local overrides.	2
	3
	4
No automated control - primarily light switches.	5
	6

Figure 3.2-1: Base building lighting: typical office space (left) and typical office lighting fixture (right)

Table 3.2-2: Base building lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Base Building Offices	2L 2' linear fluorescent T8	878	30	Varied - Primarily Schedule

Figure 3.2-2: Base building lighting control: office lighting switch (left) and typical floor relay panel (right)



Lighting for the tenant washrooms is summarized in the following figures and table.

Figure 3.2-3: Typical men's washroom lighting: LED PAR 38s (left) and 2L 4' fluorescent T8 valence fixture (right)

Figure 3.2-4: Typical women's washroom lighting: 2-lamp 2-pin CFL pot light (left) and 2-lamp 4-pin LED Sconce (right)

Table 3.2-3: Tenant washroom lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Men's Washrooms	2L 4' linear fluorescent T8	6	56	ON 24/7, no control
Men's Washrooms	LED Par 38	18	20	ON 24/7, no control
Women's Washrooms	2L 4 pin LED Sconce	6	26	ON 24/7, no control
Women's Washrooms	2L 2 pin PL Potlight	24	26	ON 24/7, no control

Lighting for the elevators and elevator lobbies is summarized in the following figure and table.

Figure 3.2-5: Typical elevator lobby lighting: PAR38 LED potlights (left), 2' linear LEDs (centre), elevator cab MR-16 LEDs (right)

Table 3.2-4: Tenant elevator lobby and elevator cab lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Elevator Lobbies	2L 2' linear fluorescent T8	26	30	ON 24/7, no control
Elevator Lobbies	PAR38 LED Potlight	24	20	ON 24/7, no control
Elevators	1L MR16 LED	12	7.5	ON 24/7, no control

Lighting for the main lobby and conference room is summarized in the following figure and table.

Figure 3.2-6: Main elevator lobby lighting (left), general conference room lighting (centre), conference room potlights (right)

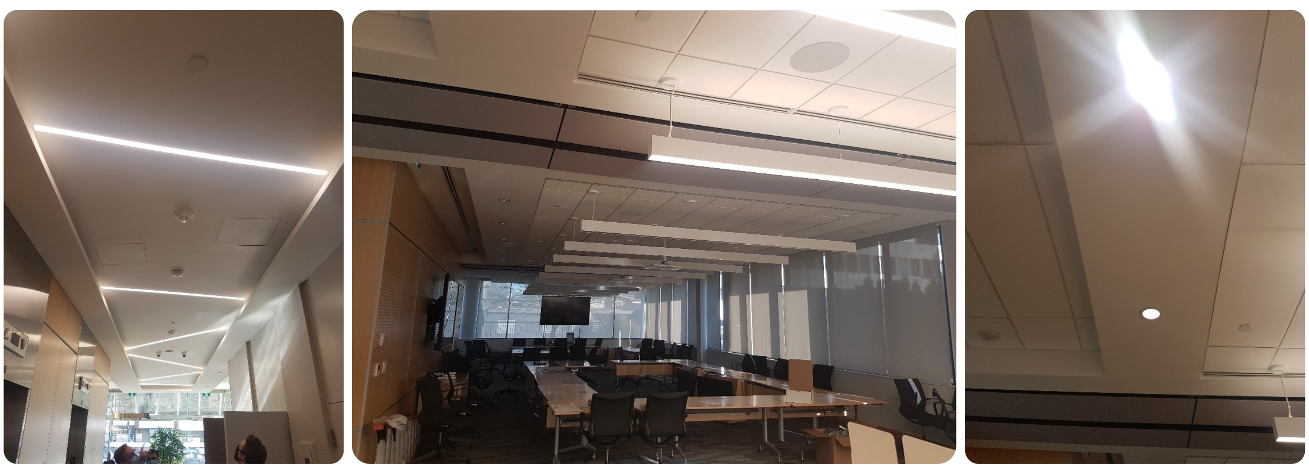


Table 3.2-5: Main lobby and conference room lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Main Lobby	8' LED Strip Lights	7	32 (est.)	ON 24/7, no control
Conference Room	1L 8' linear LED	14	32 (est.)	Occupancy sensor with local override
Conference Room	PAR38 LED Potlight	22	20	Occupancy sensor with local override

Lighting in the fitness centre is summarized in the following figure and table.

Figure 3.2-7: Fitness centre light switch (left) and general fitness centre lighting (right)

Table 3.2-6: Fitness centre lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Fitness Centre	2L 4' linear fluorescent T8	8	56	Manual switch

Lighting in stairwells and service areas (mechanical, elevator, telephone, sprinkler rooms, etc.) is summarized in the following figures and table.

Figure 3.2-8: Service area lighting: elevator machine room (left), and inside AHU1 (right)

Figure 3.2-9: Service area lighting: stairwell lighting (left) and mechanical room light switch (right)


Table 3.2-7: Service area lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Mechanical Rooms	2L 4' linear fluorescent T8	20	56	Manual switch
Mechanical Rooms	2L 4' linear LED	5	24	Manual switch
Mechanical Rooms	1L 4 pin LED	1	13	Manual switch
Stairwell	2L 4' linear LED*	16	24	ON 24/7, no control

**Building Operations confirmed that approximately 95% of the stairwell lighting is LED, with the remaining 5% consisting of 2L 4' fluorescent T8s.*

Underground parking lighting is summarized in the following figures and table. The parkade lights are ON 24/7.

Figure 3.2-10: Underground parking lighting: general (left) and LED lamps (right)


Table 3.2-8: Underground parking lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Parkade	2L 4' linear LED*	33	24	ON 24/7, no control
Parking Elevator Lobbies	2L 4' linear fluorescent T8	6	56	ON 24/7, no control
Loading Dock	2L 4' linear fluorescent T8	2	56	ON 24/7, no control

**Building Operations confirmed that approximately 90% of the parkade lighting is LED, with the remaining 10% consisting of 2L 4' fluorescent T8s.*

Exit sign lighting is summarized in the following figures and table. The exit sign lights are on 24/7.

Figure 3.2-11: Parkade exit sign (left) and office space exit sign (right)

Table 3.2-9: Exit sign lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Exit signs	Exit Sign	48	12	ON 24/7, no control

Exterior lighting is summarized in the following figures and table. Photocells were observed on site which are believed to have, at one point, controlled exterior lighting at 1665 West Broadway. During the site visit, the exterior lights were observed to be ON during the daytime, which is supported by discussion with Building Operations. A control timer for the exterior lighting was also observed on site, but appears to no longer be in use.

Based on conversations with building operations, these lights remain ON 24/7.

Figure 3.2-12: Exterior lighting: photocell (left), canopy potlight (centre), and timer (right)

Table 3.2-10: Exterior lighting summary

Location	Fixture Type	Quantity (Est.)	Watts/Fixture	Control
Exterior Canopy Lighting	Potlight	26	20 (est.)	ON 24/7, no control

Spaces visited during the audit and their measured light levels are summarized in the following table. Light levels are typically within or above suggested IESNA Standard.

Table 3.2-11: Measured light levels

Space Types	Illuminance - Horizontal (LUX)	
	IESNA Standard	Measured
Office - Interior	300 - 500	400-500
Office - Perimeter	300 - 500	500-600
Office - Hallway	100 - 300	150 - 400
Lobby	100 - 300	160 - 300
Washrooms	100	135 -240
Stairwells	45 - 55	300
Mechanical rooms	100 - 300	135 - 425
Parking	30 - 50	160-200

3.3 Ventilation and Air Distribution Systems

Outdoor air is provided to the lobbies and office spaces by two variable volume air handling units, AHU1 and AHU2. AHU1 is fitted with hydronic heating and cooling. AHU2 is fitted with hydronic heating, and direct exchange cooling.

Table 3.3-1: AHU summary

AHU ID	Location	Area Served	Make	Model	Fan	Motor Power (hp)	Flow Control
AHU1	Penthouse	Floors 1-5	Carrier	42CEA08VLDY6AYAR	Supply	30	VFD
					Return	20 (est.)	VFD
AHU2	Office Roof	Floor 6	McQuay	RPS 018CSW	Supply	5	VIV

Both AHUs are controlled via the Control Solutions Automated Logic Building Automation System (BAS). Based on BAS observations, AHU1 runs 24/7, while AHU2 is scheduled to run from 4:00 AM – 6:00 PM, 7 days per week.

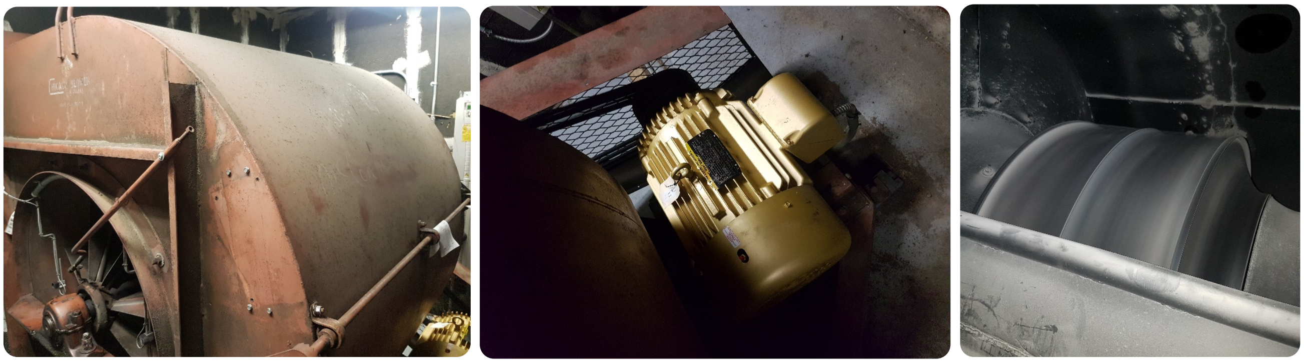
Preliminary ventilation calculations, based on ASHRAE Standard 62.1 (but with only rough inputs), indicate that the areas served by AHU1 and AHU2 require 4,500 cfm of outdoor air at full occupancy. This equates to about 5,000 cfm at the fans, allowing 10% for shaft leakage.

At the time of writing this report, no documentation outlining the fan flowrates was available. In lieu of fan cfm, the fan flow rates were approximated at 1,000 cfm/horsepower; this results in a total estimated flowrate of 35,000 cfm. With a minimum damper position of 20% (pre-COVID minimum setpoint) this suggests that 7,000 cfm of fresh air would be provided and that the ASHRAE 62.1 minimum ventilation conditions would generally be met.

3.3.1 AHU1 – Supply Fan Serving Floors 1-5

AHU1 provides fresh air to a VAV system on floors 1 through 5, and is fitted with a 30 hp supply fan with an efficiency of 94.1%. The return fan was operating during the time of the site visit, and the motor nameplate was inaccessible. As such, the return fan horsepower was estimated based on available BAS data at 20 hp.

