

## **NECB 2015 Update to Economic Analysis for Archetype Buildings**

Prepared for: Government of Newfoundland and Labrador  
Government Purchasing Agency  
30 Strawberry Marsh Road, St. John's, NL  
A1B 4R4

Attention: Gerald Crane  
Office of Climate Change and Energy Efficiency

Prepared by: Caneta Research Inc.  
7145 West Credit Ave.  
Suite 102, Building 2  
Mississauga, Ontario  
L5N 6J7

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## 1. Introduction

As a follow-up to the report prepared in March 2015, Caneta has been asked to extend the energy and life-cycle costing analysis to include the addition of National Energy Code for Buildings (NECB) 2015 standard for St. John's, Newfoundland (NECB Climate Zone 6). This update will provide an indication of the economics and energy impacts for new buildings designed NECB 2015 relative to both NECB 2011 and what is considered current practice in the province (ASHRAE 90.1-2007).

The electricity cost and projected electricity escalation rates were updated from the values used in the original 2015 study. The new electricity rates, in cost per unit energy ( $\$/\text{kWh}$ ), are shown in the following table for Newfoundland and Labrador Hydro - General Service (Rate No. 2.1, 2.3, 2.4).

Note: There are no electricity rate projections publicly available for the purposes of this study. The analysis for commercial buildings is based on preliminary 2017 projected rates (to take effect April 1, 2017), includes a 2% cost of living increase in each of 2018 and 2019, is calculated for 2020 based on publicly available residential rates for when Muskrat Falls comes on line, and includes a 2% cost of living increase annually thereafter. There is uncertainty regarding the precise rates in each year going forward, particularly for 2020 and the rates used in this analysis are illustrative for life cycle modelling purposes only.

	2016	2017	2018	2019	2020	2021+
<b>GS 0-100 kW (110 kVA)</b>	9.4	9.5	9.7	9.9	18.9	increase by 2% each year
<b>GS 110-1000 kVA</b>	8.9	9.0	9.2	9.4	17.9	increase by 2% each year
<b>GS &gt;1000 kVA</b>	8.2	8.4	8.5	8.7	16.6	increase by 2% each year

In addition to the update electricity costs, the original capital costs estimates were also adjusted for inflation to reflect current costs.

## 2. NECB 2015 Energy Efficiency Parameters

For the archetype buildings evaluated in this study, the key differences between NECB 2011 and NECB 2015 are:

- Adjusted lighting power density allowances. NECB 2015 values have been modified to match ASHRAE 90.1-2013 values.
- Increased requirements for daylight sensing controls of light fixtures.
- Reduction in the maximum flow rate for plumbing fixtures to match the requirements in the 2015 Model National Plumbing Code. As a result, hot water consumption is reduced through lower flow rates of lavatory fixtures and showerheads.

The lighting power densities in the NECB 2015 building archetypes were modelled in accordance with Table 4.2.1.5 of the NECB 2015, in conjunction with Clause 4.3.3.10 and

Clause 4.3.3.7 for occupancy and daylight control, respectively.

The hot water load reductions were estimated based on past analysis correlating actual DHW consumption to nominal fixture flow reduction.

### **3. Annual Energy Comparison**

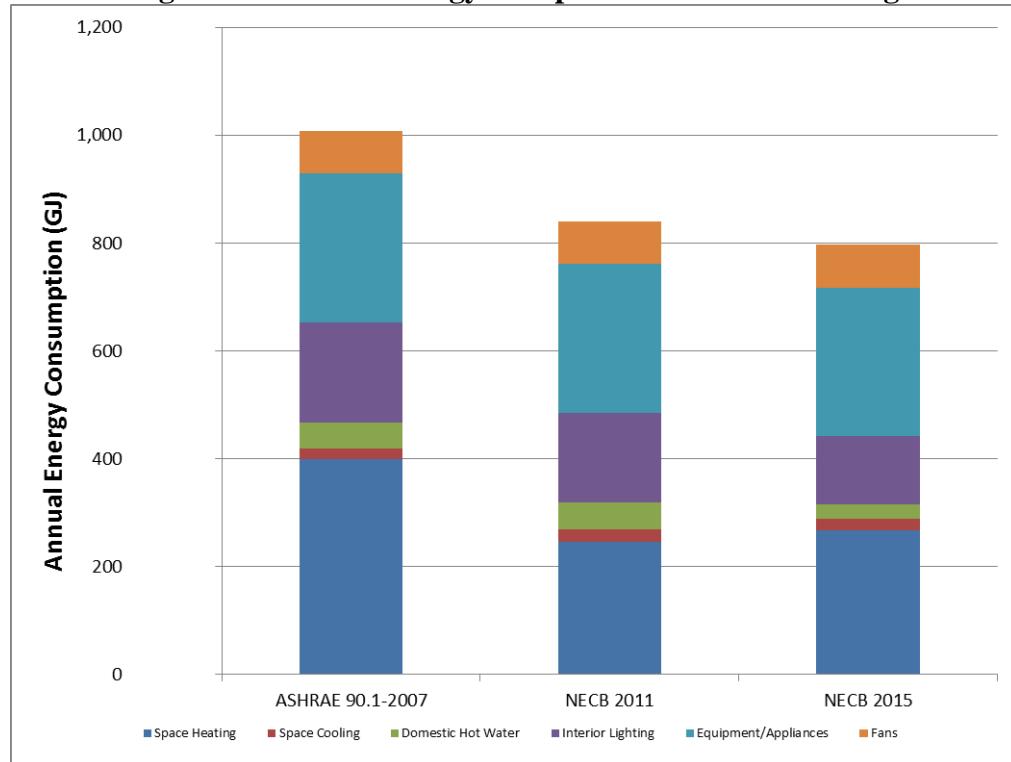
The annual energy consumptions of the 5 archetypes are summarized below. One table is provided for each archetype.

