City of Vancouver Archetype EUIs

MURB **Wood Frame Mid-Rise** **Wood Frame Mid-Rise**

Weather: Typical year for Vancouver, BC. 2

Schedules: Schedules are identical between the Reference and Proposed Design with main fans on 24 hrs/day and suites with lighting and equipment schedules derived from utility load research studies and bill calibration efforts.

Floor Area: 100,000.00 ft² (9,290 m²) with 13.3% common/corridor space; does not include about 40,000 ft² of unheated underground parking.

Suites: 102 apartments averaging 850 ft² net area each, distributed over 6 storeys.

Note that all end-use energy is included for all cases, even though NECB and ECB compliance allow for exclusion of some end-uses (e.g., exterior lighting). Also, ECB path corresponds to proposed case configured to acheive 22% energy cost savings.

Item	Proposed** (TypWoodFrame)	MNECB+ecoEnergy (TypWoodFrame-MNECBRef)	ASHRAE 90.1-2007 App G (TypWoodFrame-PRM)	ASHRAE 90.1-2010 App G (TypWoodFrame-PRMv4)	NECB 2011	ASHRAE 90.1-2010 ECB* (TypWoodFrame-ECB2010)	Notes (FAST analysis)
PROPOSED ENERGY SAVINGS	**Hot Water Heating - $:**	25% (1 pt - 2009)	**22% (6 pts - 2009)**	**22% (9 pts - v4)**	16% (6 pts - v4)	14% (n/a for LEED)	NOTE: NECB is least stringent for electric baseboard case due to no effective switching of energy sources, but only for energy cost savings. Energy use savings, which is how NECB compliance is gauged, is the most stringent for compliance.
	Energy Use:	(33% energy use)	**(27% energy use)**	**(29% energy use)**	(12% energy use)	(22% energy use)	
	Electric Baseboards - $:	26% (1 pt - 2009)	**23% (6 pts - 2009)**	20% (8 pts - v4)	**23% (9 pts - v4)**	2% (n/a for LEED)	
	Energy Use:	(46% energy use)	**(43% energy use)**	(38% energy use)	**(21% energy use)**	(11% energy use)	
EXTERIOR SURFACES							
Wall	Ro-15.9, based on Trade-Off method although prescriptive requirement is Ro-19.6; 35,210 ft² net area (50,300 ft² gross)	Electric Heat Source / Gas/Heat Pump Heat Source Admin Region BC-A 12.6 / 7.0	Mass / Metal / **Steel** / Other / R_o Climate Zone 5 0% / 0% / 100% / 0% / 15.6 12.5 / 17.5 / 15.6 / 19.61	Mass / Metal / **Steel** / Other / R_o Climate Zone 5 0% / 0% / 100% / 0% / 15.6 12.5 / 14.49 / 15.6 / 19.61	No variation by construction Climate Zone 4 18.0	Mass / Metal / Steel / Other / R_o Climate Zone 5 0% / 0% / 0% / 100% / 19.6 12.5 / 14.49 / 15.6 / 19.61	Stud walls with R-22 batts between studs at 16" o.c. (overall per 90.1-2010 Table A3.4). *CoV compliance via Trade-Off approach (COMCheck)* , since prescriptive requirement is not satisfied. Note that ECB varies from PRM in that PRM dictates application of Steel construction.
Roof	Ro-26, based on Trade-Off method although prescriptive requirement is Ro-37; 16,670 ft² area	Electric Attic | **Joist** | Flat / Gas/Heat Pump Attic | **Joist** | Flat 41 | 25 | 13.8 Apply R-25 / 31 | 25 | 12.1 Apply R-25	**Ins. above Deck (ci)** / Attic and Other / R_o 100% / 0% 20.8 / 37.0 / 20.8	**Ins. above Deck (ci)** / Attic and Other / R_o 100% / 0% 20.8 / 37.0 / 20.8	No variation by construction 25.0	Ins. above Deck (ci) / Attic and Other / R_o 0% / 100% 20.8 / 37.0 / 37.0	Wood joist roof with R-28 batts btwn joists; overall per 90.1-2010 Table A2.4 (tho COMCheck indicates R-27.8). Note that many "joist" roofs would be classified as attic by the MNECB since they have open cavity space above the joists (and below the upper deck), and yet others might be "Flat" deck roofs with continuous insulation. Note that ECB varies from PRM in that PRM dictates the application of above deck roof type.
Exposed Floor (over Parkade)	Ro-15.6 16,670 ft² area	Electric Heat Source / Gas/Heat Pump Heat Source 13.8 / 12.1	Steel Joist 0% / 100% / 0% / 26.3 15.6 / 26.3 / 30.3	Steel Joist 0% / 100% / 0% / 26.3 15.6 / 26.3 / 30.3	No variation by construction 25.0	Mass 100% / 0% / 0% / 15.6 15.6 / 26.3 / 30.3	Baseline equivalent to 8" concrete floor over parkade with 4.6" spray applied cellulosic fibre. Note that ECB varies from PRM in that PRM dictates application of more stringent Steel Joist type instead of Mass type.
GLAZING							
Exposure	30% 15,100 ft²	30% (same as Proposed)	30% (same as Proposed)	30% (same as Proposed)	30% (same as Proposed)	30% (same as Proposed)	Note that the NECB 2011 prescribes that the fenestration percentage is set at 40%, but the CoV altered this provision.
Window U-value	Uo-0.36 **EAc1 6 pts: U-0.28; Elec BBs: U-0.20** **22% Svgs - HW: U-0.28; Elec BBs: U-0.20**	Electric Heat Source / Gas/Heat Pump Heat Source .60 op | .56 fixed / .60 op | .56 fixed 0.57 / 0.57	Non-metal / store c.w./ door / Metal / metal / Other / U_o 0% / 0% / 20% / 80% / 0.60 0.35 / 0.45 / 0.80 / 0.55	Non-metal / store c.w./ door / Metal / metal / Other / U_o 0% / 0% / 20% / 80% / 0.60 0.35 / 0.45 / 0.80 / 0.55	No variation by window type 0.42	Non-metal / store c.w./ door / Metal / metal / Other / U_o 100% / 0% / 0% / 0% / 0.35 0.35 / 0.45 / 0.80 / 0.55	Baseline with low-e units at centre-of-glass U-0.30 with air fill in vinyl or fiberglass frame and aluminum spacers. Note that many designers still prefer metal frames windows in which case, this performance is plausible with argon and warm edge spacers. ECM case requires at least non-conductive frames, with triple pane applied to electric baseboard case for the 22% cost savings requirement.
Window Shading Coefficient	0.35	Same as Proposed	0.46 (all orientations)	0.46 (all orientations)	No requirements (same as for Baseline for Performance Path)	0.46 (all orientations)	MNECB allows for SC set at 0.74 if it improves relative savings -- which it rarely does.

