RECOMISSIONING THE CITY OF NEW WESTMINSTER'S BUILDING AUTOMATION SYSTEMS

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Abstract

The purpose of this project was to research the many opportunities that building automation systems (BAS) can have toward reducing a building's GHG emissions and to conduct research on how to implement the recommissioning of the BAS in four City of New Westminster civic buildings; City Hall, The Police Building, The Library and Century House.

Annie Dahan, UBC Sustainability Scholar, 2020

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This project was conducted under the mentorship of The City of New Westminster staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of The City of New Westminster or the University of British Columbia.

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1. Introduction

The goal of this project is to learn about the many opportunities that building automated systems can have toward reducing a buildings GHG emissions and understanding how to implement them into the City of New Westminster's existing buildings.

This research project is part of the City of New Westminster's Long-Term Goal of working towards a zero-carbon future by implementing projects to achieve New Westminster's Seven Bold Steps in Response to the Climate Emergency. These build on New Westminster's Climate Emergency Declaration, and seek to achieve the City's Climate Emergency Goal, Objectives and Targets. The City is working towards reducing its carbon emissions by 45% by 2030 and becoming carbon neutral by 2050. To reach the 2030 goal, significant reductions must be made including a reduction of 322 tons of CO2e from existing buildings; 800 tons of CO2e from new buildings (which fully replace old facilities); and 709 tons of CO2e from the city's fleet.

This research is based off an ASHRAE level 1 audit of 14 city-owned buildings completed by SES Consulting in 2020. The audit outlines specific projects that can be undertaken to reduce the existing building portfolio's GHG emissions by 25% and provides a basic financial analysis for each of the projects. The report has identified that 10 of the buildings have excellent opportunities for Building Automated Systems (BAS) upgrades and recommissioning. The audit suggested that the city begin by implementing the Building Automation Systems (BAS) projects first, as these systems can help highlight where the most energy usage comes from, which can help explain the need for future retrofitting projects. The study also showed that the BAS projects offer large energy consumption reductions in quick payback periods (5-8 years). The City of New Westminster has decided to move forward with several BAS projects; this report documents the in-depth research completed on how to implement such projects, providing both general and building-specific information.

The following table summarizes the financial and environmental analysis of the 10 buildings that were recommended to recommission or install a BAS. The four chosen buildings are highlighted and the total estimated cost, annual savings, simple payback, and potential GHG reduction for these chosen buildings is shown (all calculations are taken from the "City of New Westminster - Benchmarking and Level 1 Studies" report written by SES Consulting, January 13, 2020, EDMS Doc# 1556828).

Building	Cost	Simple Payback	Annual Savings				Current Vendor	Building Size (ft2)
			$	GJ	kWh	GHG		
Queens Park Arena	$ 100,000	8.9	$ 11,200	380	96,700	20	-	81,200
City Hall	$ 50,000	5	$ 10,100	460	65,100	18.6	ESC - Delta Controls	54,000
Moody Park Arena	$ 53,000	7	$ 7,600	160	89,100	8.9	-	33,500
Century House	$ 16,000	4.2	$ 3,800	130	31,500	6.8	ESC - Delta Controls	28,100
Police Building	$ 26,000	5.9	$ 4,400	120	41,100	6.4	ESC - Delta Controls	52,740
Library	$ 25,000	5.7	$ 4,400	100	50,300	5.5	ESC - Delta Controls	44,000
Glenbrooke Fire Hall	$ 14,000	5	$ 2,800	100	21,200	5.2	Reliable Controls	14,500
Queensborough Community Centre	$ 14,000	8.2	$ 1,700	90	4,300	4.7	ESC - Delta Controls	27,900
Eng Ops Building	$ 36,000	8.6	$ 4,200	80	51,500	4.5	Reliable Controls	24,600
Electrical Ops Building	$ 15,000	11.5	$ 1,300	40	5,900	2.1	Reliable Controls	8,160
Total for the 4 chosen buildings	**$ 117,000**	**5.2**	**$ 22,700**	**810**	**188,000**	**37.3**	**?**	**178,840**

Figure 1: Costs and savings analysis of the implementation of BAS recommissioning projects done by SES Consulting

2. Overview of Building Automation Systems

A building automation system is a system that automates the controls settings of various building system components including HVAC, lighting and access control. The BAS provides a user interface that allows the end user to, view the system status, detect potential issues related to building system performance, and program the lights and building climate so that they are based on occupancy schedules.

2.1 Purpose

The objectives of a BAS are:

- *Reduction in energy consumption and operating costs* – programming occupancy schedules and building zones can ensure that a building's systems are only being used when required thus reducing the energy consumption and cost of utilities.
- *Improved life cycle of utilities* – monitoring performance and device failures and providing malfunction alarms to building maintenance staff allows for quicker reaction to faulty devices therefore elongating equipment lifetime.
- *Improved occupant comfort and safety* – Programing multiple occupancy zones and related schedules allows for greater occupant comfort; occupants often also have the option to override the system when it comes to lighting and HVAC in smaller rooms.

2.2 The technicalities of a BAS

A building automation system consists of four "layers"[1]:

- Input/Output/Controller Layer – the purpose of inputs (usually consisting of sensors, switches etc) is to provide data to the controller which then makes decisions that drive outputs (actuators, relays, valves, etc).
- Field Trunk Layer – the field trunk allows the controllers to communicate inputs and outputs to the supervisory device
- Supervisory Layer – the main purpose of the supervisory device is to act as a protocol gateway, by converting the serial information passed along by the field trunk into IP level communication.
- Server/Application Layer – the main purpose of the server is to consolidate all system data from multiple supervisory devices and get a single point of visualization for the end user. The server connects with the user interface and the user can login to program commands, alarms and view energy trends and graphics.

[1] Phil Zito, *The Ultimate Guide to Building Automation Systems* (2019) https://guides.smartbuildingsacademy.com/building-automation-system

2.2 BAS functionalities

A building automation system can have many functionalities. The Natural Resources Canada CanmetENERGY Recommissioning Guide as well as the U.S. Energy Star program recommend that building systems be recommissioned every 3-5 years, to stay up to date and continue to ensure optimal building functionality. The following list of measures was provided in the SES audit as important elements that must be updated frequently.[1]

- *Scheduling and Optimal Start* – Building systems are programmed to turn on and off depending on occupant schedules to limit unnecessary energy consumption during unoccupied periods. Optimal schedules are created to ensure occupant comfort during their entire duration in the building while minimizing system run times. Occupant override buttons can be installed for unscheduled afterhours use.

- *Zone level scheduling* – Zones are programmed in a building depending on varying occupancy demands, therefore different zones can have different runtime schedules. For example, if an office space is used until 7pm whereas the warehouse in the basement is used until 5pm, the different building sections can be programmed to have different start/stop times.

- *Night-Time Setback* – In cold climates, heating should not be turned off completely at night as it can take more energy to reheat the building the next morning then it would have to maintain some heating throughout the night. Therefor an optimal nighttime heating setpoint and start routine is programed to reduce unnecessary heat loss from overheating an empty building, while optimizing energy use and ensuring occupant comfort in the morning.

- *Demand controlled ventilation* – Installing CO2 sensors to monitor indoor air quality can reduce unnecessary heating and cooling by ensuring that fresh air is only supplied when necessary (when CO2 levels are high).

- *Reduce Minimum Damper Positions* – Ensure that the minimum outdoor air damper position setpoints are not set too high because they may be providing more outdoor air than required to meet minimum ventilation standards. Reducing minimum damper positions, in combination with real-time air quality monitoring, will reduce heating and cooling demand while ensuring adequate indoor air quality.

- *Occupancy Sensors for Zone Control* – Installing occupancy sensors in zones with intermittent occupancy can prevent unnecessary ventilation when spaces are empty.

- *Heating OAT Lockout* - Programming an outdoor air temperature lockout will disable non-critical heating systems during the warmer summer months when the demand for heating is low. Demand for heating is low when fresh air requirements are minimal and internal heating loads such as occupants, lighting and solar gain provide sufficient space heating at a given outdoor air temperature.

[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)

- *Cooling OAT Lockout* – Programming an outdoor air temperature lockout will disable non-critical cooling systems during the colder winter months when the demand for cooling is low.

- *Weather Predictor* – Programming a weather predictor to estimate the daily high temperature early in the morning and lock out the heating systems when the predicted high temperature will be warmer than 20°C (adjustable). This will prevent overheating in the morning which can then result increased cooling demands in the afternoon.

- *Domestic Hot Water (DHW) Pump Scheduling* – Scheduling DHW circulation pumps will reduce afterhours pumps circulation therefore reducing afterhours heat loss through the DHW supply lines.

- *Connect domestic hot water to building automation system (BAS)*

3. The current state of each of the buildings' BAS

It is recommended to continue with only the buildings we are ready to commit to recommission thus, it recommended to start with the following 4 buildings: City Hall, The Police Building, The Library, and Century House. These buildings were chosen because according to the Level 1 Audit they have the largest potential for greenhouse gas emission reductions. All these buildings are currently managed by ESC – Delta Controls and are on a server.

3.1 City Hall

Building	Cost	Simple Payback	Annual Savings				Building Size (ft2)
			$	GJ	kWh	GHG	
City Hall	$ 50,000	5	$ 10,100	460	65,100	18.6	54,000

Figure 2: City Hall data from the SES Level 1 Audit

City Hall was originally constructed in 1953, and its HVAC consists of a mixture of systems. The newer section of the building has various air volumes (VAV) allowing for greater efficiency in the HVAC systems, however the older section has constant air volumes (CAV). The building is ventilated by multiple air handling units (AHUs), of which heating water is provided by two natural gas boilers[1]:

- a rooftop unit (RTU1) with gas heating and direct expansion (DX) cooling that serves 12 VAVs which provide air to the east wing of the building on all three floors;
- a second rooftop unit, RTU-2 serves the HR Annex in the basement
- a multi-zone AHU with a heating water pre-heat coil and DX cooling provides air to the west half of the main floor and to the south and north wings of the upper floor

[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)

- AHU-1, equipped with heating water pre-heat and DX cooling provides air to the west wing 2nd floor offices
- AHU-3, equipped with heating water pre-heat and DX cooling provides air to the west part of the basement spaces

The building automation system is over 20 years old and has gone through various upgrades through the years. It has very rudimentary controls and just like the HVAC systems, is a mixture of many different types of equipment. There is a potential opportunity here to completely upgrade the BAS of City Hall depending on the City of New Westminster's budget as it would be a larger capital project with longer payback periods. The level 2 audit should include a comparison of the costs and environmental benefits of recommissioning the current system versus replacing it. Things to be considered while making this decision should also include how invasive and disruptive a full replacement would be.

The building has recently undergone a phased renovation which converted basement-level storage space into offices and reconfigured the existing office areas and public interfaces. This renovation provides an important opportunity to increase the delta zoning controls in the new office sections and improve the controls in the existing sections. Increasing the zoning would reduce energy consumption by ensuring that only occupied areas would receive conditioned air.[1]

According to the building's facilities maintenance operator, most of the current BAS devices are reliable, however the sensors should be checked and recalibrated if necessary. ESC runs maintenance semi-annually to ensure all equipment is running properly, however they do not check for calibration.

The ESC DDC Contract for City Hall includes 32 hours of client-directed on-site maintenance time semi-annually, that can be utilized to recommend DDC maintenance tasks if no directed tasks are identified. The contract also states that ESC will evaluate any new products and/or software may enhance or improve the current system.

The BAS currently has the following elements in place; however, it is recommended that they be investigated and recommissioned to maximize they're efficiency.

- ✓ Schedule and Optimal Start
- ✓ Zone level scheduling
- ✓ Night-Time Setback
- ✓ Demand controlled ventilation
- ✓ Cooling OAT Lockout
- ✓ Heating OAT Lockout

The BAS does not currently have the following elements in place; thus, they should be added during the recommissioning. Currently, only the exterior lights are connected to the BAS, during recommissioning all the lighting systems should be added to the BAS.

- ✓ Weather Predictor
- ✓ Connect domestic hot water to building automation system (BAS)
- ✓ Reduce Minimum Damper Positions
- ✓ Occupancy Sensors for Zone Control

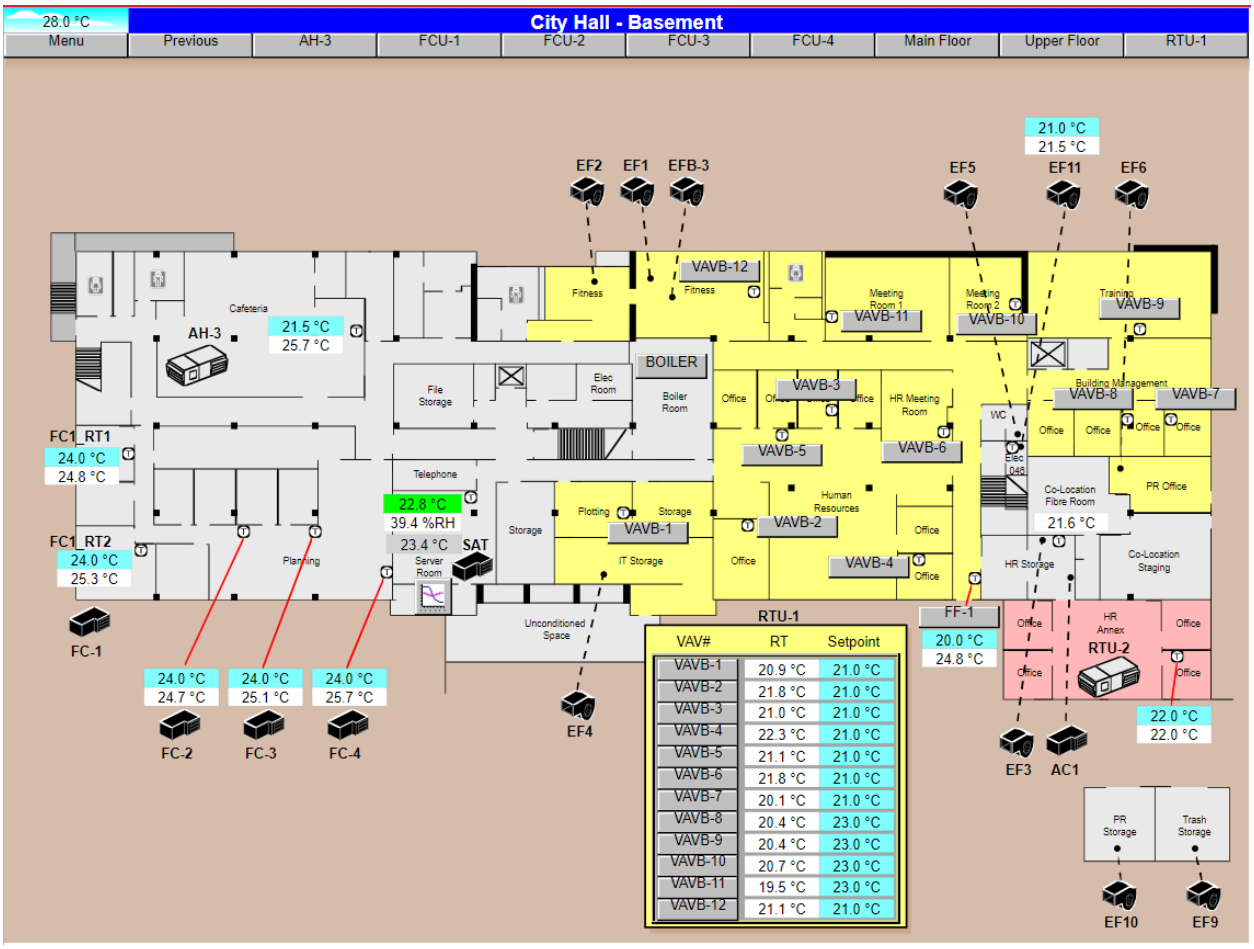
[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)

