

Cold Climate Region E. College Ave Apartments: Case Study #8 City of Boulder, SmartRegs Ordinance Low-Rise Multi-Family, 1950's Vintage

Boulder, CO

Program	SmartRegs Ordinance
Location:	Boulder, CO 80303
Building Type:	Low-Rise Multi-Family
Building Size:	17550+ ft ² living space
Foundation:	Slab-on-grade
HVAC/DHW:	In-unit gas heat, central HW
Configuration:	2 Stories
Unit count:	18 1-br, 18 2-br, 1 3-br
SWA Contact:	Lois Arena

SmartRegs requirements were adopted to meet the City of Boulder's sustainability objectives including environmental health, economic vitality and social equity. According to current statistics, rental properties comprise approximately 50 percent of Boulder's housing stock¹. Therefore, by requiring property owners to upgrade rental properties, the SmartRegs program aids in advancing Boulder's community sustainability objectives, and will hopefully result in lower energy bills for tenants.

The program offers two compliance paths; one that uses a prescriptive checklist to rate energy efficiency, and one that uses an energy model. As will be demonstrated in this case study, energy models are not meant to be exact, but indicative, and are not meant to predict exact energy costs or energy cost savings. They are meant to be used as a tool to better understand the impact of energy efficient upgrades. If utility bills are available and performance testing conducted, the energy models can be calibrated to yield more accurate results.

In order to demonstrate compliance with SmartRegs, the property owner of these 37 rental units opted to use the Prescriptive Checklist. Prior to upgrades, these units were well below the 100 point threshold. The complex was constructed in the 1950's, with minimal attic insulation, no wall insulation, and single pane windows. Heating is provided by ductless in-unit natural gas heaters and hot water is provided by 6 centrally located gas storage water heaters. No cooling or mechanical ventilation is provided, although some tenants install window air conditioners on their own. Actual annual bills per unit range from \$200-\$600 for electricity and \$250-\$550 for natural gas, with almost \$210 in just monthly service charges.



This 2-story, multi-family apartment building in Boulder, CO underwent extensive retrofits to all its 37 units.

Energy Efficient Improvements

	Before	After
Attic:	R-9 attic insulation	R-50 blown-in cellulose
Walls:	R-0	R-13 blown-in cellulose
Windows:	Single, metal	Double, low-e, vinyl
Slab floor:	R-0	same
Doors:	Metal doors	Foam-filled, fiberglass
Air Leakage:	11.4 ACH ₅₀	8.7 ACH ₅₀
Appliances:	750 kWh/yr	450 kWh/yr
Lighting:	Upgraded to 30-100% compact fluorescents	
Heating	60 AFUE, natural gas	same

Additional SmartRegs Features

None

SmartRegs Checklist Score*: 106 to 117 points

(Score must be ≥ 100 points)

HERS Index: from 87 to 100

*100 points on the SmartRegs checklist should approximately equate to a HERS index of 120.

¹2011 SmartRegs Handbook, City of Boulder

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Each apartment is scored individually in the SmartRegs program to account for floor plan configuration differences. Differences in layout and location can result in different exposed envelope areas, which in turn, can affect the SmartRegs score. For example, a **corner unit** on the 1st floor will generally have a lower SmartRegs score than an **interior unit** on the 1st floor, because that interior unit will have a greater percentage of shared walls (see Wall section of checklist below).

WALLS	Base: Final:			
	R-VALUE	25%	50%	75% 100%
No Insulation		0	0	0 0
>R-3 Continuous		3	6	9 12
R-5 Continuous		4	8	12 15
R-13		5	10	15 20
Uninsulated Basement Wall		5	10	15 20
>R-19		5	11	16 21
Insulated Basement Wall		6	13	19 26
Shared Wall		6	13	19 26

Likewise, mid-level units with shared floors and ceilings will generally score higher than ground-level or top-floor units.

The following table lists the SmartRegs scores for an interior 1 bedroom unit and an interior 2 bedroom unit, which represent 26 of the 37 units. A

	Corner, 1 BR	Interior, 2 BR	Interior, 1 BR
Pre-Retrofit	1st floor	1st floor	2nd floor
SmartRegs	48	79	58
HERS	157	142	173

ground-level corner 1 bedroom unit with an attic above, is listed to demonstrate the worst case. The 1st floor interior unit scored more than the other units because a shared ceiling is worth 27 points and the existing attic insulation in the other two units did not earn any points in the checklist.