Figure 3.3.1-1: AHU1 supply fan (left), AHU1 supply fan motor (centre) and AHU1 return fan (right)



The output of the supply fan for AHU1 is modulated via a variable frequency drive (VFD) controlled by the BAS to satisfy a duct static pressure setpoint observed to be 70 Pa at the time of the site visit. Based on BAS observations, this static pressure setpoint modulates between 50 - 200 Pa based on how many downstream variable air volume units are calling for additional flow.

The output of the return fan for AHU1 is modulated by a VFD which, based on BAS observations, is set to 60% of the VFD output of the supply fan.

Figure 3.3.1-2: AHU1 return fan VFD (left), AHU1 supply fan VFD (right)

AHU1 is fitted with two hydronic coils, one used for heating, and the other used for cooling the supply air. These coils are fed from the primary hot/chilled water loop with flow through the coils controlled by three-way valves which modulate to maintain the supply air temperature setpoint.

Based on BAS observations, the supply air temperature setpoint for AHU1 modulates between 15°C and 29°C depending on the number of zones that are calling for heating or cooling. The setpoint was observed to be 15°C at the time of the site visit.

Figure 3.3.1-3: AHU1 heating coil

The outdoor air dampers for AHU1 are typically set to their minimum position, which was 40% at the time of the site visit (20% before COVID, based on discussion with Building Operations). Based on BAS observations, when the outdoor air temperature is below 18.5°C and cooler than the return air temperature, the dampers employ air-side economizing, and modulate to maintain a supply air temperature setpoint, set through the BAS (15°C at the time of the site visit).

3.3.2 AHU2 -Supply Fan Serving Floor 6

AHU2 is a rooftop unit equipped with a DX cooling system as well as a heating coil fed from the base building primary hot water loop. Based on BAS observations, the heating/cooling coils work to maintain a supply air temperature setpoint that modulates between 15°C and 27°C depending on the number of zones calling for heating or cooling (20.5°C at the time of the site visit).

AHU2 is capable of operating in two different stages of cooling when required. For heating, a three-way valve modulates the amount of hot water flow going to the heating coils to maintain the supply air temperature setpoint.

AHU2 serves solely the 6th floor and is fitted with a 5 hp supply fan. The supply fan is equipped with variable inlet vanes, which modulate to maintain a static pressure setpoint set by the BAS (50 Pa at the time of the site visit). Based on BAS observations, this static pressure setpoint modulates between 50 and 150 Pa, based on how many downstream variable air volume units are calling for additional flow.

The outdoor air dampers for AHU2 are typically set to their minimum position, which was 40% at the time of the site visit (20% before COVID based on discussion with Building Operations). When the outdoor air temperature is below 18.5°C and cooler than the return air temperature, the dampers employ air-side economizing and modulate to maintain a supply air temperature setpoint.

Figure 3.3.2-1: AHU2 front view (left), and AHU2 side view (right)

3.3.3 Zone Level Air Distribution: Variable Air Volume Boxes and Fan Coil Units

The fresh air supply is ducted from the AHUs to a floor level Variable Air Volume (VAV) system. The VAVs modulate their airflow using a damper to control to a zone temperature setpoint. Based on BAS observations, the zone level setpoint is set by the BAS at 22°C, but can be adjusted to +/- 2°C at the zone level thermostats. There are approximately 21 VAVs per floor, and each VAV has its own thermostat.

Each floor is also fitted with four perimeter fan coil units (FCUs) which, based on conversations with Building Operations, deliver air to the perimeter zones by pulling it from the interior ceiling plenum and conditioning it with a single coil per unit (capable of providing either heating or cooling). Based on BAS observations, valves serving these FCU coils modulate to maintain a zone temperature setpoint, calculated as the average of the VAV zone temperature setpoints in the area.

Figure 3.3.3-1: Typical FCU distribution vent (left) and typical DDC thermostat (right)

Based on observations from the BAS, there is a wide array of fan coil unit control schedules at the building ranging from ON 24/7 to ON only a few hours a day. All FCUs are enabled based on heating or cooling calls, which are generated based on deviations from the local zone temperature setpoints. The way in which these heating or cooling calls are generated varies by fan coil unit, and is also typically different during occupied and unoccupied hours.

Table 3.3.3-1: FCU and VAV summary

Equipment	Est. Quantity	Flow Range
VAVs	126	40-525 cfm
FCUs	24	-

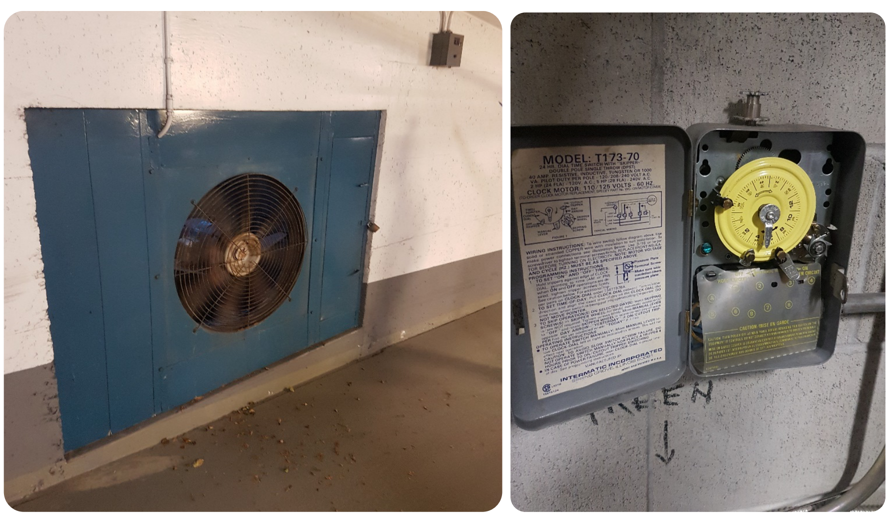
3.3.4 Miscellaneous Ventilation

Sanitary exhaust for the men’s and women’s washrooms is served by a single constant volume 1 hp fan, ON 24/7.

Figure 3.3.4-1: Washroom exhaust fan: casing (left) and motor (right)

Ventilation on the parking garage levels is provided by one exhaust fan with an estimated 5 hp motor. There is a timer that looks to have controlled this fan in the past, but based on conversations with Building Operations, the parking garage exhaust fan runs 24/7.

Figure 3.3.4-2: Parkade exhaust fan (left) and timer (right)



There is also a 1 hp supply fan servicing the elevator mechanical room. This fan is enabled ON when the zone temperature surpasses a temperature setpoint, set by a local thermostat.

Figure 3.3.4-1: Elevator mechanical room supply fan

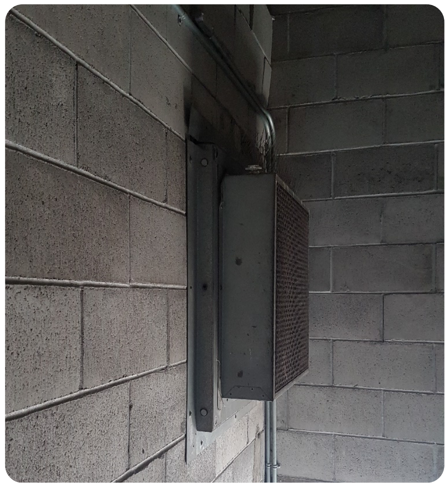


Table 3.3.4-1: Miscellaneous Supply and Exhaust fans summary

Location	Area Served	Make	Model	Motor Power (hp)
Penthouse	Bathrooms	Chicago Blower	EM3116T	1
Parkade	Parkade	-	-	5 est.
Elevator Mechanical Room	Elevator Mechanical Room	Greenheck	-	1

There are additional, smaller supply and exhaust fans servicing specific utility areas such as the transformer room, the generator room, and the penthouse boiler room.

Lastly, there is a small Heat Recovery Ventilation unit, HRV 104, that serves miscellaneous areas on the east side of the first floor (conference room, café, etc.). Based on the BAS this unit is equipped with a supply fan, a return fan, no heating or cooling coils, and is ON 24/7.

3.4 Cooling Systems

Primary cooling to the property is provided by a York air-cooled chiller. The chiller is rated at 96-tons of cooling, has a nameplate efficiency of 1.2 kW/ton, and supplies cooling to AHU1, and the fan coils on floors 1-6.

Figure 3.4-1: Chiller 1

Table 3.4-1: Chiller details

Chiller ID	Make	Model	Location	Systems Served	Refrigerant	Cooling Capacity (ton)	Cooling Efficiency (kW/ton)
Chiller 1	York	YLAA0100SE	Rooftop	FCUs & AHU1	R410A	95.8	1.2

Based on BAS observations, the chiller is enabled any time the outdoor air temperature is above 17°C, and will switch OFF once the outdoor air temperature reaches 16°C. The chilled water temperature setpoint, observed to be 15 °C at the time of the site visit, modulates between 7°C – 15°C based on AHU1's deviation from its supply air temperature setpoint.

The primary chilled water loop is served by one constant volume pump, P2 and serves:

- The cooling coil in AHU1, and
- The cooling coils in the fan coil units throughout the building.

Chilled water is supplied to AHU1 from the primary chilled water loop by a booster pump, P3. There is a three-way valve that modulates the flow of chilled water going to the cooling coil of AHU1 to maintain the supply air temperature setpoint set by the BAS.

The fan coils throughout the building receive their chilled water through a combined heating/cooling loop (further information available in Section 3.6).

Figure 3.4-2: Primary chilled water pump P2 (left), and AHU cooling coil pump P3 (right)

Table 3.4-2: Chilled water pump summary

Pump ID	Location	Loop Served	Make	Model	Motor Power (hp)	Motor Efficiency (%)
P2	Penthouse	Chiller CHWR	WEG	00318EP3H82TC	3	87.5%
P3	Penthouse	AHU CHWS	Armstrong	FD27	2	86.5%

Additional cooling at the property comes from AHU2, which provides cooling by using its internal compressors to cool the air going to the 6th floor when required. The compressors can operate in two stages of cooling, which are engaged when the system cannot meet its supply air temperature setpoint, set by the BAS (20.5°C at the time of the site visit).

Table 3.4-3: AHU2 cooling summary

Equipment ID	Make	Model	Location	Systems Served	Refrigerant	Cooling Capacity (ton)	Cooling Efficiency (kW/ton)	Est. Age (yrs)
AHU2	McQuay	RPS 018CSW	Rooftop	AHU2 Supply Air	R410A	18	Standard	20+

3.5 Heating Systems

Base building heating is provided by a central natural gas fired boiler plant, consisting of three direct-vent pulse combustion Laars boilers (condensing boilers). Each boiler is rated at a 473 MBH output and has a nameplate efficiency of 95%. All three boilers are connected in parallel to supply heating to the hot water loop.