✓ Domestic Hot Water (DHW) Pump Scheduling

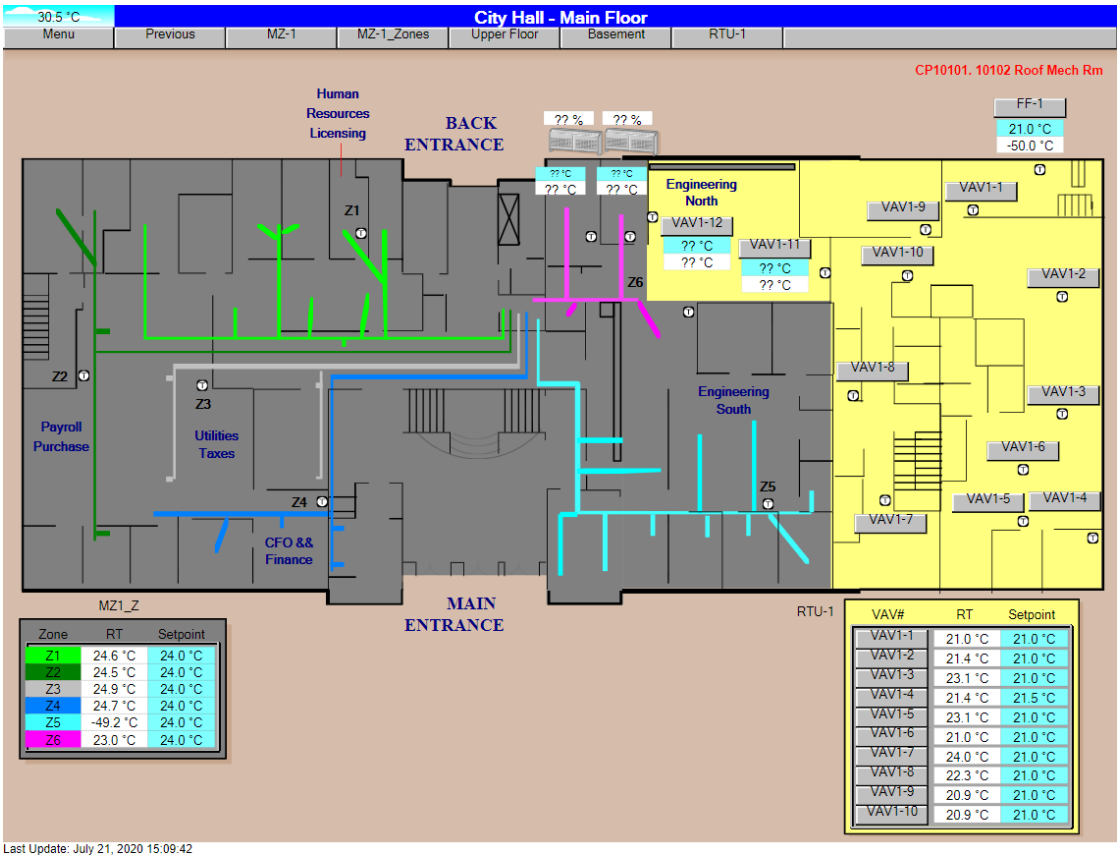
The savings analysis for City Hall done by SES Consulting in the Level 1 Audit assumes:

> *The planned renovations will upgrade BAS zone controls without optimizing for energy usage, opportunities exist to reduce HVAC schedules, add schedules for exhaust fans, and reduce the AHU outdoor air rates. It should be noted that the BAS zone control upgrade assumption significantly impacts project cost and energy reduction opportunity. It allows the BAS to take advantage of additional control capabilities while minimizing the amount of new BAS zone devices need to be installed as part of the measure.* [1]

The following are screenshots from the current BAS User Interface with ESC. All of the buildings are on the same user interface, which is very convenient and useful. As can be seen from the images, the user interface is quite outdated, and the support of this interface will most likely be discontinued.



[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)



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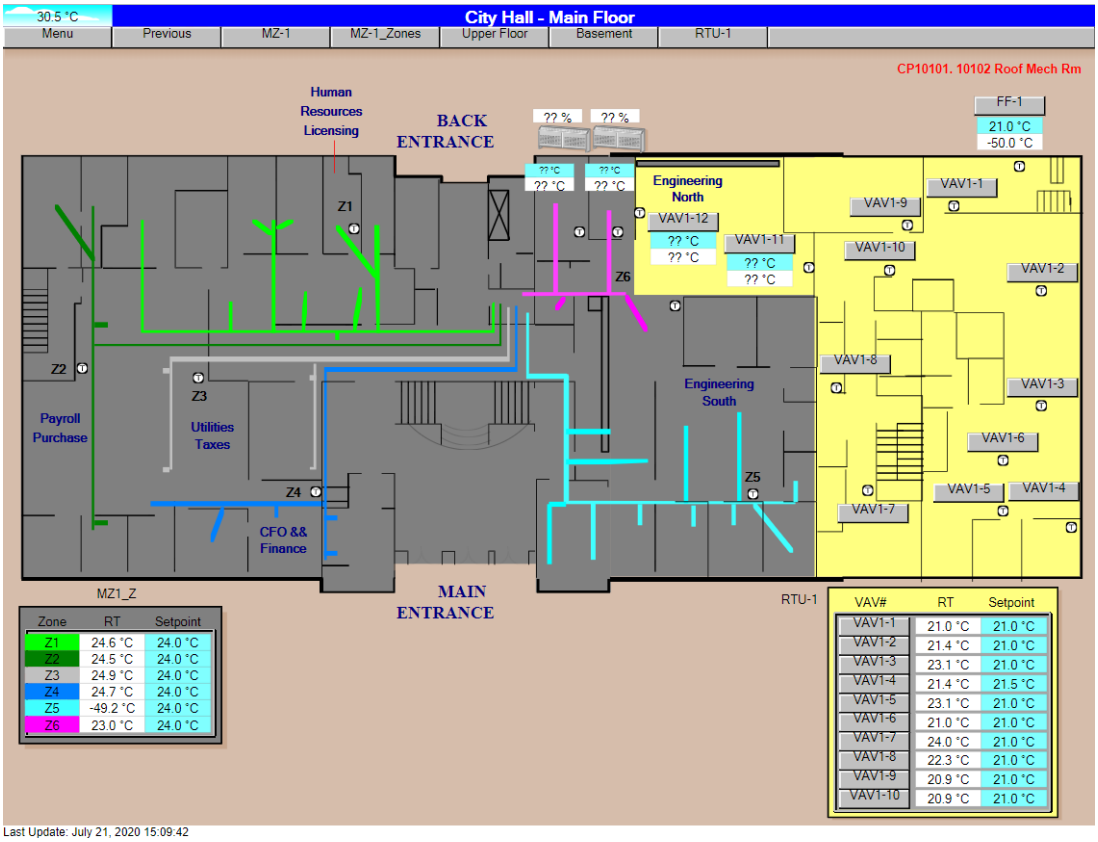

