Cold Climate Region
Case Study #6: 1036 12th Street
City of Boulder, SmartRegs Ordinance
Multi-Family, Early 1900's Vintage

Boulder, CO

Program:	SmartRegs Ordinance
Location:	Boulder, Colorado
Building Type:	Multi-Family
Number of units:	2
Building Size:	1033 ft^2 Upper/285 ft^2 Lower
Foundation:	Basement/Crawlspace: Unconditioned
Configuration:	3 bedrooms, 2 baths
SWA Contact:	Lois Arena

Due to their proximity to the University of Colorado, there are several older neighborhoods in Boulder that are dominated by rental properties. Many of these old, single family homes, such as this bungalow built in 1919, have been divided into more than one unit: this home has been divided into two rental units. The main level plus a loft area comprise one (upper unit), and a much smaller garden basement area (lower unit) comprises the other.

According to Boulder's SmartRegs requirements, each rental unit in a building must be tested and scored separately. Unusual layouts, common walls and floors, shared equipment, and occupant use of the space can make this quite challenging. Efficiency levels and testing results for each unit in this home are shown in the table at right. As can be seen in that table, the resulting SmartRegs scores and HERS Indices are quite different for each even though they are located in the same building.

It is common when rating multi-family buildings that some units will score better than others. Contributing factors include whether the unit is on the bottom, middle or top floor of the building, the amount of exposed surface to outside, and differences in lighting and appliances in each space. Differences in the HERS Index can also be the result of the affects of solar exposure and the amount of window area.

The lower unit in this building, being partially below grade and substantially bordered by conditioned space of the upper unit (entire ceiling and 50% of the walls) scores much higher on the SmartRegs checklist than the upper unit. Of the 51 point difference between the two units, 43 points come from the fact that the lower unit's ceiling and 50% of its walls border the upper unit.

This home has been divided into two rental units. While the lower unit complies with Boulder's SmartRegs ordinance, improvements must be made to the upper unit .

Energy Efficient Features

Attic:	R-11 blown & batts
Walls:	Uninsulated brick
Windows:	Predominantly single pane wood
Foundation:	Crawlspace ceiling R-19, Basement R-0
Heating:	Central system - forced air, natural gas, 80 AFUE, in unconditioned basement
Cooling:	None
Ductwork:	Uninsulated & in unconditioned space
Hot Water:	Atmospheric, natural gas, unconditioned space, 0.59 EF
Air Leakage:	Upper: 31.4 ACH@50 pascals, 2.12 ACHn Lower: 43.5 ACH@50 pascals, 1.96 ACHn

Additional SmartRegs Features

Low-flow faucets and showerheads, programmable thermostat

SmartRegs Checklist Score*: 59 points Upper
110 points Lower

(The final score must be ≥ 100)

HERS Index: 181 Upper/128 Lower

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

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Boulder, CO

The minimum allowable score when using the prescriptive method for compliance with Boulder's SmartRegs ordinance is 100 points. The lower unit of this property scores 110 points, but the upper only scores 59, therefore, the owner will have to improve the upper unit of this property by 2019 in order to maintain their rental license.

When developing the SmartRegs checklist, program creators intended that 100 points should approximately equate to a HERS index of 120. Given this assumption, the lower unit should have a HERS Index less than 120, and the upper should have an index well above that.

To validate this assumption, SWA modeled both units in this home using REM/Rate, a simulation program used to analyze the energy use of residential buildings. As anticipated, the upper unit received a HERS Index of 181, much higher than 120 points, but the lower unit only received an index of 128 even though the SmartRegs score was 110.