City of Vancouver Archetype EUIs

Item	Proposed** (TypWoodFrame)	MNECB+ecoEnergy (TypWoodFrame-MNECBRef)	ASHRAE 90.1-2007 App G (TypWoodFrame-PRM)	ASHRAE 90.1-2010 App G (TypWoodFrame-PRMv4)	NECB 2011	ASHRAE 90.1-2010 ECB* (TypWoodFrame-ECB2010)	Notes (FAST analysis)
SPACE CONDITIONS							
Interior Lighting	0.60 W/ft² common, less 3% for OS / 0.84 W/ft² suites **EAc1 6 pts - Elec BBs: 0.20 W/ft² ste ltg svgs** **22% Svgs - Elec BBs: Same as above**	0.7 W/ft² common / suites same as Proposed (unregulated)	0.7 W/ft² common / suites same as Proposed (unregulated)	0.582 W/ft² common (0.60 W/ft², less 3% PAF) / suites unregulated	0.582 W/ft² common (0.60 W/ft², less 3% PAF) / suites unregulated	0.582 W/ft² common (0.60 W/ft², less 3% PAF) / **suites unregulated (i.e., same as Proposed)**	LEED potentially allows for credit on suite lighting, but it is problematic to demonstrate and only provides for savings on hard-wired fixtures. Note that LEED Canada 2009 differs from LEED (USGBC) v4 that references ENERGY STAR Simulation Guidelines, which allow a comparison to an even more generous allowance (and unrealistic diversified load) of 1.1 W/ft². OS savings based on mainly stair wells being controlled as required by Code. ECM requires detailed demonstration of savings associated with hard-wired lighting (which is not available via the ECB method, and potentially more credited under LEED v4).
Parking Lighting	0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control; add 1 kW for misc. exterior loads	0.3 W/ft² x 40000 ft² = 12 kW; add 1 kW for misc. exterior loads	0.3 W/ft² x 40000 ft² = 12 kW; add 1 kW for misc. exterior loads	0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control (Misc. loads same as Baseline)	0.25 W/ft² x 40000 ft² = 10 kW; note **no OS control** (Misc. loads same as Baseline)	0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control (Misc. loads same as Baseline)	Occupancy Sensor (OS) control reduction based on 2/3rds of lights being controlled (the others assumed serving designed security lighting); applied LEED-referenced 30% savings for these fixtures.
Equipment density	0.55 W/ft² ~38 MWh/year for 2-3 elevators	+33% for Energy Star appliances; process credit available			+33% for Energy Star appliances, assuming process credit applies consistent with LEED v4	Same as Proposed (no non-regulated process credit)	Load estimate based on load reseach data and calibrated model indicators, but can vary significantly. With LEED (MNECB, PRM), non-regulated loads (e.g., EnergyStar appliances) may receive credit. Note that ecoEnergy credit highly variable due to a wide range of Energy Star ratings and applicable appliances; MNECB provides for defaults that equate to 0.46 W/ft² (Building Type Basis).
GENERAL HVAC							
Air Handling	Constant volume central make-up air unit (MAU) serving tempered fresh air via corridor pressurization with baseboard heating	Single zone CV systems (e.g. PTACs/fan coils) at 0.4 cfm/ft², including associated corridors, with heating via natural gas hot water boiler. Relatively odd exceptions can apply with certain common spaces that dictate the application of VAV with reheat (not accounted for in this study).	Single zone PTACs with no baseboards, or MAU as fresh air is directly provided via zone units. Hot water heating via natural gas boilers with all fossil or "fossil/electric hybrid" serving space heating.	Same as 90.1-2007	Identical configuration to Proposed with same heat sources, but with PTACs serving suites.	Identical configuration to Proposed except baseboards replaced by: (A) PTACs for hydronic case, (B) PTHPs for electric baseboard case	For PRM, if all space heat were supplied via electricity, PTAC would be replaced by PTHPs (i.e., consistent with ECB approach). Note: ECB compliance dictates the use of heat pumps where suites are heated with electric baseboards; it also infers maintaining consistent air systems with different heating sources (e.g., MAU with gas heat but suites with electric heat pumps), although this is not completely clear and was addressed via an ASHRAE 90.1-1999 clarification interpretation we submitted.
Heating Source	Hot water for MAU and baseboards					Hot water for MAU and terminal heating, **except heat pumps if Proposed has electric baseboards**	
Cooling Source	None				None	DX, but effectively none since capacity same as Proposed	ASHRAE technically calls for cooling to be added to Proposed and Baselines, which LEED v4 may as well with submissions going to the USGBC, but leave out to reflect more realistic energy use.
FAN SYSTEM							
Fan Power	MAU: 2.0" total static pressure at 50% overall fan efficiency (0.00064 bhp/cfm)	For residential HVAC types: 0.5"/25% supply, no return (Includes common stairs, corridors, and mechanical grouped with residential type function)	Fixed at 0.3 W/cfm Sized based on 20℉ dT to satisfy heating or cooling load (although mechanical cooling not provided)	Fixed at 0.3 W/cfm Sized based on 20℉ dT to satisfy heating or cooling load (although mechanical cooling not provided)	not to exceed **0.9 W/cfm**, based on 2.6" tsp and 40% fan efficiency (assuming 85% η motor)	**Same kW/cfm as for Proposed (since under limit)**	Note that ASHRAE's ECB approach provides for a fan power limit that is lower than for the PRM. While the limit may not be exceeded, the ECB baseline fan power is to be set the same as the Proposed case if lower. Hence, it would be zero if there are no fan units in the suites, making the PRM more generous.

City of Vancouver Archetype EUIs

Item	Proposed** (TypWoodFrame)	MNECB+ecoEnergy (TypWoodFrame-MNECBRef)	ASHRAE 90.1-2007 App G (TypWoodFrame-PRM)	ASHRAE 90.1-2010 App G (TypWoodFrame-PRMv4)	NECB 2011	ASHRAE 90.1-2010 ECB* (TypWoodFrame-ECB2010)	Notes (FAST analysis)
Outside Air	0.097 cfm/sf	Same as Baseline / Proposed case			Same as Baseline / Proposed case		Based on LEED requirements referencing ASHRAE 62.1-2007; direct suite supply at 50 cfm/kitchen and 25 cfm/bath, plus 0.06 cfm/sf for common/corridor space.
Heat Reclaim	N/A **EAc1 6 pts - Elec BBs: 60% effective (+1" added to tsp)** **22% Svgs: No change**	N/A	N/A	N/A	**50% effective sensible recovery since MAU >8900 cfm (conservative interpretation)**	N/A (unless exhaust is centralized and returned)	ASHRAE 90.1 exempts heat recovery if the largest exhaust source does not exceed 75% of ventilation delivery (6.3.6.1.(h)), which is also cited for the PRM. The NECB also exempts heat recovery for dwelling units with individual air systems, and does not clearly define what is considered as an "exhaust air system." Hence, application of heat recovery for the NECB case may not apply and is conservative here.
HVAC CONTROL							
Heating and Cooling Setpoints	MAU provides 65℉ air to corridors Average estimate of 72℉ with night setback to 68°for heating (not metered); 78℉ for cooling (residences keep homes warmer and con sistent with EnergyStar)						Note that many actual MURBs from audit keep MAU setpoint closer to 70℉. From calibrated bill analysis, *metered suites might maintain something closer to 68℉ with a setback to 64℉ or lower; this would apply to most cases with electric baseboards but I maintained the indicated setpoints for consistency.*
HEATING PLANT							
Central Heating Efficiency	80% efficiency; HW reset **EAc1 6 pts: 85% modulating boilers; Elec BBs: 81% η modulating furnace** **22% Svgs: 92% η condensing boilers; Elec BBs: 94% η condensing furnace**	One 80% efficient boiler; no HW reset	Two 80% efficient boilers with HW reset	Two 80% efficient boilers with HW reset	**One 82.5% efficient fully modulating boiler with HW reset** **Elec BB case with 81% efficient modulating furnace**	Two 80% efficient boilers with HW reset; **PTHPs at COP 3.2** with defrost starting below 40℉ and electric backup	Variation provides for electric baseboards serving suites; MAU heating served by hydronic coils except case with electric baseboards, where a gas-fired unit applies instead. Note that a PTHP at a COP of 3.2 corresponds to a cooling efficiency of EER 11.2, based on ASHRAE tables.
Hot Water Flow	Variable flow at 40 ft head and 65% pump *η* (11.6 W/gpm), based on 30℉ dT	Constant flow with same head as Proposed, based on 29℉ dT	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% *η*), based on a 50℉ dT	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% *η*), based on a 50℉ dT	**Constant flow with same head as Proposed, based on 29℉ dT**	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	MNECB via ecoEnergy allowances provide for possible credit due to more efficient pumps, but the credit is neglible (if any applies).
DOMESTIC HOT WATER (DHW)							
Heating Efficiency	80% **22% Svgs - Elec BBs: Same as above**	80%	80%	80%	80%	80%	The Proposed plant is assumed to be reasonably sized, but note that significant over-sizing can make a noticeable difference. The MNECB, Appendix G and NECB limit the amount of oversizing, but the ECB retains the same over-sizing level as for the Proposed Design, making it less stringent in this respect.
Avg. Load (Btu/sf/day)	17.8	Same as Baseline, but increased to account for ~9% for Energy Star appliance savings plus another 18% assuming 2.0 gpm showers (17% savings) and 1.3 gpm faucets (41% savings).			Same as previous reference cases, assuming same LEED eligible credits apply.	**Same as Proposed**	Average load derived from bill calibration studies. ecoEnergy savings based on showers accounting for 33% of DHW load from GVRD information (showers and faucets account for 33% and 24% of DHW load for residences, respectively).

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UTILITY RATES							
Electricity	BC Hydro Residential and MGS Tariffs; blended avg. of $0.114/kWh, excl. fixed charges	Same as rates as Proposed (although may results in different blended avg.)	Same as rates as Proposed (although may results in different blended avg.)	Same rates as Proposed	Same rates as Proposed (although compliance is not based on energy costs)	Same rates as Proposed	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.
Natural Gas	FortisBC Rate 3, plus carbon tax; blended avg. of $10.43/GJ, excl. fixed charges	Same as rates as Proposed	Same as rates as Proposed	Same rates as Proposed	Same rates as Proposed (although compliance is not based on energy costs)	Same rates as Proposed	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.

Archetype Proposed design starting point is compliant with ASHRAE 90.1-2010 prescriptively (including possible application of envelope trade-off).* ***Maroon *entries represent changes to this base Proposed case to reach 6 EAc1 points under LEED 2009.* ***Blue*** *entries represent changes to the base Proposed case to reach 22% energy cost savings.*

**Red represents corresponding requirements that increase energy over ASHRAE 90.1-2010 while green result in energy savings (which doesn't necessarily translate equivalently to energy costs).*

City of Vancouver Archetype EUIs

MURB **Concrete High-Rise** **Concrete High-Rise**

Weather: Typical year for Vancouver, BC.

Schedules: Schedules are identical between the Reference and Proposed Design with main fans on 24 hrs/day and suites with lighting and equipment schedules derived from utility load research studies and bill calibration efforts.

Floor Area: 100,000.00 ft² (9,290 m²) with 13.3% common/corridor space; does not include about 40,000 ft² of unheated underground parking.

Suites: 102 apartments averaging 850 ft² net area each, distributed over 14 storeys.

Note that all end-use energy is included for all cases, even though NECB and ECB compliance allow for exclusion of some end-uses (e.g., exterior lighting). Also, ECB path corresponds to proposed case configured to acheive 22% energy cost savings.