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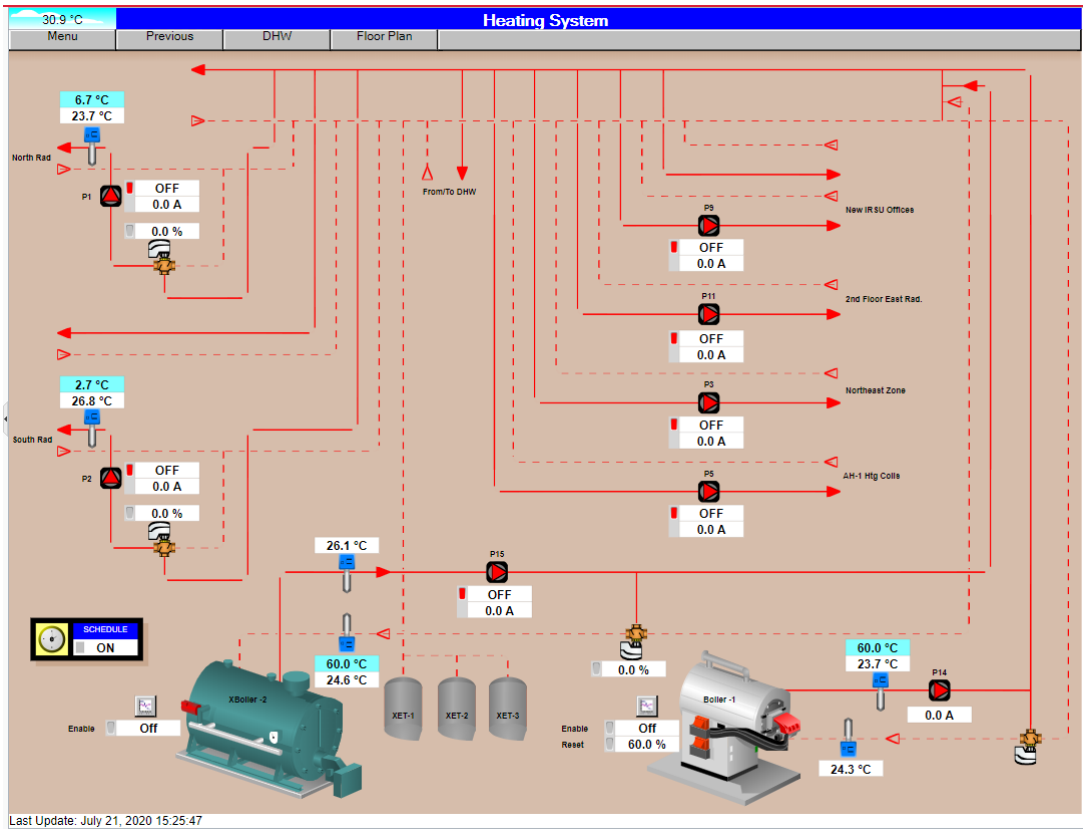
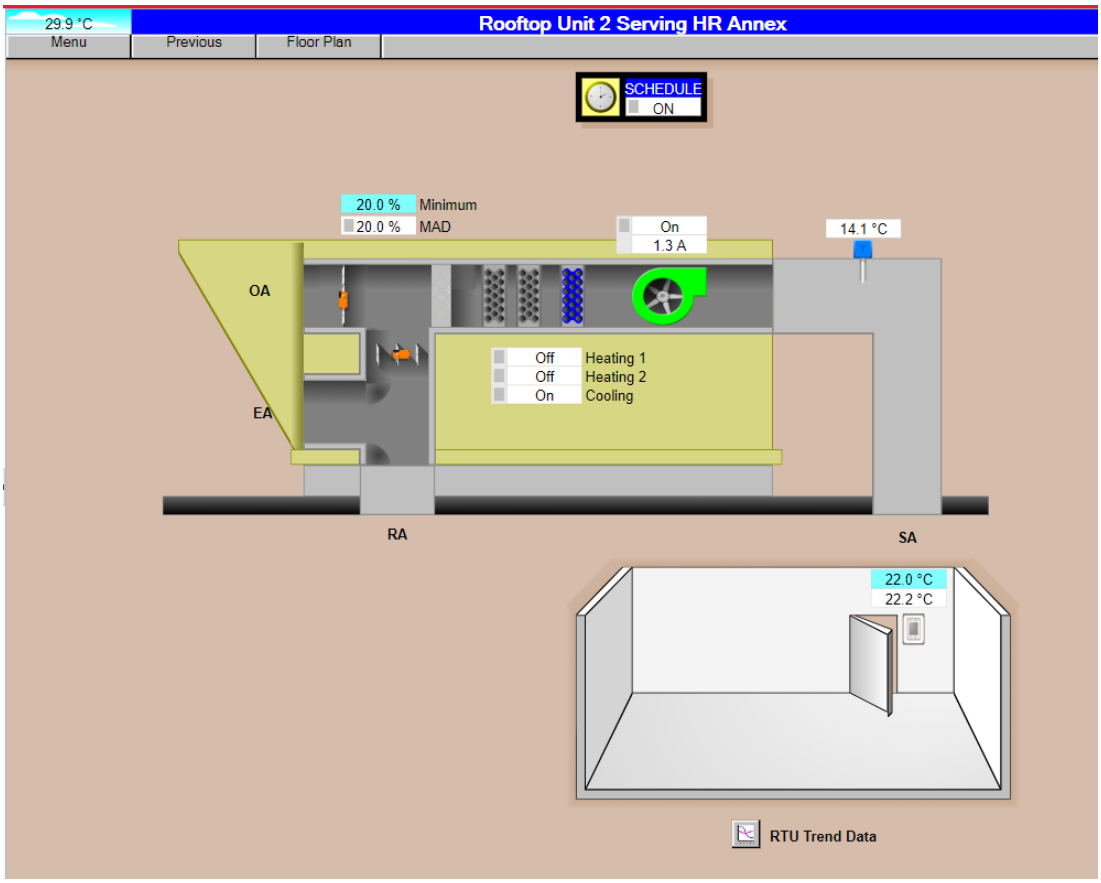
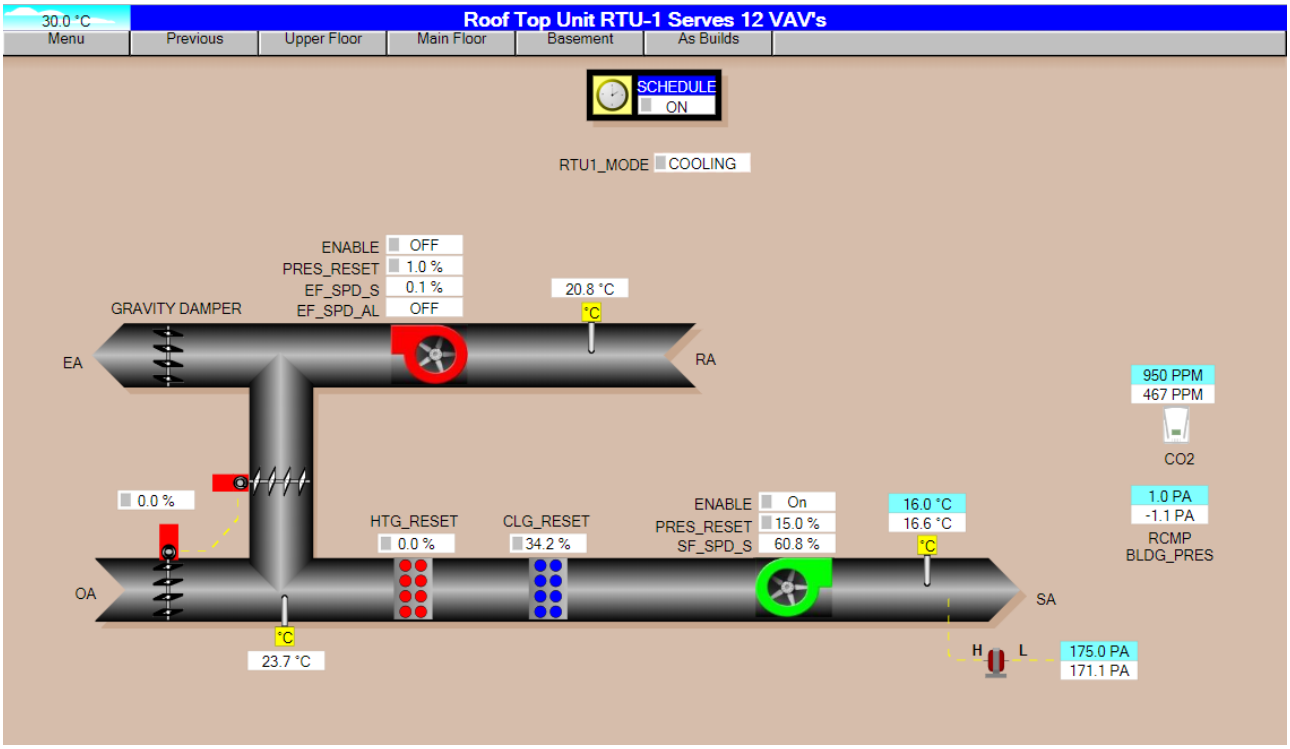
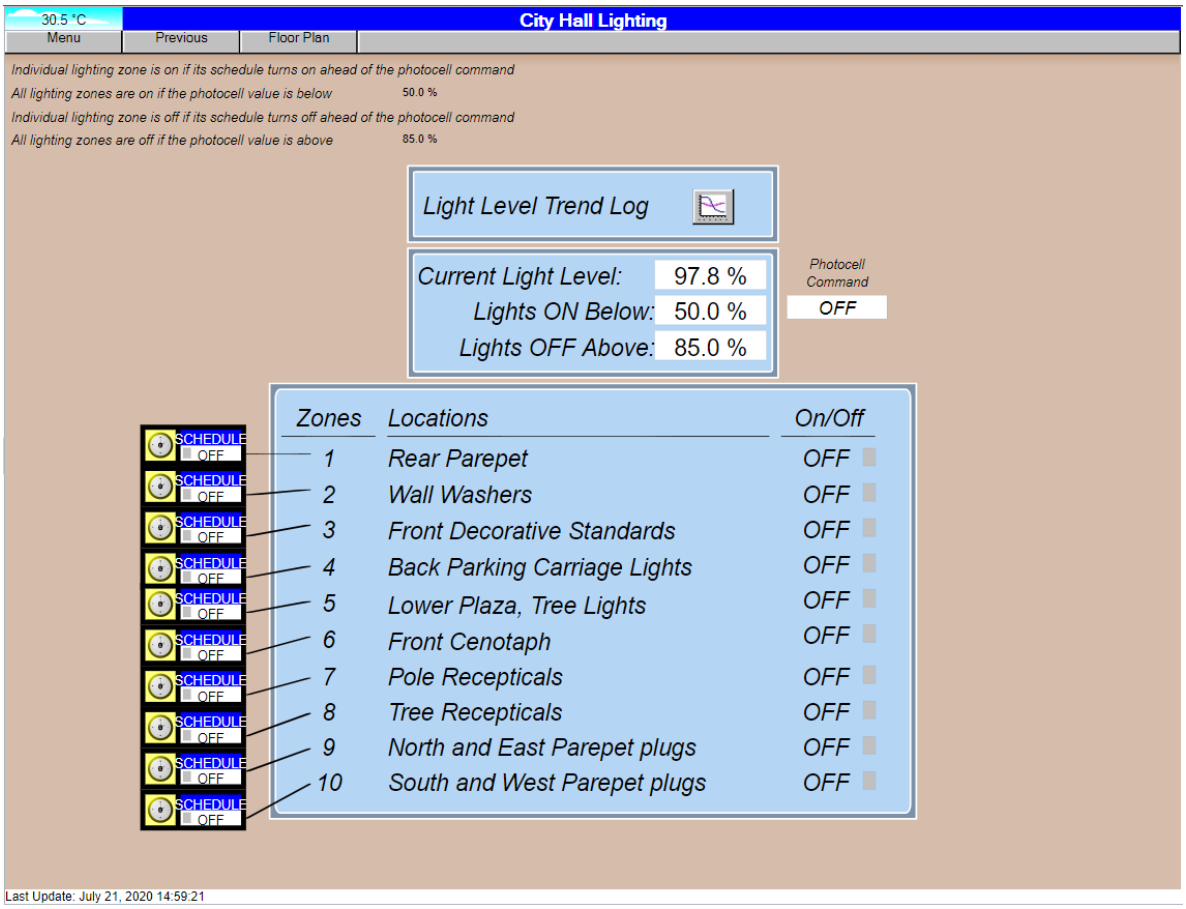

30.9 °C
Heating System
Menu
Previous
DHW
Floor Plan
6.7 °C
23.7 °C
North Rad
P1
OFF
0.0 A
0.0 %
From/To DHW
P9
New IR SU Offices
OFF
0.0 A
P11
2nd Floor East Rad.
OFF
0.0 A
2.7 °C
26.8 °C
South Rad
P3
Northeast Zone
OFF
0.0 A
P2
OFF
0.0 A
0.0 %
P5
AH-1 Htg Coils
OFF
0.0 A
26.1 °C
P15
OFF
0.0 A
SCHEDULE
ON
60.0 °C
24.6 °C
XBoiler -2
XET-1
XET-2
XET-3
Enable
Off
0.0 %
Boiler -1
Enable
Reset
Off
60.0 %
60.0 °C
23.7 °C
P14
0.0 A
24.3 °C
Last Update: July 21, 2020 15:25:47


29.9 °C
Rooftop Unit 2 Serving HR Annex
Menu
Previous
Floor Plan
SCHEDULE
ON
20.0 %
Minimum
20.0 %
MAD
On
1.3 A
14.1 °C
OA
EA
Off
Heating 1
Off
Heating 2
On
Cooling
RA
SA
22.0 °C
22.2 °C
RTU Trend Data


30.0 °C
Roof Top Unit RTU-1 Serves 12 VAV's
Menu
Previous
Upper Floor
Main Floor
Basement
As Builds
SCHEDULE
ON
RTU1_MODE
COOLING
ENABLE
OFF
PRES_RESET
1.0 %
EF_SPD_S
0.1 %
EF_SPD_AL
OFF
GRAVITY DAMPER
20.8 °C
°C
EA
RA
950 PPM
467 PPM
CO2
0.0 %
HTG_RESET
0.0 %
CLG_RESET
34.2 %
ENABLE
On
PRES_RESET
15.0 %
SF_SPD_S
60.8 %
16.0 °C
16.6 °C
°C
1.0 PA
-1.1 PA
RCMP
BLDG_PRES
OA
SA
°C
23.7 °C
H
L
175.0 PA
171.1 PA


30.5 °C
City Hall Lighting
Menu
Previous
Floor Plan
Individual lighting zone is on if its schedule turns on ahead of the photocell command
All lighting zones are on if the photocell value is below
50.0 %
Individual lighting zone is off if its schedule turns off ahead of the photocell command
All lighting zones are off if the photocell value is above
85.0 %
Light Level Trend Log
Current Light Level:
97.8 %
Lights ON Below:
50.0 %
Lights OFF Above:
85.0 %
Photocell Command
OFF
Zones
Locations
On/Off
1
Rear Parepet
OFF
2
Wall Washers
OFF
3
Front Decorative Standards
OFF
4
Back Parking Carriage Lights
OFF
5
Lower Plaza, Tree Lights
OFF
6
Front Cenotaph
OFF
7
Pole Recepticals
OFF
8
Tree Recepticals
OFF
9
North and East Parepet plugs
OFF
10
South and West Parepet plugs
OFF
SCHEDULE
OFF
Last Update: July 21, 2020 14:59:21

3.2 Police Building

Building	Cost	Simple Payback	Annual Savings				Building Size (ft2)
			$	GJ	kWh	GHG	
Police Building	$ 26,000	5.9	$ 4,400	120	41,100	6.4	52,740

Figure 3: Police Building data from the SES Level 1 Audit

The Police building is occupied 24 hours a day by its employees and is open to the public during regular business hours every day. It was originally built in 1939 and will be undergoing a replacement of half of its heat pumps in the upcoming year, which provides a great opportunity to recommission its BAS. The building is conditioned by 2 make up air units (MUA) and about 50 heat pumps.

> "MUA-1 serves most of the building and heats supply air with a HW coil. MUA-2 serves the cell block and heats supply air with a gas-fired heating section. There are 2 condensing boilers that provide HW to MUA-1 and the terminal heat pumps. The heat pump water loop is also connected to 2 cooling towers in order to meet cooling needs in the summer months. Domestic hot water (DHW) is supplied by 4 instantaneous water heaters connected to 2 storage tanks." [1]

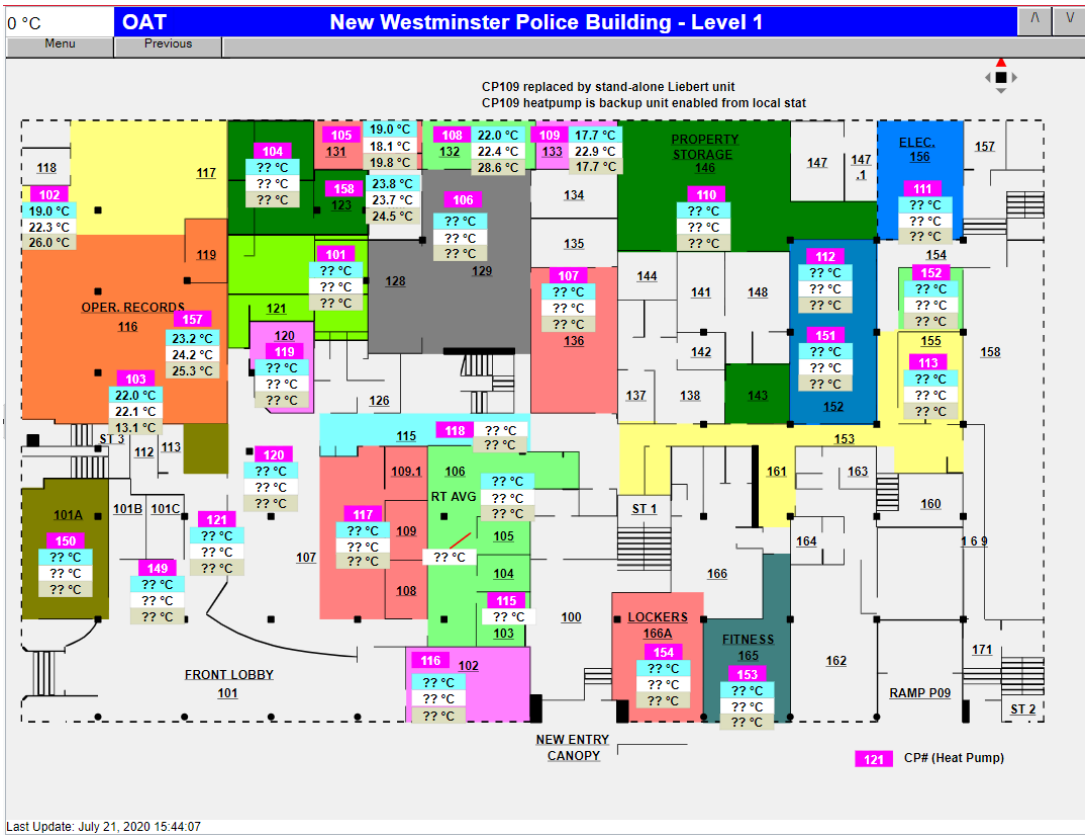
Management of the Police Building's BAS is also contracted out to ESC, the same service provider as at City Hall. The contract scope is similar for both systems.