There could be several reasons why the HERS Index is higher than 120, but according to the SmartRegs prescriptive checklist, the unit is in compliance. A few issues that affect the HERS index but not the SmartRegs score include:

- Smaller homes tend to get higher HERS Indices because the surface area to volume ratios are higher than for larger homes.
- The higher the window to wall area ratio the more heat loss from the home. SmartRegs doesn't measure areas, just efficiencies of the components.
- Orientation is not considered in SmartRegs, but will affect a HERS index due to its impact on solar gain.
- SmartRegs uses steps in efficiency levels and associates points with each step (table at right) vs. using the actual efficiency as is done in a HERS model.
- Definitions of conditioned vs. unconditioned basements are slightly different between the two methods.

Facts about SmartRegs

2 Compliance Paths: Prescriptive or Performance
- Prescriptive: ≥ 100 points on Checklist
- Performance: HERS Index <= 120

Garden Level Lower Apartment

ATTIC Base:_____ Final:_____

TYPE	25%	50%	75%	100%
No Insulation	0	0	0	0
R-19	6	12	18	24
R-30	6	13	19	26
R-38 or Better	7	13	20	26
Shared Ceilings	7	14	20	27

Attic Section of SmartRegs Checklist

Therefore, although 100 on the checklist is intended to approximately equate to a HERS Index of 120, it can sometimes be higher or lower than that.

In the case of this lower unit, it is in fact only 285 ft2: a very small space. It also receives very little solar gain because most of the windows are highly shaded by neighboring property and vegetation. And finally, although the basement of the upper unit is considered conditioned according to SmartRegs standards, it is modeled as unconditioned according to HERS standards.

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Cold Climate Region: Case Study #6 SmartRegs Compliance (cont.)

Boulder, CO

Various improvement options for this property owner include:

- Bsmt/Crawlspace (50% of unit's footprint): insulating the walls to R-19, air sealing and installing a vapor barrier on the crawlspace floor (6 points—includes points for bringing ductwork into conditioned space);
- Insulating 75% of the attic to R-30 (20 points—25% is vaulted and cannot be brought to R-30);
- Replacing the water heater with an instantaneous, 82 EF model (5 points);
- Installing an ENERGY STAR refrigerator <= 350 kWh/yr (4 points);
- Install storm windows on all single-pane, wood windows (6 points);
- Reducing the air leakage to 0.75 ACHn (4 points);

Package 1: The property owner is free to implement any combination of energy improvements as long as the final checklist score is at least 100. If all of the above improvements are implemented, the upper unit would score 104 points and results in a HERS Index of 115. The costs to implement all of the above improvements would probably exceed $10,000.

Another option would be to install at least 1 kW of PV (photovoltaics) on the roof. This upgrade receives 44 points on the SmartRegs checklist, but can only be counted toward compliance if the home already scores 70 points or higher. Since the upper unit only scores a 59 in its current condition, efficiency improvements that increase the score by at least 11 points will have to be made first before the PV can be counted.

Package 2: The easiest improvement would be to insulate the flat ceilings to R-30 for 20 points, and then install 1 kW of PV for an additional 44 bringing the final SmartRegs score to 123. Costs for this option would be around $4000.

While this combination of improvements results in compliance with the prescriptive path, the corresponding HERS Index is only 162. The impacts on utility bills, energy use and greenhouse gas production are addressed on the following page.

R-19 insulation is installed between the floor joists in the ceiling of this crawlspace but gets no credit on the SmartRegs checklist because heating ducts are present.

Attic is only insulated to R-11. Kneewalll access hatches are extremely leaky.

SmartRegs Score and HERS Index for each Upgrade Package.

	Package 1	Package 2
Upgrade Item	Attic & Foundation Insulation, Storm Windows, 0.75 ACHn, New Refridg., Instant. Water Heater	Attic Insulation, PV
SmartRegs	104	123
Hers Index	115	162