Figure 3.5-1: Boiler plant

Table 3.5-1: Boiler summary

Boiler ID	Location	Make	Model	Heating Output (MBH)	Heating Efficiency	Age (yrs)
Boiler 1	Penthouse	Laars	NTH500NXN1	473	95%	12
Boiler 2	Penthouse	Laars	NTH500NXN1	473	95%	12
Boiler 3	Penthouse	Laars	NTH500NXN1	473	95%	12
Totals				**1,418**	**-**	**-**

Heating is enabled at the building anytime when the outdoor air temperature falls below 14°C, and stays on until the outdoor air temperature reaches 15°C. Boilers are controlled via the BAS to maintain a hot water loop supply temperature setpoint based on the following OAT reset schedule.

Table 3.5-2: Hot water loop temperature reset schedule

OAT (°C)	Supply Setpoint (°C)
10	75
35	30

The primary hot water loop is circulated by one constant volume pump, P6, which is located on the return water side of the loop. Hot water from this loop is supplied to:

- The heating coil in AHU1,
- The heating coil in AHU2,
- The heating coils in the fan coil units on floors 1-6, and
- The ground floor perimeter radiation units.

Hot water from the primary hot water loop is circulated to AHU1 by a constant volume booster pump, P5, which is located on the return from the fan. The hot water flow to AHU1's heating coil is modulated via a three-way valve to maintain a supply air temperature setpoint set by the BAS (15°C at the time of the site visit).

Hot water from the primary hot water loop is circulated to AHU2's heating coil by a constant volume booster pump, P10, which is located on the supply to the fan. The hot water flow to AHU2 is modulated via a three-way valve to maintain a supply air temperature setpoint set by the BAS (20.5°C at the time of the site visit).

The fan coils receive their hot water through a combined heating/cooling loop (further information available in Section 3.6).

Figure 3.5-2: Hot water pumps: P6 pump/motor (left) and P5 pump/motor (right)

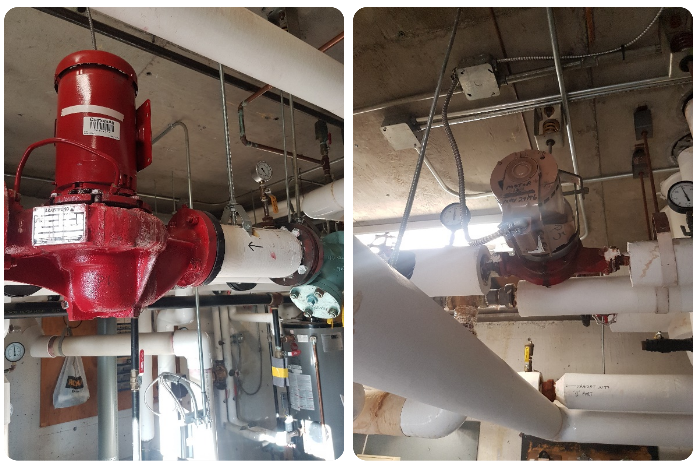


Table 3.5-3: Hot water pump summary

Pump ID	Location	Loop Served	Make	Model	Motor Power (hp)
P5	Penthouse	AHU1 HWR	Armstrong	E6312 LR37479	1/4
P6	Penthouse	Boiler HWR	Armstrong	4380	1
P10	Penthouse	AHU2 HWR	Armstrong	E6312 LR37479	1/4

3.5.1 Lower Level Heat Pumps

Additional heating and cooling are provided to the ground floor by a series of heat pumps which are monitored through the BAS and controlled based on local demand.

Figure 3.5.1-1: Heat pump units in the parkade (left) and heat pump units outside the fitness centre (right)

Table 3.5.1-1: Heat pump unit summary

Tag	Location	Area Served	Make	Model	Cooling Capacity (tons)	Heating Capacity (MBH)
A/C- 102E	Parkade	Health Boardroom	Mitsubishi	PUZ-A24NHA6	2	26
A/C- 103S	Parkade	Care Boardroom	Mitsubishi	PUZ-A24NHA6	2	26
A/C- 101E	Parkade	Quality Room	Mitsubishi	PUZ-A18NHA6	1 ½	19
A/C- 102L	Parkade	Board Room	Mitsubishi	PUZ-A24NHA6	2	26
A/C- 103E	Parkade	Care Boardroom	Mitsubishi	PUZ-A18NHA6	1 ½	19
A/C- 101N	Parkade	Quality Boardroom	Mitsubishi	PUZ-A24NHA6	2	26
A/C- 104	Parkade	Lunch Room	Mitsubishi	PUZ-A18NHA6	1 ½	19
-	Parkade	Fitness Centre	Fujitsu	ASU18RLB	1 ½	18
Total					**14**	**179**

3.6 Common Heating and Cooling Loop

At 1665 West Broadway, the building is either in heating or cooling mode; the boiler and chiller can't run at the same time.

Which system should be enabled is controlled automatically by the BAS based on OAT. Based on BAS observations, when the OAT is greater than 17°C, cooling is enabled and, when the OAT is less than 14°C, heating is enabled. There is a 1°C deadband for both the heating and cooling systems, which means that between 15°C and 16°C neither the boiler plant nor chiller are enabled.

Several pumps are shared by both heating and cooling systems. Hydronic heating/cooling is supplied to the FCUs on floors 1-6 by P4. The FCUs and perimeter radiation units on the ground floor are supplied hot water by P7.

Figure 3.6-1: Central heating and cooling loop pumps: P7 pump/motor (left) and P4 (right) pump/motor

Table 3.6-1: Central heating and cooling loop pump summary

Pump ID	Location	Loop Served	Make	Model	Motor Power (hp)
P4	Penthouse	Level 2-5 Fan Coils C/HWR	Madison Electrical	MUE504	1 ½
P7	Penthouse	Ground Flr C/HWS	Marathon	V QA 48S17D1053	1/3

3.7 Elevators

There are two elevators at 1665 West Broadway that service all 3 levels of parking, as well as the 6 office floors. The elevator details are summarized in the following table.

Figure 3.7-1: Elevator 1

Table 3.7-1: Elevator summary

Elevator Make	Motor Type	Power (hp)	Quantity	Total Power (hp)	Est. Age (yrs)
Torin Drive	Permanent Magnet Synchronous	16.2	2	32.4	< 1 year

3.8 Domestic Water

3.8.1 Domestic Cold Water Systems

Domestic cold water (DCW) is supplied to the building via a single point of entry, with one main meter located on the 1st level of the parkade.

Figure 3.8.1-1: Main building water meter

There is typically 1 men's and 1 women's washroom per office floor. There are 2 sinks in each washroom, 2 toilets and 2 urinals in each men's washroom, and 3 toilets in each women's washroom.

Washrooms are typically fitted with toilets rated at an estimated 6 lpf with manual flush valves, urinals rated at an estimated 3.8 lpf with automatic flush valves, and faucets controlled by automatic sensors rated at 7.6 lpm (note that there are also washrooms with older, manual faucets).

Figure 3.8.1-2: Office washroom water fixtures: toilet (left), urinals (centre), and sinks (right)

In addition to base building washrooms, there is a large kitchenette area located on the first floor, a mid-size kitchenette on the 4th floor, and smaller kitchenettes on every other floor.

There is also a fitness area off the parkade of the building which contains 2 showering areas, each with a shower head with a flow rating estimated at 7.9 lpm and a sink with a flow rate estimated at 7.6 lpm. There is also one washroom in the fitness area, with a sink with flow is also estimated at 7.6 lpm and a toilet with flow estimated at 6 lpf with a manual flush valve.

Figure 3.8.1-3: Fitness Center washroom water fixtures

3.8.2 Domestic Hot Water Systems

Domestic hot water (DHW) to the office washrooms and kitchenettes is provided by a 76-gallon gas-fired hot water tank located in the penthouse which was installed in 2019. The fitness center showers have separate hot water provided by two 29-gallon electric hot water tanks located in the parkade.

Figure 3.8.2-1: Domestic Hot Water Tanks

Table 3.8.2-1: Domestic hot water tank summary

Location	Make	Model	Areas Served	Heating Input Capacity	Heating Efficiency	Size (US Gallons)
Penthouse	Rheem	G76-200-1	Bathrooms and Kitchens	199,900 BTU/hr	80%	76
Main Floor Electrical Room	AO Smith	DEL 30 110	Fitness Centre	6 kW	100%	29
Main Floor Electrical Room	AO Smith	DEL 30 110	Fitness Centre	6 kW	100%	29

3.8.3 Irrigation

Irrigation is provided to exterior planters located on the perimeter of the building and is controlled by a Rain Bird controller. Based on site visit conditions (where the controller was observed to be off), the controller runs on an automated schedule and is scheduled to operate from 4:00 AM – 6:00 AM on Thursdays and Sundays during the summer months.

Figure 3.8.3-1: Irrigation System: general (left), controller (centre), and sprinkler (right)

3.9 Diesel Generator

There is a diesel generator located in the parkade that is enabled in the case of a power failure. The generator is rated at 30 kW and is manually run once per month to ensure it is in proper working order.

Figure 3.9-1: Diesel Generator

3.10 Submetering

There are no electricity, natural gas, or water submeters on site.

3.11 Control Systems

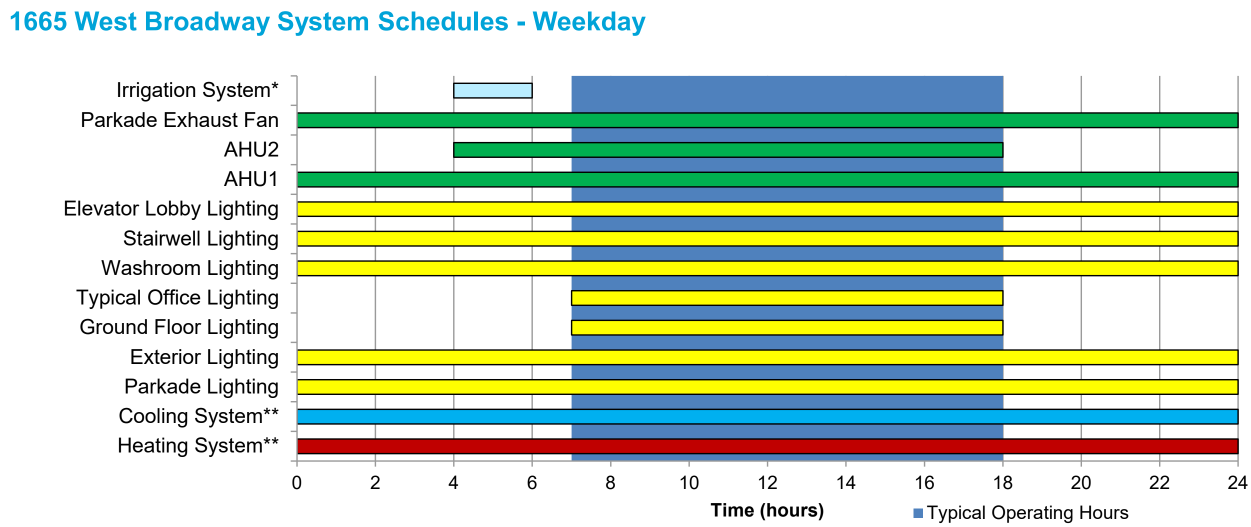
All major HVAC systems are controlled through a Control Solutions Automated Logic BAS. Tenant space temperature setpoints are controlled with DDC thermostats that are integrated into the BAS.

