MCW Consultants Ltd.

New Construction Energy Study

for

Surrey Civic Centre

Surrey, BC

V3244
ISSUED FOR REVIEW
January 8, 2013

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Vancouver, BC
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1. Executive Summary

An energy study of the new building was undertaken using IES <VE> Pro v6.3, in accordance with the requirements of the BC Hydro Power Smart New Construction Program and an initial draft was completed on the 28th February 2011.

This study included analysing the effects of upgrading the building envelope, upgrading glazing types including external shading, reducing lighting power density for both interior and exterior lighting, using advanced lighting controls, using a high efficiency air conditioning system, using low flow plumbing fixtures, and using variable speed drives for heating and cooling water pumps.

The results of the analysis are summarized in Table 1 on the following page:

1.1. Discussion and Recommendations

Recommendations are to be completed once all energy conservation measures have been analysed and all cost information has been collated.

Table 1 - Results Summary

Name	Measure	Incremental Capital Costs ($)	Unit	Total Capital Costs ($)	Annual Electricity Savings (kWh)	Annual Electricity Cost Savings ($/yr)*	Annual Maintenance Cost Savings ($/yr)	Simple Payback (years)	Non Energy Benefits	Comments
ECM#1	Increased Roof Insulation	$5,000	4,400 sm	$25,000	3,698	$251	-	-	Increased insulation levels will improve occupancy comfort by reducing drafts and improving radiant temperatures of surfaces.	
ECM#2	Increased Wall Insulation	$5,000	4,450 sm	$20,000	7,682	$597	-	-		
ECM#3	High Performance Glazing	$200,000	58,800 sm	$500,000	65,951	$6,938	-	-	Improved comfort as above. Reducing peak solar gains may reduce the size of mechanical equipment. Reduced glare from low level sun during winter.	
ECM#4	Shading Overhangs	$2,000,000	Lump sum	$2,000,000	58,217	$8,148	-	-		High cost savings from reduced demand fees in summer months.
ECM#5	Reduced Interior LPD	$100,000	Lump sum	$1,200,000	195,592	$15,207	-	-		
ECM#6	Reduced Exterior LPD	$20,000	Lump sum	$200,000	49,465	$3,118	-	-		
ECM#7	Occupancy Controls for Interior Lighting	$63,892	500 occupancy sensors	$65,540	129,052	$9,812	-$6,000	-		
ECM#8	Interior Daylighting Controls	$16,590	150 daylight sensors	$16,590	48,068	$4,320	-$6,000	-		
ECM#9	Upgraded Space Heating and Conditioning Systems	$200,000	Lump sum	$600,000	147,127	$10,624	-	-	UFAD system allows for greater occupant control over individual comfort conditions.	
ECM#10	Low Flow Plumbing Fixtures	$5,000	200 fixtures	$70,000	226,880	$21,667	-	-	Reduced domestic water use may reduce pipe sizes and demand on civic water supply.	
ECM#11	Variable Speed Drives for Cooling Pumps	$20,000	6 drives	$20,000	21,492	$2,082	-	-		
Combined savings from all measures. (LEED Proposed Case)**		TBA	$2,549,842		$3,357130	$76,110	-	-		

* Note – the annual energy savings include both demand and energy charges.
** Note – results obtained using the whole building method, hence the results are different than summing each individual element.

2. Building Description

The proposed Surrey Civic Centre will be a 18,039 m² (194,171 ft²) six-storey facility, with 37,384 m² (402,398ft²) of underground parking across three levels, to be built at the corner of 104 Ave and University Drive in Surrey, BC. The facility will include program space for six uses:

1. Office Space
2. Conference / Lecture Theatre
3. Daycare
4. Administration
5. Public gathering
6. Ancillary Spaces

The mechanical and electrical systems for these spaces will be purpose-designed for each use and occupancy, with energy-use reduction as a high priority. This building has a mandatory requirement to achieve LEED Gold. The project is currently in design development phase.

The building typically uses a lightweight construction for walls and with a concrete roof. The building sits atop a three level parkade. The office space is spread across an eastern and a western wing which are both connected by a central atrium. The exterior envelope of the building has a window-to-wall ratio of 56.9%. Images of the model can be seen in Figure 1 and Figure 2 below.

