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The Impact of Higher Energy Efficiency Standards on Housing Affordability in Alberta

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July 2010

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EXECUTIVE SUMMARY

The following report presents the results of the costing analysis completed for upgrades of EnerGuide 80 levels of energy efficiency in Alberta homes. The two major cities, Calgary and Edmonton, were considered in the analysis. The elements of residential construction were identified and pricing data was obtained to better understand the cost impact of energy efficiency upgrades on a home. *Housing price indexes, construction material price indexes, unionized trade wages,* and *land value* were the measures identified as the costing elements of residential construction. When graphed, the price of a home in Calgary and Edmonton was strongly driven by land value. Material and labour costs showed an increasing trend but land value remained as the primary reason for the rising price of homes in Calgary and Edmonton.

Pricing was obtained for the 2006 Alberta Building Code (ABC) minimum requirements and the energy efficiency upgrades. The capital cost borne by the homebuyer for every upgraded envelope component and mechanical appliance was determined using costs reported by Canadian builders in 2009. In addition, material costs were also obtained from Alberta construction material retailers to corroborate the builder reported costs. For a standard two-storey detached house, the total incremental cost to upgrade from the 2006 ABC to EnerGuide 80 levels of energy efficiency is approximately $ 6,000.

A life cycle costing analysis was completed which compared a standard house constructed to EnerGuide 80 levels of energy efficiency to one built with the 2006 ABC minimum requirements. In Calgary, the EnerGuide 80 levels of energy efficiency resulted in a positive net present value of approximately $ 6,600 (energy savings minus initial capital cost) over the study period, while in Edmonton the same upgrades resulted in a positive net present value of approximately $ 11,000. In other words, investing $35 a month as part of a mortgage to purchase the package of energy efficiency upgrades results in a monthly energy savings of about $70 in Calgary and $100 in Edmonton.

Moving to EnerGuide 80 levels of energy efficiency for housing in Alberta makes homes more affordable for homebuyers by lowering their total monthly housing costs.

INTRODUCTION

The impact of increasing energy efficiency standards on housing affordability has been questioned in the context of changes to provincial and national building and energy codes.

Determining housing affordability is complex. Home ownership costs include mortgage payments, utilities, and property taxes. Traditionally, housing affordability has been based on the percentage of household income required to service the cost of mortgage payments (principal and interest), property taxes, and utilities. The higher the percentage, the more difficult it is to afford a house.

In 2009, the average price of a standard two-storey detached house in Canada is $ 355,500. The average Canadian household spent 46.7% of their income on home ownership costs in 2009. Vancouver and Toronto showed the highest home ownership costs with 77.5% and 58.4% respectively as the proportion of household income required to service the cost of shelter. Meanwhile, Calgary and Edmonton households only spent about 40% of their income on home ownership costs. The province of Alberta has among the most affordable housing in Canada. See Appendix A for additional details. [1]

The assessment of affordability in this report was confined to understanding the trends in pricing for new homes and the extent to which changes to construction costs were reflected in higher house prices. The impact on affordability also considered the cost of carrying a larger mortgage and the monthly energy savings which would result from a package of energy efficiency upgrades. The energy efficiency upgrades, taken as a whole, represent the measures required to achieve an EnerGuide Rating of 80 for houses located in Calgary or Edmonton.

The objective of this report is to examine the impact of energy efficiency upgrades on affordability for houses in Alberta.

[1] Royal Bank of Canada Economics Research, Housing Trends and Affordability, March 2010

NEW HOUSING PRICE INDEX ANALYSIS

The relationship between the price of new housing in Alberta and construction costs was examined. The analysis is intended to reveal to what extent increased construction costs that might stem from increased energy efficiency standards would be reflected in higher housing prices.

Statistics Canada's publication: *Capital Expenditure Price Statistics*[2] captures the new housing price index which measures changes in the selling prices of new houses over time. The index establishes the changes in the "total selling price" for housing in Alberta using the year1997 as the base comparison (where 1997 =100). The survey also provides an estimate of the current cost of land. The residual (total selling price less the cost of land), relates to current cost of construction (labour and materials) and to soft costs (development charges, permits, etc.) that builders experience. Statistics Canada captures the cost of materials and labour as separate indexes.