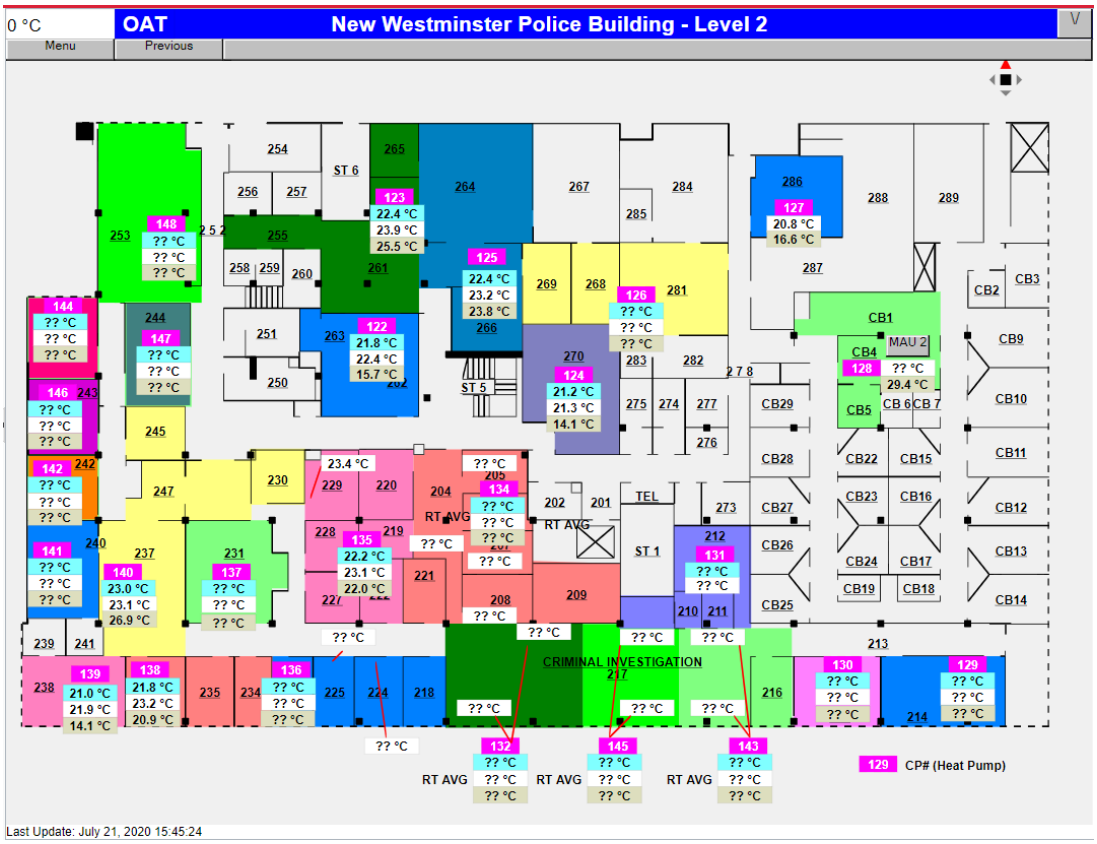
The savings analysis for the Police Building done by SES Consulting in the Level 1 Audit assumes:

> *Some areas of the building are occupied 24 hours per day; however, HVAC configuration has zone isolation ability, through variable air volume (VAV) boxes or zone isolation dampers, allowing for zone scheduling opportunities afterhours. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.*[1]

The following are screenshots from the current BAS User Interface with ESC. All of the heat pumps with question marks under them are the older heat pumps that do not support a BAS. These older heat pumps are the ones that are scheduled to be replaced shortly.

[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)


0 °C
OAT
New Westminster Police Building - Level 1
Menu
Previous
CP109 replaced by stand-alone Liebert unit
CP109 heatpump is backup unit enabled from local stat
PROPERTY STORAGE 146
ELEC. 156
OPER. RECORDS 116
FRONT LOBBY 101
LOCKERS 166A
FITNESS 165
RAMP P09
NEW ENTRY CANOPY
RT AVG
ST 1
ST 2
ST 3
121 CP# (Heat Pump)
Last Update: July 21, 2020 15:44:07


0 °C
OAT
New Westminster Police Building - Level 2
Menu
Previous
CRIMINAL INVESTIGATION 217
TEL
ST 1
ST 5
ST 6
RT AVG
129 CP# (Heat Pump)
Last Update: July 21, 2020 15:45:24

3.3 Library

Building	Cost	Simple Payback	Annual Savings				Building Size (ft2)
			$	GJ	kWh	GHG	
Library	$ 25,000	5.7	$ 4,400	100	50,300	5.5	44,000

Figure 4: Library data from the SES Level 1 Audit

The Library was constructed in 1958 and recently renovated in 2019, and it has a very comprehensive building automation system. The building is occupied during regular business hours Monday to Sunday by its employees and the public.[1] The library's HVAC consists of 11 RTUs each equipped with gas heating and DX cooling; 2 condensing boilers and an atmospheric back-up boiler to provide reheat to certain spaces; electric baseboards to reheat other spaces; and the domestic hot water (DHW) is supplied by a 175-litre electric water heater.[1] Most of the HVAC is controlled by the BAS and few new devices will need to be installed.

The savings analysis for the Library done by SES Consulting in the Level 1 Audit assumes:

> *There are opportunities to reduce HVAC schedules and the AHU outdoor air rates. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.*[1]

The ESC DDC Contract for the Library is double the costs of the others and is very thorough. It includes an analytics approach that analyses the data coming from the equipment and alerts ESC whenever something faulty occurs. This allows for quick servicing which saves the client money and energy because maintenance hours are spent more efficiently and only on the equipment that is alerted to be faulty, instead of checking everything. The analytics also report opportunities to re-sequence equipment or expand the control system to enhance the operation and functioning of the building control and mechanical systems.

The current BAS contract includes the following:

- Long term data storage
- Tracks all changes that are made
- Runs control system checks that identify deficiencies
- Tracks building performance over time
- Energy metering graphics showing energy consumption and demand management per day or per month.
- Calibrates sensors yearly
- Detailed reporting
- Fault detection and key performance indicators
- Diagnose issues and take recommended action
- Evaluate any new products and/or software that may enhance or improve the operation of your system.

However, this Kaizen user interface does not seem to be accessed by the facilities maintenance team, either from lack of awareness of these tools, or lack of training at the point of building handover from

[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)

the contractor. This gap in communication highlights the importance of user engagement when installing the BAS – without proper training and awareness, the BAS may not be used to its full potential.

There are some trends and graphics recorded on the ESC user interface, however only a select few systems per building have them. The following trend was recorded on July 21, 2020 when it was 28 C° outside. This trend shows the Supplied Air Temperature from the rooftop unit 1 ranging from 10 C° to 26 C° every hour. It seems like the system is over cooling and then shutting off repeatedly, which is an inefficient system that leads to an uncomfortable environment for the occupants. During the BAS recommissioning, systems should be checked for such behaviour and programed to prevent it from occurring by setting temperature range limits over certain time intervals.

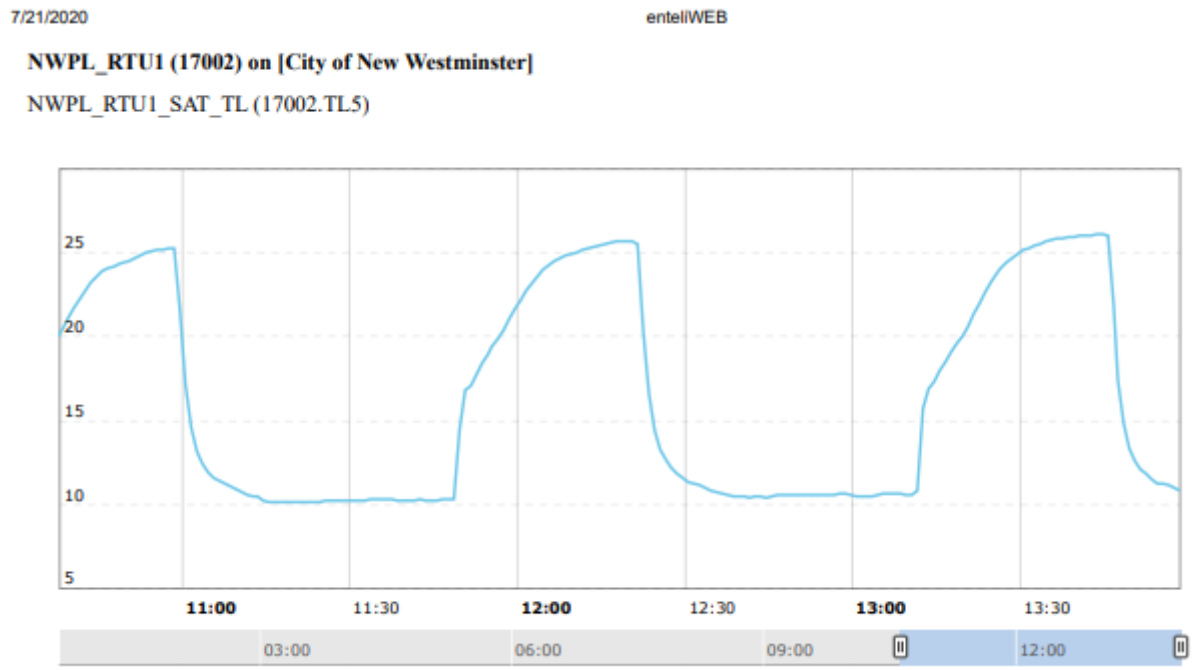
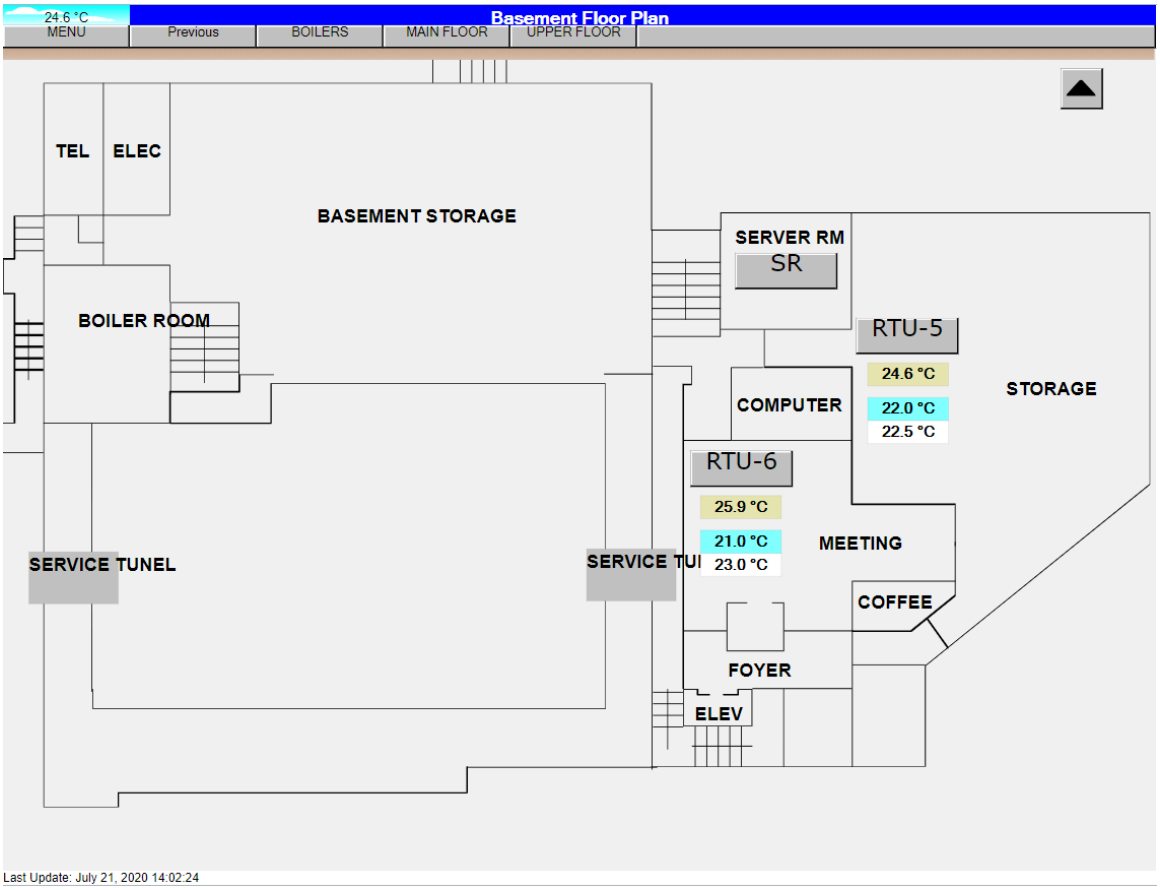
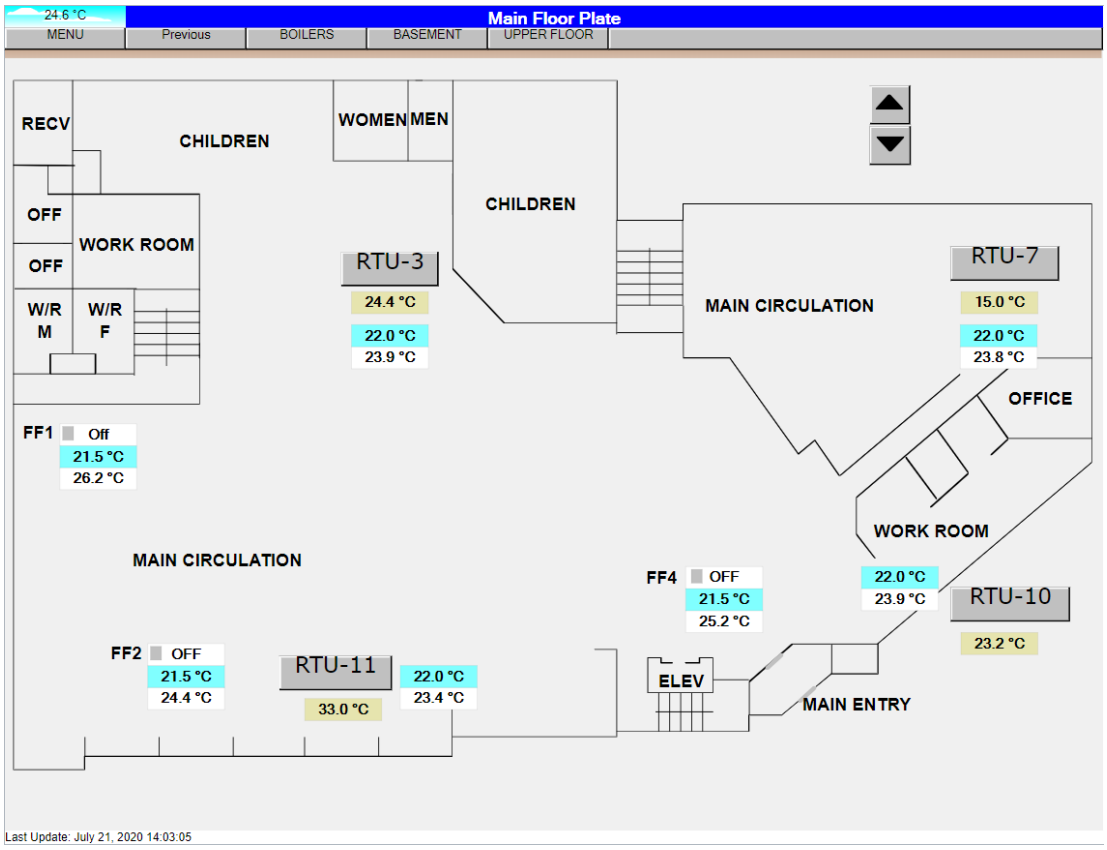