Because the minimum allowable SmartRegs score is 100 points, the property owner needed to improve the property by 2019 in order to maintain the rental permit required by the City of Boulder.

Using the worse case 1st floor corner unit as an example, at least 52 points were needed to meet the SmartRegs threshold.

Facts about SmartRegs

2 Compliance Paths: Prescriptive or Performance

- Prescriptive: 100 ≥ points on Checklist
- Performance: HERS Index ≤ 120



The attics are now insulated with approximately 13" of R-50 cellulose loose-fill insulation

These were achieved with a package of improvements that included:

- 13" of blown cellulose attic insulation (26 points)
- New double-pane, low-e windows with U-values of 0.3 (13 points)
- R-13 blown cellulose wall insulation (10 points)
- CFL replacement in 100% of lights (7 points)
- New ENERGY STAR qualified refrigerator (3 points)
- Reduced air leakage to <0.5 air changes/hour (2 points)

	Corner, 1 BR	Interior, 2 BR	Interior, 1 BR
Post-Retrofit	1st floor	1st floor	2nd floor
SmartRegs	109	106	117
HERS	97	100	87

Although the same package of improvements were implemented, the post-retrofit SmartRegs scores vary per unit, depending on the number of shared walls and ceilings.

The HERS Indices for these units post-retrofit were determined using energy models and ranged from 87 for the 2nd floor unit to 100 for the 1st floor unit. Although a HERS index is not required when using the Prescriptive checklist, it supports the claim that earning at least 100 points on the SmartRegs checklist should approximately equate to a HERS index of 120 points, which is the maximum HERS score allowed when using the Performance path for compliance.

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The energy model was not only used to calculate the HERS index, but to estimate the annual utility costs both pre- and post-retrofit for a sample of units.

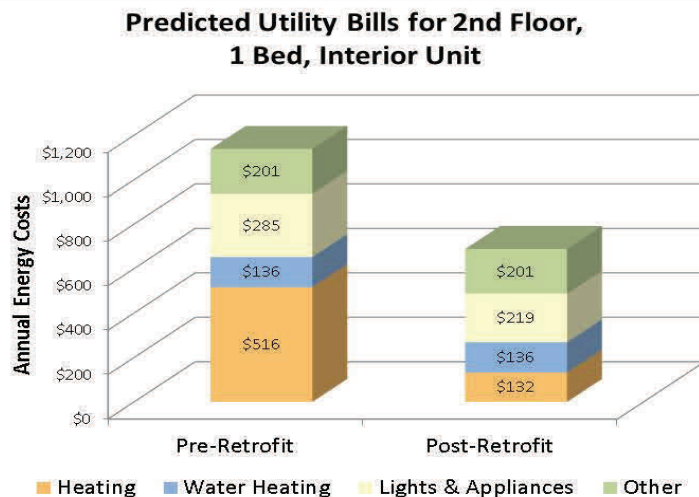
For a second floor interior 1 bedroom unit, the combination of the upgrades accounts for a 40% savings between modeled pre and post-retrofit utility bills, for an estimated energy cost savings of about \$450 per year.

In the pre-retrofit case, REM/Rate predicts that heating comprised more than one third of the annual energy costs. This was reduced by \$384 through the wall and attic insulation, window and door upgrades, and reduced air leakage.