Item	Proposed** (TypHighRise)	MNECB+ecoEnergy (TypHighRise-MNECBRef)	ASHRAE 90.1-2007 App G (TypHighRise-PRM)	ASHRAE 90.1-2010 App G (TypHighRise-PRMv4)	NECB 2011* (TypHighRise-NECBRef)	ASHRAE 90.1-2010 ECB* (TypHighRise-ECB2010)	Notes (FAST analysis)
PROPOSED ENERGY SAVINGS	**Hot Water Heating - $:**	30% (4 pts - 2009)	**25% (7 pts - 2009)**	**25% (10 pts - v4)**	16% (5 pts - v4)	15% (n/a for LEED)	NOTE: NECB is least stringent for electric baseboard case due to no effective switching of energy sources, but only for energy cost savings. Energy use savings, which is how NECB compliance is gauged, is most stringent for it.
	Energy Use:	(38% energy use)	**(31% energy use)**	**(33% energy use)**	(22% energy use)	(28% energy use)	
	Electric Baseboards - $:	**34% (6 pts - 2009)**	**31% (10 pts - 2009)**	**22% (9 pts - v4)**	**22% (9 pts - v4)**	16% (n/a for LEED)	
	Energy Use:	**(59% energy use)**	**(58% energy use)**	**(51% energy use)**	**(28% energy use)**	(32% energy use)	
EXTERIOR SURFACES							
Wall	Ro-7.2 based on Trade-Off method, although prescriptive requirement equates to Ro-11.9. 22,700 ft² net area (56,700 ft² gross) **EAc1 6pt - Elec BBs: Ro-16.6** **22% Svgs - Ro-11.2**	Electric Heat Source: 12.6 Gas/Heat Pump Heat Source: 7.0 Admin Region BC-A	Mass: 0% 12.5 Metal: 0% 17.5 **Steel**: 100% 15.6 Other: 0% 19.61 R_o: 15.6 Climate Zone 5	Mass: 0% 12.5 Metal: 0% 14.49 **Steel**: 100% 15.6 Other: 0% 19.61 R_o: 15.6 Climate Zone 5	No variation by construction **18.0** Climate Zone 4	Mass: 12% 12.5 Metal: 0% 14.49 Steel: 88% 15.6 Other: 0% 19.61 R_o: 15.1 Climate Zone 5 Trade-Off tested with COMCheck (Ro-8.2 Mass type passed) Mix of wall types corresponds to 22% Svgs case	Typical: - Concrete with 2" c.i. R-12 insulation between studs and concrete at Ro-13.2 (64% of net wall); - Spandrel panels with R-12.6 in backpan and steel stud build-out with R-12 batts at Ro-8.7 (22% of net wall); - Spandrel panels with R-4.2 covering half of exposed concrete (7% of net wall); - Uninsulated slab edges, upstands, balconies/fins and colums at Ro-1.6 (7% of net wall). *CoV compliance via Trade-Off approach (COMCheck)* . Note that ECB varies from PRM in that PRM dictates application of Steel construction. ECM for EAc1 6pt for Elec BBs based on panel wall system with exterior insulation (4" Roxul) non-conductive clips and interior R-12 batts, no spandrel panels and only ~10% of slab edges allocated to balconies. ECM for 22% Svgs based on exterior insulation (4" Roxul) with perpendicular Z-girts, no interior batts, no spandrel panels and ~20% of slab edges allocated to balconies/fins.
Roof	Ro-21.9 7,140 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: 12.1	Insulation Entirely above Deck 20.8	Insulation Entirely above Deck 20.8	No variation by construction **25.0**	Insulation Entirely above Deck 20.8	
Exposed Floor (over Parkade)	Ro-15.1 7,140 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: 12.1	Steel Joist 0% 15.6 100% 26.3 0% 30.3 26.3	Steel Joist 0% 15.6 100% 26.3 0% 30.3 26.3	No variation by construction 25.0	Mass 100% 15.6 0% 26.3 0% 30.3 **15.6**	Baseline equivalent to 8" concrete floor over parkade with 4.5" spray applied cellulosic fibre. Note that ECB varies from PRM in that PRM dictates application of more stringent Steel Joist type instead of Mass type.
GLAZING							
Exposure	60% 34,000 ft² **22% Svgs - Elec BBs: 55%**	40%	40%	40%	40%	40%	Original analysis to meet 6 EAc1 points for Elec BBs under LEED v2009 attempted to maintain 60% glazing, which required some relatively expensive measures (e.g., very high performance triple pane and EcoSpace elevators). Ensuing iteration to satisfy 22% energy cost savings target slightly relaxed window percentage if it meants such measures would not be required.

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Item	Proposed** (TypHighRise)	MNECB+ecoEnergy (TypHighRise-MNECBRef)		ASHRAE 90.1-2007 App G (TypHighRise-PRM)						ASHRAE 90.1-2010 App G (TypHighRise-PRMv4)						NECB 2011* (TypHighRise-NECBRef)	ASHRAE 90.1-2010 ECB* (TypHighRise-ECB2010)						Notes (FAST analysis)
		Electric Heat Source	Gas/Heat Pump Heat Source	Non-metal	c.w./ store	door	Metal metal	Other metal	U_o	Non-metal	c.w./ store	door	Metal metal	Other metal	U_o		Non-metal	c.w./ store	door	Metal metal	Other metal	U_o	
Window U-value	Uo-0.36 **>EAc1 6pt - Elec BBs: Uo-0.20** **22% Svgs - Elec BBs: Uo-0.25**	.60 op | .56 fixed 0.57	.60 op | .56 fixed 0.57	0% 0.35	0% 0.45	0% 0.80	100% 0.55		0.55	0% 0.35	0% 0.45	0% 0.80	100% 0.55		0.55	No variation by window type **0.42**	0% 0.35	0% 0.45	0% 0.80	100% 0.55		0.55	Baseline with nearly best available low-e double pane units, with typical mix of operable and fixed window wall glazing. PRM dictates prescriptive type of glazing proportionally aligns with actual configuration; "Other metal" category would be indicative on average. Efficiency improvement correlates to triple pane windows in very high performance metal frames (or fiberglass) for EAc1 case, and good performing frames for 22% savings case.
Window Shading Coefficient	0.35	Same as Proposed		0.46 (all orientations)						0.46 (all orientations)						No requirements (same as for Baseline for Performance Path)	0.46 (all orientations)						MNECB allows for SC set at 0.74 if it improves relative savings -- which it rarely does.
SPACE CONDITIONS																							
Interior Lighting	0.60 W/ft² common, less 3% for OS / 0.84 W/ft² suites (LEED 2009) **EAc1 6 pts: 0.29 W/ft² suite ltg svgs; Elec BBs: 0.34 W/ft² suite svgs, common at 0.50 W/ft²** **22% Svgs: 0.29 W/ft² suite ltg svgs for HW and Elec BBs**	0.7 W/ft² common / suites same as Proposed (unregulated)		0.7 W/ft² common / suites same as Proposed (unregulated)						0.582 W/ft² common (0.60 W/ft², less 3% PAF) / suites unregulated						0.582 W/ft² common (0.60 W/ft², less 3% PAF) / suites unregulated	0.582 W/ft² common (0.60 W/ft², less 3% PAF) / **suites unregulated (i.e., same as Proposed)**						LEED potentially allows for credit on suite lighting, but it is problematic to demonstrate and only provides for savings on hard-wired fixtures. Note that LEED Canada 2009 differs from LEED (USGBC) v4 that references ENERGY STAR Simulation Guidelines, which allow a comparison to an even more generous allowance (and unrealistic diversified load) of 1.1 W/ft². OS savings based on mainly stair wells being controlled as required by Code. ECM requires detailed demonstration of savings associated with hard-wired lighting (which is not available via the ECB method, and potentially more credited under LEED v4).
Parking Lighting	0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control; add 1 kW for misc. exterior loads **EAc1 6 pts - Elec BBs: 20% reduction overall** **22% Svgs: 20% reduction overall for elec BBs**	0.3 W/ft² x 40000 ft² = 12 kW; add 1 kW for misc. exterior loads		0.3 W/ft² x 40000 ft² = 12 kW; add 1 kW for misc. exterior loads						0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control (Misc. loads same as Baseline)						0.25 W/ft² x 40000 ft² = 10 kW; note **no OS control** (Misc. loads same as Baseline)	0.25 W/ft² x 40000 ft² = 10 kW, less 20% for OS control (Misc. loads same as Baseline)						Occupancy Sensor (OS) control reduction based on 2/3rds of lights being controlled (the others assumed serving designed security lighting); applied LEED-referenced 30% savings for these fixtures. Note that exterior lighting is to remain the same between the ECB and Proposed cases, but parkade lighting is not regulated as exterior lighting.
Equipment density	0.55 W/ft² ~38 MWh/year for 2-3 elevators **EAc1 6 pts - Elec BBs: 40% reduction for ecoSpace units** **22% Svgs: No change**	+33% for Energy Star appliances; process credit available														+33% for Energy Star appliances, assuming process credit applies consistent with LEED v4	Same as Proposed (no non-regulated process credit)						Load estimate based on load reseach data and calibrated model indicators, but can vary significantly. With LEED (MNECB, PRM), non-regulated loads (e.g., EnergyStar appliances) may receive credit. Note that ecoEnergy credit highly variable due to a wide range of Energy Star ratings and applicable appliances; MNECB provides for defaults that equate to 0.46 W/ft² (Building Type Basis).