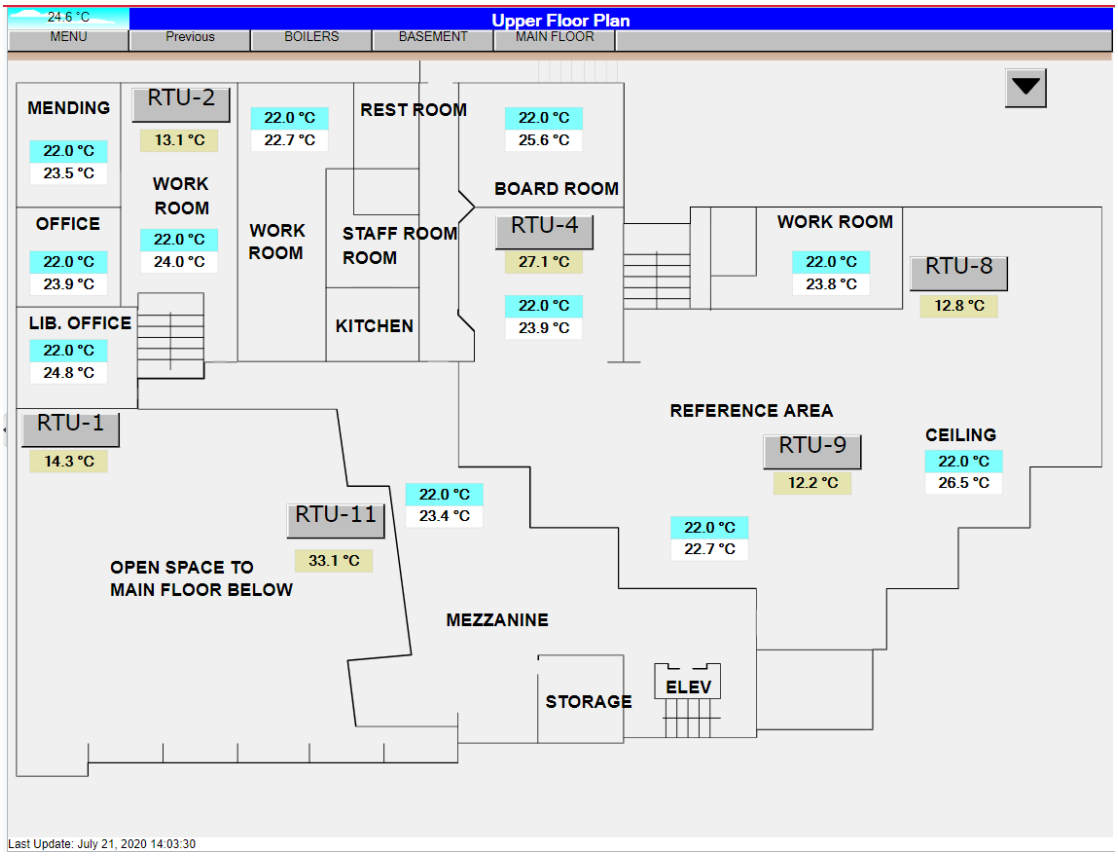
Figure 5: Library RTU-1 Supplied Air Temperature trend over 3.5 hour period.

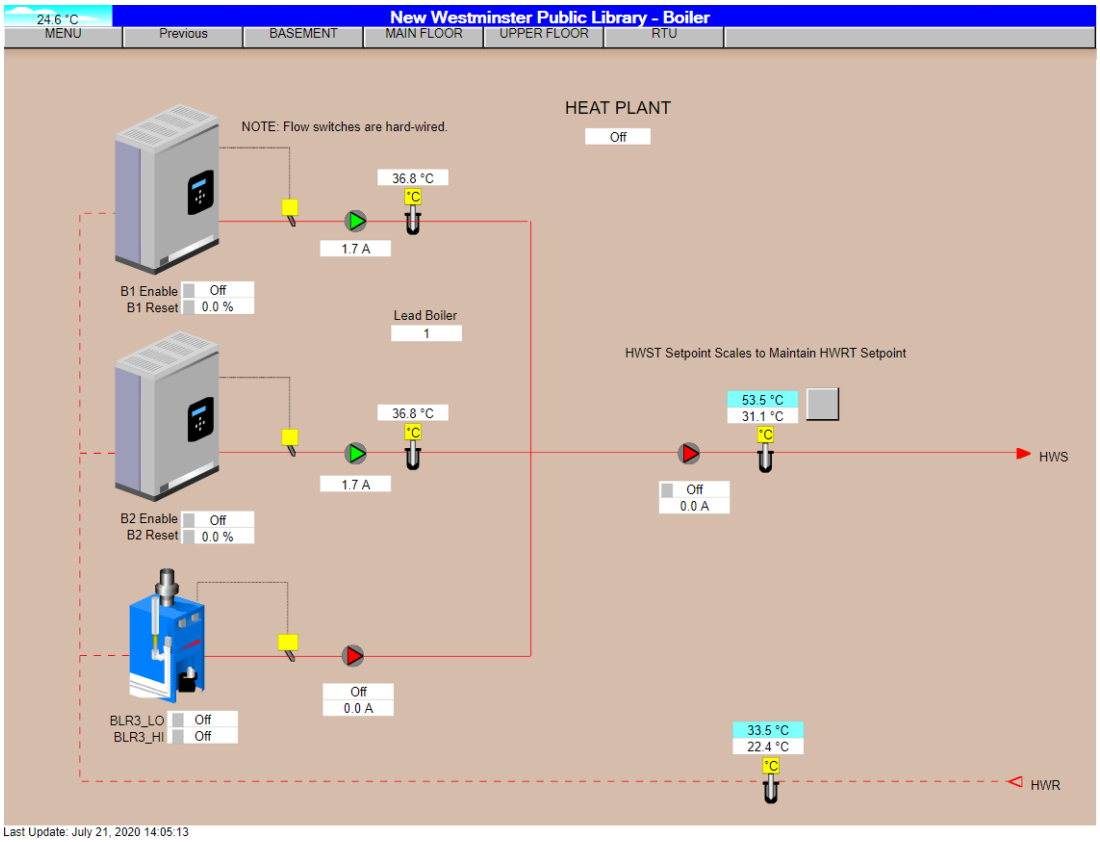
As the Library seems to have the most comprehensive BAS of the four facilities given its contract, it would be interesting to compare its Level 2 recommissioning report with the other three facilities.

The following are screenshots from the current BAS User Interface with ESC.




24.6 °C
Main Floor Plate
MENU
Previous
BOILERS
BASEMENT
UPPER FLOOR
RECV
CHILDREN
WOMEN
MEN
CHILDREN
OFF
WORK ROOM
OFF
W/R M
W/R F
RTU-3
24.4 °C
22.0 °C
23.9 °C
RTU-7
15.0 °C
22.0 °C
23.8 °C
MAIN CIRCULATION
OFFICE
FF1
Off
21.5 °C
26.2 °C
WORK ROOM
MAIN CIRCULATION
FF4
OFF
21.5 °C
25.2 °C
22.0 °C
23.9 °C
RTU-10
23.2 °C
FF2
OFF
21.5 °C
24.4 °C
RTU-11
33.0 °C
22.0 °C
23.4 °C
ELEV
MAIN ENTRY
Last Update: July 21, 2020 14:03:05


24.6 °C
Upper Floor Plan
MENU
Previous
BOILERS
BASEMENT
MAIN FLOOR
MENDING
22.0 °C
23.5 °C
RTU-2
13.1 °C
22.0 °C
22.7 °C
REST ROOM
22.0 °C
25.6 °C
WORK ROOM
22.0 °C
24.0 °C
BOARD ROOM
OFFICE
22.0 °C
23.9 °C
WORK ROOM
STAFF ROOM
ROOM
RTU-4
27.1 °C
22.0 °C
23.9 °C
WORK ROOM
22.0 °C
23.8 °C
RTU-8
12.8 °C
LIB. OFFICE
22.0 °C
24.8 °C
KITCHEN
REFERENCE AREA
RTU-1
14.3 °C
RTU-9
12.2 °C
CEILING
22.0 °C
26.5 °C
22.0 °C
23.4 °C
RTU-11
33.1 °C
22.0 °C
22.7 °C
OPEN SPACE TO
MAIN FLOOR BELOW
MEZZANINE
STORAGE
ELEV
Last Update: July 21, 2020 14:03:30



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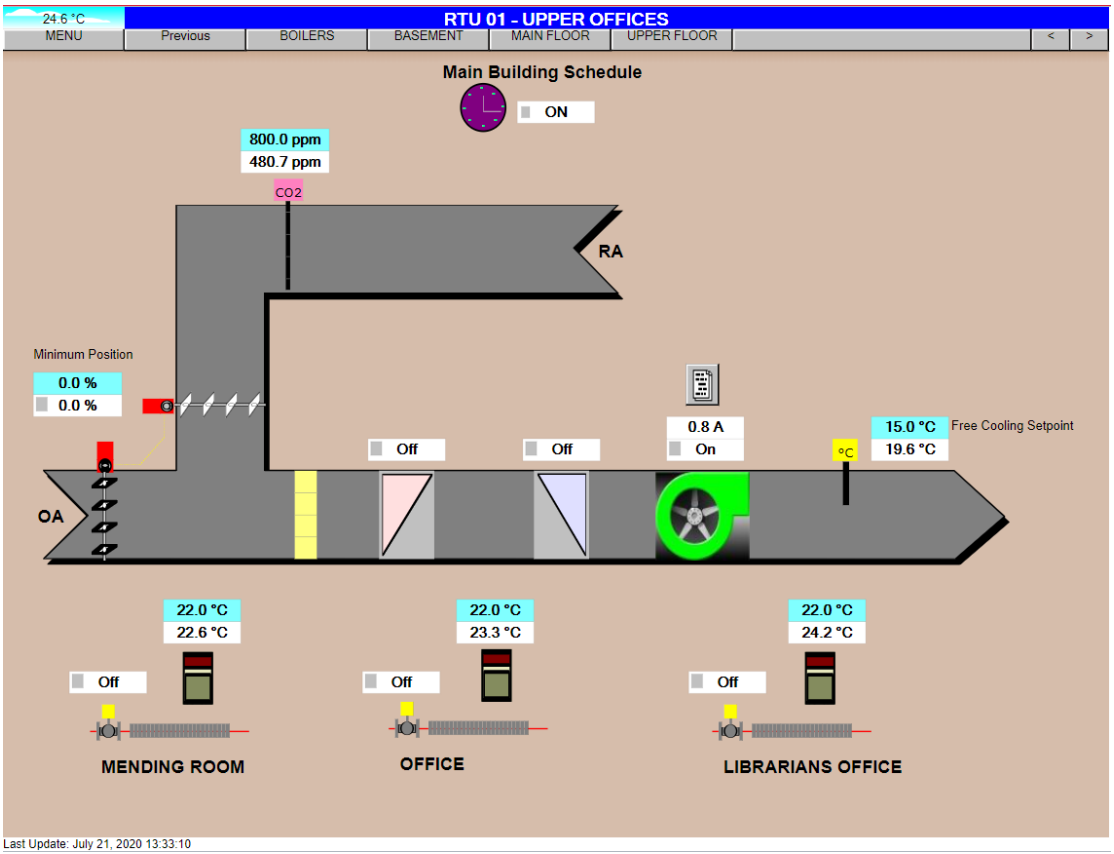

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3.4 Century House

Building	Cost	Simple Payback	Annual Savings				Building Size (ft2)
			$	GJ	kWh	GHG	
Century House	$ 16,000	4.2	$ 3,800	130	31,500	6.8	28,100

Figure 6: Century House data from the SES Level 1 Audit

The Century House was originally constructed in 1959 as a senior's center and the youth center was added in 2010. This facility offers a wide range of spaces from cafeteria settings to lounges and a gymnasium. It is occupied from 9am to 9pm on weekdays and has reduced hours on weekends.