Table 3.11-1: Control systems setpoint summary

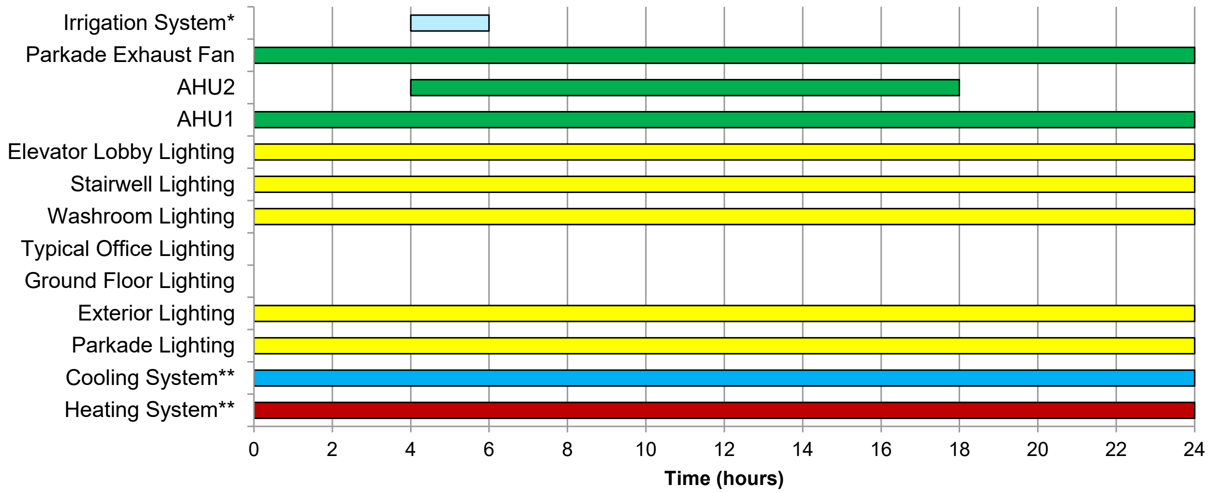
Description	Setpoint	Notes
AHU1 Supply Air Temperature	15°C	Modulates between 15°C - 35°C based on zone conditions
AHU1 Supply Air Static Pressure	70 Pa	Modulates based on flow required at VAVs
AHU2 Supply Air Temperature	20.5 °C	Modulates between 15°C - 27°C based on zone conditions
AHU2 Supply Air Static Pressure	50 Pa	Modulates based on flow required at VAVs
VAV Flow Range	40 cfm - 525 cfm	-
First Floor CO2	500 ppm	-
Typical Room Temperature	24°C	-
Domestic Hot Water Temperature	52°C	-
Hot Water Supply Temperature	30°C - 75°C	Reset between 75°C and 30°C based on OAT
Heating Enable OAT	14°C	-
Boiler Loop Freeze Protection OAT	3.33°C	-
Chilled Water Supply Temperature	15°C	Modulates based on AHU1's deviation from temperature setpoint
Cooling Enable OAT	17°C	-

The above values are based on observations from the BAS during the site visit on December 1st, 2020.

Figure 3.11-1: Building system schedules



1665 West Broadway System Schedules - Weekend



**The Irrigation system is scheduled to run on Thursdays and Sundays during the summer.*
***Heating and cooling systems are enabled based on OAT.*

4.0 Carbon and Utility Reduction Strategies

4.1 Energy, Water & Carbon Reduction Strategy

Energy

Energy use at commercial office buildings is a key facet of building operations and operating costs - today's educated tenant is increasingly aware that energy use represents the lion's share of its carbon footprint, thereby directly impacting its corporate sustainability strategy.

Concurrently, building environmental rating systems such as BOMA BEST, LEED and GRESB have become important building benchmarking and marketing tools that impact leasing decision making, and building energy use is a key component of both.

Additionally, the City of Vancouver will be mandating energy benchmarking for all properties with a GFA greater than 5,000 m², beginning in 2023.

Carbon

Carbon emissions reductions are increasingly a dominant issue in our time, with aggressive carbon emissions reduction targets – including goals of achieving Net Zero Emissions - being set by countries (China, Japan, Canada), cities (New York City and the City of Vancouver), and leading CRE organizations.

In November 2020, the City of Vancouver approved a Climate Emergency Action Plan, which represents a fundamental shift towards long-term carbon planning, consistent with the global movement towards net zero carbon. The action plan places limits on carbon use intensities for office buildings with GFAs above 10,000 m², with financial penalties projected to begin in 2025.

While 1665 West Broadway currently falls below the minimum square footage threshold, it is possible that the legislation could be updated to include smaller buildings in the future.

In order to achieve significant reductions in the building's carbon footprint and/or target net zero emissions, substantial investment in electrification of buildings and electricity grid carbon intensity reductions will be required. Potential options for GHG reduction are reviewed at a high level in Section 11.

The following sections provide a details of our proposed energy, water and GHG conservation strategy.

4.1.1 Key Components of an Energy, Water & Carbon Conservation Plan

Achievement of sustained material reductions in energy, water and carbon use at a commercial office building requires a long-term commitment. Key components of an effective energy and water management strategy are outlined as follows.

- <u>Metering Upgrades (Section 5):</u> Typically, the first step involves installing metering to properly define the building's energy use to assist in driving operational savings.
- <u>Operational Measures (Section 6):</u> Identify and implement operational measures. Traditionally referred to as 'low cost / no-cost measures' identified through a recommissioning/ongoing commissioning process.
- <u>Tenant Engagement Measures (Section 7):</u> In-suite tenant consumption can range from 30-70% of overall building energy use. Tenant involvement will be a key driver of further reductions in building energy use intensity.

- Recommended Systems Measures (Section 8): These are opportunities with material savings associated with changes/upgrades in HVAC and lighting equipment where the cost of implementation is relatively small, and/or the simple payback is generally less than 5-10 years.
- Other Measures to Consider (Section 10): Generally, measures in this section do not have compelling simple paybacks, and may involve significant capital investments.
- Carbon-Focused Reduction Opportunities (Section 11): Opportunities in this section are “beyond the scope” of a typical energy and water audit, and are considered forward-thinking strategies and technologies to help future-proof your assets while reducing your carbon footprint.
- Discounted Measures (Section 12): Measures in this section may be appealing for ongoing monitoring or incremental energy reductions, but have significant simple paybacks (+50 years) that preclude them from the “other measures to consider” section.

These seven conservation strategy components are outlined in the following sections. Each of the first four components form the “business as usual” target-setting process laid out in Section 9.

5.0 Metering Upgrades

5.1 Enable Interval Data for Main Natural Gas and Water Meters

Main meter interval data is a powerful tool that can be used to alert operations staff when energy consumption is not as expected. Issues can then be addressed and rectified to minimize energy consumption.

In EPL's experience, it has been demonstrated that the increased uptake of real-time data combined with analytics at the property level yields improved energy efficiency and reduced operating costs. This increased visibility into building performance enables better deployment of capital as well as continuous operational improvement.

Existing Case

Electricity interval data is currently collected and is accessible through BC Hydro and Stream. Natural Gas and Water consumption data is available via the utility bills (monthly and tri-annually respectively).

Recommendation

Collect interval data on a continuous basis for building natural gas and water use by installing pulse output and data collection systems and have EPL collect and display this data for analysis purposes on Stream.

As the City of Vancouver doesn't allow connections to their water meters, an external data collection device is required for water interval data collection.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Natural Gas - consumption savings	66 GJ		3.5	$800
Water - consumption savings	110 m³		--	$300
Operations / Maintenance savings	--		--	--
Total savings	**18,000 ekWh**		**3.5**	**$1,100**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$7,500	$1,100	$0	**6.8**

The installation of interval meters does not lead to direct savings, but having this data integrated into Stream allows for more detailed ongoing analysis and monitoring, and enables operations teams to catch and rectify issues sooner, resulting in more energy saved.

Assumptions and Notes

- Estimated capital costs assume the existing natural gas meter is capable of pulse outputs.
- Estimated capital costs assume that a *Flowie* device from Alert Labs be installed on the main water meter.
- Estimated savings assume a 2.5% annual reduction in Natural Gas and Water consumption.

5.2 Real-Time Monitoring of Primary Water Users

Based on the estimated Water End Use Breakdown in Section 2.3.2, it is anticipated that the Dental Office and irrigation combine for upwards of 30% of the building's water use.

Recommendation

Install submeters to monitor the water consumption of the Dental Office, as well as the irrigation system. Additionally, allocate costs to the Dental Office directly based on their submetered water use.

Savings and Payback Analysis

Payback Analysis	Estimated Capital Cost	Annual Cost Savings	Potential Incentives	Simple Payback (yrs)
Totals	$8,000	$0	$0	--

The installation of interval meters does not lead to direct savings, but having this data integrated into Stream allows for more detailed ongoing analysis and monitoring, and enables operations teams to catch and rectify issues sooner, resulting in more energy saved.

6.0 Operational Measures

6.1 Reduce the Schedule of AHU1

Based on BAS observations, AHU1 runs 24/7. This AHU provides a conditioned mixture of outdoor and return air to the lobbies and office spaces on the 1st – 5th floors.

Recommendation

Reduce the schedule of AHU1 to align with the tenant occupancy schedules and lease hours. A suggested starting point is a conservative schedule of 6:00 AM – 7:00 PM, Monday – Friday.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - fan consumption savings	31,000 kWh		0.4	$1,800
Electricity - cooling consumption savings	1,600 kWh		--	$100
Natural Gas - consumption savings	620 GJ		32.0	$7,600
Operations / Maintenance savings	--		--	$1,500
Total savings	**200,000 ekWh**		**32.0**	**$11,000**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$0	$11,000	$0	**Immediate**

Assumptions and Notes

- COVID-19 Pandemic Considerations: There are many industry recommendations and opinions regarding 'return-to-office' strategies (e.g. BOMA and ASHRAE) and many building owners and managers have prepared organization-specific guidelines. A general trend has been to be to increase outdoor air volumes and HVAC schedules to promote more airflow and run main building fans two hours before and after tenants occupy the building. The implementation of this measure will need to be reviewed with careful consideration in conjunction with Warrington's return to work and/or pandemic operation guidelines.