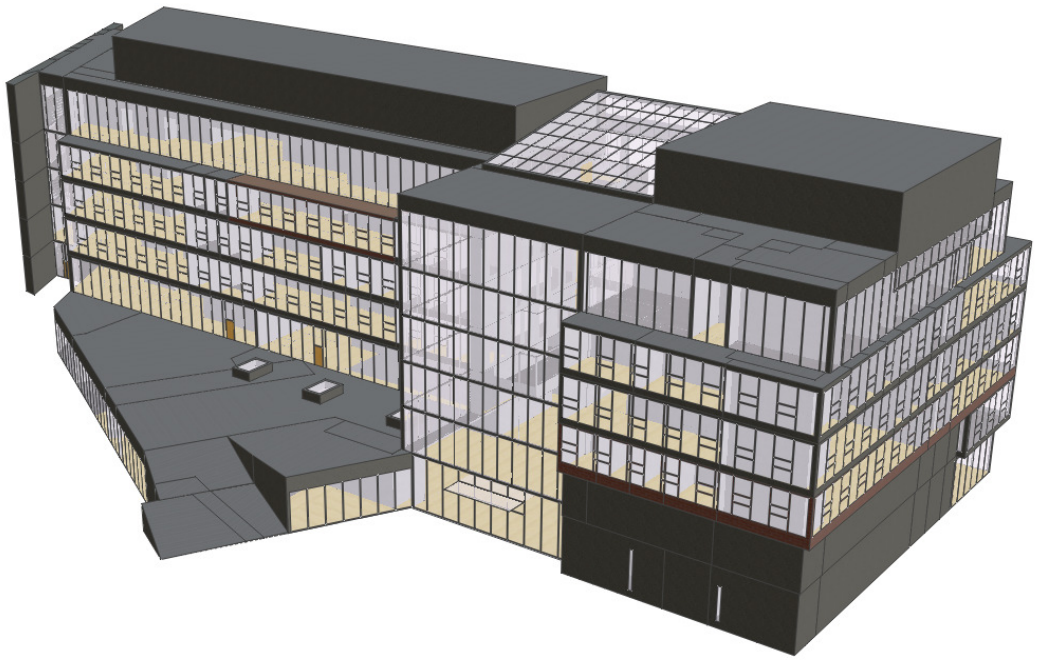

Figure 1 - Surrey Civic Centre - Base Case SE View (External Shading Removed)

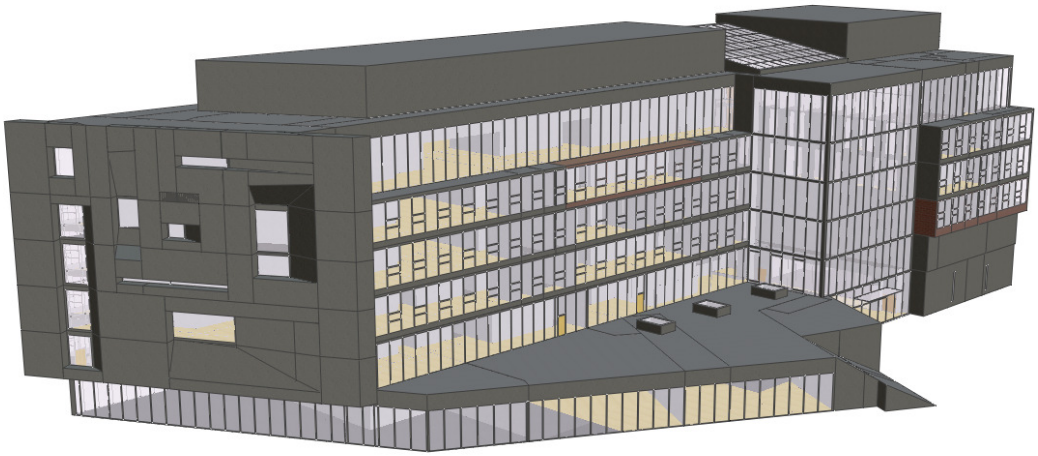

Figure 2 - Surrey Civic Centre - Base Case SW View (External Shading Removed)

Schedules for lighting, occupancy, domestic hot water and electrical equipment were based on ASHRAE schedules from the 90.1 User's Manual – Appendix G, and are based on space type for each space.