Note: The allowed lighting power density for the restaurant dinning space has increased from NECB 2011 to NECB 2015. Consequently, the energy consumption for lighting is lower in NECB 2011 than NECB 2015. However, the requirements for daylighting controls have increased, and due to the cost of daylighting controls there are still incremental capital costs associated with lighting in the restaurant archetype.

**Table 1: Energy Simulation Results – Office Building**

DESCRIPTION	Current Practice (ASHRAE 90.1-2007)	NECB 2011	NECB 2015
<b>ENERGY USED (GJ)</b>			
Space Heating	400	246	268
Space Cooling	20	24	22
Domestic Hot Water	49	49	27
Interior Lighting	186	167	125
Equip./Appliances	276	276	276
Fans	79	79	80
<i>Total</i>	<b>1,008</b>	<b>840</b>	<b>798</b>
<i>GJ/m<sup>2</sup></i>	<b>0.67</b>	<b>0.56</b>	<b>0.53</b>
<b>ELECTRICITY</b>			
Metered Peak Demand (kW)	151	131	130
Metered Consumption (kWh)	280,133	233,237	221,581
<b>ENERGY CHARGES (\$)</b>			
Electric (Consumption)	24,932	20,758	19,721
Electric (Demand)			
<i>Total</i>	<b>24,932</b>	<b>20,758</b>	<b>19,721</b>
<b>ANNUAL SAVINGS (\$)</b>			
<i>(\$/m<sup>2</sup>)</i>	0.00	4.174	5.211
<i>(\$/m<sup>2</sup>)</i>	0.00	2.78	3.47
<b>SAVINGS (Relative to 90.1-2007)</b>			
Energy Consumption	0.00	16.7%	20.9%
Energy Charges	0.00	16.7%	20.9%
<b>SAVINGS (Relative to NECB 2011)</b>			
Energy Consumption		0.00	5.0%
Energy Charges		0.00	5.0%

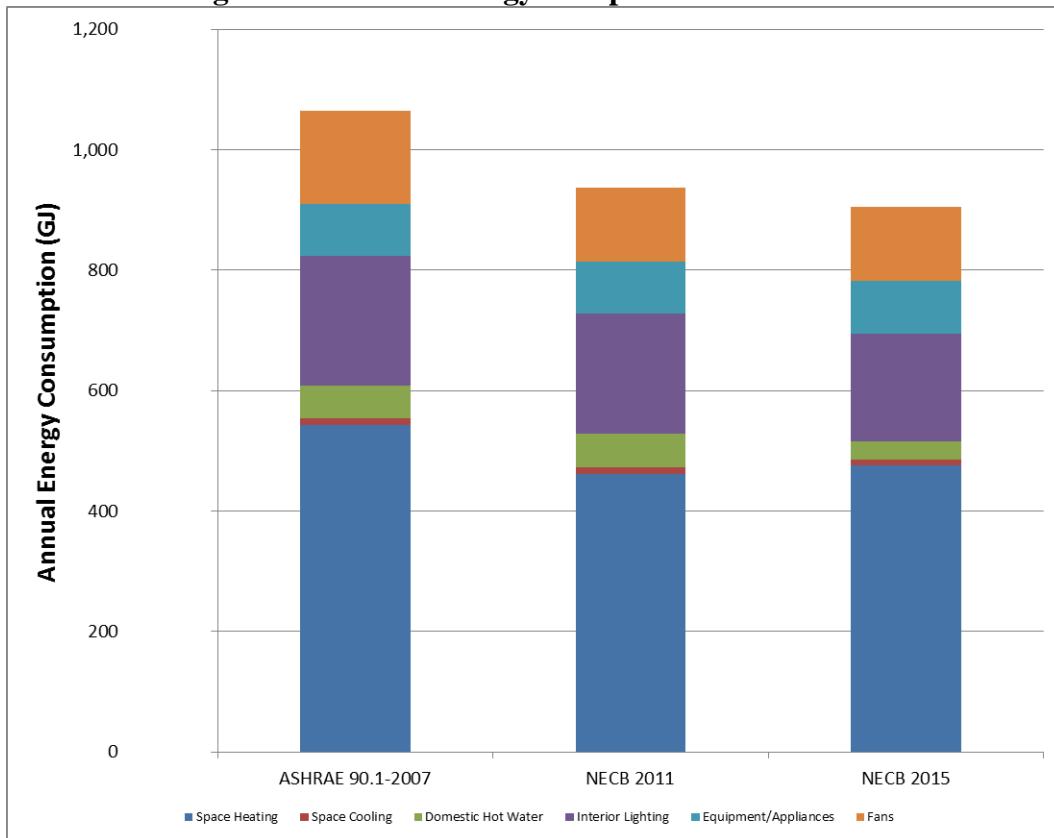
**Figure 1: Annual Energy Comparison – Office Building**