City of Vancouver Archetype EUIs

Item	Proposed** (TypHighRise)	MNECB+ecoEnergy (TypHighRise-MNECBRef)	ASHRAE 90.1-2007 App G (TypHighRise-PRM)	ASHRAE 90.1-2010 App G (TypHighRise-PRMv4)	NECB 2011* (TypHighRise-NECBRef)	ASHRAE 90.1-2010 ECB* (TypHighRise-ECB2010)	Notes (FAST analysis)
GENERAL HVAC							
Air Handling	Constant volume central make-up air unit (MAU) serving tempered fresh air to corridor and suite fan coils	Single zone CV systems (e.g. PTACs/fan coils) at 0.4 cfm/ft², including associated corridors, with heating via natural gas hot water boiler. Relatively odd exceptions can apply with certain common spaces that dictate the application of VAV with reheat (not accounted for in this study).	Single zone PTACs with no baseboards, or MAU as fresh air is directly provided via zone units. Hot water heating via natural gas boilers with all fossil or "fossil/electric hybrid" serving space heating.	Same as 90.1-2007	Identical configuration to Proposed, as Table 8.4.4.8.A indicates that the "HVAC system shall be modeled as being identical to that of the proposed with same heat sources."	Identical configuration to Proposed except baseboards and fan coils replaced by: (A) PTACs for hydronic case, (B) PTHPs for electric baseboard case	For PRM, if all space heat were supplied via electricity, PTAC would be replaced by PTHPs (i.e., consistent with ECB approach). Note: ECB compliance dictates the use of heat pumps where suites are heated with electric baseboards; it also infers maintaining consistent air systems with different heating sources (e.g., MAU with gas heat but suites with electric heat pumps), although this is not completely clear and was addressed via an ASHRAE 90.1-1999 clarification interpretation we submitted.
Heating Source	Hot water for MAU and baseboards **EAc1 6pt - Elec BBs: Gas-fired MAU** **22% Svgs: Same as above**					Hot water for MAU and terminal heating, **except heat pumps if Proposed has electric baseboards**	
Cooling Source	Air-cooled chiller	Reciprocating chiller	DX	DX	DX	DX	
FAN SYSTEM							
Fan Power	MAU: 2.0" total static pressure at 50% overall fan η (0.00064 bhp/cfm) Fan coils: S/A at 0.8 cfm/ft² with 0.5" tsp at 30% overall fan η **EAc1 6pt: 40% reduction with ECM motors for Elec BBs** **22% Svgs: Same as above (for Elec BBs)**	For residential HVAC types: 0.5"/25% supply, no return (Includes common stairs, corridors, and mechanical grouped with residential type function)	Fixed at 0.3 W/cfm Sized based on 20℉ dT to satisfy heating or cooling load (although mechanical cooling not provided)	Fixed at 0.3 W/cfm Sized based on 20℉ dT to satisfy heating or cooling load (although mechanical cooling not provided)	MAU at **0.90 W/cfm and PTACs at 1.0 W/cfm**, based on 2.6" tsp and 40% fan efficiency (assuming 85% & 75% η motor)	**Same kW/cfm as for Proposed (since under limit);** note that savings may still apply for better sized fans	Note that ASHRAE's ECB approach provides for a fan power limit that is lower than for the PRM. While the limit may not be exceeded, the ECB baseline fan power is to be set the same as the Proposed case if lower. Hence, it would be zero if there are no fan units in the suites, making the PRM more generous. Note that the NECB is likely mistake with Section 8 as the suite fan power increased significantly (8.4.4.19.3). ECM based on lower static pressure and higher efficiency motors. Electric baseboard case goes further with variable speed capability of ECM motors applied to reduce average supply flow.
Outside Air	0.097 cfm/sf	Same as Baseline / Proposed case			Same as Baseline / Proposed case		Based on LEED requirements referencing ASHRAE 62.1-2007; direct suite supply at 50 cfm/kitchen and 25 cfm/bath, plus 0.06 cfm/sf for common/corridor space.
Heat Reclaim	N/A **EAc1 6pt: 65% effective; Elec BBs: 75% effective** **22% Svgs: Same as above (65% for HW, 75% for Elec BBs)**	N/A	N/A	N/A	**50% effective sensible recovery since MAU >8900 cfm (conservative interpretation)**	N/A (unless exhaust is centralized and returned)	ASHRAE 90.1 exempts heat recovery if the largest exhaust source does not exceed 75% of ventilation delivery (6.3.6.1.(h)), which is also cited for the PRM. The NECB also exempts heat recovery for dwelling units with individual air systems, and does not clearly define what is considered as an "exhaust air system." Hence, application of heat recovery for the NECB case may not apply and is conservative here.
HVAC CONTROL							
Heating and Cooling Setpoints	MAU provides 65℉ air to corridors Average estimate of 72℉ with night setback to 68° for heating (not metered); 78℉ for cooling (residences keep homes warmer and con sistent with EnergyStar)						Note that many actual MURBs from audit keep MAU setpoint closer to 70℉. From calibrated bill analysis, *metered suites might maintain something closer to 68℉ with a setback to 64℉ or lower; this would apply to most cases with electric baseboards but I maintained the indicated setpoints for consistency.*

City of Vancouver Archetype EUIs

Item	Proposed** (TypHighRise)	MNECB+ecoEnergy (TypHighRise-MNECBRef)	ASHRAE 90.1-2007 App G (TypHighRise-PRM)	ASHRAE 90.1-2010 App G (TypHighRise-PRMv4)	NECB 2011* (TypHighRise-NECBRef)	ASHRAE 90.1-2010 ECB* (TypHighRise-ECB2010)	Notes (FAST analysis)
HEATING PLANT							
Central Heating Efficiency	80% efficiency; HW reset **EAc1 6 pts: *85% modulating* boilers; Elec BBs: 94% *η* condensing furnace** **22% Svgs: Same as above**	One 80% efficient boiler; no HW reset	Two 80% efficient boilers with HW reset	Two 80% efficient boilers with HW reset	**One 82.5% efficient fully modulating boiler with HW reset** **Elec BB case with 81% efficient modulating furnace**	Two 80% efficient boilers with HW reset; Elec BBs: **PTHPs at COP 3.2** with defrost starting below 40℉ and electric backup	Variation provides for electric baseboards serving suites; MAU heating served by hydronic coils except case with electric baseboards, where a gas-fired unit applies instead. The Proposed plant is assumed to be reasonably sized, but note that significant over-sizing can make a noticeable difference. The MNECB, Appendix G and NECB limit the amount of oversizing, but the ECB retains the same over-sizing level as for the Proposed Design, making it less stringent in this respect.
Hot Water Flow	Variable flow at 40 ft head and 65% pump *η* (11.6 W/gpm), based on 30℉ dT	Constant flow with same head as Proposed, based on 29℉ dT	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% *η*), based on a 50℉ dT	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% *η*), based on a 50℉ dT	**Constant flow with same head as Proposed, based on 29℉ dT**	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	MNECB via ecoEnergy allowances provide for possible credit due to more efficient pumps, but the credit is neglible (if any applies). Note that NECB Section 8 provisions conflict with what is prescriptively required (i.e., about the same as ASHRAE).
COOLING	*Note: the presence of cooling switches the advantage for LEED to the MNECB from ASHRAE*						
Cooling Efficiency	Air cooled chiller serving fan coils at 10 EER **EAc1 6pt - Elec BBs: Increased efficiency and water-side economizer** **22% Svgs: Same as above for elec BBs**	Reciprocating chiller at 3.8 COP	PTACs at EER 10.5	PTACs at EER 11	**Air cooled chiller (same type as Proposed) at 2.8 COP; no CHW reset**	PTACs at EER 11.0; PTHPs at EER 11.2	Adding cooling not only adds cooling energy, but more significantly, increases fan energy for the Proposed and MNECB Reference. In contrast, the ASHRAE Baseline maintains the same fan energy. Efficiency improvement provided for cutting cooling input requirements by about a third.
Chilled Water Temperature	12℉ rise; 44℉ supply	10℉ rise; 45℉ supply	n/a	n/a	11℉ rise; 45℉ supply	n/a	
Chilled Water Flow	Variable flow using VSDs	Constant	n/a	n/a	**Constant flow with same head as Proposed**	n/a	ASHRAE 90.1-2010 doesn't explicitly reference VSDs, but with the decrease to variable flow for 5HP systems (vs 50HP before), apply VSDs as they are common in practice.
Cooling Tower	N/A	Two cell cooling tower with 85℉ - 95℉ temperature rise, and a constant speed fan with cycling control and 5.9 hp/1000 MBH. Constant speed tower pump at same head as Proposed.	n/a	n/a	n/a	n/a	
DOMESTIC HOT WATER (DHW)							
Heating Efficiency	80% **EAc1 6pt: 94% condensing heaters for elec BBs** **22% Svgs: Same as above (for elec BBs)**	80%	80%	80%	80%	80%	
Avg. Load (Btu/sf/day)	17.8	Same as Baseline, but increased to account for ~9% for Energy Star appliance savings plus another 18% assuming 2.0 gpm showers (17% savings) and 1.3 gpm faucets (41% savings).			Same as previous reference cases, assuming same LEED eligible credits apply.	**Same as Proposed**	Average load derived from bill calibration studies. ecoEnergy savings based on showers accounting for 33% of DHW load from GVRD information (showers and faucets account for 33% and 24% of DHW load for residences, respectively). Since LEED does not apply to ECB method, assume no credit provided for low-flow fixtures.