6.2 Reduce the Schedule of AHU2

Based on BAS observations, AHU2 is scheduled to run from 4:00 AM – 6:00 PM, 7 days per week. AHU2 provides a conditioned mixture of outdoor and return air to the lobbies and office spaces on the 6th floor.

Recommendation

Reduce the schedule of AHU2. A suggested starting point is a conservative schedule of 6:00 AM – 7:00 PM, Monday – Friday.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - fan consumption savings	3,700 kWh		--	$200
Electricity - cooling consumption savings	300 kWh		--	--
Natural Gas - consumption savings	26 GJ		1.4	$300
Operations / Maintenance savings	--		--	$100
Total savings	**11,000 ekWh**		**1.4**	**$600**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$0	$600	$0	**Immediate**

Assumptions and Notes

- See Measure 6.1 *COVID-19 Pandemic Considerations.*

6.3 Review and Correction of Fan Coil Unit Control

Each floor has four perimeter fan coil units (FCUs) which deliver conditioned air to the perimeter zones. The FCUs are enabled based on heating or cooling demand determined by deviations from the local zone temperature setpoints.

Based on a high-level BAS review, the fan coil unit runtimes vary greatly, ranging from ON 24/7 to ON only a few hours a day.

It was determined that this variation was caused by the inconsistent implementation of the programming that generates the heating or cooling call – some FCUs call for heating and run 24/7 in the winter.

Recommendation

Engage a third party to complete a review of the Fan Coil Unit programming to rectify the discrepancies in schedules and heating/cooling operation.

The corrected control sequences should be set up such that fan coil units run only when required for heating in the winter, and cooling in the summer, the schedules are set and being followed, and that the after-hours enable setpoints are within reasonable upper and lower bounds.

It is recommended to complete this as part of a larger, full building operational review, such as via the proposed Smart Building Analytics investigation described in Section 6.7.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - fan consumption savings	15,000 kWh		0.2	$900
Operations / Maintenance savings	--		--	--
Total savings	**15,000 kWh**		**0.2**	**$900**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$1,500	$900	$0	**1.7**

Assumptions and Notes

- Savings assume that, when properly scheduled, the fan coil units run only 12 hours per day, 5 days per week.

- A budget cost of $500 has been included to investigate and rectify these control issues, though these costs could be avoided if the investigation is performed in-house.

6.4 Enable Parkade Exhaust Fan Controls

The parkade exhaust fan does not currently run on a schedule and is enabled 24/7. There is a timer in the basement electrical room that appears to have been used to control this fan in the past, but it is no longer working.

Recommendation

Investigate this timer to determine if it can still be used. If so, schedule the parkade exhaust fan to run a few times per day when tenants are driving in and out of the parkade (e.g., morning, lunch, and end of day). If the timer cannot be reused, replace it and schedule the fan as previously described.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - fan consumption savings	21,000 kWh		0.3	$1,300
Operations / Maintenance savings	--		--	--
Total savings	**21,000 kWh**		**0.3**	**$1,300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$500	$1,300	$0	**< 1 year**

Assumptions and Notes

- Savings assume that you will be able to reduce the exhaust fan schedule to an average of 9 hours per weekday.
- If this measure is implemented, it is recommended that you test and monitor the CO/CG levels in the parkade to ensure that you are still satisfying health and safety standards.
- The budget cost of $500 is for the replacement of the parkade fan controller.
- An alternative solution would be to install CO/CG (combustible gas) sensors throughout the parkade that enable the fan to run only when required. This option was discounted at this time on the basis of cost, but could be considered.

6.5 Recommission Exterior Lighting Control via Photocells

Photocells were observed on site which are believed to have, at one point, controlled exterior lighting. During the site visit, the exterior lights were observed to be ON during the daytime, which is supported by discussion with Building Operations.

Recommendation

Investigate why photocell control is no longer in use and recommission/replace this controller as required.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	2,300 kWh		--	$100
Electricity - peak demand savings	0.5 kW		--	$100
Operations / Maintenance savings	--		--	$100
Total savings	**2,300 kWh**		**0.0**	**$300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$500	$300	$0	**1.7**

Assumptions and Notes

- Savings assume that you will be able to reduce the exterior lighting schedule to an average of 12 hours per day.
- Costs assume that the existing photocells are wired and capable of functioning and do not require modification or replacement.
- An exterior lighting control timer was also observed on site that appears to no longer be in use. Alternative to the above suggestion, this timer could be used to control exterior lighting; however, with appropriate sensor placement, photocell control is expected to yield more efficient lighting scheduling.

6.6 Reduce Base Building Lighting Schedules

Based on site visit observations, and conversations with building operations, the base building office lighting is controlled by a variety of control systems (e.g., a GE control system, wall switches, and occupancy sensors), and is typically ON from 7:00 AM – 6:00 PM, Monday – Friday.

Recommendation

Where controlled by a schedule, work with your tenants to refine the schedules such that lighting is ON only when tenants occupy the office spaces.

As a starting point, consider scheduling the lighting ON at 8:00 AM, rather than 7:00 AM.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	9,200 kWh		0.1	$500
Electricity - cooling consumption savings	500 kWh		--	--
Natural Gas - consumption savings	-9 GJ		-0.5	-$100
Operations / Maintenance savings	--		--	$100
Total savings	**7,200 ekWh**		**-0.4**	**$500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$0	$500	$0	**Immediate**

Assumptions and Notes

- Savings assume that you will be able to reduce the base building lighting schedule by an average of one hour per day.

6.7 Implement *Smart Building Analytics* to Realize Further Operational Optimization Opportunities

Across the country, we have seen that the increased uptake of real-time data combined with analytics at the property level yields improved energy efficiency and reduced operating costs. At EPL, we call this our *Smart Building Analytics* program, which provides a means to continually optimize and drive down energy consumption using a data-driven approach to harmonizing building operations.

Through Smart Buildings Analytics, the increased visibility into building performance enables better deployment of capital as well as continuous operational improvement.

Recommendation

Implement Smart Building Analytics to leverage real-time BAS data to identify opportunities for optimization and harmonize building operations.

Through an initial high-level review of the BAS, we have identified a number of potential operational opportunities, listed below. At this stage, these measures are considered “potential opportunities” as they have not been thoroughly investigated and are based on high-level observations only. These measures would be further reviewed and investigation via the Smart Building Analytic scope.

- **Rectify AHU1 VFD cycling:** Since March of last year, the VFD on AHU1 has experienced significant cycling, often jumping from 50% output to 85% output, and back down to 50% within the span of 30 minutes. Have this VFD tuned to reduce/eliminate cycling, reducing wear and tear on the motor, and likely leading to more consistent pressure in the supply air ducts.
- **Investigate AHU2 Supply Air Pressure Sensor and Control:** The supply air pressure setpoint for AHU2 is set to modulate between 50Pa and 150Pa depending on the number of downstream VAVs calling for additional airflow, but the pressure in the ducts consistently reads 500Pa. It is recommended to calibrate this sensor.
- **Ground Floor Radiant Heating Optimization:** Based on BAS observations, there is a radiation loop providing heating to spaces on the ground floor. Savings could be achieved by implementing a lower hot water supply temperature from the boiler plant, such that the condensing boilers operate at a higher efficiency, and monitoring space temperatures on the ground floor to check that thermal comfort is maintained.
- **Boiler Plant Investigation:** There are times where, based on observations from the BAS, all 3 boilers are firing at 100%, but their supply water temperatures range from 40°C to 60°C - much lower than the loop setpoint of around 75°C. We recommend investigating the boiler control to check that the heating plant is controlling as intended. Consistent hot water supply temperatures and better setpoint tracking may be achieved as a result of rectifying issues identified in this investigation.
- **Night Setback of Boiler Hot Water Supply Temperature:** Assuming FCU and AHU schedules can align with building operating hours, it is expected that the only overnight heating demand will come from the radiant heating units on the first floor which were observed on the BAS. Given this low heating load, a potential strategy in cutting down your overnight heating losses would be to set back the temperature on the main heating loop by about 10°C.
- **Chiller Plant Schedule:** The chiller is currently enabled when the outdoor air temperature rises above 17°C, and there is a significant cooling call from either the FCUs, or AHU1. The opportunity exists to implement a schedule to only allow the chiller to turn ON during building occupied hours to avoid unnecessary building cooling overnight when no occupants are present.

- **Zone Temperature Setpoints:** During the site walkthrough, it was noted that many zone temperature setpoints were set at 24°C, which is a warmer setpoint than the standard 22°C for office buildings. It is recommended to review these setpoints, and set the temperature back (in winter) in largely unoccupied zones. In summer, you could consider setting temperature setpoints higher in largely unoccupied zones.
- **Airside Economizing Optimization:** Airside economizing is currently only enabled based on indoor and outdoor dry-bulb temperature conditions. Due to the humidity in Vancouver, consider adapting your airside economizing control to account for the impact humidity has on the latent heat of air – humid air carries more latent heat and can reduce the benefits of airside economizing.
- **Heat Recovery Ventilation Unit:** Based on BAS observations, there is a heat recovery ventilation unit that provides air to spaces on the east side of the first floor. Currently, there is not a lot of visibility into the control of this unit as supply and return air temperatures to/from the unit are not visible on the BAS. It is recommended that these temperatures be monitored and integrated into the BAS, which may provide the means to identify opportunities to improve the current control of the unit.
- **Weather Stripping on Ground Floor:** The front entrance to the building is sealed by a glass door. There was limited weather stripping on and around the door, which could lead to leakage of conditioned air from the lobby. We recommend installing additional weather stripping to increase the insulation of the main lobby and cut down on heating and cooling demands.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - consumption savings	35,000 kWh		0.4	$3,200
Natural Gas - consumption savings	130 GJ		6.7	$1,600
Operations / Maintenance savings	--		--	--
Total savings	**71,000 ekWh**		**7.1**	**$4,800**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$20,000	$4,800	TBD	**4.2**

Assumptions and Notes

- Annual cost savings are based on a 10% reduction in the baseline normalized energy use intensity, after the submetering measures (Sections 5.1 and 5.2) and fan scheduling measures (Sections 6.1 and 6.2) are implemented.
- Potential Incentives may be available through BC Hydro.

7.0 Tenant Engagement Measures

7.1 Implementation of Tenant Engagement Programs

Currently there is no formal tenant engagement program at 1665 West Broadway.