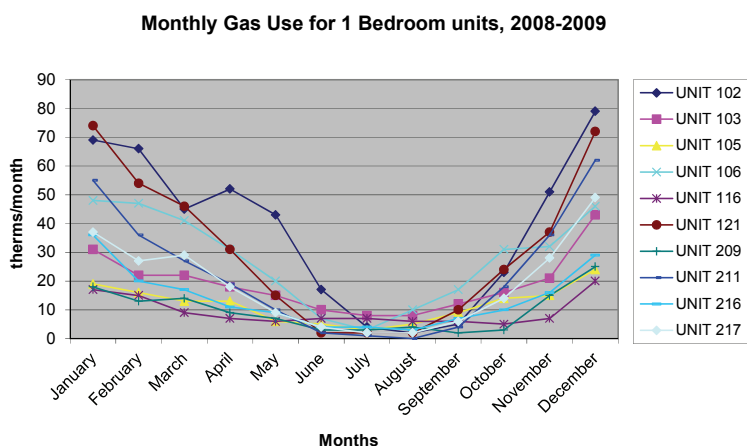
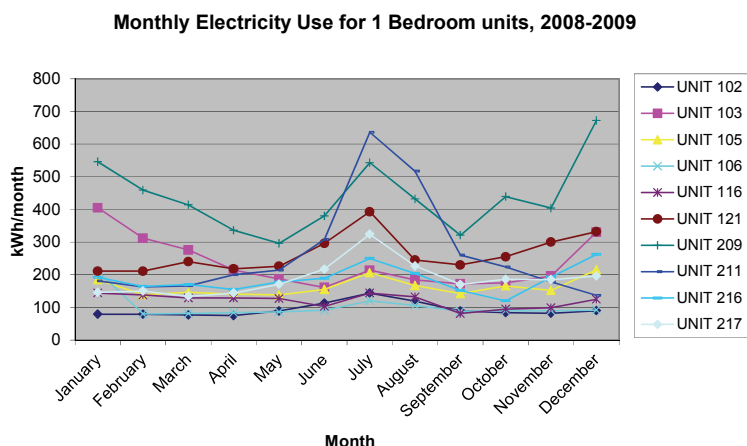
Lights and appliances are the next largest end-use, and \$66 in annual savings are predicted by lowering electricity consumption through energy-efficient lighting and a new refrigerator. The "Other" category includes monthly service charges that are unfortunately unaffected by energy efficient improvements and comprise almost 20% of the bill.

Pre-retrofit utility bills (shown in the lower two graphs at right) were available for a handful of 1 bedroom units which show spikes in electricity usage in both winter and summer. Although it is suspected that some units may have supplemented gas heating with electric resistance heating in the winter and may have installed window air-conditioning units in the summer, these were not accounted for in the energy model, as no confirmation of this was provided by property managers. Some pre-retrofit bills, therefore, show that the annual electricity consumption is higher than predicted from the energy model.

Beyond what was described above, the model makes assumptions on things like weather, thermostat settings, and how long lights are left on. This can also lead to a discrepancy between actual bills and savings estimated by the model. If actual pre-retrofit energy usage is greater than modeled, actual savings may be higher than predicted. But in this case, the models predicted higher gas usage than shown in the actual bills, therefore, actual gas savings will likely be less than predicted.



40% reduction in utility bills expected post-retrofit



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The same analysis was conducted for a first floor interior 2 bedroom unit and the combination of the upgrades account for a 23% savings between modeled pre and post-retrofit utility bills, for estimated energy cost savings of about \$231 per year. Although a slightly larger unit than the previous analysis, the overall energy use is less than the second floor unit due to the shared ceiling and, therefore, the associated savings are also less.

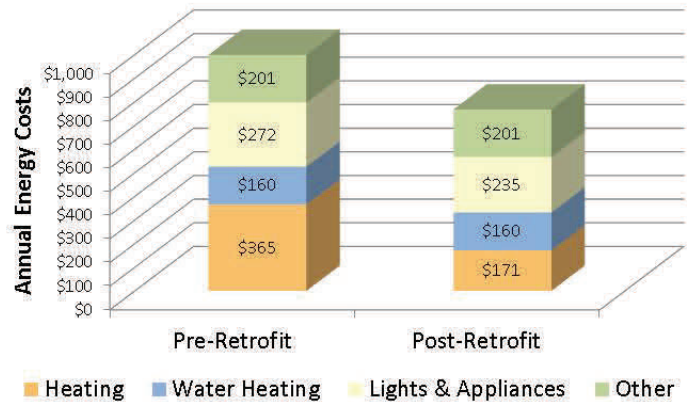
For these units, heating still comprises about one third of the annual energy costs. This was reduced by \$194 through the wall insulation, window and door upgrades, and reduced air leakage. Lights and appliances are again the next largest end-use, and \$37 in savings were achieved with compact fluorescent lighting and a new refrigerator.

As shown in the graphs to the right, the model sometimes under predicted and sometimes over predicted electricity consumption. Under predictions were mostly related to units with surges in electricity usage in the summer most likely from using window air conditioners (usually units on the 2nd floor); over predictions could result from reductions in occupancy as is typical of student housing. Based on the actual bills, \$40-\$120 per year is expected in electricity savings per unit.