The indoor design temperatures used in the model are shown in the table below:

Table 2 - Seasonal Temperature Setpoints

Season	Setpoint	Setback
Heating	21ºC (70ºF)	16ºC (65ºF)
Cooling	24ºC (76ºF)	28ºC (82ºF)

As per ASHRAE 55-2004, humidity control is not required for coastal areas.

In order to gauge the effects of changes to the envelope, a modified version of the ASHRAE 90.1 Baseline mechanical systems were used for all simulations. The system used was System 8 – VAV with PFP Boxes for Non Residential Buildings with more than five floors. The mechanical plant supplying these systems was based on a water source heat pump system, providing heat recovery during simultaneous heating and cooling, with a cooling tower and boiler.

The proposed mechanical systems are Underfloor VAV system, with radiant in-floor heating/cooling for atrium areas. Heat recovery coils for AHUs 1, 2, 3 and 4 providing heat to the condenser water system. Heat recovery from water to air pumps providing heat to the condenser water system. GSHP with back up boiler system provides heating and cooling source for the mechanical system.Lighting power densities for all simulations were based on ASHRAE 90.1 base case, using the space-by-space method.

3. Energy Costs

The energy costs used in the energy model were based on BC Hydro rates for Large General Service (Commercial): Over 150kW for 1 month, from February 2012. The rates used are shown in the table below:

Table 3 - Energy Cost Summary

Basic Charge:	19.25 cents per day
Demand Charge:	First 35 kW for NIL Next 115 kW at $4.69 per kW All additional kW at $9.00 per kW
Energy Charge:	First 14,800 kWh $0.0937 per kWh All additional kWh $0.0451 per kWh

Source: B.C Hydro Business Website, February 2012.

Overall energy costs include 2.5% rate rider and 12% HST. Baseline rate energy use penalties and discounts have been excluded from the calculated energy costs.

Natural gas costs were based on Terasen Gas rate schedule 3 for the Lower Mainland (Large Commercial > 2000 GJ/year), effective from January 1st, 2012. A summary of the rates are shown in the table below:

Table 4 - Energy Cost Summary

Basic Charge:	$134.97 per month
Energy Charge:	$6.391 per GJ

4. Analysis

A base case model modified from a standard ASHRAE 90.1-2004 base case was developed in IES <VE> in order to compare the proposed energy conservation measures. A summary of the analysed elements of the base case and proposed buildings can be seen in Table 5 below:

Table 5 - Building Description

Model Parameter	Baseline Building	Proposed Building
Envelope Performance		
Overall Roof R-value	Insulation Entirely Above Deck - R15 as per Table 5.5-5	ECM #1: Increased roof insulation by R5. (R20 Roof Final)
Overall Wall R-value	Steel Framed Wall – Average R12 as per Table 5.5-5	ECM #2: Increased Wall insulation by R6 (R18 Wall Final)
Vertical Glazing Properties	For less than 40% glazing based on gross wall area: U=0.57 SHGC =0.39 As per Table 5.5-5	ECM #3: Low E Glazing with the following Values: U=0.25 SHGC= 0.28 Window wall radio 56.9%