**Table 2: Energy Simulation Results – Box Retail**

DESCRIPTION	Current Practice (ASHRAE 90.1-2007)	NECB 2011	NECB 2015
<b>ENERGY USED (GJ)</b>			
Space Heating	543	462	476
Space Cooling	11	11	10
Domestic Hot Water	55	55	30
Interior Lighting	215	200	179
Equip./Appliances	87	87	87
Fans	155	123	124
<i>Total</i>	<b>1,065</b>	<b>938</b>	<b>906</b>
<i>GJ/m<sup>2</sup></i>	<b>1.07</b>	<b>0.94</b>	<b>0.91</b>
<b>ELECTRICITY</b>			
Metered Peak Demand (kW)	161	147	148
Metered Consumption (kWh)	295,836	260,469	251,603
<b>ENERGY CHARGES (\$)</b>			
Electric (Consumption)	26,329	23,182	22,393
Electric (Demand)			
<i>Total</i>	<b>26,329</b>	<b>23,182</b>	<b>22,393</b>
<b>ANNUAL SAVINGS (\$)</b>			
<i>(\$/m<sup>2</sup>)</i>	0.00	3.148	3,937
<i>(\$/m<sup>2</sup>)</i>	0.00	3.15	3.94
<b>SAVINGS (Relative to 90.1-2007)</b>			
Energy Consumption	0.00	12.0%	15.0%
Energy Charges	0.00	12.0%	15.0%
<b>SAVINGS (Relative to NECB 2011)</b>			
Energy Consumption		0.00	3.4%
Energy Charges		0.00	3.4%

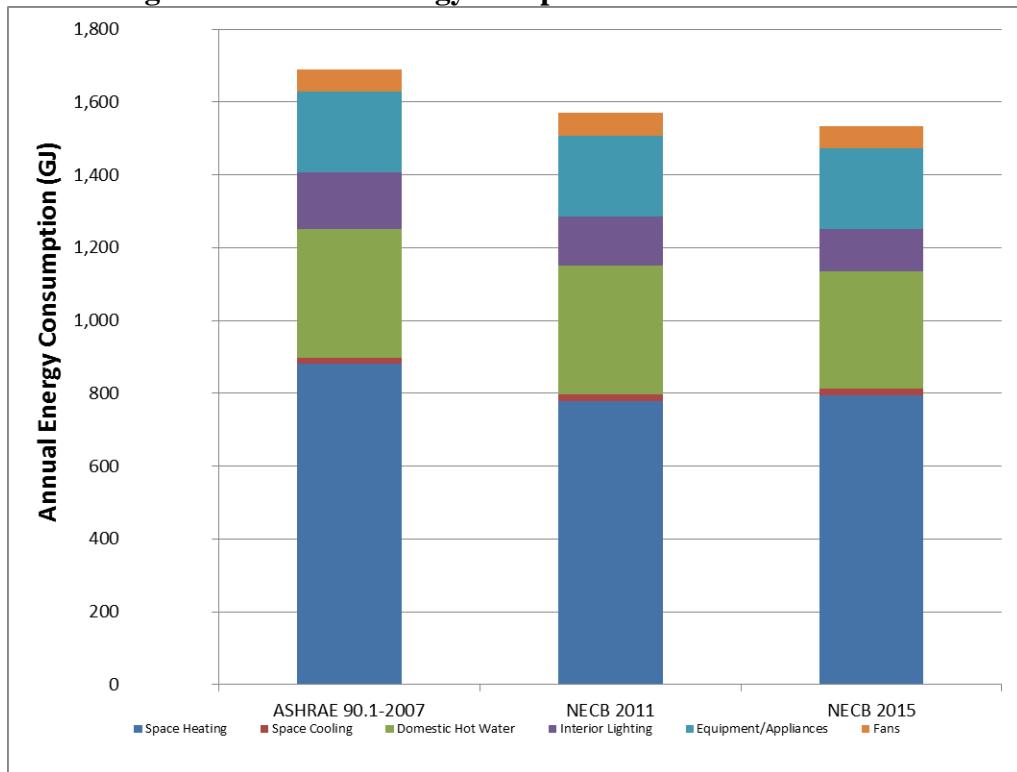
**Figure 2: Annual Energy Comparison – Box Retail**