Recommendation

As part of a comprehensive strategy to drive down normalized energy use intensity, implement a tenant engagement program to elicit tenant participation in energy reduction efforts. Due to the ongoing COVID-19 pandemic it is recommended that this measure be implemented upon the resumption of tenants regularly coming into the building.

Examples of tenant engagement measures:

- Creation of a tenant 'Green Committee': Engage tenant representatives to brainstorm regarding conservation opportunities.
- Friendly competition programs: Friendly competitions between different floors/area with monthly rewards can encourage further energy reduction.
- Energy consumption communication program: interactive displays in common areas showing real-time energy consumption combined with tenant-specific communications can combine to engage tenants to work towards a target.
- Energy reduction seminars: Seminars can be held to inform tenants of energy reduction strategies and tips can lead to further energy savings. Challenge tenants to design energy efficient office spaces during their next renovation.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - consumption savings	5,700 kWh		0.1	$500
Operations / Maintenance savings	--		--	--
Total savings	**5,700 kWh**		**0.1**	**$500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$5,000	$500	--	**10.0**

Assumptions and Notes

- Based on level of commitment, reduction of in-suite electricity consumption is estimated at 2.5%.
- Costs associated with setting up programs designed to encourage continued tenant engagement efforts are estimated to be $5,000 for the first year.

8.0 Recommended Systems Measures

8.1 Lighting Measures

8.1.1 Relamp 2-Lamp, 2’ Fluorescent Base Building Fixtures with LED Lamps

Base Building office lighting is provided by 2-lamp, 2’ fluorescent T8 fixtures. Based on site visit observations and conversations with building operations the lighting is typically ON from 7:00 AM – 6:00 PM, Monday – Friday.

Recommendation

Relamp the existing fixtures with LED plug-and-play equivalents.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	32,000 kWh		0.4	$1,900
Electricity - cooling consumption savings	1,700 kWh		--	$100
Electricity - peak demand savings	12.0 kW		--	$1,800
Natural Gas - consumption savings	-30 GJ		-1.6	-$400
Operations / Maintenance savings	--		--	--
Total savings	**25,000 ekWh**		**-1.2**	**$3,400**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$20,000	$3,400	TBD	**5.9**

Assumptions and Notes

- Potential incentives may be available through BC Hydro.
- Ballast types should be confirmed beforehand to check compatibility with LED lamps.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and lighting (e.g., IESNA) requirements.
- If advanced lighting control (see Section 10.3) is considered for the property, consideration should be given to installing lamps and drivers with dimmable capabilities (or new fixtures) so that an advanced lighting control system can take full advantage of the existing system.

8.1.2 Relamp Non-LED Washroom Fixtures with LED Lamps and Install Occupancy Sensors to Control Lighting

The men’s washrooms are illuminated via a combination of 2-lamp, 4’ linear fluorescent fixtures, as well as LED PAR38 potlights. The women’s washrooms are illuminated with a combination of 2-lamp, 4-pin LED sconces, as well as 2-Lamp, 2-pin PL potlights.

These fixtures are not currently controlled and are ON 24/7.

Recommendation

Retrofit the 2-lamp, 4’ linear fluorescent fixtures, and the 2-Lamp, 2-pin PL potlights with LED lamps. Install occupancy sensors to turn the washroom lights OFF when unoccupied.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	11,000 kWh		0.1	$600
Electricity - cooling consumption savings	500 kWh		--	--
Electricity - peak demand savings	0.5 kW		--	$100
Natural Gas - consumption savings	-10 GJ		-0.5	-$100
Operations / Maintenance savings	--		--	$100
Total savings	**8,700 ekWh**		**-0.4**	**$700**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$3,300	$700	TBD	**4.7**

Assumptions and Notes

- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and IESNA requirements.

8.1.3 Relamp 2-Lamp, 4’ Fluorescent Mechanical Room and Fitness Centre Fixtures with LED Lamps and Install Occupancy Sensors to Control Lighting

The Fitness Centre and Mechanical Rooms are illuminated with 2-lamp, 4’ linear fluorescent fixtures. These fixtures are controlled via wall switches.

Recommendation

Retrofit these fixtures with LED equivalents, and control the mechanical room lighting with occupancy sensors.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	1,700 kWh		--	$100
Electricity - peak demand savings	0.9 kW		--	$100
Operations / Maintenance savings	--		--	--
Total savings	**1,700 kWh**		**0.0**	**$200**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$1,300	$200	TBD	**6.5**

Assumptions and Notes

- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and IESNA requirements.

8.1.4 Relamp 2-Lamp, 4', and 2-Lamp, 2' Fluorescent Elevator Lobby Fixtures with LED Lamps and Install Occupancy Sensors to Control 50% of Elevator Lobby Lighting

The elevator lobbies are illuminated with a combination of the following fixtures:

- 2-lamp 4' linear fluorescent,
- 2-lamp 2' linear fluorescent, and
- LED PAR38 potlights

These fixtures are not controlled and are ON 24/7.

Recommendation

Retrofit the linear fluorescent fixtures with LED equivalents. Install occupancy sensors to turn every second elevator lobby fixture OFF when the area is empty. Leave the remaining 50% of fixtures ON 24/7 for emergency purposes.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	7,900 kWh		0.1	$500
Electricity - cooling consumption savings	400 kWh		--	--
Electricity - peak demand savings	0.6 kW		--	$100
Natural Gas - consumption savings	-7 GJ		-0.4	-$100
Operations / Maintenance savings	--		--	--
Total savings	**6,400 ekWh**		**-0.3**	**$500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$2,500	$500	TBD	**5.0**

Assumptions and Notes

- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check that light levels satisfy occupant and IESNA requirements.

8.2 HVAC Measures

8.2.1 AHU2 Upgrade/Replacement

AHU2 is a rooftop unit equipped with a DX cooling system as well as a heating coil fed from the base building primary hot water loop. This unit provides a conditioned mixture of return and outdoor air to the tenants on the 6th floor.

We understand that this unit is at its end of life has been budgeted for replacement in 2021.

Recommendation

With this piece of equipment at end of life, there are fundamentally three options that we suggest considering for your planning purposes:

- Option 0: Like-for-Like Replacement
- Option 1: High Efficiency Option
- Option 2: Fuel Switching / GHG Retrofit Option

The option you choose will depend on a number of factors such as timeline, availability of capital, importance of GHG footprint and energy efficiency, the longer-term operating costs of the building, prices of fuel (electricity vs gas) and the general goals and direction for the asset.

For the purposes of this analysis, we have provided a commentary on Options 1 and 2, and a payback analysis for Option 1.

Option 1: Replace AHU2 with a High Efficiency Option

Install a high-efficiency rooftop unit. Typically, a high-efficiency RTU will have a variable speed drive for the fan, a more efficient internal cooling system and have an EER (energy efficiency ratio) greater than 12.

If GHG reduction is a priority, consider a unit that does not require a dedicated natural gas feed. The costs and savings below assume that this option is selected, and that the replacement will be tied into the base building hot water loop in the same manner as AHU2.

Option 2: Fuel Switching / GHG Retrofit Option

An alternative would be to consider a fuel switching option to reduce building's dependence on natural gas and thereby reduce the building's GHG footprint. An option to consider would be retrofitting the existing AHU with an air-source pump system, which uses electricity as its fuel source. Note that while this system would have a higher efficiency and lower GHG emissions, the operating costs would be higher due to the current cost of electricity vs. gas. On this basis, the decision to fuel switch is largely predicated on the direction of the ownership and need/desire to meet carbon reduction targets, if any.

Further engineering analysis, starting with a feasibility assessment to review key items such electrical capacity/distribution, followed by a full engineering design would be required, should you wish to pursue or consider with this option. Incentives are likely available via programs such as Clean BC.

Savings and Payback Analysis (Option 1: Replace AHU2 with a High Efficiency Option)

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - cooling consumption savings	4,900 kWh		0.1	$300
Electricity - peak demand savings	4.9 kW		--	$400
Operations / Maintenance savings	--		--	--
Total savings	**4,900 kWh**		**0.1**	**$700**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$10,000	$700	TBD	**14.3**

Assumptions and Notes

- The costs presented in this measure are considered "incremental costs" over a standard efficiency unit.
- The costs/savings presented assume that Option 1 is selected.
- Energy savings were calculated as the incremental energy saved by installing a high-efficiency unit, rather than a standard efficiency unit.

8.3 Water Conservation Measures

8.3.1 Install Aerators on Washroom Sinks

There is typically 1 men's and 1 women's washroom per office floor, with 2 sinks in each washroom. There are an additional 2 sinks in the Fitness Centre washrooms. Washroom sinks are typically fitted with faucets controlled by automatic sensors rated at 7.6 lpm (note that there are also washrooms with older, manual faucets).

Recommendation

Install low-flow aerators on the washroom faucets, typically with a rating of 1.9 lpm.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Water - consumption savings	210 m³		--	$500
Operations / Maintenance savings	--		--	--
Total savings	**0 kWh**		**0.0**	**$500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$500	$500	$0	**1.0**

Assumptions and Notes

- Estimated capital costs assume aerators are installed by Building Operations.

8.3.2 Retrofit Urinals with Low-Flow Diaphragms

There is typically 1 men's washroom per office floor, with 2 urinals in each washroom. The urinals are typically fitted with automatic flush valves rated at an estimated 3.8 lpf.

Recommendation

Retrofit urinal flush valves with low-flow diaphragms, typically rated at 1.9 lpf.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Water - consumption savings	110 m³		--	$300
Operations / Maintenance savings	--		--	--
Total savings	**0 kWh**		**0.0**	**$300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$500	$300	$0	**1.7**

Assumptions and Notes

- Estimated capital costs assume urinal flush valves are retrofitted by Building Operations.
- A replacement of the entire flush valve was discounted on the basis of costs.

8.3.3 Install a Moisture-Based Irrigation Controller

Irrigation is provided to exterior planters located on the perimeter of the building and is controlled by a Rain Bird controller. Based on site visit conditions (where the controller was observed to be off), the controller runs on an automated schedule and is scheduled to operate from 4:00 AM – 6:00 AM on Thursdays and Sundays during the summer months.

Recommendation

The irrigation controls should be replaced with a new control system equipped with moisture sensors to minimize unnecessary irrigation.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Water - consumption savings	210 m³		--	$500
Operations / Maintenance savings	--		--	--
Total savings	**0 kWh**		**0.0**	**$500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$4,000	$500	$0	**8.0**

Assumptions and Notes

- Savings are estimated based on historic precipitation data for the City of Vancouver.

9.0 Target Normalized Energy Use

As outlined in Section 4, the recommended energy conservation strategy is to set a normalized energy use intensity (NEUI) target, both to allow for building performance to be compared to industry benchmarks and so targets can remain valid in the face of material tenant changes in terms of type, occupant density, and operating hours.