City of Vancouver Archetype EUIs

Item	Proposed** (TypHighRise)	MNECB+ecoEnergy (TypHighRise-MNECBRef)	ASHRAE 90.1-2007 App G (TypHighRise-PRM)	ASHRAE 90.1-2010 App G (TypHighRise-PRMv4)	NECB 2011* (TypHighRise-NECBRef)	ASHRAE 90.1-2010 ECB* (TypHighRise-ECB2010)	Notes (FAST analysis)
UTILITY RATES							
Electricity	BC Hydro Residential and MGS Tariffs; blended avg. of $0.114/kWh, excl. fixed charges	Same as rates as Proposed equates to $0.100/kWh	Same as rates as Proposed equates to $0.101/kWh	Same rates as Proposed	Same rates as Proposed (although compliance is not based on energy costs)	Same rates as Proposed	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.
Natural Gas	FortisBC Rate 3, plus carbon tax; blended avg. of $10.43/GJ, excl. fixed charges	Same rates as Proposed	Same rates as Proposed	Same rates as Proposed	Same rates as Proposed (although compliance is not based on energy costs)	Same rates as Proposed	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.

Archetype Proposed design starting point is compliant with ASHRAE 90.1-2010 prescriptively (including possible application of envelope trade-off).* ***Maroon *entries represent changes to this base Proposed case to reach 6 EAc1 points under LEED 2009.* ***Blue*** *entries represent changes to the base Proposed case to reach 22% energy cost savings.*

**Red represents corresponding requirements that increase energy over ASHRAE 90.1-2010 while green result in energy savings (which doesn't necessarily translate equivalently to energy costs).*

City of Vancouver Archetype EUIs

Office **High-Rise** **High-Rise**

Weather: Typical year for Vancouver, BC.

Schedules: Schedules are identical between the Reference and Proposed Design and are derived from research studies (which indicate longer hours than MNECB default schedules.

Floor Area: 260,000 ft² (24,200 m²) 18-storey facility; simplified zoning with 4 perimeter and 1 core, uniformly loaded (internally) zones per floor. Does not include about 100,000 ft² of unheated underground parking.

Note that all end-use energy is included for all cases, even though NECB and ECB compliance allow for exclusion of some end-uses (e.g., exterior lighting).

Item	Proposed** (OfficeFC / OfficeFCv4)	MNECB+ecoEnergy (Office-MNECBRef)	ASHRAE 90.1-2007 App G (Office-PRMref)	ASHRAE 90.1-2010 App G (Office-PRMv4)	NECB 2011* (Office-NECBRef)	ASHRAE 90.1-2010 ECB* (Office-ECB2010)	Notes (CBIPTest analysis)
PROPOSED **Costs ($):** **ENERGY SAVINGS** **Energy Use:**		**36% (7 pts - 2009)** **(37% energy use)**	11% (0 pts - 2009) (18% energy use)	17% (6 pts - v4) (29% energy use)	**22% (9 pts - v4)** **(28% energy use)**	14% (n/a for LEED) (20% energy use)	
EXTERIOR SURFACES							
Wall	Ro-8.3 41,500 ft² net area (103,700 ft² gross) **>22% Svgs: Ro-9.3 (via lower thermal bridging / added insulation)**	Electric Heat Source: 12.6 Gas/Heat Pump Heat Source: **7.0** Admin Region BC-A	Mass 0% / Metal 0% / **Steel** 100% / Other 0% → R_o 15.6 12.5 / 17.5 / 15.6 / 19.61 Climate Zone 5	Mass 0% / Metal 0% / **Steel** 100% / Other 0% → R_o 15.6 12.5 / 14.49 / 15.6 / 19.61 Trade-Off tested with COMCheck, which fails with double pane windows Climate Zone 5	No variation by construction **18.0** Trade-Off Method complies for vertical surfaces Climate Zone 4	Mass 10% / Metal 0% / Steel 90% / Other 0% → R_o 15.2 12.5 / 14.49 / 15.6 / 19.61 ECB dictates one-to-one correlation of wall types Climate Zone 5	Proposed with high performance curtain wall with 4" semi-rigid insulation in spandrels and R-9 spray foam in between interior studs (spray foam n/a for slab edges). Proposed design with nearly the best available curtainwall system will not comply with ASHRAE 90.1-2010 via envelope trade-off method using ComCheck, unless triple pane windows are used. As many offices have over 60% glazing and even lower wall R-values, compliance via ECB method is most applicable option available to many (most) offices in Vancouver.
Roof	Ro-22.2 15,300 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: **12.1**	Insulation Entirely above Deck 20.8	Insulation Entirely above Deck 20.8	No variation by construction **25.0**	Insulation Entirely above Deck 20.8	
Exposed Floor (over Parkade)	Ro-15.1 14,400 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: **12.1**	Steel Joist 0% / 100% / 0% → 26.3 15.6 / 26.3 / 30.3	Steel Joist 0% / 100% / 0% → 26.3 15.6 / 26.3 / 30.3	No variation by construction 25.0	Mass 100% / 0% / 0% → **15.6** 15.6 / 26.3 / 30.3	Baseline equivalent to 8" concrete floor over parkade with 4.5" spray applied cellulosic fibre. Note that ECB varies from PRM in that PRM dictates application of more stringent Steel Joist type instead of Mass type. For NECB compliance, Trade-Off Method unlikely given amount of insulation dictated for floor, even though walls/windows can comply with Proposed configuration.
GLAZING							
Exposure	60% 62,200 ft²	40%	40%	40%	40%	40%	Baseline with nearly best available low-e double pane units available in a high performance curtain wall frame. Note that with Trade-off Method, triple pane would be required (which appears to have a limit of about 70% window-to-wall ratio).
Window U-value	Uo-0.32 **Uo-0.21 (triple pane)**	Electric Heat Source: .56 fixed / 0.56 Gas/Heat Pump Heat Source: .60 op | .56 fixed / **0.56**	Non-metal 0% / **store** 100% / **c.w./ door** 0% / Metal 0% / Metal 0% / Other 0% → U_o 0.45 0.35 / 0.45 / 0.80 / 0.55	Non-metal 0% / **store** 100% / **c.w./ door** 0% / Metal 0% / Metal 0% / Other 0% → U_o 0.45 0.35 / 0.45 / 0.80 / 0.55	No variation by window type **0.42**	Non-metal 0% / **store** 100% / **c.w./ door** 0% / Metal 0% / Metal 0% / Other 0% → U_o 0.45 0.35 / 0.45 / 0.80 / 0.55	U-value based on CSA-rated sizes, which are typically generous; hence, actual performance likely worse.
Window Shading Coefficient	0.22	Same as Proposed	0.46 (all orientations)	0.46 (all orientations)	No requirements (same as for Baseline for Performance Path)	0.46 (all orientations)	MNECB allows for SC set at 0.74 if it improves relative savings -- which it rarely does.

City of Vancouver Archetype EUIs

Item	Proposed** (OfficeFC / OfficeFCv4)	MNECB+ecoEnergy (Office-MNECBRef)	ASHRAE 90.1-2007 App G (Office-PRMref)	ASHRAE 90.1-2010 App G (Office-PRMv4)	NECB 2011* (Office-NECBRef)	ASHRAE 90.1-2010 ECB* (Office-ECB2010)	Notes (CBIPTest analysis)
SPACE CONDITIONS							
Interior Lighting	0.9 W/ft² OS control on 70% and daylighting on 35%, for a 24.5% savings (0.68 W/ft² adj.) **>22% Svgs: 0.70 W/ft² (0.528 adj.)**	1.67 W/ft² (18 W/m²) No controls	1.0 W/ft² Limited OS controls (meeting, lounges), provide for roughly 3% savings.	0.9 W/ft² OS control on 70% and daylighting on 35%, provides for a 24.5% savings	0.9 W/ft² OS control on 70% and daylighting on 10%, provides for a 23.5% savings	0.9 W/ft² OS control on 70% and daylighting on 35%, provides for a 24.5% savings	0.9 W/ft² represents ASHRAE 90.1-2010 requirements on a building basis. Occupancy sensor (OS) and daylighting control are assumed at the 2010 side-lighting requirements, conservatively assuming mostly open office (enclosed offices rarely are required to have daylighting due to room size <250 ft²). Note that NECB doesn't require daylighting control unless daylit space is >100 m², but this has very little impact.
Parking Lighting	0.25 W/ft² x 100000 ft², less 20% for OS control = 20 kW; add 5 kW for avg. misc. loads (e.g., parkade fans) **>22% Svgs: 20% savings on parkade lighting**	0.3 W/ft² No controls	0.3 W/ft² No controls	0.25 W/ft² x 100000 ft², less 20% for OS control = 20 kW (Misc. loads same as Baseline)	0.25 W/ft² x 100000 ft² = 25 kW; note **no OS control** (Misc. loads same as Baseline)	0.25 W/ft² x 100000 ft², less 20% for OS control = 20 kW (Misc. loads same as Baseline)	0.25 W/ft² represents ASHRAE 90.1-2010 requirements on a building basis; estimate occupancy sensors apply to 2/3rds of lighting not left on continuously for security purposes. Note that exterior lighting is to remain the same between the ECB and Proposed cases, but parkade lighting is not regulated as exterior lighting.
Equipment density	0.7 W/ft² ~120 MWh/year for 6 elevators **>22% Svgs: 40% reduction for ecoSpace units**	Same as Proposed, unless non-regulated savings can be demonstrated, per LEED and Appendix G provisions (e.g., for high efficiency elevators)			Same as Proposed, unless non-regulated savings can be demonstrated to be consistent with LEED v4	Same as Proposed (no non-regulated process credit)	MNECB default of 0.7 W/sf is relatively typical, although non-regulated loads can vary significantly.
GENERAL HVAC							
Air Handling	Fan coils served by constant volume central make-up air unit (MAU).	Variable air volume with reheat via baseboards	Variable air volume with terminal reheat *for each floor*	Variable air volume with terminal reheat for each *floor*	Variable air volume with reheat via baseboards	Four-pipe fan coil served by MAU (same configuration as Proposed)	We see a relatively even representation between VAV, fan coil and distributed heat pumps in the market. All can perform relatively well and equivalently. Note that the NECB Section 8 does not indicate to provide for a VAV system for each floor, although this was adopted into CanQUEST due to limitations with its adaptation from eQUEST.
Heating Source	Hot water	Hot water	Hot water	Hot water	Hot water	Hot water	
Cooling Source	Chilled water	Chilled water	Chilled water	Chilled water	Chilled water	Chilled water	
FAN SYSTEM							
Fan Power	MAU: 3.5"/1.5" static at 60% fan η for supply/return (0.98 W/cfm); Fan coils: 0.5" static at 25% fan η (0.23 W/cfm) **>22% Svgs: 34% fan energy reduction with better design, efficiencies and controls**	4.0" static at 55% fan η for supply; 1.0" static at 30% fan η for return	4.4" static at 60% fan η for overall (supply, return *and exhaust*), based on conservative 1.0 W/cfm estimated requirement	4.4" static at 60% fan η for overall (supply, return *and exhaust*), based on conservative 1.0 W/cfm estimated requirement	4.0" static at 55% fan η for supply; 1.0" static at 30% fan η for return	**Same kW/cfm as for Proposed (since under limit)**	Note that ASHRAE's ECB approach provides for a fan power *limit* that is lower than for the PRM. While the limit may not be exceeded, the ECB baseline fan power is to be set the same as the Proposed case if lower (i.e., no credit provided for lower Proposed fan power).
Outside Air	0.25 cfm/sf	Same as Baseline / Proposed case			Same as Baseline / Proposed case		ASHRAE 62.1-2007 for LEED would typically dictate lower (e.g., ~0.15 cfm/ft²), but Vancouver and the BC Code dictates higher ASHRAE 62.1-2001 levels.
Fan Curve (VAV only)	N/A	Forward curve inlet vane (c)	VSD fan curve, as specified in Table G3.1.3.15	VSD fan curve, as specified in Table G3.1.3.15	**Forward curve inlet vane (same as MNECB)**	N/A	PRM fan curve is very similar to MNECB VSD curve (which performs relatively close to MNECB Type "c" curve).