**Table 3: Energy Simulation Results – Multi-Residential**

DESCRIPTION	Current Practice (ASHRAE 90.1-2007)	NECB 2011	NECB 2015
<b>ENERGY USED (GJ)</b>			
Space Heating	881	780	795
Space Cooling	17	18	17
Domestic Hot Water	352	352	324
Interior Lighting	156	135	114
Equip./Appliances	223	223	223
Fans	59	62	60
<i>Total</i>	<b>1,689</b>	<b>1,570</b>	<b>1,533</b>
<i>GJ/m<sup>2</sup></i>	<b>0.84</b>	<b>0.78</b>	<b>0.77</b>
<b>ELECTRICITY</b>			
Metered Peak Demand (kW)	134	124	122
Metered Consumption (kWh)	469,079	436,045	425,895
<b>ENERGY CHARGES (\$)</b>			
Electric (Consumption)	41,748	38,808	37,905
Electric (Demand)			
<i>Total</i>	<b>41,748</b>	<b>38,808</b>	<b>37,905</b>
<b>ANNUAL SAVINGS (\$)</b>			
<i>(\$/m<sup>2</sup>)</i>	0.00	2,940	3,843
0.00		1.47	1.92
<b>SAVINGS (Relative to 90.1-2007)</b>			
Energy Consumption	0.00	7.0%	9.2%
Energy Charges	0.00	7.0%	9.2%
<b>SAVINGS (Relative to NECB 2011)</b>			
Energy Consumption		0.00	2.3%
Energy Charges		0.00	2.3%

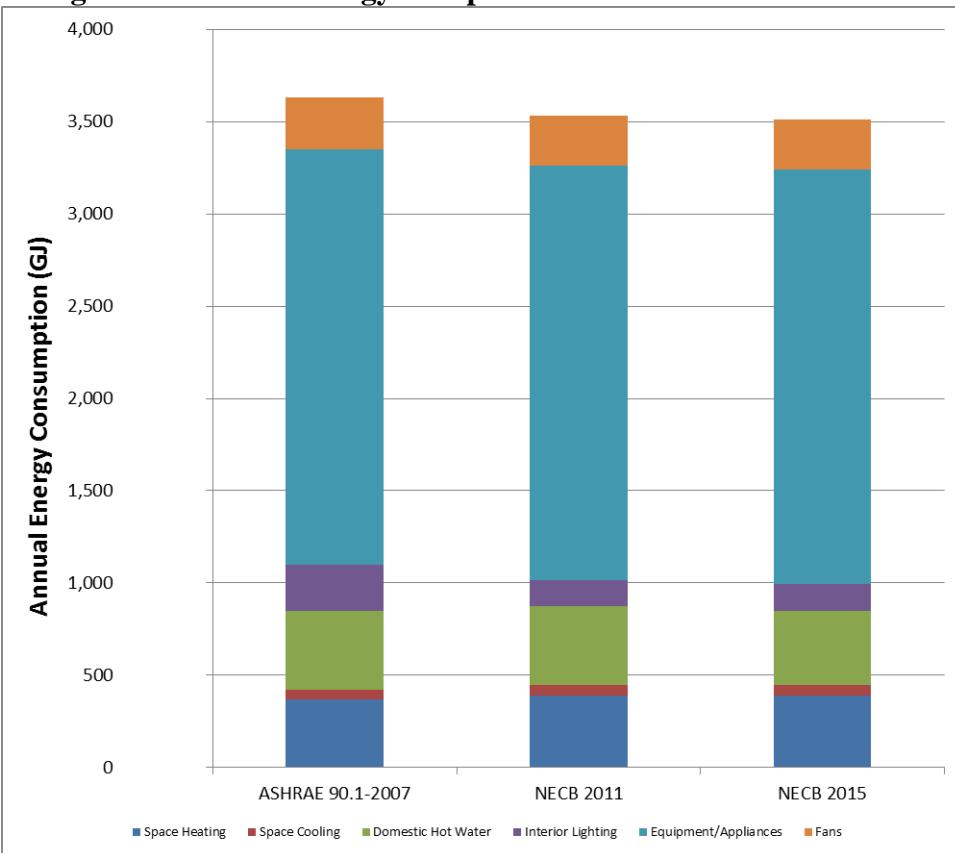
**Figure 3: Annual Energy Comparison – Multi-Residential**