For 1665 West Broadway, a NEUI target of **19.6 ekWh/ft^2** is proposed, representing a 28.7% reduction from the existing baseline. The target ENERGY STAR score is **93**.

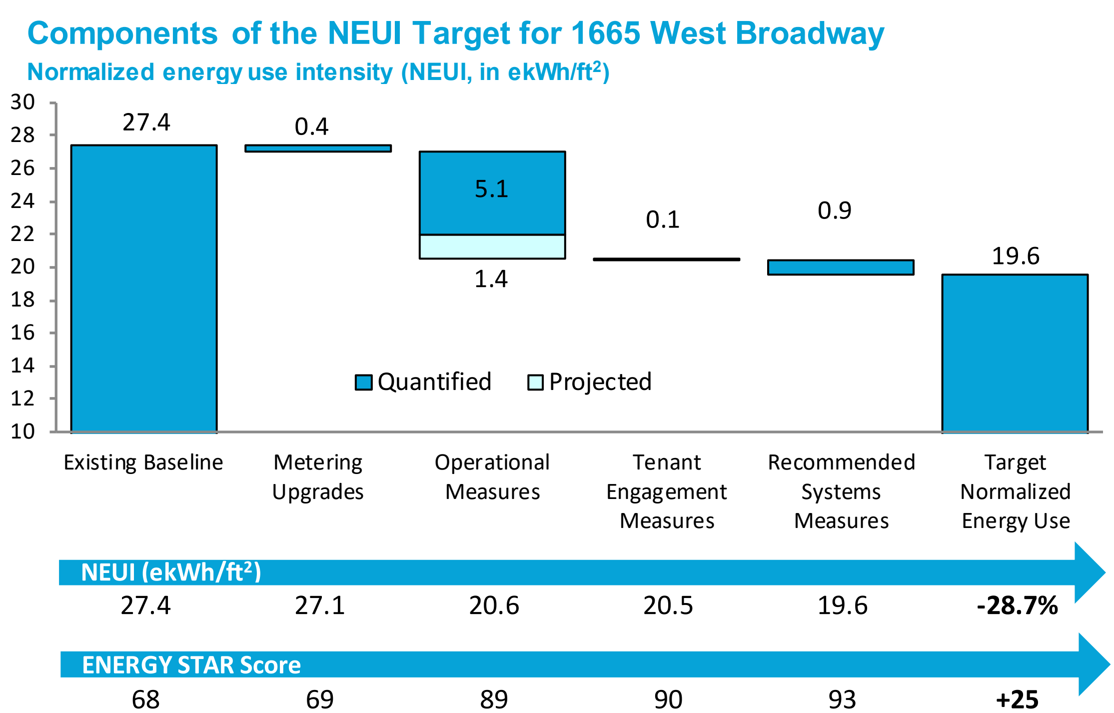
The contribution of each savings component is summarized in the following table and figure.

Table 9.0-1: Energy and water conservation strategy

Measure	Sect.	Energy Savings (%)	Water Savings (%)	GHG Savings (tCO_2e)	Annual Cost Savings*	Estimated Costs	Simple Payback
Metering upgrades	5	1.2%	2.4%	3.5	$1,100	$15,500	14.1 y
Operational measures	6	22.2%	0.0%	40.6	$19,400	$22,500	1.2 y
Tenant engagement	7	0.4%	0.0%	0.1	$500	$5,000	10.0 y
Recommended systems measures	8	3.2%	11.7%	-1.8	$6,800	$42,100	6.2 y
Totals		**27.0%**	**14.2%**	**42.4**	**$27,800**	**$85,100**	**3.1 y**

* Annual cost savings include the reduction of energy, water, and operations / maintenance costs.

Figure 9.0-1: Breakdown of the Normalized Energy Targets



10.0 Other Measures to Consider

These opportunities generally involve significant capital investments and/or measures where the simple payback is not as compelling. These opportunities are typically implemented as part of an asset renewal program (because the payback on the incremental cost to install high efficiency equipment is often attractive).

There are potential incentives for lighting related measures available through BC Hydro. The three measures listed in this section currently have paybacks of 20+ years, but if these incentives are pursued, the paybacks for these "other measures" may become more attractive.

10.1 Install Occupancy Sensors to Dim Stairwell Lighting

The stairwells are illuminated by 4', 2-lamp fixtures, the vast majority of which have already been retrofitted with LED lamps. The stairwell lighting is not controlled, and is ON 24/7.

Measure Description

Install dimmable ballasts on every fixture and one occupancy sensor per floor to dim the fixtures when the stairwell is unoccupied, and turn on to 100% when the stairwell is occupied. Due to safety standards, these fixtures should default to ON in the case of failure.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	4,600 kWh		0.1	$300
Operations / Maintenance savings	--		--	--
Total savings	**4,600 kWh**		**0.1**	**$300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$6,400	$300	TBD	**21.0**

Assumptions and Notes

- This measure assumes that the current fixtures and lamps are compatible with dimmable ballasts.
- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and lighting (e.g., IESNA) requirements.
- Savings assume that lights can be dimmed to 20% output when zones are unoccupied.

10.2 Install Occupancy Sensors to Control Parkade Lighting

The parkade is illuminated by 4', 2-lamp fixtures, the vast majority of which have already been retrofitted with LED lamps. The parkade lighting is not controlled, and is ON 24/7.

Measure Description

Install dimmable ballasts on every fixture and one occupancy sensor for every 2 fixtures to dim them when the parkade is unoccupied, and turn on to 100% when the parkade is occupied. Due to safety standards, these fixtures should default to ON in the case of failure.

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	4,100 kWh		--	$200
Operations / Maintenance savings	--		--	--
Total savings	**4,100 kWh**		**0.0**	**$200**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$5,900	$200	TBD	**30.0**

Assumptions and Notes

- This measure assumes that the current fixtures and lamps are compatible with dimmable ballasts.
- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and lighting (e.g., IESNA) requirements.
- Savings assume that lights can be dimmed to 20% output when zones are unoccupied.

10.3 Advanced Lighting Controls with New LED Fixtures

Base Building office lighting is provided by 2L, 2' fluorescent T8 fixtures, and based on site visit observations and conversations with building operations, is typically ON from 7:00 AM – 6:00 PM, Monday – Friday.

Measure Description

Instead of relamping the existing office tenant and common area fixtures with "plug-and-play" LED lamps (as recommended in Section 8.1.1), the existing fixtures could be replaced with new LED fixtures fitted with dimmable ballasts/drivers while implementing advanced lighting controls.

An advanced 'intelligent' lighting control system differs from a basic lighting control scheme in that each light fixture is assigned its own network address and is individually controlled. This provides the ultimate in end-use control, allowing for the implementation of multiple control schemes, and providing the platform to reduce energy use to the absolute minimum.

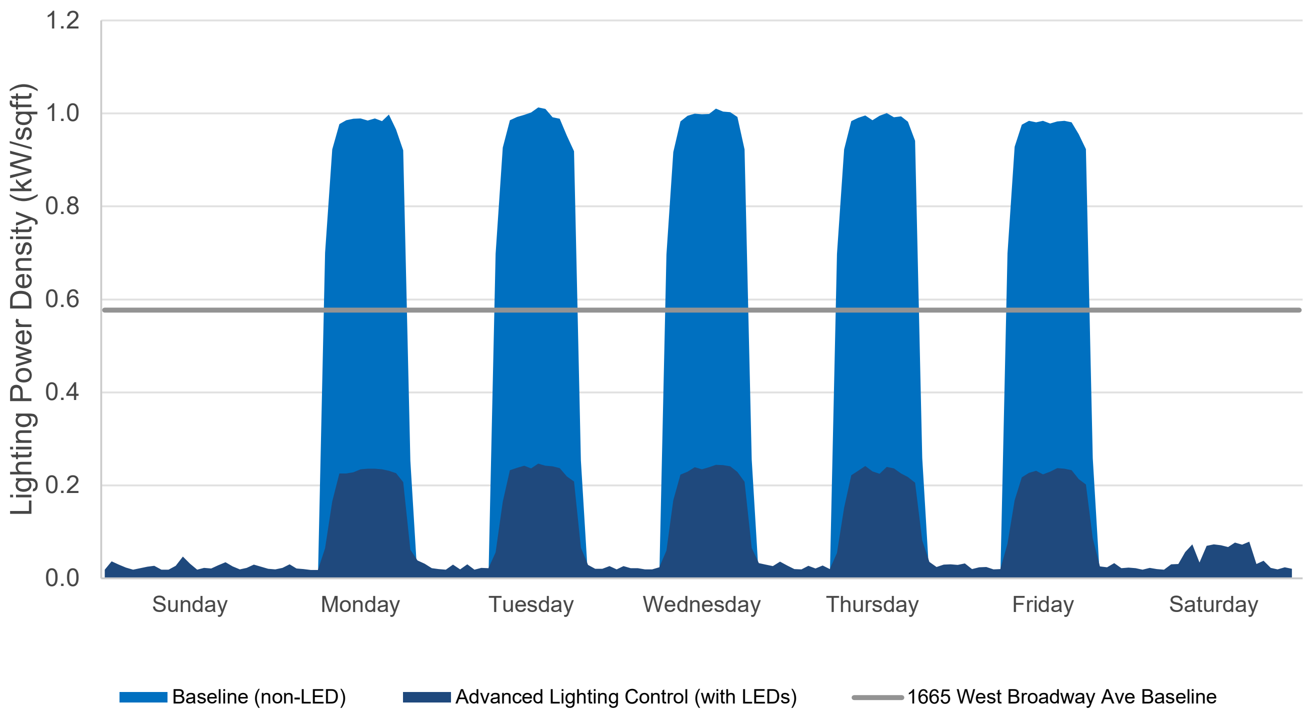
While the investment is significant, the building would benefit from the complete flexibility in terms of being able to create and change zoning and modify light levels down to the individual fixture. This system would also serve to help future-proof the building, as it is expected that with the industry movement towards Smart buildings, occupants are going to want this type of individual controllability.

This system would use the following strategies to conserve energy:

- Task tuning – setting the light levels according to user preference / zone requirement.
- Daylight harvesting – reducing light levels on the perimeter during daylight hours.
- Occupancy sensors.
- Scheduling − enabling lighting during off-peak hours, by fixture.
- Emergency lighting configuration – emergency fixtures can be dimmed or turned OFF when not required, and programmed to default to 100% ON in the event of a power failure.

Energy Profiles Limited has helped install an advanced lighting control system in a client office building. Consumption savings of 80% and demand savings of 50% during occupied hours are being achieved when compared to standard lighting layouts without any advanced lighting control strategies.

