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Populus
Sustainable Design Consulting

College Avenue Multi-Family Energy Efficiency Case Study: Final Report

March 26, 2010

Submitted to

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INTRODUCTION

In April of 2009, The City of Boulder retained Populus Sustainable Design Consulting ("Populus") to perform a case study providing energy analysis and quantifying the estimated impacts and costs of energy efficiency measures at 2905-2915 College Avenue, Boulder, a 35-unit multi-family building. Subsequently, the building's owners have engaged in making substantial improvements to the property guided by the recommendations of the City-sponsored analysis. Populus has been engaged to perform follow-up testing and analysis to quantify the improvements being implemented at 2905-2915 College Avenue and to compare these results against the proposed SmartRegs performance and prescriptive options. Further, Populus has provided below a financial analysis using the actual costs of the installed measures. In order to reduce the expense of the case study, a sampling of 6 representative units was selected for preliminary and final analysis. This sampled data was averaged then applied to all 35 units in order to make whole-building performance and financial analyses.

CASE STUDY: 2905-2915 COLLEGE AVENUE

Tested Units

Unit #	Area (sf)
101	417
114	652
119	716
206	702
214	493
209	520
Average	583.3

Energy/Code Compliance Analysis by Unit

HERS INDEX			
Unit #	Before	After	Reduction
101	136	90	46
114	122	90	32
119	161	98	63
206	145	82	63
214	142	80	62
209	130	78	52
Average	139	86	53

Prescriptive Points			
Unit #	Before	After	Increase
101	48	108	60
114	76	105	29
119	38	101	63
206	62	123	61
214	71	125	54
209	63	123	60
Average	60	114	55

Estimated Annual CO2 Emissions (Metric Tons)			
Unit #	Before	After	Reduction
101	4.17	2.72	1.45
114	4.81	3.63	1.18
119	7.35	4.72	2.63
206	5.53	3.27	2.27
214	4.35	2.45	1.91
209	4.26	2.63	1.63
Average	5.08	3.24	1.84

Estimated Annual Natural Gas Usage (Therms)			
Unit #	Before	After	Reduction
101	493	328	165
114	506	342	164
119	935	517	418
206	615	306	309
214	479	253	226
209	457	253	204
Average	581	333	248

Estimated Annual Electric Usage (kWh)			
Unit #	Before	After	Reduction
101	1777	1066	711
114	2420	2030	390
119	2595	2195	400
206	2557	1862	695
214	1985	1234	751
209	2059	1435	624
Average	2232	1637	595

Estimated Annual Energy Costs ($/yr)			
Unit #	Before	After	Reduction
101	$ 724.00	$ 542.00	$ 182.00
114	$ 793.00	$ 640.00	$ 153.00
119	$ 1,046.00	$ 730.00	$ 316.00
206	$ 827.00	$ 560.00	$ 267.00
214	$ 687.00	$ 471.00	$ 216.00
209	$ 678.00	$ 488.00	$ 190.00
Average	$ 792.50	$ 571.83	$ 220.67

Energy/Code Compliance Analysis by Improvement (per Unit)

HERS INDEX Reduction								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	11	14	11	3	2	5	2	46
114	9	17	0	1	1	1	1	32
119	20	24	13	4	6	2	1	63
206	15	19	15	3	5	3	1	63
214	10	28	13	3	4	5	2	62
209	9	22	14	3	1	4	2	52
Average	12	21	11	3	3	3	2	53

Prescriptive Point Increase								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	13	13	26	0	0	7	1	60
114	13	13	0	0	0	2	1	29
119	19	13	26	0	2	2	1	63
206	13	14	26	0	1	6	1	61
214	6	13	26	0	1	7	1	54
209	13	14	26	0	0	6	1	60
Average	13	13	22	0	1	5	1	55

Estimated Annual CO2 Emission Reduction (Metric Tons)								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	0.18	0.36	0.18	0.00	0.00	0.36	0.09	1.45
114	0.27	0.54	0.00	0.00	0.00	0.09	0.09	1.18
119	0.91	1.09	0.54	0.27	0.36	0.36	0.18	2.63
206	0.45	0.54	0.45	0.09	0.18	0.36	0.18	2.27
214	0.27	0.73	0.36	0.09	0.18	0.45	0.18	1.91
209	0.27	0.54	0.36	0.09	0.00	0.36	0.18	1.63
Average	0.39	0.64	0.32	0.09	0.12	0.33	0.15	1.84

Estimated Annual Natural Gas Usage Reduction (Therms)								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	48	67	44	11	9	-10	-4	165
114	54	97	0	11	10	-4	-5	164
119	128	156	71	18	30	-8	-4	418
206	86	108	78	23	34	-10	-4	309
214	42	119	52	11	17	-11	-5	226
209	42	106	58	11	-5	-9	-5	204
Average	67	109	51	14	16	-9	-5	248