Material Costs

The cost of materials was extracted from the publication using the *Industrial Product Price Index, By Industry*. The industry product price index presents the factory gate price movement for those manufacturers of building materials. Using 1997=100 as the base comparison again, the index shows the changes in shipment selling prices sold by 10 major manufacturing groups:

1) Veneer and plywood mills,
2) Asphalt paving, roofing and saturated materials,
3) Ventilation, heating and air conditioning,
4) Household appliance manufacturing,
5) Communication and energy wire and cable,
6) Plastic pipe and pipe fitting,
7) Ready-mix concrete,
8) Glass and glass product manufacturing,
9) Spring and wire product manufacturing, and
10) Paint and coating manufacturing.

The price of *Asphalt paving, roofing and saturated materials manufacturing industry* shows a strong divergence from the rest of the other industry groups. This is shown in Figure 1. Presumably this is related to the strong influence of oil prices. Of the other product price indexes, the *Ready-mix concrete manufacturing* industry group had the steepest price increase and was chosen as a comparator to the total price of housing to reveal any positive correlation.

[2] Catalogue no. 62-007-X, Statistics Canada, October to December 2007 & 2009

Figure 1: Industry Product Price Index for Canada; 2002 - 2009

This figure presents the cost of materials of 10 construction industries.

Labour Costs

Construction union wage rates for trades engaged in building construction presented in the publication was used to establish the cost of labour. The *Wage Rate Index* for Alberta presents changes to the basic rate and rates including selected supplementary payments across 16 major construction trades:

1) Carpenter,
2) Crane operator,
3) Cement finisher,
4) Electrician,
5) Labourer,
6) Plumber,
7) Reinforcing steel erector,
8) Structural steel erector,
9) Sheet metal worker,
10) Heavy equipment operator,
11) Bricklayer,
12) Painter,
13) Plasterer,
14) Roofer,
15) Truck driver, and
16) Insulator.

The data from these indexes were combined and graphed to determine the relationship between the following variables: total selling price of the house, cost of land, cost of labour, and the cost of materials.

Figures 2 and 3 on the following page show the rising cost of labour and materials that are attributable to the total selling price of the house. However, the rate of increase in these two attributes is outweighed by the significant rise in land value. The trend in the cost of land for both cities shows a strong impact on the new housing price index. Compared to the cost of labour and materials, the main reason for the increase in house prices is **primarily due to land costs.**

An energy efficiency upgrade can be defined as another form of construction upgrade to the house. The cost elements attributable to construction have been identified as labour and materials. Provided that the cost of land is the primary reason for rising house prices, the authors of this report suggest that implementing energy efficiency upgrades will not significantly impact the affordability of a home in the province of Alberta.

Figure 2: New Housing Price Index for Calgary, Alberta; 2002 - 2008

This figure presents the total house selling price (new housing price index) and its attributable cost elements: cost of land (land only), cost of labour (union wage), and cost of materials (ready-mix concrete manufacturing).