City of Vancouver Archetype EUIs

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Heat Reclaim	70% effective enthalpy wheel, represented at 60% net effectiveness **>22% Svgs: 80% total effectiveness**	N/A	N/A	N/A	**50% effective sensible recovery (since exhaust >8900 cfm)**	**50% effective total heat recovery**	ASHRAE 90.1 likely requires heat recovery, and is relatively common for such dedicated outdoor air systems.
HVAC CONTROL							
Heating and Cooling Setpoints	Heating at 72℉ with 64℉ setback Cooling at 75℉ (off at night)	Same as Proposed	Same as Proposed	Same as Proposed	Same as Proposed	Same as Proposed	
Supply Air Temperature Control	MAU delivers 55℉ air; fan coils at 55℉ minimum for cooling and 110° maximum for heating	Minimum at 55℉, reset based on warmest zone Maximum up to 110℉	Minimum 55 - 60℉ for cooling, reset based on warmest zone Maximum up to 92℉	Minimum 55 - 60℉ for cooling, reset based on warmest zone Maximum up to 92℉	Consistent with CanQUEST, minimum at 55℉, reset based on warmest zone	MAU delivers 55℉ air; fan coils at 55℉ minimum for cooling and 92° maximum for heating	NECB 8.4.4.19.a indicates constant supply air temperature, which not only prescriptively violates the NECB, but NRCan and LEED identified as an error as well. Note that if constant control is applied, it manifests in a significant savings difference.
Minimum Supply Flow	Same as supply at ~1.1 cfm/ft² **>22% Svgs: Avg 25% reduction (better sizing, multi-speed optimization)**	0.4 cfm/ft²	0.4 cfm/ft²	30% of peak flow	**0.4 cfm/ft²**	Constant volume, auto-sized to meet load	The 2010 version of ASHRAE 90.1 Appendix G changed the minimum flow requirement from previous versions.
Economizer	Water-side	Enthalpy	Dry bulb	Dry bulb	Enthalpy	Water-side	Enthalpy makes little or no difference compared to dry bulb.
HEATING PLANT							
Central Heating Efficiency	85% efficient, modulating boilers HW reset **>22% Svgs: 90% seasonally η condensing boilers**	One 80% efficient boiler; no HW reset	Two 80% efficient boilers with HW reset	Two 80% efficient boilers with HW reset	**One 82.5% efficient fully modulating boiler with HW reset**	Two 80% efficient boilers with HW reset	
Hot Water Flow	Variable flow with VSDs at 60 ft head and 65% pump η, based on 29℉ dT	Constant flow with same head as Proposed, based on 29℉ dT	Variable flow with VSDs at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	Variable flow with VSDs at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	**Constant flow with same head as Proposed, based on 29℉ dT**	Variable flow with VSDs at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	MNECB via ecoEnergy allowances provide for possible credit due to more efficient pumps, but the credit is neglible (if any applies). Note that NECB Section 8 provisions conflict with prescriptive requirements for pumps.
COOLING							
Central Cooling Efficiency	Two centrifugal chillers at 6.0 COP; with CHW reset	Centrifugal chiller at 5.2 COP; no CHW reset	Two screw chillers at 4.9 COP; with CHW reset	Two screw chillers at 5.2 COP (0.68 kW/ton); with CHW reset	Centrifugal chiller (same type as Proposed) at **5.0 COP; no CHW reset**	Two screw chillers at 5.2 COP (0.68 kW/ton); with CHW reset	ASHRAE 90.1-2010 changed requirements to provide for a "Path A" and "Path B" efficiency levels, where Path A has a lower full-load rating but a higher IPLV and Path A visa versa. As Appendix G doesn't indicate which to apply, we applied Path A since the simulation provided for an IPLV which was well below the requirement. NECB COP derived from CanQUEST code.
Chilled Water Temperature	12℉ rise; 44℉ supply	10℉ rise; 45℉ supply	12℉ rise; 44℉ supply	12℉ rise; 4 4℉ supply	11℉ rise; 45℉ supply	12℉ rise; 44℉ supply	
Chilled Water Flow	Variable flow with VSDs at 75 ft head and 65% pump η (22 W/gpm)	Constant flow with same head as Proposed	Variable flow with VSDs at 22 W/gpm (75 ft head at 65% η)	Variable flow with VSDs at 22 W/gpm (75 ft head at 65% η)	**Constant flow with same head as Proposed**	Variable flow with VSDs at 22 W/gpm (75 ft head at 65% η)	Note that NECB Section 8 provisions conflict with prescriptive requirements for pumps.

City of Vancouver Archetype EUIs

Item	Proposed** (OfficeFC / OfficeFCv4)	MNECB+ecoEnergy (Office-MNECBRef)	ASHRAE 90.1-2007 App G (Office-PRMref)	ASHRAE 90.1-2010 App G (Office-PRMv4)	NECB 2011* (Office-NECBRef)	ASHRAE 90.1-2010 ECB* (Office-ECB2010)	Notes (CBIPTest analysis)
Cooling Tower	Two cell tower with 85℉ - 95℉ temperature rise, and a variable speed fan with cycling control and 32.8 gpm/hp, with wet bulb reset down to 68℉. Constant speed tower pump at 40' head and combined efficiency of 65%.	Two cell tower with 85℉ - 95℉ temperature rise, and a constant speed fan with cycling control and 5.9 hp/1000 MBH. Constant speed tower pump at same head as Proposed.	Two cell tower with 85℉ - 95℉ temperature rise, approach to design wb temperature (68℉) with wb reset control down to 70℉, a two speed fan with cycling control and 32.8 gpm/hp of fan power (i.e,. E-I-R = 0.021). Constant speed pumping at 19 W/gpm (60 ft head at 60% η).	Two cell tower with 85℉ - 95℉ temperature rise, approach to design wb temperature (68℉) with wb reset control down to 70℉, a two speed fan with cycling control and 32.8 gpm/hp of fan power (i.e,. E-I-R = 0.021). Constant speed pumping at 19 W/gpm (60 ft head at 60% η).	Two cell tower with 85℉ - 95℉ temperature rise, and a **constant speed fan** with cycling control and **5.9 hp/1000 MBH**. Constant speed tower pump at **same head as Proposed**.	Two cell tower with 85℉ - 95℉ temperature rise, approach to design wb temperature (68℉) with wb reset control down to 70℉, a two speed fan with cycling control and 32.8 gpm/hp of fan power (i.e,. E-I-R = 0.021). Constant speed pumping at 19 W/gpm (60 ft head at 60% η).	Maintain consistent conditions, although they may vary for Performance (Modelling) Path.
DOMESTIC HOT WATER (DHW)							
Heating Efficiency	80%	80%	80%	80%	80%	80%	
Avg. Load (kBtu/day)	16,300	Same as Proposed, but without accounting for about 50% reduction for low flow fixtures (mostly faucets).			Same as Proposed, without low-flow fixtures	**Same as Proposed**	Since LEED does not apply to ECB method, assume no credit provided for low-flow fixtures.
UTILITY RATES							
Electricity	BC Hydro MGS Tariffs; blended avg. of $0.084/kWh, excl. fixed charges	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	
Natural Gas	FortisBC Rate 3, plus carbon tax; blended avg. of $10.40/GJ, excl. fixed charges	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	

Archetype Proposed base design is compliant with ASHRAE 90.1-2010 via ECB method.* ***Maroon *entries represent changes to this base Proposed case to reach 6 EAc1 points under LEED 2009.* ***Blue*** *entries represent changes to the base Proposed case to reach 22% energy cost savings.*

**Red represents corresponding requirements that increase energy over ASHRAE 90.1-2010 while green result in energy savings (which doesn't necessarily translate equivalently to energy costs).*

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Retail **Ground Floor** **Ground Floor**

Weather: Typical year for Vancouver, BC.