**Table 4: Energy Simulation Results – Full Service Restaurant**

DESCRIPTION	Current Practice (ASHRAE 90.1-2007)	NECB 2011	NECB 2015
<b>ENERGY USED (GJ)</b>			
Space Heating	369	391	388
Space Cooling	54	57	57
Domestic Hot Water	427	427	405
Interior Lighting	248	138	143
Equip./Appliances	2,249	2,249	2,249
Fans	281	270	271
<i>Total</i>	<b>3,628</b>	<b>3,532</b>	<b>3,512</b>
<i>GJ/m<sup>2</sup></i>	<b>5.85</b>	<b>5.70</b>	<b>5.67</b>
<b>ELECTRICITY</b>			
Metered Peak Demand (kW)	235	230	229
Metered Consumption (kWh)	1,007,906	981,040	975,659
<b>ENERGY CHARGES (\$)</b>			
Electric (Consumption)	89,704	87,313	86,834
Electric (Demand)			
<i>Total</i>	<b>89,704</b>	<b>87,313</b>	<b>86,834</b>
<b>ANNUAL SAVINGS (\$)</b>			
(\$/m <sup>2</sup> )	0.00	3.86	4.63
<b>SAVINGS (Relative to 90.1-2007)</b>			
Energy Consumption	0.00	2.7%	3.2%
Energy Charges	0.00	2.7%	3.2%
<b>SAVINGS (Relative to NECB 2011)</b>			
Energy Consumption		0.00	0.5%
Energy Charges		0.00	0.5%

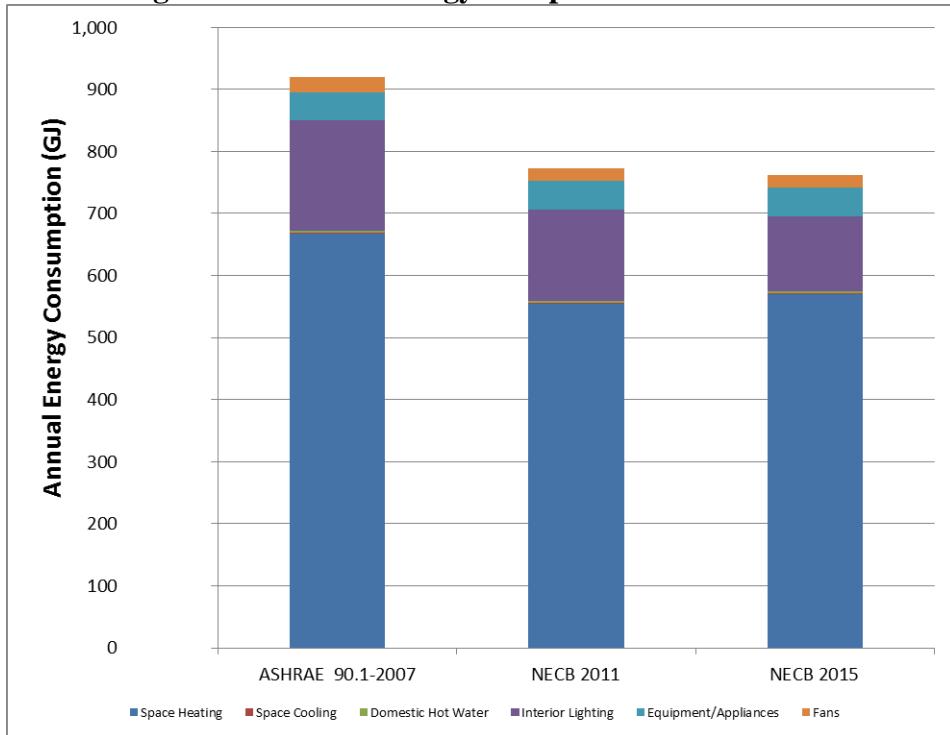
**Figure 4: Annual Energy Comparison – Full Service Restaurant**