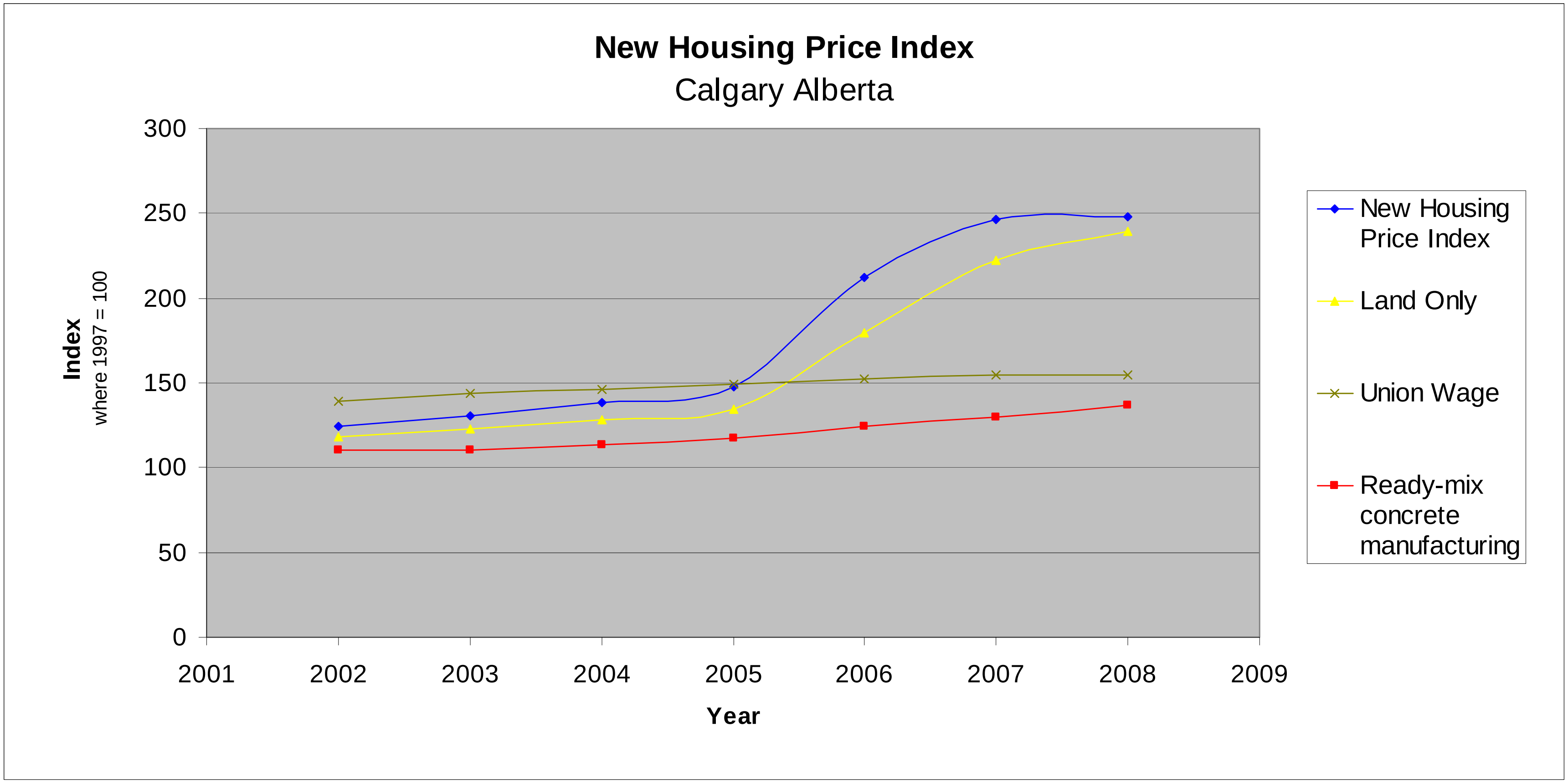
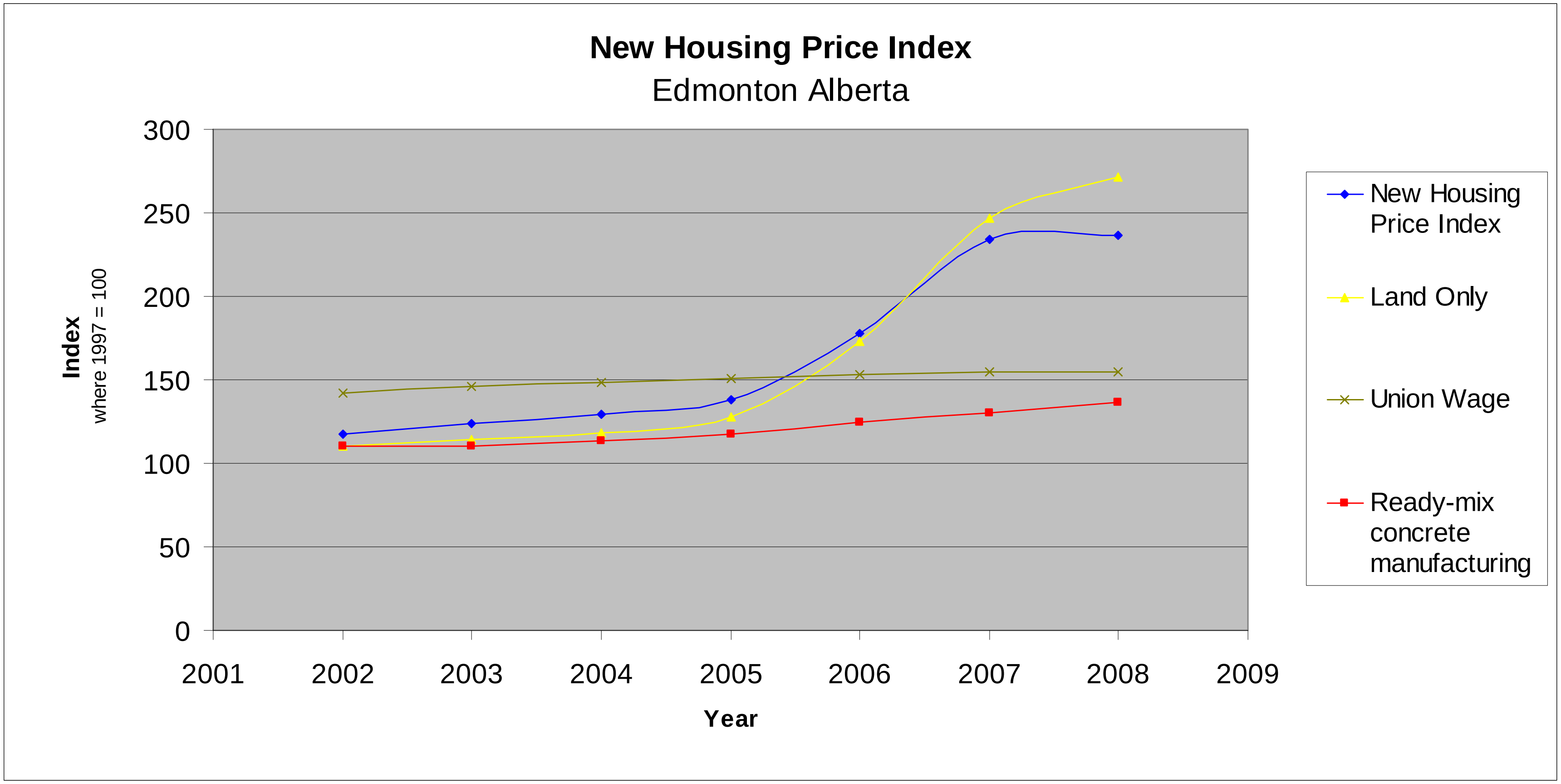