Weekly Lighting Profile - EPL Client Building



Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	44,000 kWh		0.5	$2,600
Electricity - cooling consumption savings	2,300 kWh		--	$100
Electricity - peak demand savings	14.0 kW		--	$2,100
Natural Gas - consumption savings	-41 GJ		-2.1	-$500
Operations / Maintenance savings	--		--	$200
Total savings	**35,000 ekWh**		**-1.6**	**$4,500**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$320,000	$4,500	TBD	**71.0**

Assumptions and Notes

- Incentives are potentially available through BC Hydro.
- Electrical demand savings are based on a 10% reduction in lighting power density.
- Electricity consumption savings are estimated at 20% of existing lighting consumption after the scheduling reduction recommended in Section 6.6.
- Tenant comfort is not expected to be impacted with the implementation of this measure, though we recommend implementing a test area to gauge occupant feedback.

11.0 Carbon-Focused Reduction Opportunities

The City of Vancouver's Climate Emergency Action Plan represents a fundamental shift towards long-term carbon planning, consistent with the global movement towards net zero carbon. Currently, plans are in place to impose significant financial penalties on Commercial Office Buildings that do not meet strict carbon intensity targets (30 $kgCO_2e/m^2/yr$ by 2025, and 15 $kgCO_2e/m^2/yr$ by 2025).

Though 1665 West Broadway currently falls below the size threshold for these penalties (10,000 m^2), it is prudent to begin planning for decarbonization of your building – regulations for smaller assets could be coming down the line.

11.1 Decarbonization of Heating Plant

Natural gas use from heating makes up 94% of all emissions at the building. Reducing or eliminating the natural gas use from heating will involve utilizing electricity for heating requirements. Below, we have outlined a few high-level options for your consideration. Implementation of the measures outlined below would allow you to eliminate all natural gas consumption at the property and could reduce your annual emissions by ~90 tCO_2e.

Geo-Exchange System

A geo-exchange system utilizes the earth as a natural heat source during the heating season and as a heat sink during the cooling season. Energy is transferred between the building and ground through a water and glycol mixture.

Installation of a geo-exchange system in the lower levels of the parkade could be considered to reduce heating and cooling provided by the central systems.

Air-Source Heat Pumps

An air-source heat pump system could also be considered to replace the heating system at 1665 West Broadway. This system relies on drawing and rejecting heat from the outside air to maintain thermal comfort. This option would be a less invasive, but also potentially a less-efficient alternative to ground-source heat pumps.

Boiler Electrification

Replacing your current boiler with an electric alternative would also be an option to significantly reduce your GHG emissions. This option also represents a one-for-one replacement strategy for your current heating plant.

Additional Considerations

The three options presented are considered only at a very high level. Before moving forward with any of the above, we recommend performing detailed studies of each of these options if you would like to pursue decarbonization of your building. Additionally, there are likely incentives available for decarbonization projects that should also be considered.

Other non-energy related considerations that may impact the feasibility of these measures include the capacity of your existing electrical distribution, structural and space constraints associated with install of new equipment, and the limits on supply water temperatures for the various systems (an electric boiler will be able to provide hotter water than a geo-exchange system).

11.2 Installation of Solar PV Panels on the Roof

Electricity is currently completely provided to 1665 West Broadway by BC Hydro, with no on-site electricity generation.

Measure Description

A solar PV system could be installed on the roof to generate usable solar power which offsets consumption from the grid.

Energy, Emissions, and Cost Savings Summary

Based on a high-level assessment of rooftop area, it is assumed that an 83 kW (AC) solar PV system could be installed, at approximately 450 m^2 of space. Assuming 120,000 kWh/year of electricity is produced by such a system, annual cost savings of approximately $9,400 are anticipated.

Annual GHG emission reductions are estimated to be 1.4 tCO_2e, or approximately 1% of the building's current carbon footprint.

Notes and Assumptions

- At a high level, the payback for this measure will be longer than 25 years.
- Should installation of solar panels on the rooftop be considered, it is recommended to:
  - Have a structural engineer review the roof capacity to confirm the roof structure can support the PV loads.
  - Have a roofing consultant perform a roof membrane condition assessment, to assess the expected remaining useful life of the membrane. It may make sense to replace the membrane prior to the installation of a solar system as doing so is typically much more costly once solar panels are installed.

12.0 Discounted Measures

The measures in this section were considered, but were discounted on account of high costs and long paybacks (50+ years).

12.1 Submetering and Cost Allocation of Tenant Lighting and Plug Loads

Increasingly, the market trend is to meter tenant electricity consumption and allocate the associated electricity costs directly to the responsible tenant. Not only does this allow fair allocation of costs, but it also incents individual tenants to reduce their electricity consumption, as they are paying for it (i.e. being billed directly).

In-suite tenant electricity use can range from 30-70% of overall building electricity consumption. As such, efforts to reduce this consumption play a key role as part of an overall strategy to reduce energy use intensity.

Existing Case

The tenant electricity use at 1665 West Broadway is currently not submetered. Tenant in-suite lighting and plug loads are estimated at approximately 227,000 kWh, representing about 31% of the overall building electricity use. There are six office floors at 1665 West Broadway, with some space on the 6th floor leased to tenants other than Doctors of BC. There is also a server room on the first floor.

Measure Description

A submetering system could be installed to capture in-suite tenant lighting and receptacle loads, and allocate costs directly to the responsible tenants. This would enable tenant electricity costs to be allocated to each suite. The installation of submeters does not lead to direct savings, but it is an important tool in empowering tenants to cut down on their energy use. Energy savings typically follow as a function of human nature: behavior can be influenced given a suitable price signal.

This measure is considered “discounted” due to the Doctors of BC already paying for the majority of their own energy use, though it could be considered to increase the visibility into your building’s energy use.

Assumptions and Notes

- As noted in the measure recommendation, the installation of submeters does not lead to direct energy savings.
- Capital costs based on the installation of 14 electricity submeters would be in the range of $40,000.

12.2 Control Base Building Lighting with Occupancy Sensors

Base Building office lighting is typically scheduled ON from 7:00 AM – 6:00 PM, Monday – Friday.

Measure Description

Occupancy sensors could be installed to turn the lighting OFF when no one is in the space. This would be a particularly useful control strategies for the floors not currently connected to the GE lighting control system (e.g., floors 5 and 6).

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Electricity - lighting consumption savings	3,700 kWh		--	$200
Electricity - cooling consumption savings	200 kWh		--	--
Natural Gas - consumption savings	-3 GJ		-0.2	--
Operations / Maintenance savings	--		--	$100
Total savings	**3,100 ekWh**		**-0.2**	**$300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$22,000	$300	TBD	**73.0**

Assumptions and Notes

- Potential incentives may be available through BC Hydro.
- Small test areas should be re-lamped beforehand to check light levels satisfy occupant and lighting (e.g., IESNA) requirements.

12.3 Replace Toilets with Low-Flow Equivalents

There is typically 1 men's and 1 women's washroom per office floor. There are 2 toilets in each men's washroom, and 3 toilets in each women's washroom. There are an additional 2 toilets in the Fitness Centre washrooms.

Washrooms are typically fitted with toilets rated at an estimated 6 lpf with manual flush valves.

Measure Description

Toilets could be replaced with units rated at 4.8lpf (or lower).

Savings and Payback Analysis

Savings Analysis	Utility		GHG (tCO_2e)	Cost
Water - consumption savings	120 m^3		--	$300
Operations / Maintenance savings	--		--	--
Total savings	**0 kWh**		**0.0**	**$300**
Payback Analysis	**Estimated Capital Cost**	**Annual Cost Savings**	**Potential Incentives**	**Simple Payback (yrs)**
Totals	$35,000	$300	$0	**120.0**

Assumptions and Notes

- Estimated capital costs assume that toilets are installed by a third party.

Appendix A Detailed Economic Analysis

Measure Name	Estimated Annual Savings				Capital Cost w. Incentives	Simple Payback (years)
	Energy (ekWh)	Water (m³)	Emissions (tCO_2e)	Utility Cost		
Metering Upgrades						
Enable Interval Data for Main Natural Gas and Water Meters	18,000	110	3.5	$1,100	$7,500	6.8 y
Real-Time Monitoring of Primary Water Users	0	0	0.0	$0	$8,000	--
Operational Measures						
Reduce the Schedule of AHU1	200,000	0	32.0	$11,000	$0	Immediate
Reduce the Schedule of AHU2	11,000	0	1.4	$600	$0	Immediate
Review and Correction of Fan Coil Unit Control	15,000	0	0.2	$900	$1,500	1.7 y
Enable Parkade Exhaust Fan Controls	21,000	0	0.3	$1,300	$500	< 1 year
Recomission Exterior Lighting Control via Photocells	2,300	0	0.0	$300	$500	1.7 y
Reduce Base Building Lighting Schedule	7,200	0	-0.4	$500	$0	Immediate
Implement Smart Building Analytics to Realize Further Operational Optimization Opportunities	71,000	0	7.1	$4,800	$20,000	4.2 y
Tenant Engagement Measures						
Implementation of Tenant Engagement Programs	5,700	0	0.1	$500	$5,000	10.0 y
Recommended Systems Measures						
Relamp 2-Lamp, 2' Fluorescent Base Building Fixtures with LED Lamps	25,000	0	-1.2	$3,400	$20,000	5.9 y
Relamp Non-LED Washroom Fixtures with LED Lamps and Install Occupancy Sensors to Control Lighting	8,700	0	-0.4	$700	$3,300	4.7 y
Relamp 2-Lamp, 4' Fluorescent Mechanical Room and Fitness Centre Fixtures with LED Lamps and Install Occupancy Sensors to Control Lighting	1,700	0	0.0	$200	$1,300	6.5 y
Relamp 2-Lamp, 4', and 2' Fluorescent Elevator Lobby Fixtures with LED Lamps and Install Occupancy Sensors to Control 50% of Elevator Lobby Lighting	6,400	0	-0.3	$500	$2,500	5.0 y
AHU2 Upgrade/Replacement	4,900	0	0.1	$700	$10,000	14.3 y
Install Aerators on Washroom Sinks	0	210	0.0	$500	$500	1.0 y
Retrofit Urinals with Low-Flow Diaphragms	0	110	0.0	$300	$500	1.7 y
Install a Moisture-Based Irrigation Controller	0	210	0.0	$500	$4,000	8.0 y
Totals (all Sections)	***397,900***	***640***	***42.4***	***$27,800***	***$85,100***	***3.1 y***

Measures outlined in the previous sections (and table above) include the assessment of non-financial considerations, and there were none identified that are not explicitly discussed in the report. Changes in maintenance costs associated with any measure have been factored in where applicable when calculating simple payback, if not explicitly stated.

The operation/maintenance cost savings listed in the sections above are based on the difference between existing and proposed *annualized* 1-for-1 equipment replacement costs. The costs are annualized by considering the existing and proposed rated lifetime (in hours) and annual operating hours of the equipment.