Shading	No Shading	ECM#4: External shading including vertical fins on south and west exposures; overhangs on south and west exposures; and roof overhang.
Lighting Performance		
Lighting Power Density	The requirements for design of lighting system outlined in Section 9 based on the space-by-space method.	ECM#5: Reduced interior LPD by 15%. ECM#6: Reduced LPD for exterior lighting by 30%.
Lighting Controls	The requirements for design of lighting system outlined in Section 9.	ECM#7: Occupancy Controls in offices, corridors, lobby, washrooms, services rooms, and parkade. ECM#8: Daylight control for perimeter spaces.
Mechanical Systems		
Heating/Cooling/Ventilation System **Terminal Units**	Based on Table G3.1.1A for Non-residential & 5 floors or more or greater than 150,000 sq. ft. with primary heating for proposed case being heat pump: System No.8: VAV w/PFP Boxes System Type: Variable air volume with reheat. Fan Control: Variable Volume Cooling Type: Chilled Water Heating Type: Heated Water No heat recovery	ECM#9: Underfloor VAV system. Radiant in-floor heating/cooling for atrium. Hydronic unit heaters for service areas. Heat recovery coils for AHUs 1, 2, 3 and 4 providing heat to the condenser water system. Heat recovery from water to air pumps providing heat to the condenser water system.
DHW System	Domestic hot water provided by electricity heating system.	ECM#10: Domestic how water provided by electricity heating system. Low flow plumbing fixtures is used to reduce DHW demand.
Central Plant		
Cooling System	Water source heat pumps with cooling tower.	ECM#9: Ground source heat pumps.
Cooling Efficiency	WSHP COP = 3.52 Cooling Tower Fan = 0.0105 W(fan) / W(heat rejection)	ECM#9: Seven WSHP units. Cooling PL: COP= 5.7 Cooling FL: COP= 4.8
Heating System	Water source heat pumps with boiler. Heat recovery from cooling	ECM#9: Ground source heat pumps. Heat recovery from cooling

	WSHPs via condenser water system.	WSHPs via condenser water system.
Heating Efficiency	WSHP COP = 4.2 Boiler Efficiency = 80%	ECM#9: Seven WSHP units. Heating PL: COP= 3.7 Heating FL: COP= 3.3
Pumps	Single speed	ECM#11: Variable frequency drives on chilled and heated water pumps.

4.1. EPM –Energy Penalty Model

An EPM (energy penalty model) with window wall ratio of 56.9% is simulated in addition to the baseline model. The other settings of the EPM model are the same as the baseline model. As per "guideline of window wall ratio" from BC Hydro, the energy consumption and cost of all ECMs are compared to those in EPM model.

Table 6 - EPM Energy Savings Summary

Utility	Baseline Energy Use (kWh)	EPM Energy Use (kWh)	Baseline Energy Cost ($)	EPM Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,387,772	4,485,884	$365,930.16	$372,452.70	-98,112	-$6,523	-2.19%	-1.75%
Gas	883,223	1,014,623	$ 24,573.33	$27,959.31	-131,400	-$3,386	-12.95%	-12.11%
Total	5,270,995	5,500,507	$ 390,503.49	$400,412.01	-229,512	-$9,909	-4.17%	-2.47%

4.2. ECM#1 – Increased Roof Insulation

The proposed energy conservation measure is to increase the roof insulation above the minimum standard required by ASHRAE 90.1. The base case insulation value, according to table 5.5-5 of ASHRAE 90.1 for Insulation Entirely above Deck is R15. The proposed insulation level is R20.

A model was derived from the base case model by increasing the roof insulation in each space hence the energy savings can be compared directly with the base case model.

The results are as follows:

Table 7 - ECM#1 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#1 Energy Use (kWh)	EPM Energy Cost ($)	ECM#1 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,482,187	$372,452.70	$372,201.38	3,698	$251	0.08%	0.07%
Gas	1,014,623	1,000,697	$27,959.31	$27,600.46	13,926	$359	1.37%	1.28%
Total	5,500,507	5,482,883	$400,412.01	$399,801.84	17,624	$610	0.32%	0.15%

4.3. ECM#2 – Increased Wall Insulation

The energy conservation measure involves increasing the external wall insulation above that required by ASHRAE 90.1. The base case insulation value, according to table 5.5-5 of ASHRAE 90.1 for Steel-Framed is an average of R12, based on the given assembly maximum U-value of 0.084. The proposed insulation value for external walls is R18.

Again the model was derived from the base case by increasing the external wall insulation in each space.

The results are as follows.