Figure 3: New Housing Price Index for Edmonton, Alberta; 2002 - 2008

This figure presents the total house selling price (new housing price index) and its attributable cost elements: cost of land (land only), cost of labour (union wage), and cost of materials (ready-mix concrete manufacturing).



ANALYSIS OF ENERGY EFFICIENCY IMPROVEMENTS

The effects of energy efficiency improvements to the building envelope and mechanical systems were simulated using the HOT2000 computer simulation program. Table 1 shows the 2006 Alberta Building Code envelope and mechanical minimums used for the base case simulation. The energy efficiency upgrades examined were based on the "Upgrade #1" improvements shown in Table 2 below[3].

Table 1: 2006 Alberta Building Code Minimums	
House Section	Component
Ceiling	R34
Main walls	R12
Window	Zone A
Foundation Walls	R8
Ventilation	Principal Exhaust
Furnace	Gas @ 80% AFUE
Domestic Hot Water	0.58 EF
Airtightness	4.55 ACH @ 50Pa

Table 2: Upgrade #1 Improvements	
House Section	Component
Ceiling	R50
Main walls	R24
Window	Zone B
Foundation Walls	R20 full height
Ventilation	HRV @ 70%
Furnace	Gas @ 90% AFUE
Domestic Hot Water	0.58 EF
Airtightness	2.50 ACH @ 50Pa

[3] KEW Consulting, EnerGuide for New Houses Design Comparison Report: Calgary and Edmonton, 2009.

The improvements in Calgary resulted in an EnerGuide rating of ERS 81 and in Edmonton, an ERS 80. The annual energy savings in Calgary and Edmonton are approximately 89,000 megajoules and 115,000 megajoules respectively. Table 3 below summarizes the reduction in energy consumption when employing EnerGuide 80 levels of energy efficiency.