**Table 5: Energy Simulation Results – Warehouse**

DESCRIPTION	Current Practice (ASHRAE 90.1-2007)	NECB 2011	NECB 2015
<b>ENERGY USED (GJ)</b>			
Space Heating	668	554	570
Space Cooling	1	1	1
Domestic Hot Water	4	4	3
Interior Lighting	177	147	121
Equip./Appliances	45	45	45
Fans	24	20	20
<i>Total</i>	<b>919</b>	<b>772</b>	<b>761</b>
<i>GJ/m<sup>2</sup></i>	<b>0.46</b>	<b>0.39</b>	<b>0.38</b>
<b>ELECTRICITY</b>			
Metered Peak Demand (kW)	102	88	88
Metered Consumption (kWh)	255,349	214,407	211,521
<b>ENERGY CHARGES (\$)</b>			
Electric (Consumption)	22,726	19,082	18,825
Electric (Demand)			
<i>Total</i>	<b>22,726</b>	<b>19,082</b>	<b>18,825</b>
<b>ANNUAL SAVINGS (\$)</b>			
<i>(\$/m<sup>2</sup>)</i>	0.00	3,644	3,901
0.00		1.82	1.95
<b>SAVINGS (Relative to 90.1-2007)</b>			
Energy Consumption	0.00	16.0%	17.2%
Energy Charges	0.00	16.0%	17.2%
<b>SAVINGS (Relative to NECB 2011)</b>			
Energy Consumption		0.00	1.3%
Energy Charges		0.00	1.3%

**Figure 5: Annual Energy Comparison – Warehouse**



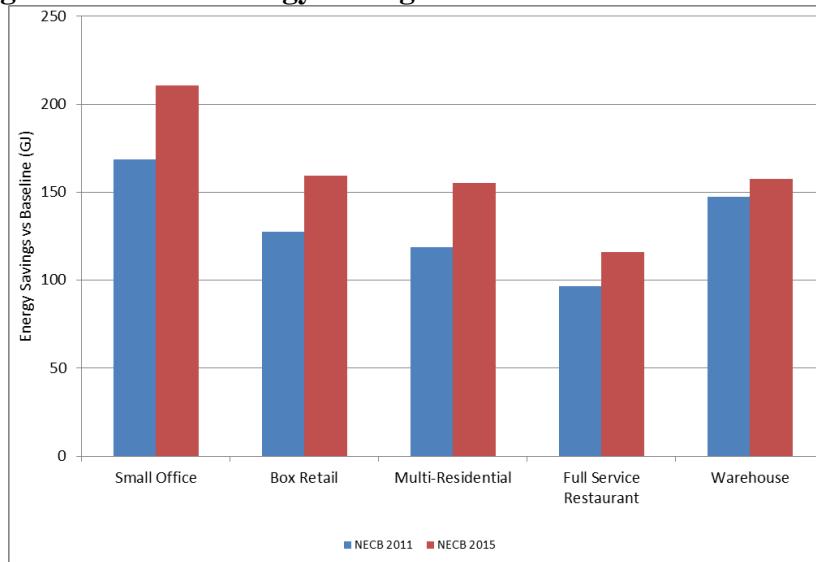
## 4. Summary of Energy Results

The energy savings relative to ASHRAE 90.1-2007 baseline and NECB 2011 baseline are illustrated in Figures 7 and 8.

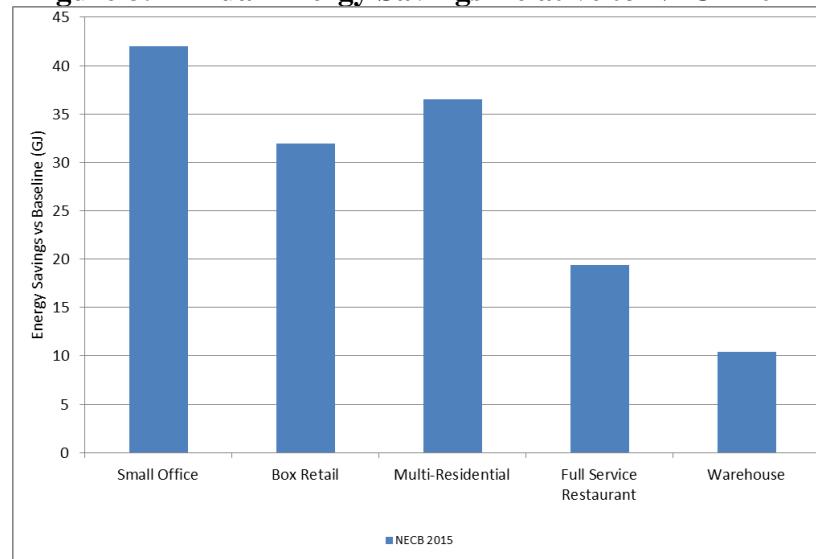
The energy results for NECB 2011 have not changed from the study done in 2015. The implementation of NECB 2015 measures further increased energy savings compared to the ASHRAE baseline.

When compared to the NECB 2011 baseline, the reduction in energy consumption in NECB 2015 buildings ranged from 10 GJ to 42 GJ. The office building had the highest energy reduction and the warehouse building had the lowest energy reduction.