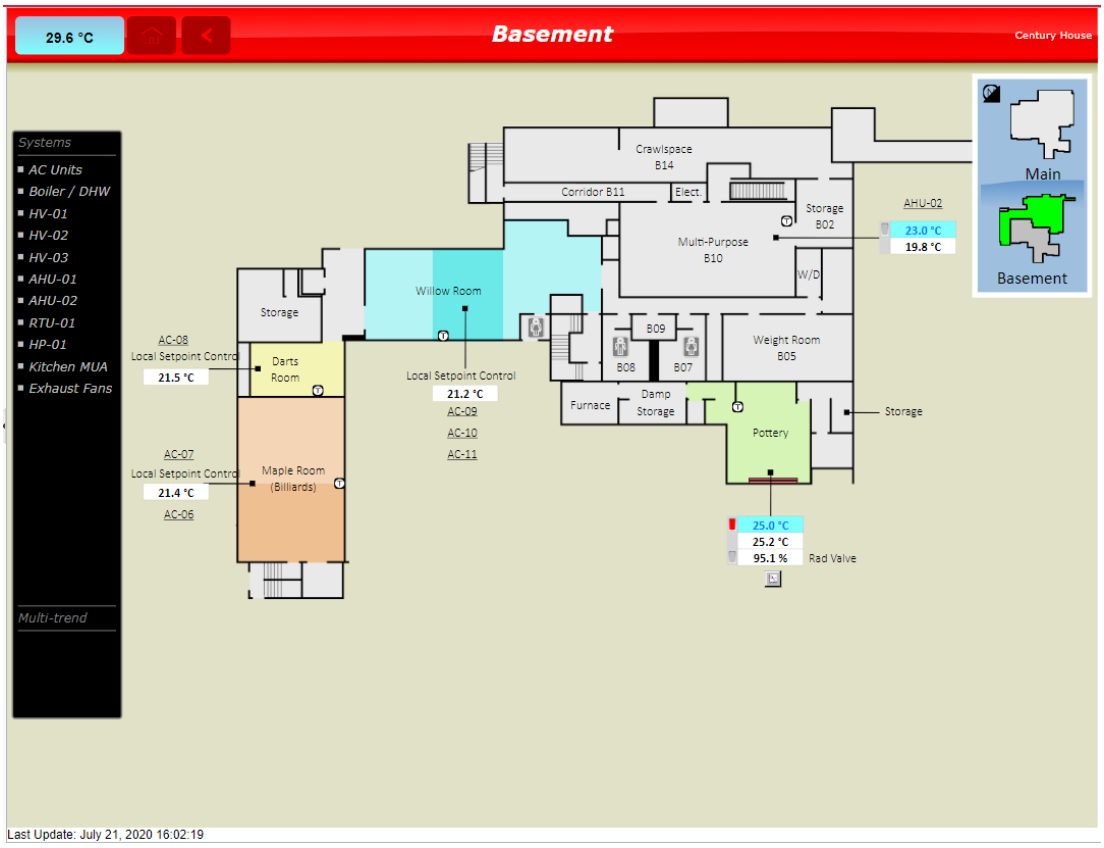
> The Century House is conditioned by an MUA, a heat pump (HP) and 3 rooftop units, HV-1, HV-2 and HV-3. The MUA provides gas heating and ventilation to the kitchen. HP-1 provides heating, cooling and ventilation to the Oak Room. The HV units provide DX cooling, gas heating and ventilation to the remaining areas of century house. The Youth Center is conditioned by 2 AHUs and a rooftop unit, RTU-1. The AHUs are equipped with a reversible heat pump ad electric duct heater. AHU-1 serves the Youth Offices while AHU-2 serves the multipurpose room. RTU-1 provides gas heating, DX cooling and ventilation to the Youth Centre Lounge. There are 2 condensing boilers that provide HW for space heating and DHW. An additional 2 gas water heaters in the custodian room provide additional DHW and an electric water heater supplies the kitchen with DHW. A majority of these systems are controlled by a Delta BAS.[1]

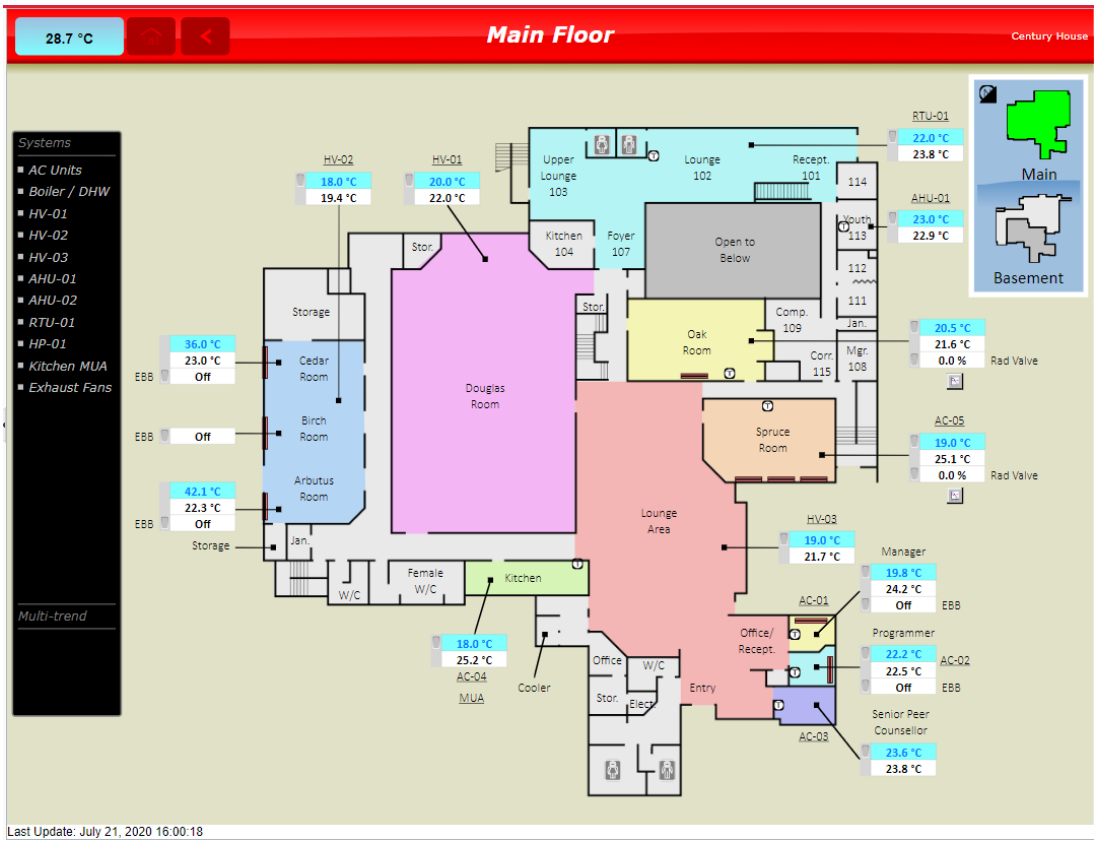
The savings analysis for the Century House done by SES Consulting in the Level 1 Audit assumes:

> *There are opportunities to reduce HVAC schedules and the AHU outdoor air rates. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.*[1]

The following are screenshots from the current BAS User Interface with ESC.

[1] SES Consulting, *City of New Westminster – Benchmarking and Level 1 Studies* (2020)


29.6 °C
Basement
Century House
Systems
AC Units
Boiler / DHW
HV-01
HV-02
HV-03
AHU-01
AHU-02
RTU-01
HP-01
Kitchen MUA
Exhaust Fans
Multi-trend
Crawlspace B14
Corridor B11
Elect.
Storage B02
Multi-Purpose B10
W/D
AHU-02
23.0 °C
19.8 °C
Main
Basement
Storage
Willow Room
B09
B08
B07
Weight Room B05
AC-08
Local Setpoint Control
21.5 °C
Darts Room
Local Setpoint Control
21.2 °C
AC-09
AC-10
AC-11
Furnace
Damp Storage
Pottery
Storage
AC-07
Local Setpoint Control
21.4 °C
AC-06
Maple Room (Billiards)
25.0 °C
25.2 °C
95.1 %
Rad Valve
Last Update: July 21, 2020 16:02:19


28.7 °C
Main Floor
Century House
Systems
AC Units
Boiler / DHW
HV-01
HV-02
HV-03
AHU-01
AHU-02
RTU-01
HP-01
Kitchen MUA
Exhaust Fans
Multi-trend
HV-02
18.0 °C
19.4 °C
HV-01
20.0 °C
22.0 °C
Upper Lounge 103
Lounge 102
Recept. 101
RTU-01
22.0 °C
23.8 °C
AHU-01
23.0 °C
22.9 °C
Main
Basement
Kitchen 104
Foyer 107
Open to Below
Youth 113
114
112
111
Stor.
Storage
Oak Room
Comp. 109
Jan.
Corr. 115
Mgr. 108
20.5 °C
21.6 °C
0.0 %
Rad Valve
Douglas Room
Spruce Room
AC-05
19.0 °C
25.1 °C
0.0 %
Rad Valve
36.0 °C
23.0 °C
Off
EBB
Cedar Room
Birch Room
Off
EBB
42.1 °C
22.3 °C
Off
EBB
Arbutus Room
Storage
Jan.
Lounge Area
HV-03
19.0 °C
21.7 °C
Manager
19.8 °C
24.2 °C
Off
EBB
W/C
Female W/C
Kitchen
AC-01
Office/ Recept.
Programmer
22.2 °C
22.5 °C
Off
AC-02
EBB
18.0 °C
25.2 °C
AC-04
MUA
Cooler
Office
W/C
Stor.
Elect.
Entry
Senior Peer Counsellor
23.6 °C
23.8 °C
AC-03
Last Update: July 21, 2020 16:00:18

4. How to go about BAS recommissioning

A Level 1 ASHRAE audit has already been completed for the targeted buildings. The next step would include performing a level 2 audit for the BAS specifically.

Type of Audit	Audit Description
Level 1 – Walk-through (Building Scale)	• Brief on-site survey of the building • Savings and cost analysis of low-cost/no-cost Energy Conservation Measures (ECM) • Identification of potential capital improvements meriting further consideration • Corrective measures are briefly described • Quick estimates of implementation costs, potential operating cost savings, and simple payback periods are provided • Adequate to prioritize energy efficiency projects and to assess the need for a more detailed audit • Not sufficient for reaching a final decision on implementing proposed measures
Level 2 – Energy Survey and Analysis (Systems Scale)	• More detailed building survey focused on one system/part of the building • Breakdown of energy usage – utility bills are collected for a 24 to 36-month period to allow the auditor to evaluate the facility's energy/demand rate structures and energy usage profiles. • Detailed financial analysis is performed for each measure based on implementation cost estimates, site-specific operating cost savings, and the customer's investment criteria • Sufficient detail is provided to justify project implementation
Level 3 – Detailed Survey and Analysis (Capital-Intensive Project Scale)	• Attention to Capital-intensive projects identified during the Level 2 audit • More detailed field analysis • More rigorous field analysis • Cost and savings calculations with high level of confidence required for major capital investment decisions

Figure 7: Overview of the three levels of ASHRAE auditing.

Step 1: Hire a consultant to do an ASHRAE Level 2 study of the Building Automation Systems for the 4 chosen buildings and write out specifications, to then be handed over to the vendor for implementation. This step has the potential to be fully funded by the BC Hydro & Fortis BC Continuous Optimization Program (*See section 5.1 BC Hydro & Fortis BC – Continuous Optimization Program*).

What kinds of services would be provided in this Level 2 audit?

- ✓ Kick off meeting with CNW to identify priorities
- ✓ Support the CNW with the filling out of the funding application for the BC Hydro Continuous Optimization Program
- ✓ Review of Level 1 audits done by SES
- ✓ On site walk through of each facility with focus on the BAS
- ✓ In depth audit of existing control systems
- ✓ Real time systems specific data collection
- ✓ Analysis of utility bills from a 24 to 36-month period to evaluate the facility's energy/demand rate structures and energy usage profiles
- ✓ Perform detailed financial analysis for each energy reduction measure based on implementation cost estimates, and site-specific operating cost savings – usually between 10/20 measures are identified per building
- ✓ Evaluate the estimated potential GHG reductions for each recommissioning measure
- ✓ Write detailed specifications of all the smaller scale projects with paybacks of under 2 years to give to the vendor for implementation
- ✓ Explore larger capital opportunities; if more expensive opportunities are discovered than these will require a separate implementation funding request to perform the Level 3 audit and write out the detailed specifications. Level 3 audits are not funded by the Continuous Optimization program, however there is a potential for these larger scale projects to be funded by other programs (*See section 5. Funding Opportunities and see section 6.1 Case Study 1 – Kitsilano Community Center for an example*).

How long would the Level 2 audit take?

Ideally, the consultant would want to see a seasonal operation of each facility, in order to observe how the systems function during the summer and winter. Therefore, it should take about 6 months total as they can work on multiple buildings at once. If there is a rush, it is possible to do it in a shorter time frame, however the recommissioning would not be as thorough without an understanding of a seasonal operation.

See Appendix 1 for a draft RFP for the hiring of a consultant to complete a Level 2 Audit of the chosen facilities.

Step 2: Hire a Vendor to implement the specifications written by the consultant. All the work would be done according to the specifications.

The City of New Westminster's purchasing policy states that if the work to be done by the vendor will cost less than $15,000 then the City can choose the vendor directly without going through a tendering

process. Currently the City of New West's building operations manager is very content with ESC's work to date. See Appendix 2 for a list of questions to be included in the RFP/RFQ for the Vendor, if necessary.

5. Funding opportunities

5.1 BC Hydro & Fortis BC's Continuous Optimization Program - Real Time Energy Management

This program supports building control/retro commissioning opportunities and is centered on "existing" building controls systems to achieve energy efficiency (ie kwh reduction). This option is to fund the Level 2 study of how the building automated system can be updated by reprogramming it, including the specifications. It will not fund the implementation done by the vendor nor the purchase of new equipment and devices.

The funding is $0.15/sq ft which has typically been enough to fully cover the cost of the Level 2 Audit provided by the consultant.

The eligibility criteria are as follows:

- ✓ You must be a large, Tier 1 commercial customer with an Energy Manager.
- ✓ You must be an owner or long-term leaseholder of an existing large commercial or institutional building or a facility with a total indoor floor area of at least 50,000 square feet.
- ✓ You must have an existing Direct Digital Control (DDC) building automation system with remote access.
- ✓ You must not be planning any major renovations to the building or upgrades to its HVAC equipment within the next 12 months.
- ✓ This program is only open to new participants. Participants from continuous optimization programs from the past five years are not eligible.
- ✓ You must be prepared to provide on-site support and have the financial resources to implement the recommended cost-effective measures.

The consultant/contractor chosen to complete the retrofits should be an approved member of BC Hydro's Alliance of Energy Professionals, if they are not, the consultant may contact BC Hydro for assistance with gaining membership. After review and consent from BC Hydro, the application may continue moving forward while membership application is being completed.

Both SES Consulting and Prism Engineering Consultants are familiar with this funding program and would be willing to help with the funding application if hired. The City of New Westminster's BC Hydro Key Account manager is Rick Truong.

BC Hydro usually opens for funding applications in January.

https://www.bchydro.com/powersmart/business/programs/continuous-optimization.html

5.2 Custom Project Implementation Funding – BC Hydro

Custom Project Implementation funding is available to commercial, government and institutional Key Account customers with a BC Hydro-funded Energy Manager. The funding is designed to help reduce the capital cost of implementing electrical energy efficiency projects. Project Implementation allows customers to meet internal hurdle rates, such as payback periods and return on investment. Through the program, you could receive funding for up to 75% of the incremental cost of lighting projects.

The minimum threshold is an annual energy savings (estimate) of 50,000 kwh/year electrical savings. If the City of New Westminster is exploring the possibility of a BC Hydro funded Energy Manager, then this funding would be accessible through this framework.

This funding could apply for new or upgrading existing Building Automation Systems; it would fund the purchase of new equipment and devices that are needed to upgrade or install the BAS.

