Cold Climate Region
Case Study #7: 1172 Jay Street
City of Boulder, SmartRegs Ordinance
Multi-Family Low-Rise, 1950's Vintage

Boulder, CO

Program	SmartRegs Ordinance
Location:	Boulder, Colorado
Building Type:	Multi-family, low-rise, Triplex
Units Analyzed:	2
Area/unit:	763 ft^2
Foundation:	Slab on grade
Configuration:	2 bedrooms, 1 bath
SWA Contact:	Lois Arena

This 1950's rental property is located on "the hill" in Boulder, a popular destination for students moving into the area. From this neighborhood students are just a short bike ride from the University of Colorado and enjoy close proximity to restaurants, mass transit and hiking trails.

This building contains three rental units: 2 on the upper floor (which have identical floor plans) and one apartment on the lower level. At the time of this audit, only the upper left unit had been through a SmartRegs inspection. The owner felt that having one inspection was enough to: 1) get a sense of the worst-case SmartRegs score for this property, and 2) plan for improvements if necessary.

SWA was able to inspect both upper units. Efficiency levels and test results are listed in the table to the right. Based on those inspections it was determined that the upper right unit scored 82 points on the SmartRegs checklist while the left unit only scored 74 points.

During the initial SmartRegs inspection, the upper left apartment scored 85 points, but since that first inspection, a window air-conditioner (A/C) was installed by the occupant. Because the A/C was poorly installed, this measure also increased the air leakage of the unit. Finally, it appears that several compact fluorescent bulbs (CFL's) were replaced with incandescent bulbs. All of these measures resulted in a loss of points on the SmartRegs checklist.

Due to the changes made after the initial SmartRegs inspection, the upper left unit is the focus of this case study. The impacts of occupant behavior on the goals of the SmartRegs program are discussed in the following pages.

This apartment (upper left) initially scored 85 points on the SmartRegs checklist. At the time of this audit, the score was reduced to 74 points due to the addition of a window air-conditioning unit by the occupants.

Energy Efficient Features

Attic:	R-8 Blown Fiberglass insulation
Walls:	R-11 Fiberglass batts
Windows:	Combination of single wood, single wood with storm window
Foundation:	Slab-on-grade
Heating:	60% AFUE natural gas boiler
Cooling:	10.8 EER window unit
Hot Water:	0.60 EF, natural gas, conditioned space, 50 gallons
Air Leakage:	13.82 ACH@50 pascals, 0.75 ACHn

Additional SmartRegs Features

None.

SmartRegs Checklist Score*: 74 points**

(The final score must be ≥ 100)

HERS Index: 147

*100 points on the SmartRegs checklist should approximately equate to a HERS index of 120.
**Original score of 85 was adjusted for post-occupancy changes, resulting in a SmartRegs score of 74.

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As has been quite common to date, the owner of this property opted to use the prescriptive method of compliance and have the auditor fill out a checklist rather than perform energy modeling to determine if the property was in compliance.

As noted earlier, the initial SmartRegs score for this unit was 85 points. With the addition of the A/C and some incandescent light bulbs by the occupant, the score dropped to 74. Because the minimum allowable score is 100 points, the owner will have to improve the property to maintain the rental permit required by the City of Boulder.

The property owner is free to implement any combination of energy improvements as long as the final checklist score is at least 100. There are several combinations that would bring this home into compliance Below are two options.

Package #1: (+28 points)

- Replacing the boiler with one that is 90% efficient,
- Replacing the bulbs in all light fixtures with CFLs,
- Replace the refrigerator with a model <=350 kWh/yr.

This package results in a HERS Index of 105 and a SmartRegs score of 102.

Package #2: (+44 points)

- Install 1 kW of photovoltaic-generated power.

Package #2 results in a HERS Index of 128 and a SmartRegs score of 118.

Note that, while the installation of PV increases the SmartRegs score to 118 (well above compliance), the HERS Index only drops to 128. The reason for this is that the SmartRegs program prioritizes improvements not only by energy savings but also by carbon reduction. Because the emissions from electricity generation are so much greater than those generated from heating a home with natural gas, any measure that reduces electrical consumption is weighted more heavily than one that reduces the heating demand. Thus, the credit a home receives for PV in the SmartRegs program is more than is applied through the HERS rating, which only looks at consumption, not emissions.

Facts about SmartRegs

2 Compliance Paths: Prescriptive or Performance

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

A window air-conditioner was installed after the initial SmartRegs inspection. A large air-gap around the A/C resulted in a significant increase in the overall infiltration rate of the apartment.

Replacing this 60% efficient gas boiler with a 90% efficient unit gains 17 points on the SmartRegs checklist. Installing 1 kW of PV is awarded 44 points.