Table8 - ECM#2 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#2 Energy Use (kWh)	EPM Energy Cost ($)	ECM#2 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,478,202	$372,452.70	$371,855.87	7,682	$597	0.17%	0.16%
Gas	1,014,623	996,933	$27,959.31	$27,503.47	17,690	$456	1.74%	1.63%
Total	5,500,507	5,475,135	$400,412.01	$399,359.34	25,372	$1,053	0.46%	0.26%

4.4. ECM#3 – High Performance Glazing

The use of high performance glazing in place of ASHRAE 90.1 minimum glazing was analysed. The base case values referenced in Table 5.5-5 of ASHRAE 90.1-2004 for a fixed window are a U value of 0.57 and a Solar Heat Gain Coefficient (SHGC) of 0.39. The proposed glazing values are a U value of 0.25 and an SHGC of 0.28. The results are as follows:

Table 9 - ECM#3 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#3 Energy Use (kWh)	EPM Energy Cost ($)	ECM#3 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,398,934	$372,452.70	$365,514.40	86,951	$6,938	1.94%	1.86%
Gas	1,014,623	728,708	$27,959.31	$20,591.71	285,915	$7,368	28.18%	26.35%
Total	5,500,507	5,127,641	$400,412.01	$386,106.11	372,866	$14,306	6.78%	3.57%

4.5. ECM#4 – External Shading

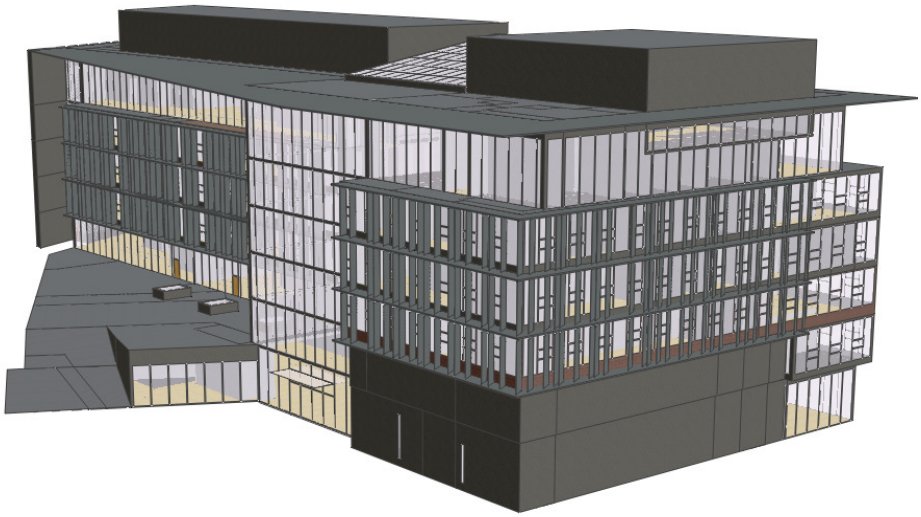

Figure 3 – ECM#4 External Shading SE View

The energy savings made through the use of external shades to reduce solar gains was analysed. Overhangs and stationary vertical fins were added to the south and west facing exposures, between the third and fifth floors. In addition the roof canopy was added as shown in Figure 3. The results are compared with the ASHRAE 90.1 base case with no overhangs or shading.

The results are shown below in Table .

Table 10 - ECM#4 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#4 Energy Use (kWh)	EPM Energy Cost ($)	ECM#4 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,427,668	$372,452.70	$364,305.04	58,217	$8,148	1.30%	2.19%
Gas	1,014,623	1,097,276	$27,959.31	$30,089.16	-82,653	-$2,130	-8.15%	-7.62%
Total	5,500,507	5,524,943	$400,412.01	$394,394.19	-24,436	$6,018	-0.44%	1.50%

4.6. ECM#5 – Reduced Interior Lighting Power Density

In order to assess the impact of selecting energy efficient lighting fixtures, the interior lighting power density throughout the building was reduced by 15% compared to the maximum values stated by ASHRAE 90.1 2004 Table 9.6.1.

The results are shown below in Table 7.

Table 7 - ECM#5 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#5 Energy Use (kWh)	EPM Energy Cost ($)	ECM#5 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,293,292	$372,452.70	$357,246.09	192,592	$15,207	4.29%	4.08%
Gas	1,014,623	1,047,521	$27,959.31	$28,807.04	-32,898	-$848	-3.24%	-3.03%
Total	5,500,507	5,340,813	$400,412.01	$386,053.13	159,694	$14,359	2.90%	3.59%

4.7. ECM#6 – Reduced Exterior Lighting Power Density

In order to assess the impact of selecting energy efficient lighting fixtures, the exterior lighting power density was reduced by 30% over the minimum efficiency required by ASHRAE 90.1 2004. The exterior lighting analysis allows for the area of the plaza. The results are shown below in Table .