5.3 Federation of Canadian Municipalities, Green Municipal Fund

The Green Municipal Fund funds three types of projects:

- **Studies**: Assess whether your initiative is technically and financially feasible, as well as its potential environmental, social and economic impact.
- **Pilot projects:** Evaluate a small-scale version of your initiative in real-life conditions, or a full-scale, replicable version.
- **Capital Projects**: Install a full-scale version of your project (usually done after you've conducted a pilot project).

Relevant Funding Opportunities:

1. Study: Retrofit of municipal facilities - https://fcm.ca/en/funding/gmf/study-retrofit-municipal-facilities
    a. Must improve energy efficiency by at least 30% in municipal facilities
    b. Grant: Up to 50% of eligible costs to a maximum of $175,000
    c. This funding would be applicable for the Level 2 Audit done by the consultant. It is recommended to apply for the BC Hydro Continuous Optimization Funding for this step instead as they cover most, if not all of the costs of the study.

2. Pilot project: Retrofit of municipal facilities - https://fcm.ca/en/funding/gmf/pilot-project-retrofit-municipal-facilities
    a. Must improve energy efficiency by at least 30% in municipal facilities
    b. Grant: Up to $500,000 to cover up to 50% of eligible costs

3. Capital project: Retrofit of municipal facilities - https://fcm.ca/en/funding/capital-project-retrofit-municipal-facilities
    a. Must improve energy efficiency by at least 30% in municipal facilities
    b. Regular loans and grants: Receive a low-interest loan of up to $5 million and a grant worth up to 15% of the loan; cover up to 80% of your eligible costs.

c. High-ranking project loans and grants: These qualify for a low-interest loan of up to $10 million and a grant worth up to 15% of the loan; cover up to 80% of your eligible costs.

How to apply:

- Prerequisites and required supporting documents
  - ✓ A municipal plan such as a sustainable community plan
  - Evidence of consultation with your provincial or territorial government
  - A letter from the municipal government or municipally owned corporation confirming the amount of its cash contributions to the initiative. The cash contribution must be at least 10 per cent of the eligible costs.
  - A letter from each confirmed funding source identified in the Sources of Funding table. The letter must indicate the amount of cash and/or in-kind contributions to the initiative.
- Complete a project workbook (Excel spreadsheet)
  - The workbook lists all the eligible and ineligible costs
  - Must fill out a project budget
  - Must fill out all the sources of funding
- Confirmation that other funding sources are being secured
- Fill out application form – questions about the projects and expected outcomes
- FCM commits to informing applicants of results within 4-5 months of receiving completed application

5.4 BC & NRCAN - ISO 50001 Energy Management Systems Standard

Funds are available to cover 75% of total costs up to $80,000 for

- Development of an energy baseline
- Energy use assessment
- Energy performance monitoring and reporting
- Professional and technical service fees
- Professional training
- Salaries of internal employees for work related to the implementation of energy management projects
- Purchase of instrumentation, software and metering equipment (*Instrumentation, software and metering equipment funding is capped at 25% of costs up to $40,000.)*

To be eligible for NRCan's financial assistance for ISO 50001 implementation projects, institutional buildings must be registered with the ENERGY STAR® Portfolio Manager benchmarking tool.

More information about this program can be found at:
https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-industry/energy-management-industry/iso-50001-energy-management-systems-standard/20405

6. Literature Review on BAS

6.1 Case Study 1 – Kitsilano Community Center

The Kitsilano Community Center building had two overlapping HVAC systems making it very inefficient. The consultant, Prism Engineering, decided to integrate the entire HVAC into one large connected system; which entailed recovering heat from the ice rink to heat up the rest of the building. The project reduced the community center's GHG emissions by 82%.[1]

Two things to be learned from this project:

- "The greatest challenge in projects with a similar configuration is in the control integration between the equipment's manufacturer internal control and the central building automated system. Detailed specifications and coordination of the control systems integration, including specific settings integrated controllers, was the key to properly commissioning the system and achieving the expected performance." – Prism Engineering
- While performing a Level 2 study of the quick payback projects the consultant identified this higher capital heat recovery project that led to much larger reductions in greenhouse gas reductions. This heat recovery project required a request for a custom project implementation funding for the level 3 study, and it was granted.

6.2 The relationship between the BAS and the occupant

The most important issue affecting the misuse of energy efficiency in public buildings is the users' behaviour, which generally wastes resources carelessly (leaving lights, computers and monitors running all night, making needless use of elevators, etc.) largely because they don't pay the energy bill.[2] Building Automation Systems are an obvious solution to some of these issues because as building systems become automated, they leave little room for occupant mishaps. However, research has shown that the energy reduction results after implementing a BAS are often lower than expected, because these intelligent systems don't usually consider the occupants' behaviour and their preferences.[2]

All occupants are different and have different comfort requirements, making it difficult to program for maximum energy efficiency while maintaining maximum occupant comfort. Occupants will often override the systems to be more comfortable, as they do not see the energy bills and are not properly educated on the importance and goals of the systems at play.

When properly informed however, research shows that occupants will willingly sacrifice some comfort to reduce energy consumption. There is also a large opportunity for occupants to help reduce energy usage without sacrificing comfort by unplugging electric appliances and ensuring all computers are turned off before leaving for the night. Gamification has been widely recognized as a potential solution

[1] Prism Engineering, *Kitsilano Community Center Case Study* (2020)
[2] Óscar García et al. *Energy Efficiency in Public Buildings through Context-Aware Social Computing* (2017)

to bridging the communication gap between system designers and end users, by educating the user about the decisions the control system makes.[1]

> "Serious games have great potential because they are designed to attractively educate and promote changes in the behaviour of its participants. Users enjoy, have fun and interact among them while gaining awareness of the problem to be solved. Offering tangible incentives enables more effective learning of the habits sought. Furthermore, the development of these games over extended periods of time can reinforce the objectives achieved, so that users acquire behavioural changes gradually and transparently over time."[2]

Several serious games of this sort have been developed; however it does not seem like any have been satisfactory enough to grow exponentially yet. Garcia identified the following games in 2017[2]:

- IBM CityOne Game, which proposes real problems related to the environment and energy saving that users must solve;
- EnergyLife, which provides awareness of the consumption of electrical devices through sensor networks and awards users with points if this awareness improves with time;
- Power Explorer, which also works with data from sensors to raise young people's awareness with regards to energy consumption;
- Energy Chickens, where the health of a virtual chicken is reflected by the user's energy savings when using some selected devices

Ideally, there would be an application on the occupant's smartphones or computers that had three major functions. Firstly, the app would show in real time how much energy is currently being used by each aspect of the room they are currently in (lighting, HVAC, electrical outlets, etc.). Second, the app would give this energy use an understandable comparison for the average person. For example: "you are currently using x% more/less energy than yesterday", or "if every office building in New Westminster consumed the same amount of energy per square foot as this one today, the City would be reducing X% of GHG emissions". Third, the app would reward the users points whenever they would use less energy than the average for that day (the average energy consumption on a cold day would be different than that of a warm day). These points could then be used to buy coffee, drinks or snacks in the building. These three functionalities have been outlined in Rist's research as being the most effective in promoting sustainable energy consumption behaviour.[3]

Charged is a Greek application that covers all three functionalities and is currently in its pilot project phase. It is being piloted at the EcoUrbanBuilding (ICAEN headquarters) in Barcelona; the National Art History Musuem in Luxembourg; and the General Secretariat of the Municipality of Athens (DAEM headquarters). "The design of the game follows a cleanweb approach and implements a novel social innovation process that is designed based on human inceptives factors and helps users to understand the environmental implications of their actions and adopt a greener, more active and responsible behaviour."[4]

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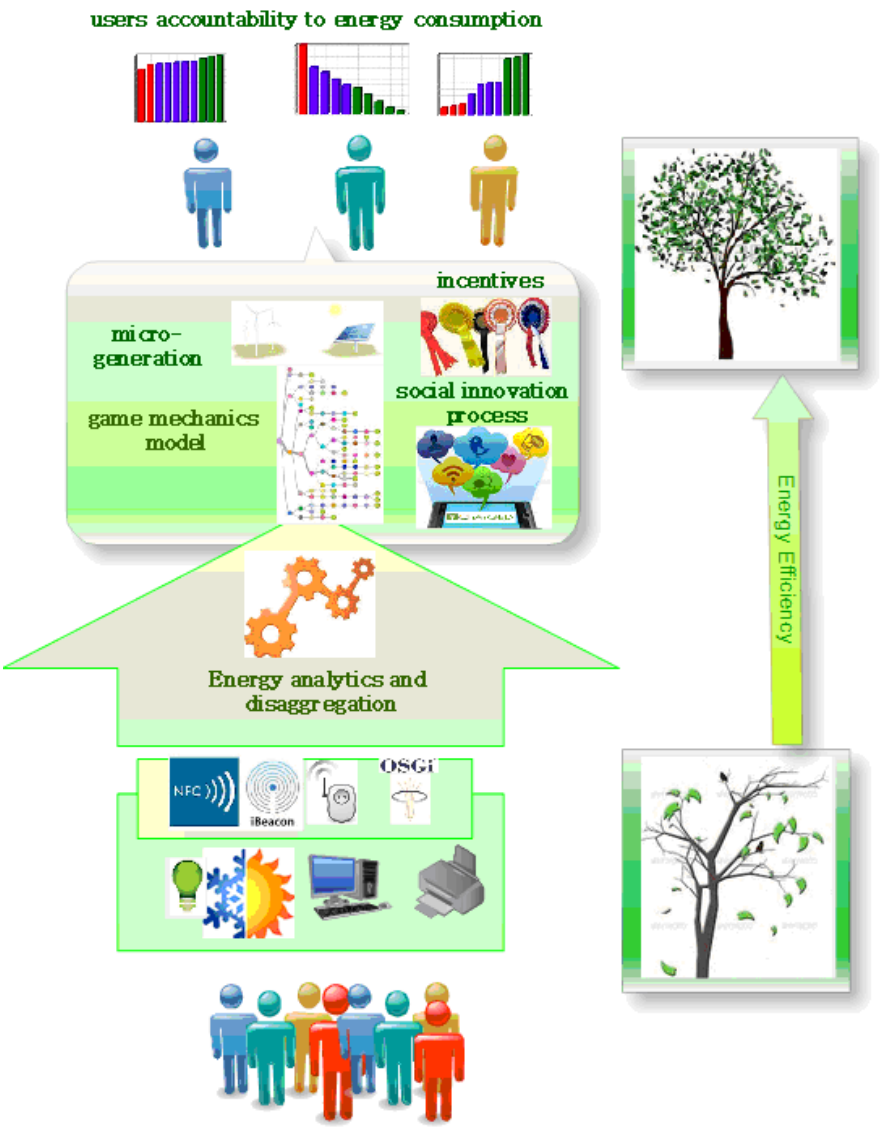
[1] Cambeiro et al. *A Building Automation Case Study - Setup and Challenges* (2018)

[2] Óscar García et al. *Energy Efficiency in Public Buildings through Context-Aware Social Computing* (2017)

[3] Rist and Masoodian, *Promoting Sustainable Energy Consumption Behavior through Interactive Data Visualizations* (2019)

[4] http://www.charged-project.eu/The-project



For building automation systems to be as efficient as possible, they need to engage with the human occupants and be as transparent as possible to prevent the occupants from constantly overriding the systems. The occupants need to understand the importance of these systems and people understand best when they can visualize a systems importance in real time rather than just being told that something is important and needs to be followed. Modern everyday life is so far removed from our environmental impacts that it is easy to ignore and forget them.

Appendix 1 – Draft of Request for Proposal/ Request for Qualifications – For Consultant[1]

1.0 BACKGROUND

This project is a part of the City of New Westminster's Long-Term Goal of working towards a zero-carbon future by implementing projects to achieve New Westminster's Seven Bold Steps in Response to the Climate Emergency. These build on New Westminster's Climate Emergency Declaration, and seek to achieve the City's Climate Emergency Goal, Objectives and Targets. The City is working towards reducing its carbon emissions by 45% by 2030 and becoming carbon neutral by 2050. To reach the 2030 goal, significant reductions must be made including a reduction of 322 tons of CO2e from the existing buildings.

An ASHRAE level 1 audit of 14 city owned buildings was completed by SES Consulting in 2018. The audit outlined specific projects that can be undertaken to reduce the building portfolio's GHG emissions by 25% and provides a basic financial analysis for each of the projects. The report has identified that 10 of the buildings have excellent opportunities for Building Automated Systems (BAS) upgrades and recommissioning. The audit suggested that the city begin by implementing the Building Automation Systems (BAS) projects first, as these systems can help highlight where the most energy usage comes from, which can help explain the need for future retrofitting projects. The study also showed that the BAS projects offer large energy consumption reductions in quick payback periods (5-8 years).

Therefor the City of New Westminster has decided to move forward with four BAS recommissioning projects.

The following table summarizes the financial and environmental analysis of the 10 buildings that were recommended to recommission or install a BAS. The four chosen buildings are highlighted and the totals for these chosen buildings is calculated.

Building	Cost	Simple Payback	Annual Savings				Current Vendor	Building Size (ft2)
			$	GJ	kWh	GHG		
Queens Park Arena	$ 100,000	8.9	$ 11,200	380	96,700	20	-	81,200
City Hall	$ 50,000	5	$ 10,100	460	65,100	18.6	ESC - Delta Controls	54,000
Moody Park Arena	$ 53,000	7	$ 7,600	160	89,100	8.9	-	33,500
Century House	$ 16,000	4.2	$ 3,800	130	31,500	6.8	ESC - Delta Controls	28,100
Police Building	$ 26,000	5.9	$ 4,400	120	41,100	6.4	ESC - Delta Controls	52,740
Library	$ 25,000	5.7	$ 4,400	100	50,300	5.5	ESC - Delta Controls	44,000
Glenbrooke Fire Hall	$ 14,000	5	$ 2,800	100	21,200	5.2	Reliable Controls	14,500
Queensborough Community Centre	$ 14,000	8.2	$ 1,700	90	4,300	4.7	ESC - Delta Controls	27,900
Eng Ops Building	$ 36,000	8.6	$ 4,200	80	51,500	4.5	Reliable Controls	24,600
Electrical Ops Building	$ 15,000	11.5	$ 1,300	40	5,900	2.1	Reliable Controls	8,160
Total for the 4 chosen buildings	**$ 117,000**	**5.2**	**$ 22,700**	**810**	**188,000**	**37.3**	**?**	**178,840**

[1] This RFP was drafted based off the NRCAN CanmetENERGY Guide for Recommissioning, Appendix E – RFP checklist for recommissioning services. Found here: https://www.tru.ca/__shared/assets/Sustainable_Building_Operation_and_Maintenance_Guideline33420.pdf

1.1 City Hall and the current state of its BAS

City Hall was originally constructed in 1953, and its HVAC consists of a mixture of systems. The newer section of the building has various air volumes (VAV) allowing for greater efficiency in the HVAC systems, however the older section has constant air volumes (CAV). The building is ventilated by multiple air handling units (AHUs), of which heating water is provided by two natural gas boilers[1]:

- a rooftop unit (RTU1) with gas heating and direct expansion (DX) cooling that serves 12 VAVs which provide air to the east wing of the building on all three floors;
- a second rooftop unit, RTU-2 serves the HR Annex in the basement
- a multi-zone AHU with a heating water pre-heat coil and DX cooling provides air to the west half of the main floor and to the south and north wings of the upper floor
- AHU-1, equipped with heating water pre-heat and DX cooling provides air to the west wing 2nd floor offices
- AHU-3, equipped with heating water pre-heat and DX cooling provides air to the west part of the basement spaces

The building automation system is over 20 years old and has gone through various upgrades through the years. It has very rudimentary controls and just like the HVAC systems, is a mixture of many different types of equipment.