Schedules: Schedules are identical between the Reference and Proposed Design and are based mainly on MNECB defaults, as the referencing project was a LEED CS application where the specific tenant operations were not fully known.

Floor Area: 36600 ft² (plus 46900 ft² for renovated below grade parking), distributed over 2 storeys.

Note that all end-use energy is included for all cases, even though NECB and ECB compliance allow for exclusion of some end-uses (e.g., exterior lighting).

Item	Proposed** (Retail_Pro / Retail_ProLEEDv4)	MNECB+ecoEnergy (Retail_MNECBRef)	ASHRAE 90.1-2007 App G (Retail_PRMRef)	ASHRAE 90.1-2010 App G (Retail_PRMv4)	NECB 2011* (Retail-NECBRef)	ASHRAE 90.1-2010 ECB (Retail_ECB2010)	Notes (DOE2.1e analysis)
PROPOSED ENERGY SAVINGS	**Costs ($):** **Energy Use:**	**33% (7 pts - 2009) (43% energy use)**	-7% (Fails EAp2) (2% energy use)	13% (6 pts - v4) (21% energy use)	**22% (11 pts - v4) (20% energy use)**	18% (n/a for LEED) (19% energy use)	
EXTERIOR SURFACES							
Wall	Ro-15.6 15,340 ft² net area (18,900 ft² gross)	Electric Heat Source: Admin Region BC-A: 12.6 Gas/Heat Pump Heat Source: 7.0 Ro-9.0 with electrically heated service spaces	Mass 0% / Metal 0% / **Steel** 100% / Other 0% Climate Zone 5 12.5 / 17.5 / 15.6 / 19.61 R_o 15.6	Mass 0% / Metal 0% / **Steel** 100% / Other 0% Climate Zone 5 12.5 / 14.49 / 15.6 / 19.61 R_o 15.6	No variation by construction Climate Zone 4 18.0 Trade-Off Method doubtfully would pass, especially at same window percent	Mass 90% / Metal 10% / Steel 0% / Other 0% Climate Zone 5 12.5 / 14.49 / 15.6 / 19.61 R_o **12.7**	Over 90% of walls consist of renovated concrete block walls at Ro-17.6 (RSI-3.1) with nominal R-20 interior spray foam insulation which has a 2" continuous layer between the wall and inner steel stud wall, pulled away from the exterior wall. Remaining walls at Ro-6.7 (RSI-1.2) for steel stud cementious panel rainscreen with nominal R-20 spray foam insulation between the studs. Proposed design satisfied City of Vancouver Bylaw via envelope trade-off method for ASHRAE 90.1-2007, which is nearly identical to 2010.
Roof	Ro-22.2 0 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: **12.1**	Insulation Entirely above Deck 20.8	Insulation Entirely above Deck 20.8	No variation by construction 25.0	Insulation Entirely above Deck 20.8	**No roof area** applied, so as to proportionally represent ground floor retail as part of a larger mixed use facility.
Exposed Floor (over Parkade)	Ro-15.7 14,700 ft² area	Electric Heat Source: 13.8 Gas/Heat Pump Heat Source: **12.1**	Steel Joist 0% / 100% / 0% / 26.3 15.6 / 26.3 / 30.3	Steel Joist 0% / 100% / 0% / 26.3 15.6 / 26.3 / 30.3	No variation by construction 25.0	Mass 100% / 0% / 0% 15.6 / 26.3 / 30.3 **15.6**	Baseline equivalent to 8" concrete floor over parkade with 4.7" spray applied cellulosic fibre. Note that ECB varies from PRM in that PRM dictates application of more stringent Steel Joist type instead of Mass type.
GLAZING							
Exposure	19% 3,500 ft²	19%	19%	19%	19%	19%	Note that the NECB 2011 prescribes that the fenestration percentage is set at 40%, but the CoV altered this provision.
Window U-value	Uo-0.43	Electric Heat Source: .60 op | .56 fixed: 0.56 Gas/Heat Pump Heat Source: .60 op | .56 fixed: **0.56**	Metal / Non-metal: 0% / **Store** c.w.: 90% / **door**: 10% / Metal / metal: 0% / Other 0.35 / 0.45 / 0.80 / 0.55 U_o 0.49	Metal / Non-metal: 0% / store c.w.: 90% / door: 10% / Metal / metal: 0% / Other 0.35 / 0.45 / 0.80 / 0.55 U_o 0.49	No variation by window type 0.42	Metal / Non-metal: 0% / store c.w.: 90% / door: 10% / Metal / metal: 0% / Other 0.35 / 0.45 / 0.80 / 0.55 U_o 0.49	Operable type (glass doors) represent 10% of window area
Window Shading Coefficient	0.22	Same as Proposed	0.46 (all orientations)	0.46 (all orientations)	No requirements (same as for Baseline for Performance Path)	0.46 (all orientations)	MNECB allows for SC set at 0.74 if it improves relative savings -- which it rarely does.
SPACE CONDITIONS							
Interior Lighting	0.65 W/ft² overall, including parkade and OS control; retail at 1.4 W/ft² **22% Svgs: 25% retail lighting reduction, including display lighting**	1.36 W/ft² overall, with mix of retail (2.8 W/ft²) and parking (below)	0.81 W/ft² overall, including mix of retail (1.5 W/ft²) and parking (below)	0.72 W/ft² overall, including mix of retail (1.4 W/ft²) and parking (below)	0.75 W/ft² overall, including mix of retail (1.4 W/ft²) and parking (below)	0.72 W/ft² overall, including mix of retail (1.4 W/ft²) and parking (below)	Unspecified retail lighting originally set at City Bylaw of 1.4 W/ft² LPA for Proposed. ASHRAE 90.1-2010 and NECB LPDs account for minor influence of occupancy sensors for small stair well. ECM dictates reducing lighting including exempted display window lighting (assuming another 0.15 W/sf of non-regulated plug load allocated to display lighting). This may be very challenging, partly due to market acceptance to specifying in a tenant lease agreement. Application of LEDs for display lighting and/or daylighting may be options to help achieve.