Table 12 - ECM#6 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#6 Energy Use (kWh)	EPM Energy Cost ($)	ECM#6 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,436,420	$372,452.70	$369,334.43	49,465	$3,118	1.10%	0.84%
Gas	1,014,623	1,014,623	$27,959.31	$27,959.31	0	$0	0.00%	0.00%
Total	5,500,507	5,451,042	$400,412.01	$397,293.74	49,465	$3,118	0.90%	0.78%

4.8. ECM#7 – Interior Occupancy Controls

The use of occupancy controls to reduce the energy use of interior lighting was analysed. This was modelled as a 10 % reduction in lighting power density in the listed areas (offices, corridors, lobby, washrooms, service rooms and parkade) as per ASHRAE 90.1 Table G3.2.

The results are shown below in Table 8.

Table 8 - ECM#7 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#7 Energy Use (kWh)	EPM Energy Cost ($)	ECM#7 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,356,833	$372,452.70	$362,640.71	129,052	$9,812	2.88%	2.63%
Gas	1,014,623	1,036,817	$27,959.31	$28,531.24	-22,195	-$572	-2.19%	-2.05%
Total	5,500,507	5,393,650	$400,412.01	$391,171.95	106,857	$9,240	1.94%	2.31%

4.9. ECM#8 – Interior Daylighting Controls

Daylighting levels in perimeter spaces were obtained using the radiance calculation package included with IES <VE> Pro. Lighting controls were modelled such that lights would be fully on when there is no light and gradually reduce to 30% when the sensed illuminance level 500lux is reached.

The results are shown below in Table 9.

Table 9 - ECM#8 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#8 Energy Use (kWh)	EPM Energy Cost ($)	ECM#8 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,437,816	$372,452.70	$368,132.33	48,068	$4,320	1.07%	1.16%
Gas	1,014,623	1,024,470	$27,959.31	$28,213.07	-9,848	-$254	-0.97%	-0.91%
Total	5,500,507	5,462,287	$400,412.01	$396,345.40	38,220	$4,067	0.69%	1.02%

4.10. ECM#9 – Efficient Heating and Air Conditioning Systems

The proposed mechanical system was analysed to determine the potential energy savings of the design, compared of the ASHRAE 90.1 base case system. The underfloor VAV system for office areas was modelled by raising R/A setpoint to 83F (average R/A temp as determined using UFAD design guide methods). The atrium conditioning was provided using a radiant floor slab.

The results are shown below in Table 10.

Table 10 - ECM#9 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#9 Energy Use (kWh)	EPM Energy Cost ($)	ECM#9 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,338,758	$372,452.70	$361,828.86	147,127	$10,624	3.28%	2.85%
Gas	1,014,623	329,300	$27,959.31	$10,299.57	685,323	$17,660	67.54%	63.16%
Total	5,500,507	4,668,058	$400,412.01	$372,128.43	832,449	$28,284	15.13%	7.06%

4.11. ECM#10– Low Flow Plumbing Fixtures

The proposal to use low flow plumbing fixtures will lead to a 75% reduction in domestic hot water use, based on LEED base case fixture flow rates. The impact of this saving on the overall energy use of the building can be seen below in Table .

Table 11 - ECM#10 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#10 Energy Use (kWh)	EPM Energy Cost ($)	ECM#10 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,259,005	$372,452.70	$350,787.11	226,880	$21,666	5.06%	5.82%
Gas	1,014,623	1,014,623	$27,959.31	$27,959.31	0	$0	0.00%	0.00%
Total	5,500,507	5,273,627	$400,412.01	$378,746.42	226,880	$21,666	4.12%	5.41%

4.12. ECM#11 – Variable Speed Drives for Cooling Water Pumps

It is proposed to use variable speed drives on chilled and heating water pumps. The use of VSDs was modelled and the results are shown below in Table .