Table 3: Upgrade #1 Improvements Annual Energy Savings			
House Section	Component	Energy Savings (MJ) Calgary	Energy Savings (MJ) Edmonton
Ceiling	R50	2,787	3,212
Main walls	R24	27,285	30,912
Window	Zone B	22,213	25,191
Foundation Walls	R20 full height	4,380	4,502
Ventilation	HRV @ 70%	16,614	33,206
Furnace	Gas @ 90% AFUE	16,054	18,962
Domestic Hot Water	0.58 EF	0	0
Airtightness	2.50 ACH @ 50Pa	captured with HRV	captured with HRV
Total Energy Savings (MJ)		89,333	115,985
Energy Consumption of Base House (MJ)		174,761	201,615
Reduction in Energy Consumption (%)		51 %	57 %

Life Cycle Costs

A modified life cycle cost approach was used to establish the economic benefits/costs associated with each compliance package. The life cycle cost approach was selected based on the ASTM Standards on Building Economics[4] . Unlike simple payback, the life cycle cost (LCC) method considers the time value of money (inflation and mortgage rates), energy price escalation, and the benefits imparted by the energy measure beyond the payback period. LCC considers the full range of economic variables that establish the economic viability of a measure. It is the approach used by ASHRAE 90.1 and the basis for the approach used in this study.

To perform the life cycle costing analysis, the following data was used:

1) the capital cost of each upgrade borne by the homebuyer,
2) the current energy price of natural gas,
3) the estimated mortgage rate, and
4) the forecasted energy escalation rate.

[4] ASTM E 917-05 Standards on Building Economics, 6th Edition, 2007

Capital Costs

Pricing was obtained for the 2006 ABC minimum requirements and energy efficiency upgrades. The capital cost borne by the homebuyer for every upgraded envelope component and mechanical appliance was determined using costs reported by Canadian builders in 2009. In addition, material costs were also obtained from Alberta construction material retailers to corroborate the builder reported costs. The total incremental cost to upgrade from the 2006 ABC to the EnerGuide 80 levels of energy efficiency for a standard two-storey detached house is approximately $ 6,000. Table 4 below summarizes the initial costs for each energy efficiency upgrade. Please see Appendix B for explanation of operating costs, interest rates and energy price escalation assumptions.

Table 4: Capital Costs - 2006 ABC to Upgrade #1 -

Measure	Size *	Current code (2006 ABC)	Cost ($)	Upgrade #1	Cost ($)	Incremental ($)
Ceiling	1149.16	R34	$ 769.94	R50 w/ raised heel	$ 2,172.89	$ 1,402.96
Main walls	1974.79	R12	$ 2,437.16	R24	$ 3,640.43	$ 1,203.26
Window	282.22	Zone A	$ 6,265.28	Zone B	$ 6,127.10	-$ 138.18
Foundation Wall	1161.98	R8	$ 717.02	R20	$ 2,108.70	$ 1,391.68
Slab	1151.07		$ -		$ -	$ -
Building Envelope Subtotal ($)			$ 10,189.41		$ 14,049.12	$ 3,859.72
Ventilation		Principal Exhaust	$ 403.11	70% HRV	$ 2,022.09	$ 1,618.98
Furnace		80% AFUE	$ 750.00	90% AFUE	$ 1,113.78	$ 363.78
Domestic Hot Water		0.58 EF	$ 325.00	0.58 EF	$ 325.00	$ -
Electrical Credits/CFLs			$ -		$ -	$ -
ACH		4.55 @ 50Pa	$ -	2.50 @ 50Pa	$ -	$ -
Air Source Heat Pump			$ -		$ -	$ -
Mechanicals Subtotal ($)			$ 1,478.11		$ 3,460.86	$ 1,982.76
Total ($)			**$ 11,667.51**		**$ 17,509.99**	**$ 5,842.47**

* based on house characteristics of KEW Consulting's EnerGuide for New Houses Design Comparisons Report

Life Cycle Costing Results

Using the life cycle costing formula from the ASTM standard (see Appendix C), the net present value for each upgrade was calculated. The results are summarized in Table 5 and 6.

In both cases, Calgary and Edmonton, the proposed upgrades provide the homebuyer with a positive net present value. This indicates that at the end of the mortgage period (estimated at 25 years), the combination of upgrades provide a positive net worth. Considering the savings in energy costs each month, after 25 years, the combination of upgrades not only pay for themselves entirely but on top of that, also provide a positive net worth of at least $ 6,600 in Calgary and $11,000 in Edmonton. Edmonton showed a higher net worth due to higher operating costs.

Investing $35 a month as part of a mortgage to purchase the package of energy efficiency upgrades results in a monthly energy savings of about $70 in Calgary and $100 in Edmonton. These translate into net savings (energy savings less cost) of $35 and $65 that homebuyers can use towards lowering their home ownership costs.