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Predicted annual utility bills for the home As-Is (according to SWA's audit) and for each upgrade package outlined on the previous page are displayed in the graph to the right. For the As-Is case, REM/Rate predicts an annual utility bill of $1,250: the bulk of the bill, about 38%, is attributed to heating.

Predicted utility bill savings for the first option package —90% efficient boiler, 100% CFL lighting and installing an Energy Star refrigerator (HERS index of 105) - average $231 per year.

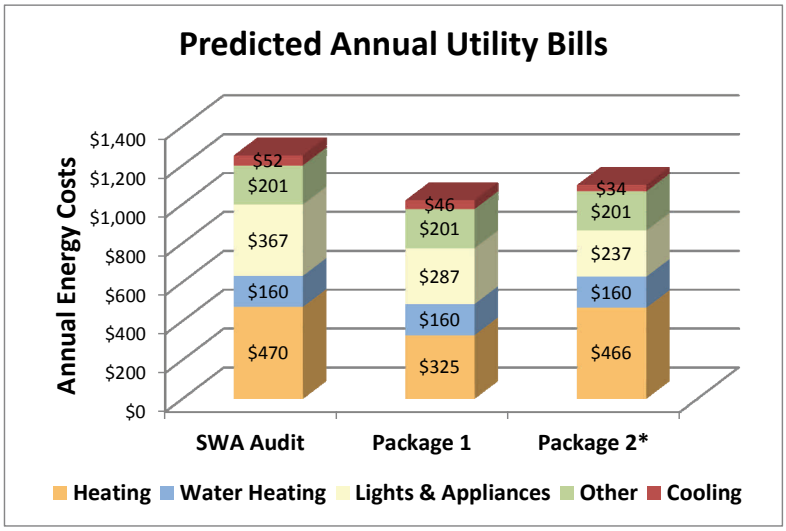
The second upgrade option—adding 1kW of solar-generated power (HERS Index of 128) - results in predicted annual energy savings of $148 per year.

Predicted emissions for each scenario are shown at right. It should be noted that even though the addition of 1kW of PV results in only a 7% reduction in energy consumption at the site[1] (as compared to a 23 % reduction from package 1) it results in very similar reductions of emissions: 18% reduction in CO_2 for PV vs. a 22% reduction for package 1.

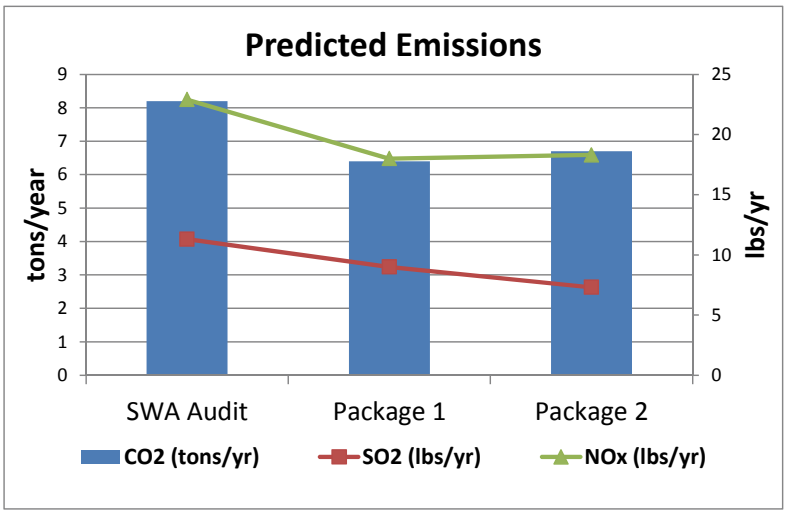
When production and transmission losses from the power plant (the source[2]) are factored in, emissions due to electricity generation increase by a factor of 3.3[3]. Therefore, even though Package #2 saves fewer MMBtu's at the site than Package #1 (7% reduction vs. 23%), it results in a bigger reduction in greenhouse gases per MMBtu saved (table at right) when energy use at the source is considered.

This demonstrates the point from the previous page that reductions in electric use result in bigger emissions savings than those that reduce heating provided by natural gas. Therefore, improvements that reduce electric use are more heavily weighted than those that reduce gas use.

Figures & Statistics



** Savings from Photovoltaics incorporated into Cooling and Lights & Appliances categories*



[1]*Site Energy Use: The energy directly consumed at a site (in this case the home) typically measured with utility meters.*

[2]*http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf*

[3]*Source Energy Use: The sum of the energy consumed at a site PLUS the energy required to extract, convert, and transmit that energy to the site.*

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Up to this point, the discussion about improvements, utility bills and emissions has all been based on the results of the audit conducted by SWA in August of 2011. But, as noted in the introduction, this apartment had received a SmartRegs inspection prior to this audit. What was discovered was that, in the time between the two inspections, the occupant had made a couple of changes that negatively impacted the energy efficiency of that unit, and hence the SmartRegs score and HERS Index.