There is a potential opportunity here to completely upgrade the BAS. The level 2 audit should include a comparison of the costs and environmental benefits of recommissioning the current system versus replacing it. Things to be considered while making this decision should also include how invasive and disruptive a full replacement would be.

The building has recently undergone a phased renovation which converted storage space into offices and reconfigured the existing office areas and public interfaces. This renovation provides an important opportunity to increase the delta zoning controls in the new office sections and improve the controls in the existing sections. Increasing the zoning would reduce energy consumption by ensuring that only occupied areas would receive conditioned air.[2]

1.2 The Police Building and the current state of its BAS

The Police building is occupied 24 hours a day by its employees and is open to the public during regular business hours every day. It was originally built in 1939 and will be undergoing a replacement of half of its heat pumps in the upcoming year, which provides a great opportunity to recommission its BAS. The building is conditioned by 2 make up air units (MUA) and about 50 heat pumps. The Heat pumps are on from 5:30am until 9pm every day.

MUA-1 serves most of the building and heats supply air with HW coil. MUA-2 serves the cell block and heats supply air with a gas-fired heating section. There are 2 condensing boilers that provide HW to MUA-1 and the terminal heat pumps. The heat pump water loop is also connected to 2 cooling towers in

[1] City of New Westminster Benchmarking and Level 1 Studies – SES Consulting

[2] City of New Westminster Benchmarking and Level 1 Studies – SES Consulting

order to meet cooling needs in the summer months. Domestic hot water (DHW) is supplied by 4 instantaneous water heaters connected to 2 storage tanks.[1]

1.2 The Library and the current state of its BAS

The Library was constructed in 1958 and recently renovated in 2019, and it has a very comprehensive building automation system. The building is occupied during regular business hours Monday to Sunday by its employees and the public.

The library's HVAC consists of 11 RTUs each equipped with gas heating and DX cooling; 2 condensing boilers and an atmospheric back-up boiler to provide reheat to certain spaces; electric baseboards to reheat other spaces; and the domestic hot water (DHW) is supplied by a 175-litre electric water heater.[1] Most of the HVAC is controlled by the BAS and few new devices will need to be installed.

The ESC DDC Contract for the Library is very thorough; it includes The Kaizen Analytics approach that analyses the data coming from the equipment and alerts ESC whenever something faulty occurs. The analytics also report opportunities to re-sequence equipment or expand the control system to enhance the operation and functioning of the building control and mechanical systems.

As the Library seems to have the most comprehensive BAS of the four facilities given its contract, it would be interesting to compare its Level 2 recommissioning report with the other three facilities.

1.2 The Century House and Youth Center and the current state of its BAS

The Century House was originally constructed in 1959 as a senior's center and the youth center was added in 2010. This facility offers a wide range of spaces from cafeteria settings to lounges and a gymnasium. It is occupied from 9am to 9pm on weekdays and has reduced hours on weekends.

> The Century House is conditioned by an MUA, a heat pump (HP) and 3 rooftop units, HV-1, HV-2 and HV-3. The MUA provides gas heating and ventilation to the kitchen. HP-1 provides heating, cooling and ventilation to the Oak Room. The HV units provide DX cooling, gas heating and ventilation to the remaining areas of century house. The Youth Center is condition by 2 AHUs and a rooftop unit, RTU-1. The AHUs are equipped with a reversible heat pump ad electric duct heater. AHU-1 serves the Youth Offices while AHU-2 serves the multipurpose room. RTU-1 provides gas heating, DX cooling and ventilation to the Youth Centre Lounge. There are 2 condensing boilers that provide HW for space heating and DHW. An additional 2 gas water heaters in the custodian room provide additional DHW and an electric water heater supplies the kitchen with DHW. A majority of these systems are controlled by a Delta BAS.[1]

[1] City of New Westminster Benchmarking and Level 1 Studies – SES Consulting

2.0 BUSINESS REQUIREMENTS & SCOPE OF WORK

Part 1: ASHRAE Level 2 Audit of the Building Automation Systems for the 4 chosen buildings: City Hall, Century House, Police Building, Library.

a) Kick off meeting with CNW to identify priorities
b) Support the CNW with the filling out of the funding application for the BC Hydro Continuous Optimization Program
c) Review of Level 1 audits
d) On site walk through of each facility with focus on the BAS
e) In depth audit of existing control systems
f) Real time systems specific data collection
g) Analysis of utility bills from a 24 to 36-month period to evaluate the facility's energy/demand rate structures and energy usage profiles
h) Perform detailed financial analysis for each measure based on implementation cost estimates, and site-specific operating cost savings
i) Evaluate the estimated potential GHG reductions for each recommissioning measure
j) Identification of larger capital opportunities; if more expensive opportunities are identified than these will require a separate implementation funding request to perform the Level 3 audit and write out the detailed specifications. Level 3 audits are not funded by the Continuous Optimization program, however there is a potential for these larger scale projects to be funded by other programs and that will be explored on a case by case basis.

Part 2: Detailed Specifications

a) Write detailed specifications for all project recommendations with a payback of under 2 years to provide to the vendor so they can then be implemented
b) Overview the implementation process

Appendix 2 – Draft of Request for Proposal/ Request for Qualifications – For Vendor

All material in this document is courtesy of Phil Zito. See document *How to evaluate BAS* – by BAM/Phil Zito for more information on why we are asking the questions and how the answers will allow us to evaluate a vendor's BAS. https://guides.smartbuildingsacademy.com/evaluatebas

In the RFP or RFQ it is important to make it clear that the goal behind this project is to reduce the buildings' GHG emissions. Methods of tracking energy use and informing occupants of the carbon emissions related to building use are sought.

1) Please detail out how we can purchase future products for this building automation system.
    a. You cannot purchase the controls except through a proposal from a salesperson
    b. You can purchase the controls but only by going through the local branch or re-seller
    c. You can purchase the controls from multiple re-sellers
    d. You can purchase the controls direct from the factory
    e. Other:
    f. Additional comments:

2) Please detail out how you will integrate to the following systems (list systems and versions here). Please be clear if this will be a native integration or will require additional devices.
    a. The contractor cannot integrate or connect with any of the systems
    b. The contractor can connect with less than 50% of the systems
    c. The contractor can connect with greater than 50% of the systems but only using other products
    d. The contractor can connect with greater than 50% of the systems natively
    e. Other:
    f. Additional comments:

3) Please detail out how we will purchase your configuration software and any and all licensing costs for this software. Please also detail out any software we cannot have or any limitations to our version of the software.
    a. The contractor will not provide you with their configuration software
    b. The contractor will provide you with a limited version of their configuration software
    c. The contractor will provide you with a full version of their configuration software, but it requires a yearly license
    d. The contractor will provide you with a full version of their configuration software for a one-time cost
    e. Other:
    f. Additional comments:

4) Please detail out if you have an open Application Programming Interface. Please also detail out if this API has documentation, sample applications, and if the API requires a developer license.
    a. The building automation provider has no API

b. The building automation provider has an API with no documentation
c. The building automation provider has an API with documentation but it requires a developer license
d. The building automation provider has an API with documentation and it does not require a developer license
e. Other:
f. Additional comments:

5) Please detail out how your graphics support a variety of browser and device types, if your graphics package is responsive, and if it supports HTML/5.
    a. The graphics cannot be viewed through a browser and require custom software
    b. The graphics can be viewed through a browser but are not responsive and do not support HTML/5
    c. The graphics can be viewed through a browser and support HTML/5 but are not responsive
    d. The graphics can be viewed through a browser support HTML/5 and are responsive
    e. Other:
    f. Additional comments:

6) Please detail out if your graphics software is available to customers, if it requires HTML expertise, if it supports multiple image types, and if it has a graphics library.
    a. You cannot purchase the graphics package except through a proposal from a salesperson
    b. You can purchase the graphics software but it requires HTML knowledge to edit
    c. You can purchase the graphics software and it has a graphics library
    d. You can purchase the graphics software and it has a graphics library and supports multiple image types
    e. Other:
    f. Additional comments:

7) Please describe your graphics library that is available to users and if users can add their own stencils to the library
    a. There is no graphics library only a few premade graphics for specific units
    b. The library is limited to simple block symbols like boxes and gauges
    c. The library contains multiple HVAC devices with 2D and 3D pieces
    d. The library contains multiple HVAC devices with 2D and 3D pieces and the owner can add new stencils to the graphics
    e. Other:
    f. Additional comments:

8) Please detail out how your alarms are prioritized and how your prioritization works
    a. The alarms cannot be prioritized
    b. The alarms have preset priorities that cannot be adjusted
    c. The alarms have priorities that can be adjusted through a vendor programming tool

d. The alarms have priorities that can be adjusted by the end-user
e. Other:
f. Additional comments:

9) Please detail out how your alarms are sequenced and the sequencing capabilities of your alarming system.
    a. The alarms cannot be sequenced
    b. The alarms have preset sequences that cannot be changed
    c. The alarm sequences can be changed by a vendor
    d. The alarm sequences can be changed by the end-user
    e. Other:
    f. Additional comments:

10) Please detail out how your alarms are transmitted and the transmission capabilities of your alarming system.
    a. The alarms cannot be transmitted outside the BAS
    b. The alarms only support e-mail transmission outside the BAS
    c. The alarms can support e-mail and paging SMS text outside the BAS
    d. The alarms can support e-mail paging SMS text and SNMP outside the BAS
    e. Other:
    f. Additional comments:

11) Please detail out how your trends data is stored, where it is stored, and what database type is used for storage.
    a. There is no ability to store trends
    b. Trend data is stored in a flat file document
    c. Trend data is stored in a proprietary database
    d. Trend data is stored in a common database.
    e. Other:
    f. Additional comments:

12) Please detail out how your trends data is accessed.
    a. The trend data can only be access through the BAS by the vendor
    b. The trend data can be accessed inside and outside the BAS by the vendor
    c. The trend data can be accessed through the BAS by an authenticated user
    d. The trend data can be accessed inside and outside the BAS by an authenticated user
    e. Other:
    f. Additional comments:

13) Please detail out how your trend data is visualized by the end-user.
    a. The trend data cannot be visualized
    b. The trend data can be visualized by the vendor
    c. The trend data can be visualized as raw data by the end-user
    d. The BAS software has a visualization solution for the end-user to view trend data

e. Other:
f. Additional comments:

14) Please detail out how your configuration tools allow users to configure and program controllers.

a. The configuration tools are not available to the customer
b. A limited version of the configuration tools are provided to the customer
c. The configuration tool is provided to the customer but the programming library is not
d. The full version of the configuration tool along with a programming library is provided to the customer
e. Other:
f. Additional comments:

15) Please detail out how your configuration tools allow users to adjust and customize settings.
a. There is no support for hard-coded settings
b. Hard-coded settings cannot be adjusted
c. Hard-coded settings can only be adjusted by vendors
d. Hard-coded settings can be adjusted by customers
e. Other:
f. Additional comments:

16) Please describe how your configuration tool allows users to create and backup databases
a. Databases can only be accessed by the vendor
b. Customers can backup databases
c. Customers can edit current databases
d. Customers can create edit and backup databases
e. Other:
f. Additional comments:

17) Ensure that the BAS has 10% additional logical and physical capacity.

18) Please detail out how your BAS supports redundancy (e.g Virtual Servers, Dual-Field Controllers, etc.)
a. The BAS does not support redundancy
b. The BAS supports Virtual Servers
c. The BAS supports Dual Field Controllers
d. The BAS supports Dual Supervisory Devices
e. Other:
f. Additional comments:

19) Please detail out the level of access to the system and the tools that will be provided to the owner at the completion of this job.
a. The BAS does not provide the ability to configure or modify the system
b. The BAS limits the capabilities to configure and modify the system

c. The BAS provides full access to configure and modify the system but do not include tools
d. The BAS provides full access to configure and modify the system and include the tools
e. Other:
f. Additional comments:

20) Please describe what kind of training and technical documentation is available for the user.
    a. We do not provide training or technical documentation to users
    b. We provide in-person training to users
    c. We provide online and in-person training to users
    d. We provide online and in-person training and provide technical documents to users
    e. Other:
    f. Additional comments:

21) Please detail out your process for identifying the levels of training required for our team.
    a. We only provide one level of training
    b. We provide multiple levels of training but only one level will be given
    c. We will train your team based on the level of training you require
    d. We will evaluate your teams strengths and weaknesses with BAS and adjust the training accordingly
    e. Other:
    f. Additional comments:

22) Please detail out how you will develop your training plan.
    a. We train based on what is in the specification
    b. We have a single set training program
    c. We have three different training programs
    d. We work with our customers to tailor our training program
    e. Other:
    f. Additional comments:

23) Please describe the availability of on-demand training for our team.
    a. We do not provide on-demand training
    b. We provide on-demand training, but it is in-formal
    c. We can provide on-demand training for a price
    d. We have a formalized on-demand training program that is free for previous customers.
    e. Other:
    f. Additional comments:

24) Please detail out how you will approach ensuring a great user experience for the occupants? For example, do you have a smartphone application that allows occupants to use personalized controls and visualize how the building's carbon footprint changes depending on the energy usage?