Table 5: Life Cycle Costing Analysis I Calgary, Alberta

SCENARIO	
Discount rate	5.0%
Energy escalator	1.0%

House Section	Component	Energy Savings [MJ]	Monthly Energy Savings $	Present Value Energy Savings $	Present Value Upgrade Cost	Total NPV
Ceiling	R40	0	$ -	$ -	$ -	$ -
	R50	2787	$ 2.05	$ 388.22	$ 1,402.96	$ (1,014.74)
Walls	R12	0	$ -	$ -	$ -	$ -
	R24 1" XPS	27285	$ 20.05	$ 3,800.69	$ 1,203.26	$ 2,597.43
Foundation	R8	0	$ -	$ -	$ -	$ -
	R20 batt	4380	$ 3.22	$ 610.12	$ 1,391.68	$ (781.56)
Windows	Zone A (2.0 W/m^2)	0	$ -	$ -	$ -	$ -
	Zone B (1.8 W/m^2)	22213	$ 16.33	$ 3,094.18	$ (138.18)	$ 3,232.37
Gas Furnace	80% AFUE	0	$ -	$ -	$ -	$ -
	90% AFUE	16054	$ 11.80	$ 2,236.26	$ 363.78	$ 1,872.48
HRV	Principal exhaust fan + 4.5	0	$ -	$ -	$ -	$ -
	70% HRV + 2.5 ACH	16614	$ 12.21	$ 2,314.27	$ 1,618.98	$ 695.28
					Upgrade #1 NPV	**$ 6,601.26**

Total Monthly Energy Savings	Total Monthly Upgrade Cost	Total Monthly Net
$ 72.74	$ (34.15)	**$ 38.59**

Table 6: Life Cycle Costing Analysis I Edmonton, Alberta

SCENARIO	
Discount rate	5.0%
Energy escalator	1.0%

House Section	Component	Energy Savings [MJ]	Monthly Energy Savings $	Present Value Energy Savings $	Present Value Upgrade Cost	Total NPV
Ceiling	R40	0	$ -	$ -	$ -	$ -
	R50	3212	$ 2.48	$ 470.31	$ 1,402.96	$ (932.64)
Walls	R12	0	$ -	$ -	$ -	$ -
	R24 1" XPS	30912	$ 23.88	$ 4,525.63	$ 1,203.26	$ 3,322.37
Foundation	R8	0	$ -	$ -	$ -	$ -
	R20 batt	4502	$ 3.48	$ 659.12	$ 1,391.68	$ (732.56)
Windows	Zone A (2.0 W/m^2)	0	$ -	$ -	$ -	$ -
	Zone B (1.8 W/m^2)	25191	$ 19.46	$ 3,688.01	$ (138.18)	$ 3,826.20
Gas Furnace	80% AFUE	0	$ -	$ -	$ -	$ -
	90% AFUE	18962	$ 14.65	$ 2,776.11	$ 363.78	$ 2,412.33
HRV	Principal exhaust fan + 4.5	0	$ -	$ -	$ -	$ -
	70% HRV + 2.5 ACH	33206.5	$ 25.65	$ 4,861.53	$ 1,618.98	$ 3,242.55
					Upgrade #1 NPV	**$ 11,138.25**

Total Monthly Energy Savings	Total Monthly Upgrade Cost	Total Monthly Net
$ 99.27	$ (34.15)	**$ 65.12**

CONCLUSION

This report explored the cost impacts of energy efficiency upgrades on Alberta homes. Using the most recent studies available, the cost of achieving EnerGuide 80 (ERS 80) was identified and analysed. The capital cost borne by the homebuyer for every upgraded envelope component and mechanical appliance was determined to be approximately $ 6,000.

A life cycle costing analysis was completed to compare a house built of each component was conducted. The results showed a positive net present value of $ 6,600 and $ 11,000 for Calgary and Edmonton respectively over a typical 25-year mortgage. This positive net worth shows that the homebuyer's monthly investment towards the energy efficiency upgrades is outweighed by the money saved in energy costs. The energy performance of the upgrades not only pays for the cost of the upgrades, but also offers additional savings. These savings help lower housing costs and make Alberta housing more affordable.