**Figure 7: Annual Energy Savings Relative to ASHRAE 90.1-2007**

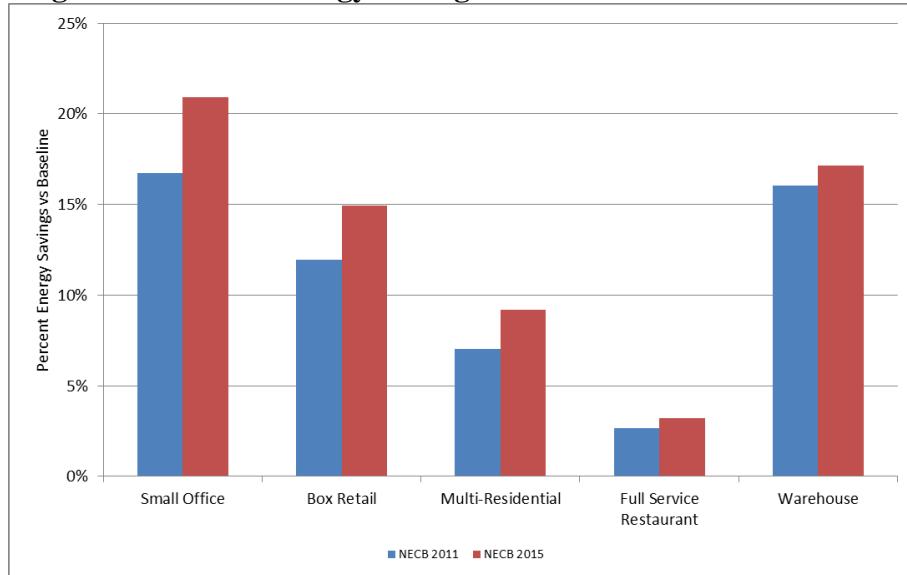


**Figure 8: Annual Energy Savings Relative to NECB 2011**

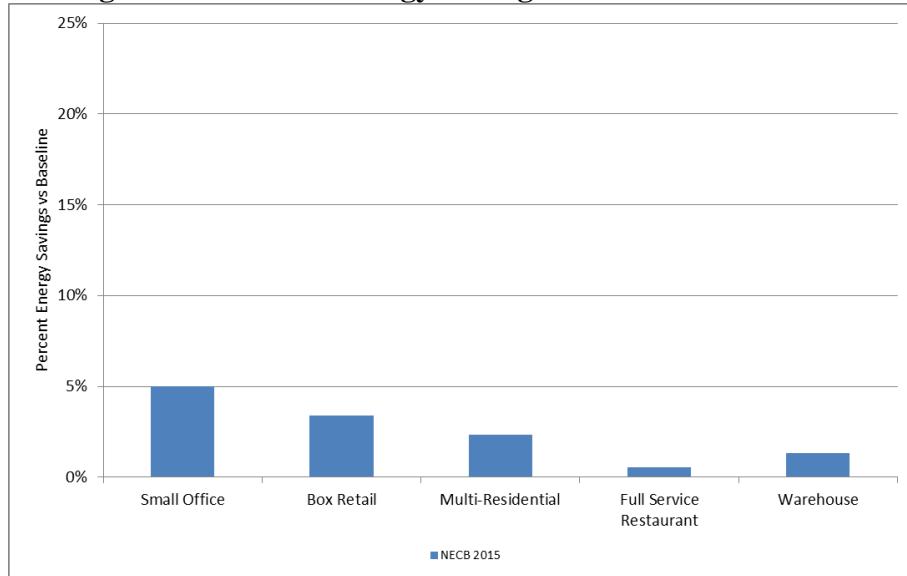


The percent energy savings relative to ASHRAE 90.1-2007 baseline and NECB 2011 baseline are illustrated in Figure 9 and 10.

**Figure 9: Percent Energy Saving Relative to ASHRAE 90.1-2007**



**Figure 10: Percent Energy Saving Relative to NECB 2011**



## 5. Capital Costs

The capital costs have been adjusted to reflect 2016 building construction cost. A weighted average factor for construction sectors was used to scale the capital cost estimates for St. John's calculated in the March 2015 study. The incremental capital costs for NECB 2015 design implementation were added directly on the NECB 2011 design. The costs for lighting power density adjustment and daylight sensors were derived from RS Means.

The low flow fixtures were estimated to be a “no cost” measure for new constructions. Faucet flow rates can be modified by replacing the aerator. Consequently the incremental cost is minimal when purchasing new faucets and shower heads.