City of Vancouver Archetype EUIs

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Parking Lighting	0.12 W/ft² including 20% credit for OS	0.3 W/ft²	0.3 W/ft²	0.25 W/ft², less 20% of OS (0.20 W/ft² effective)	0.25 W/ft²; note **no OS control**	0.25 W/ft², less 20% of OS (0.20 W/ft² effective)	0.25 W/ft² represents ASHRAE 90.1-2010 requirements on a building basis; estimate occupancy sensors apply to 2/3rds of lighting not left on continuously for security purposes. Note that exterior lighting is to remain the same between the ECB and Proposed cases, but parkade lighting is not regulated as exterior lighting.
Equipment density	0.7 W/ft² ~12 MWh/year for vertical transport	Same as Proposed			Same as Proposed		Pre LEED CS requirements, provide for 20 W/person in tenant fit-out spaces.
GENERAL HVAC							
Air Handling	Retail with distributed heat pumps served by MAUs; small CRUs to provide MAUs with central electric resistance heating; transition / circulation zones with single zone fan units with electrical baseboards.	Packaged VAV with baseboards for multiple zone systems; constant volume for single zone systems.	Packaged VAV with terminal reheat (System 5) *for each floor.* Packaged single zone (PSZ) heat pumps (System 4) serving electrically heated transition zones, as space conditions vary "significantly from the rest of the building."	Packaged VAV with terminal reheat (System 5) for each floor. Packaged single zone (PSZ) heat pumps (System 4) serving electrically heated transition zones, as space conditions vary "significantly from the rest of the building."	Packaged **constant volume single zone** systems with air-source heat pumps for zones served by distributed heat pumps, and electric resistance otherwise; all zones to have electric baseboards.	Identical configuration to Proposed (distributed heat pumps with electric resistance MAUs) packaged rooftop heat pumps (System 9) serving zones with fan units and electric baseboards.	Note that for ASHRAE 90.1, cooling is technically to be provided but LEED Canada has over-riden this such that the same level of cooling (comfort) is represented. Unfortunately, the USGBC likely will overturn this with LEED v4, but this is maintained here to reflect a more realistic and consistent comparison. Also, while Appendix G dictates heat pumps for Proposed zones with electric heating, these are associated with service / transition spaces where heat is barely on. Hence, it does not make much difference in this case, but for many ground floor retail, it could make a bigger difference as it is very common for ground floor retail to be heated *only* by air-source heat pumps and/or electric resistance. Note that the NECB contains circular references that make it confusing whether heat pumps should apply when the Proposed Design is a distributed heat pump system. Because of this inconsistency, we applied the same approach as CanQUEST applies air-source heat pumps with baseboards served by the same source as serves the distributed heat pumps (i.e., hot water from a gas-fired boiler). Note that the ancillary zones served by electric resistance are mapped to PTACs with electric baseboards. All baseboards are sized based on LS-B peak x 1.3 (consistent with CanQUEST).
Heating Source	Gas-fired hot water boiler / heat pumps; electric resistance serving corridors, stairs	Gas-fired hot water boiler (as generated by EE4, which arguably is not fully correct)	Gas-fired hot water boiler for VAV Heat pump for PSZ	Gas-fired hot water boiler for VAV Heat pump for PSZ	**Air-source heat pumps / electric resistance**	Gas-fired boiler serving **distributed heat pumps** (System 6) Gas-fired furnace serving MAUs (System 11) Heat pump with electric backup (System 9)	
Cooling Source	DX; None for transition zones	DX; None for transition zones	DX; None for transition zones	DX; None for transition zones	DX; None for transition zones	DX; None for transition zones	
FAN SYSTEM							
Fan Power	Coincident fan power of 32.0 kW for 50,200 cfm zone flow (0.64 W/cfm) overall **22% Svgs: 30% energy savings**	Coincident fan power of 21.1 kW for 38,300 cfm (0.64 W/cfm) overall	Coincident fan power of 20.6 kW for 21,200 cfm (0.97 W/cfm) overall	Same as 90.1-2007: Coincident fan power of 14.0 kW for 18600 cfm (0.75 W/cfm) overall	Coincident power of 12.9 kW for 16900 cfm (0.76 W/cfm) overall, based on packaged units at 2.6" tsp and 40% fan efficiency	**Same kW/cfm as for Proposed (since under limit)**, but sizing provides for lower flow (20,000 cfm zone flow)	Note that ASHRAE's ECB approach provides for a fan power *limit* that is lower than for the PRM, but the ECB baseline fan power is to be set the same as the Proposed case if lower. ECM based on lower static pressure, higher efficiency fans and motors, as well as optimal sizing and variable speed capability (e.g., with ECM motors) applied to reduce average supply flow.
Outside Air	0.24 cfm/sf	Same as Baseline / Proposed case			Same as Baseline / Proposed case		
Fan Curve (VAV only)	N/A	Relative poor "riding curve" (a) for smallest systems; axial flow with inlet vanes (b) for medium size system	VSD fan curve, as specified in Table G3.1.1.15	VSD fan curve, as specified in Table G3.1.1.15	N/A	N/A	
Heat Reclaim	none	N/A	N/A	N/A	N/A	N/A	Exhaust heat recovery is not required by Code since no MAU (100% O/A) provides more than 4000 cfm. For the comparative Baseline cases it rarely would be applicable since either the O/A fraction is too low or O/A is too low.

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HVAC CONTROL							
Heating and Cooling Setpoints	Heating at 72℉ with 64℉ setback Cooling at 75℉ (off at night)	Same as Proposed	Same as Proposed	Same as Proposed	Same as Proposed	Same as Proposed	
Supply Air Temperature Control	MAU delivers 55℉ air; heat pumps at 55℉ minimum for cooling and 110° maximum for heating	Minimum at 55℉, reset based on warmest zone Maximum up to 110℉	Minimum 55 - 60℉ for cooling, reset based on warmest zone Maximum up to 90℉	Minimum 55 - 60℉ for cooling, reset based on warmest zone Maximum up to 90℉	Consistent with CanQUEST, minimum at 55℉	MAU delivers 55℉ air; heat pumps at 55℉ minimum for cooling and 90° maximum for heating	NECB 8.4.4.19.a indicates constant supply air temperature, which not only prescriptively violates the NECB, but NRCan and LEED identified as an error as well. Note that if constant control is applied, it manifests in a significant savings difference.
Minimum Supply Flow	Same as supply at ~1.1 cfm/ft²	0.4 cfm/ft² for all zones	0.4 cfm/ft² for VAV systems	30% of peak flow	**0.4 cfm/ft²**	Constant volume	The 2010 version of ASHRAE 90.1 Appendix G changed the minimum flow requirement from previous versions.
Economizer	none	Enthalpy	Dry bulb	Dry bulb	Enthalpy	none	Enthalpy makes little or no difference compared to dry bulb.
HEATING PLANT							
Central Heating Efficiency	90% efficient condensing boiler; HP COP 5 - 5.2 **22% Svgs: 20% improvement in annual efficiency**	One 80% efficient boiler	Two 81.1% efficient (80% AFUE) boilers with HW reset	Two 81.1% efficient (80% AFUE) boilers with HW reset	**One 82.5% efficient fully modulating boiler with HW reset**	**Single 80% efficient boiler / 4.2 COP water-source HPs; 80% efficient furnaces; 7.7 HSPF air-source HPs**	Note that MNECB is over-sized by the minimum of (1) the Proposed over-sizing ratio or 1.3, whichever is smaller. Appendix G simply fixes the degree of over-sizing at 1.25, as does CanQUEST to a 1.3 over-sizing factor. The ECB over-sizes the same as for the Proposed, which usually is more advantageous.
Hot Water Flow	Constant flow at 16.5 W/gpm against 58 ft head, based on 10℉ dT for HP loop **22% Svgs: Variable flow with VSDs**	Constant flow with same head as Proposed, based on 29℉ dT (Note: bug with EE4 resulted in only 6.7 ft of head, for 3.7 W/gpm)	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	Continuous variable flow riding pump curve at 19 W/gpm (60 ft head at 60% η), based on a 50℉ dT	**Constant flow with same head as Proposed, based on 29℉ dT**	**Pump power same as for Proposed (16.5 W/gpm), with variable speed control, riding curve, and heat pumps with two-position valves**	Note that NECB Section 8 provisions conflict with what is prescriptively required (i.e., about the same as ASHRAE).
COOLING							
Cooling Efficiency	Distributed heat pumps at 15 – 15.9 EER **22% Svgs: 20% Improvement in annual efficiency**	DX cooling at COP of 2.5	SEER 13, estimated at EER 11 based on product literature	SEER 13, estimated at EER 11 based on product literature	**SEER 14**, estimated at EER 11.8 based on EPA formula	Distributed heat pumps at 12 EER (COP 3.5); packaged heat pumps at 13 SEER (EER 11)	ASHRAE specifies seasonal cooling and heating efficiencies for small AC and HP units, but this is based on specific controlled loading and is very problematic to represent with modelling for specific conditions. Note that the MNECB is over-sized by the minimum of (1) the Proposed over-sizing ratio or 1.3, whichever is smaller. Appendix G simply fixes the degree of over-sizing at 1.15, and CanQUEST fixes to a 1.1 over-sizing factor. The ECB over-sizes the same as for the Proposed.
Cooling Tower	Fluid cooler with 87.4 - 95℉ rise and VSD fan with wetbulb reset down to 68℉. Constant speed tower pump at 34 ft head and 65% overall efficiency.	Fluid cooler with 87℉ - 95℉ temperature rise, and a variable speed fan and ~31 gpm/hp (0.020 EIR), with wet bulb reset down to 68℉. Constant speed tower pump at 34' head and combined efficiency of 65%.	N/A	N/A	N/A	Fluid cooler with two-speed fan and *assumed* 85° - 95℉ temperature rise and 32.8 gpm/hp of fan power (i.e,. E-I-R = 0.021). Constant speed pumping at same pump power as Proposed assumed.	Maintain consistent conditions, although they may vary for Performance (Modelling) Path. Note that for ASHRAE 90.1's ECB distributed heat pump system (System 6), no direction is provided for what setting should apply to the heat rejection equipment other than reference to possible two-speed fan if dictated by 6.5.5.2 (assumed to apply to be conservative). Hence, we went with settings consistent with chilled water systems.
DOMESTIC HOT WATER (DHW)							
Heating Efficiency	100% (electric)	100% (electric)	apply same as Proposed, although lower "energy factor" indicated	apply same as Proposed, although lower "energy factor" indicated	100% (electric)	apply same as Proposed, although lower "energy factor" indicated	Very small spot electric tank heaters
Avg. Load (kBtu/day)	16,300	Same as Proposed, but without accounting for about 30% reduction for low flow fixtures (faucets).			Same as Proposed, without low-flow fixtures	**Same as Proposed**	Since LEED does not apply to ECB method, assume no credit provided for low-flow fixtures.

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UTILITY RATES							
Electricity	BC Hydro SGS Tariffs; blended avg. of $0.102/kWh, excl. fixed charges	Same as rates as Proposed (although may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Same as rates as Proposed (may results in different blended avg.)	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.
Natural Gas	FortisBC Rate 2, plus carbon tax; blended avg. of $11.02/GJ, excl. fixed charges	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	Same as rates as Proposed	Rates are applicable since LEED EAc1 points are determined based on utility costs. Electric rates are relatively complicated with inclining and declining block charges for energy and demand (for non-residential) with 103 accounts.

***Archetype Proposed design starting point is compliant with ASHRAE 90.1-2010 prescriptively (including possible application of envelope trade-off). **Maroon** entries represent changes to this base Proposed case to reach 6 EAc1 points under LEED 2009. **Blue** entries represent changes to the base Proposed case to reach 22% energy cost savings.*

**Red represents corresponding requirements that increase energy over ASHRAE 90.1-2010 while green result in energy savings (which doesn't necessarily translate equivalently to energy costs).*