To better understand the impact of energy efficiency upgrades on the total house price, a preliminary analysis was conducted based on residential construction industry statistics provided by Statistics Canada for Alberta. The elements of residential construction were identified as land, labour, and material costs. The cost of labour and construction materials is the two elements attributable to energy efficiency upgrades made on a home. Leaving the cost of land as the one remaining component that affects the total price of a home.

The analysis showed that though the price of labour and materials is increasing, the primary driver for rising house prices is the value of land. The price of housing is strongly correlated to the price of land and not the price of labour or materials.

The energy simulation and life cycle costing analysis showed a positive net worth for energy efficiency upgrades. Essentially, this means that homebuyers will be receiving a positive return within the life of their mortgage for an improved, more energy efficient home, and a healthier indoor environment for their family. The increase in costs for implementing these energy efficiency improvements will raise the house price; however its impact is minimal in comparison to the effects of land value on the total house price.

Moving to EnerGuide 80 levels of energy efficiency for housing in Alberta makes homes more affordable for homebuyers by lowering their total monthly housing costs.

APPENDIX A

Housing Affordability Summary Table

Royal Bank of Canada Economics Research

Housing Affordability Summary Table: RBC Economics Research

Standard Two-Storey			
Region	**Average Price**	**Affordability Measure ***	
		2009	Avg since 1985
Canada **	$ 355,500	46.7%	43.5%
British Columbia	$ 583,700	70.2%	54.4%
Alberta	$ 370,900	37.9%	39.0%
Saskatchewan	$ 309,500	43.7%	37.8%
Manitoba	$ 260,300	38.8%	38.1%
Ontario	$ 372,900	45.6%	44.0%
Quebec	$ 249,900	41.4%	39.0%
Atlantic	$ 214,000	36.1%	38.7%
Toronto	$ 537,300	58.4%	53.7%
Montreal	$ 315,700	48.9%	41.6%
Vancouver	$ 716,000	77.5%	62.4%
Ottawa	$ 338,000	41.5%	39.5%
Calgary	$ 427,100	39.2%	40.5%
Edmonton	$ 364,900	38.7%	37.3%

* proportion of household income required to service all home ownership costs

** population weighted average

Source: *Royal Bank of Canada Economics Research, Housing Trends and Affordability, March 2010*

APPENDIX B

Costing Research

Operating Costs, Interest Rates, and Energy Escalation

Operating Costs

The annual operating costs were established using current energy prices for natural gas reported in the *EnerGuide for New Houses Design Comparison Report* prepared by KEW Consulting (2009). The table below summarizes the current energy price of natural gas used in this report.

Natural Gas Cost Assumptions	
Calgary	Edmonton
$ 8.82 / GJ	$ 9.27 / GJ

Interest Rates (2009)

To reflect the opportunity costs to the homebuyer over the life of a typical home mortgage (25 years), the discount rate is derived from to the mortgage and inflation rate. A range of discount rates were used for the analysis with 5% at the mean and 3% and 7% at the extremes.

Energy Price Forecasts

Life cycle cost analyses consider the future forecast of energy prices. The analysis considered an escalation rate of 1% as predicted by the National Energy Board (2009).

APPENDIX C

Life Cycle Costing Formula

ASTM Standards on Building Economics, 2007

Life Cycle Costing Formula

The results shown in Table 5and 6 were generated using the following formula – net present value with an escalating rate:

PV formula for annually recurring non-uniform amounts

$$PV = A_0 \times \sum_{t=1}^{n} \left(\frac{1+e}{1+d} \right)^t = A_0 \frac{(1+e)}{(d-e)} \left[1 - \left(\frac{1+e}{1+d} \right)^n \right]$$

The **Modified Uniform Present Value (UPV*) factor** is used to calculate the PV recurring annual amounts that change from year to year at a **constant** escalation rate, e (i.e., $A_{t+1} = A_t \times (1+e)$), over n years, given d. The escalation rate can be positive or negative.

$$PV = A_0 \times UPV^*_{(n,d,e)}$$

The **UPV* factor** for e = 2%, d = 3%, and n = 15 years is **13.89**.

Where, d is the discounted rate (real interest rate) and e is the energy escalator.
Interest Rate = Discount Rate + Inflation Rate + (Discount Rate x Inflation Rate)
As described in ASTM E 917-05 Standards on Building Economics 2007.