**Table 6: Incremental Capital Cost Estimates by Component for Climate Zone 6**

Building Component	Office		MURB		Box Retail Store		Warehouse		Full Service Restaurant	
	NECB 2011	NECB 2015	NECB 2011	NECB 2015	NECB 2011	NECB 2015	NECB 2011	NECB 2015	NECB 2011	NECB 2015
MUA System	\$0	\$0	\$37	\$37	\$0	\$0	\$0	\$0	\$0	\$0
Re-circulation AHU	\$1,105	\$1,105	\$0	\$0	-\$5,345	-\$5,345	\$81	\$81	-\$1,228	-\$1,228
Zone Terminal Equipment	\$1,749	\$1,749	-\$1,055	-\$1,055	-\$15,471	-\$15,471	-\$1,241	-\$1,241	\$0	\$0
Exterior Wall	\$13,910	\$13,910	\$7,055	\$7,055	\$16,771	\$16,771	\$50,420	\$50,420	\$2,396	\$2,396
Windows	\$24,449	\$24,449	\$11,257	\$11,257	\$3,170	\$3,170	\$1,734	\$1,734	\$2,458	\$2,458
Roof	\$20,335	\$20,335	\$21,191	\$21,191	\$27,081	\$27,081	\$69,326	\$69,326	\$13,143	\$13,143
Perimeter Floor Insulation	\$1,028	\$1,028	\$739	\$739	\$1,172	\$1,172	\$1,773	\$1,773	\$915	\$915
Lighting Cost	\$8,147	\$17,287	\$14,175	\$16,832	\$2,910	\$5,586	\$3,027	\$3,373	\$4,492	\$4,822
<b>Total Incremental Capital Costs</b>	<b>\$70,724</b>	<b>\$79,863</b>	<b>\$53,399</b>	<b>\$56,057</b>	<b>\$30,288</b>	<b>\$32,964</b>	<b>\$125,121</b>	<b>\$125,467</b>	<b>\$22,178</b>	<b>\$22,508</b>

**Table 7: Total Construction Costs for Archetype Buildings**

Building Archetype	Total Construction Costs per Area <sup>1</sup>	Estimated Project Costs	Incremental Capital Costs				
			NECB 2011		NECB 2015		
			Incremental Costs	Percentage of Total Project Costs	Incremental Costs (\$)	Percentage of Total Project Costs	
	(\$/ft <sup>2</sup> )	(\$/m <sup>2</sup> )	(\$)	(\$)	(\$)	(%)	
Office	142	1,527	\$2,290,499	\$70,724	3.1	\$79,863	3.5
Box Retail	98	1,059	\$1,057,223	\$30,288	2.9	\$32,964	3.1
MURB	125	1,342	\$2,680,384	\$53,399	2.0	\$56,057	2.1
Full Service Restaurant	202	2,175	\$1,347,118	\$22,178	1.6	\$22,508	1.7
Warehouse	77	833	\$1,663,818	\$125,121	7.5	\$125,467	7.5

## 6. Life Cycle Costing

**Table 8: Results of Life Cycle Cost Analysis (Relative to ASHRAE 90.1-2007)**

Building	Scenario (ASHRAE 90.1-2007, NECB 2011, NECB 2015)	Annual Electricity Savings \$	Incremental Capital Cost \$	Actual Payback (years)	IRR	Change in NPV (%)
Office	Current Practice					
	NECB 2011	\$4,174	\$70,724	16.5	10.6	0.9
	NECB 2015	\$5,211	\$79,863	14.3	11.7	1.5
MURB	Current Practice					
	NECB 2011	\$2,940	\$53,399	18.3	9.8	0.4
	NECB 2015	\$3,843	\$56,057	13.4	12.3	1.1
Box Retail	Current Practice					
	NECB 2011	\$3,148	\$30,288	8.3	17.9	3.7
	NECB 2015	\$3,937	\$32,964	7.2	20.2	5.1
Warehouse	Current Practice					
	NECB 2011	\$3,644	\$125,121	> 25	3.9	-2.9
	NECB 2015	\$3,901	\$125,467	> 25	4.4	-2.5
Full Service Restaurant	Current Practice					
	NECB 2011	\$2,391	\$22,178	8.0	18.5	2.3
	NECB 2015	\$2,870	\$22,508	6.8	21.3	3.1

**Table 8: Results of Life Cycle Cost Analysis (Relative to NECB 2011)**

Building	Scenario (NECB 2011, NECB 2015)	Annual Electricity Savings \$	Incremental Capital Cost \$	Actual Payback (years)	IRR	Change in NPV (%)
Office	NECB 2011					
	NECB 2015	\$1,037	\$9,140	7.6	19.3	0.6
MURB	NECB 2011					
	NECB 2015	\$903	\$2,658	3.2	46.5	0.7
Box Retail	NECB 2011					
	NECB 2015	\$789	\$2,676	3.5	41.6	1.4
Warehouse	NECB 2011					
	NECB 2015	\$257	\$346	1.5	87.7	0.3
Full Service Restaurant	NECB 2011					
	NECB 2015	\$479	\$330	0.7	156.9	0.8

Based on the modelled utility rate and incremental cost, the payback period for NECB 2015 design relative to NECB 2011 is low. The internal rate of return would suggest designing to NECB 2015 level is cost efficient if the building is already pursuing NECB 2011 level.