The two significant changes made include:

1. A window A/C was installed. In addition to increasing electric use, this change resulted in increased air leakage, because it was installed with a significant gap around the edges. If left in place during the winter, this will have a significant impact on the energy used for heating.
2. Some of the CFL's were replaced with incandescent lights reducing the overall percent of CFL's from 100% to 38%.

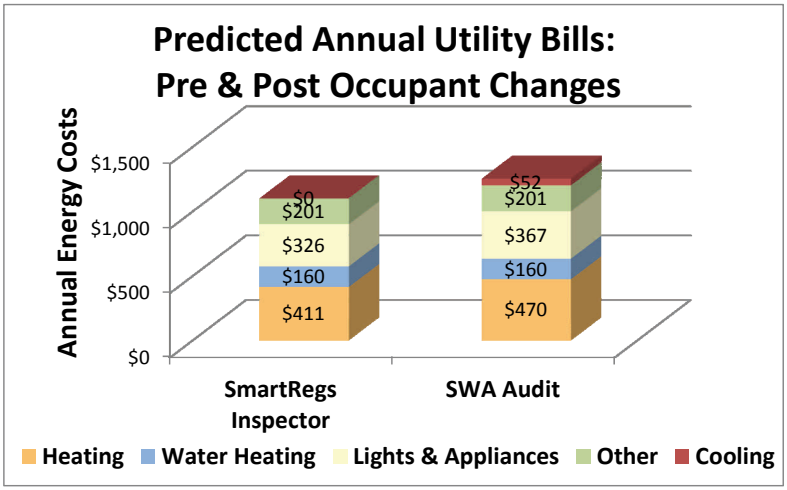
These changes result in a loss of 11 points on the SmartRegs checklist, taking the score from 85 down to 74. The HERS Index was likewise affected. That score changed from 130 to 147 (lower is better).

Overall, it is predicted that these occupant changes will increase the annual energy use by approximately 12%, increase CO_2 emissions by 16%, and will result in a $152 increase in annual utility bills. The affects of these changes are summarized in the graph and table to the right.

Of the nine case studies conducted to date, this was the first one where occupants had made a physical change that negatively altered the energy consumption and, hence, the SmartRegs score.

While it is anticipated that differences in occupant behavior (different thermostat set points, use of hot water, operation of windows during cold weather) will result in different energy use profiles for the same apartment, it is still unknown how big an affect the occupants will have on the City of Boulder's goals to reduce greenhouse gas emissions.

Figures & Statistics



Difference Between Initial SmartRegs Inspection & SWA Audit			
	Initial Inspection	SWA Audit	Difference (%)
SmartRegs Score	85	74	-14.9%
HERS Index	130	147	11.6%
Utility Bills ($)	$1,098	$1,250	12.2%
Energy Use (MMBtu)	72.1	81.8	11.9%
CO_2 Emissions (tons)	6.9	8.2	15.9%

Will changes be made that permanently and negatively affect air leakage? Will insulation be moved or compressed? Will CFL's be replaced with incandescent bulbs as was done here? What is the likelihood that these types of alterations will occur?

It can easily be concluded that, in Colorado's climate, addition of window A/C units is more likely to occur in poorly insulated homes and those with high solar gain during the summer. It also seems likely that occupants are more likely to change out CFL's from decorative fixtures without covers. Possible recommendations for changes to the program may include:

1. Unless a home has a minimum level of attic insulation and decent windows, points should not be awarded for the lack of a cooling system. Or, perhaps those points should not be awarded unless the home achieves a certain minimum score as is done with the points given for PV.
2. CFL's will not be given credit in decorative fixtures where the bulbs are entirely exposed, such as a chandelier.

Obviously, nine audits are not sufficient to make any definite conclusions. Follow up audits in the next couple of years may provide clearer answers to these types of questions.

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

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

A: The owners wanted to get a baseline worst case scenario so they could plan on how to most cost-effectively bring their properties into compliance.

Q: How many rentals does the owner have in their portfolio?

A: The owner has about 50 rental units in the city, the oldest of which was built in 1936.

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

A: Yes. At first the property manager was informing occupants of what was happening in writing, but now she verbally informs. She takes a couple of minutes to explain what's happening and that it won't cost the tenants any money.

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

A: Boiler maintenance is conducted every fall. All other improvements are conducted on an as-needed basis.

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

A: Getting the releases signed was the hardest part at first, so they incentivized them - $5 gift card. After the first few, they have experienced no problems getting the releases. The biggest occupant complaints are about the low-flow showerheads.

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

A: It's always better to have the information up front. Owners are not required to do anything right now. As many other managers/owners have noted in these interviews, this manager also stated that the energy advisor service has been very helpful to them.

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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