Table 12 - ECM#11 Energy Savings Summary

Utility	EPM Energy Use (kWh)	ECM#11 Energy Use (kWh)	EPM Energy Cost ($)	ECM#11 Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	4,464,393	$372,452.70	$370,371.08	21,492	$2,082	0.48%	0.56%
Gas	1,014,623	1,014,623	$27,959.31	$27,959.31	0	$0	0.00%	0.00%
Total	5,500,507	5,479,015	$400,412.01	$398,330.39	21,492	$2,082	0.39%	0.52%

4.13. Proposed Case

All measures were combined to form a proposed "bundle" case. This gives an indication of the overall potential energy savings from all measures. The results are shown in Table below:

Table 13 - Proposed Case Energy Savings Summary

Utility	EPM Energy Use (kWh)	Proposed Energy Use (kWh)	EPM Energy Cost ($)	Proposed Energy Cost ($)	Estimated Energy Savings (kWh/yr)	Estimated Cost Savings ($/yr)	% Energy Savings	% Cost Savings
Electricity	4,485,884	3,621,847	$372,452.70	$296,343.12	864,038	$76,110	19.26%	20.43%
Gas	1,014,623	245,199	$27,959.31	$8,132.40	769,424	$19,827	75.83%	70.91%
Total	5,500,507	3,867,045	$400,412.01	$304,475.51	1,633,462	$95,936	29.70%	23.96%

5. Study Coordinator

Energy Modeller – William Watkins P.Eng., MCW Consultants Ltd.

Energy Modeller-Xiangjin Yang, Mechanical Designer, LEED AP, MCW Consultants Ltd.

Reviewed By – Sam Louie P.Eng., LEED AP, MCW Consultants Ltd.

Reviewed By – Brian Tysoe P.Eng., LEED AP, MCW Consultants Ltd.

6. BC Hydro Power Smart NC Approved Energy Modeller

Brian Tysoe, M.A.Sc., P.Eng., LEED AP
MCW Consultants Ltd.

Appendix I – Power Smart NC Economic Analysis Spreadsheet

To be completed.

Appendix II – Energy Use Breakdown Table

Total energy Model Number	Interior Lighting (MWh)	Exterior Lighting (MWh)	Space Heating (Fossil Fuel), (MWh)	Space Heating (Electricity (MWh)	Space cooling (MWh)	Fan (MWh)	Pump (MWh)	Receptacle (MWh)	Elevator (MWh)	DHW Electricity (MWh)	Average monthly demand (KW)*	Total Energy Savings**	Energy Intensity (KWh/m2) ***
Baseline	1283	161	898	148	245	239	280	1726	20	302	1120.8	-4.17%	306.26
EPM	1283	161	1014	183	255	263	292	1726	20	302	1132.0	5500(MWh)	--
ECM#1	1283	161	1001	180	255	263	292	1726	20	302	1131.6	0.32%	--
ECM#2	1283	161	997	176	255	263	292	1726	20	302	1130.5	0.46%	--
ECM#3	1283	161	728	114	249	256	287	1726	20	302	1112.7	6.78%	--
ECM#4	1283	161	1097	205	229	255	274	1726	20	302	1090.8	-0.44%	--
ECM#5	1090	161	1047	192	249	261	291	1726	20	302	1089.7	2.9%	--
ECM#6	1283	113	1014	183	255	263	292	1726	20	302	1127.8	0.9%	--
ECM#7	1154	161	1037	189	249	262	291	1726	20	302	1107.2	1.94%	--
ECM#8	1254	161	1024	185	249	262	280	1726	20	302	1117.6	0.69%	--
ECM#9	1283	161	329	110	215	108	415	1726	20	302	1108.2	15.13%	--
ECM#10	1283	161	1014	183	255	263	292	1726	20	75	1052.3	4.12%	--
ECM#11	1283	161	1014	182	255	263	286	1726	20	302	1124.4	0.39%	--
Proposed	933	113	245	79	191	112	372	1726	20	75	878.0	29.70%	214.53

*Note- Average monthly demand is defined as the average monthly electricity demand in each model through the whole year.
**Note- Total energy savings is compared to EPM case annual energy consumption.
***Note- Energy intensity is defined as the annual energy consumption divided by the total area of the conditioned spaces.