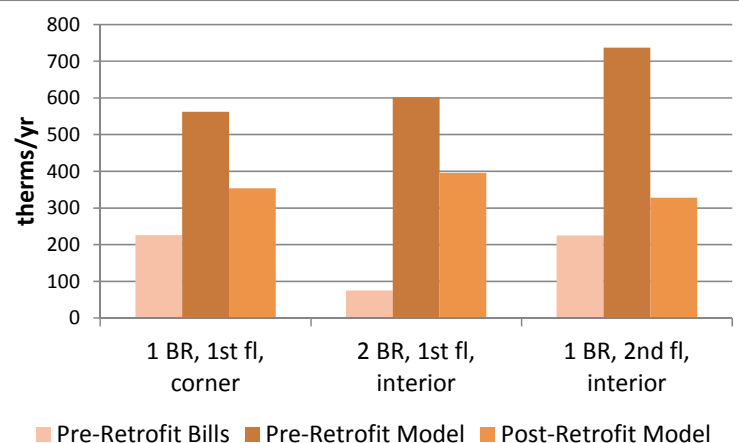
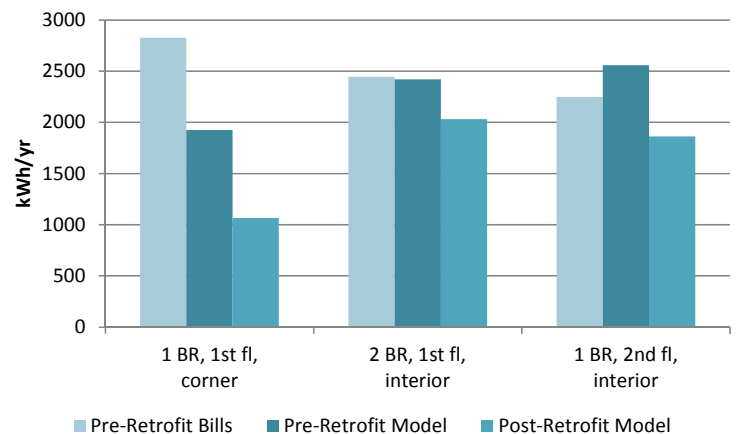
Unlike the predictions for electricity consumption, the models consistently and significantly over predicted gas consumption (see graph bottom right). It is suspected that the units are not being directly billed for the natural gas for the central water heaters (~150 therms per unit per year), but this does not explain the entire discrepancy. Multiple studies have shown that modeling software tends to over predict heating energy use in older, inefficient homes. This study definitely supports those observations.

With this in mind, it is expected that heating costs will still be reduced significantly due to the upgrades, but more along the lines of \$40-150 per year, depending on location and size of the unit. This estimate is based on the actual pre-retrofit bills and the percent reduction in heating energy use that can be expected from the upgrades performed.

Predicted Utility Bills for 1st Floor, 2 Bed, Interior



23% reduction in utility bills expected post-retrofit



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The property managers were interviewed and asked to share their feelings and concerns about Boulder's new SmartRegs ordinance. A summary of their opinions and suggestions for improvements are below.

Q: Why did you decide to participate now and not wait till later in the process?

A: A few years ago, one of the tenants wrote a letter to the owner explaining how inefficient the units were. This inspired the owner to do an extensive green retrofit to this property. He knew that the SmartRegs program was being developed, and since all the units needed to be remodeled, thought this was a good opportunity to make it a green remodel.

Each unit went up in price by about 25 - 30% after the remodel was completed, but managers have had no problem renting them.

Q: Are you educating the occupants about what and why renovations are taking place and how it will benefit them?

A: Yes, agents promote the green items, low utility bills and new windows. Students are really interested in this.

Q: What is your normal maintenance routine – i.e., every few months, once a year, on occupant turn over?

A: Heat techs check the heating system in each unit annually.

Q: What has been the biggest challenge for you throughout this process?

A: The managers were skeptical at first, but the requirements turned out to be not as bad as anticipated. One of the challenges noted was that the rebates from Xcel were not always available.

Q: What would you like other property owners to know?

A: The managers and the owner repeatedly mentioned that Populus has been a great liaison and that the advisors service has been invaluable. They also noted that they use the SmartRegs checklist used as a guide for planning their improvements.

Q: Do you feel that the occupants could have a negative effect on the retrofits.

A: This management company feels that the upgrades are durable. To date, no changes have been made to the work performed.

SWA did find compressed insulation and missing insulation on the hatch of one attic access areas, but it is suspected that this was caused by a contractor and not the occupants.

Steven Winter Associates, Inc. is the lead for the Department of Energy's Building America team called the Consortium for Advanced Residential Buildings (CARB).

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