Estimated Annual Electric Usage Reduction (kWh)								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	0	0	0	0	0	511	200	711
114	0	0	0	0	0	190	200	390
119	0	0	0	0	0	200	200	400
206	0	0	0	0	0	495	200	695
214	0	0	0	0	0	551	200	751
209	0	0	0	0	0	424	200	624
Average	0	0	0	0	0	395	200	595

Estimated Annual Energy Cost Reduction ($/yr)								
Unit #	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
101	33	47	31	8	6	40	15	182
114	38	69	0	8	7	15	15	153
119	27	108	61	15	24	15	14	316
206	58	73	53	15	23	36	14	267
214	29	80	36	8	12	40	14	216
209	28	72	39	7	0	30	14	190
Average	36	75	37	10	12	29	14	221

Financial Analysis for Entire Building by Improvement Measure

Whole Building Summary - Averages Applied to 35 Units								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
HERS INDEX Reduction	12	21	11	3	3	3	2	53
Prescriptive Point Increase	13	13	22	0	1	5	1	55
Estimated Annual CO_2 Emission Reduction (MT)	13.76	22.23	11.11	3.18	4.23	11.64	5.29	64.56
Estimated Annual Gas Usage Reduction (Therms)	2,333	3,809	1,768	496	554	-303	-158	8,668
Estimated Annual Electric Usage Reduction (kWh)	0	0	0	0	0	13,831	7,000	20,831
Estimated Annual Energy Cost Reduction ($/yr)	$1,243	$2,619	$1,283	$356	$420	$1,027	$502	$7,723
Cost of Improvement	$11,952	$56,043	$11,952	$15,332	$0	$300	$17,920	$113,499
Estimated Monthly Savings	$103.58	$218.25	$109.92	$29.67	$35.00	$85.58	$41.83	$643.58
Monthly Improvement Payment Financed at 6% for 15 Years	$100.86	$472.92	$100.86	$129.38	$0	$2.53	$151.22	$957.77
Cost Neutral From Day 1?	YES	NO	YES	NO	YES	YES	NO	NO

Financial Analysis of Improvement Measures by Unit

101								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	$598	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$31	$114	$54	$146	$0	$2	$256	$70
Cost per Prescriptive Point	$26	$123	$23	N/A	-	$1	$512	$54
Cost per Metric Ton of CO2 Reduced	$1,882	$4,413	$3,294	-	-	$24	$5,644	$2,234
Simple Payback in Years (Imp. Cost/Energy Savings)	10.3	34.1	19.3	54.8	0.0	0.2	34.1	17.8

114								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	N/A	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$38	$94	N/A	$438	$0	$9	$512	$101
Cost per Prescriptive Point	$26	$123	N/A	N/A	-	$4	$512	$112
Cost per Metric Ton of CO2 Reduced	$1,255	$2,942	N/A	-	-	$94	$5,644	$2,750
Simple Payback in Years (Imp. Cost/Energy Savings)	9.0	23.2	N/A	54.8	0.0	0.6	34.1	21.2

119								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	$598	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$17	$67	$46	$110	$0	$4	$512	$51
Cost per Prescriptive Point	$18	$123	$23	N/A	$0	$4	$512	$51
Cost per Metric Ton of CO2 Reduced	$376	$1,471	$1,098	$1,610	$0	$24	$2,822	$1,233
Simple Payback in Years (Imp. Cost/Energy Savings)	12.6	14.8	9.8	29.2	0.0	0.6	36.6	10.3

206								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	$598	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$23	$84	$40	$146	$0	$3	$512	$51
Cost per Prescriptive Point	$26	$114	$23	N/A	$0	$1	$512	$53
Cost per Metric Ton of CO2 Reduced	$753	$2,942	$1,317	$4,829	$0	$24	$2,822	$1,430
Simple Payback in Years (Imp. Cost/Energy Savings)	5.9	21.9	11.3	29.2	0.0	0.2	36.6	12.1

214								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	$598	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$34	$57	$46	$146	$0	$2	$256	$52
Cost per Prescriptive Point	$57	$123	$23	N/A	$0	$1	$512	$60
Cost per Metric Ton of CO2 Reduced	$1,255	$2,206	$1,647	$4,829	$0	$19	$2,822	$1,702
Simple Payback in Years (IC/Energy Savings)	11.8	20.0	16.6	54.8	0.0	0.2	36.6	15.0

209								
	Wall Insulation	Window Replacement	Ceiling Insulation	Door Replacement	Reduced Infiltration	Efficient Lighting	ENERGY STAR Refrigerator	Combination of Improvements
Cost of Improvement	$341	$1,601	$598	$438	$0	$9	$512	$3,243
Cost per HERS INDEX Point	$38	$73	$43	$146	$0	$2	$256	$62
Cost per Prescriptive Point	$26	$114	$23	N/A	-	$1	$512	$54
Cost per Metric Ton of CO2 Reduced	$1,255	$2,942	$1,647	$4,829	-	$24	$2,822	$1,986
Simple Payback in Years (Imp. Cost/Energy Savings)	12.2	22.2	15.3	62.6	0.0	0.3	36.6	17.1