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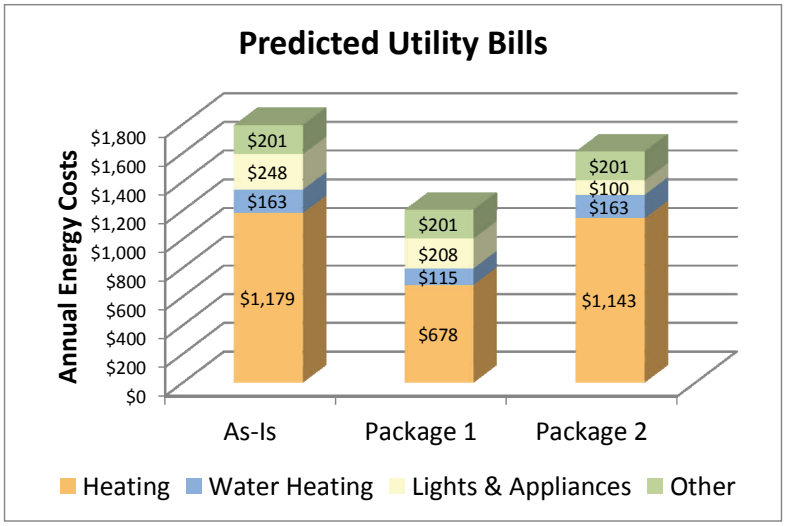
Predicted monthly utility bills for this property as it existed at the time of the initial inspection are displayed in the graph to the right. REM/Rate predicts an annual utility bill of $1,7191: about 66%, $1,179, is attributed to heating. The first option package discussed on the previous page–insulating the foundation and attic, air sealing, storm windows, new water heater and refrigerator (HERS index of 115)–results in predicted utility bill savings of 33% or $589 per year and a 38% reduction in energy consumption (see table bottom right) The second improvement package–insulating the attic and installing 1 kW of PV (HERS Index of 162)–results in predicted utility bill savings of 10% or $184 per year and a 7% reduction in energy consumption.

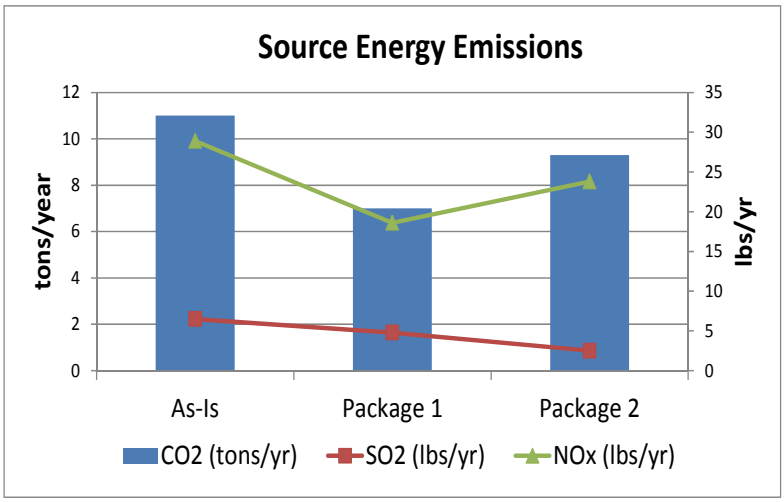
The predicted green house gas emissions for each of the three scenarios evaluated in this report are displayed in the figure to the right. When creating the SmartRegs checklist, developers weighted the points using a number of different parameters. A measure's impact on greenhouse gas reduction was one of those parameters. The result was: improvements that reduce electric use are more heavily weighted than those that reduce gas use. Here's why.

The amount of CO_2 emitted per 1 MMBtu of energy produced from burning coal is almost twice that of natural gas[1]. When production and transmission losses from the power plant are factored in, emissions due to electricity generation increase by a factor of 3.3[2]. This is the difference between energy produced at the "source" (the power plant) and energy consumed at the "site" (the home). This means that emissions from electricity generation using coal are really a factor of six greater than those from burning natural gas to heat a home in Colorado's climate.

Therefore, even though Package #2 saves fewer MMBtu's at the site than Package #1 (7% reduction vs. 38%), it results in a bigger reduction in greenhouse gases per MMBtu saved (table at right) when energy use at the source is considered. This is why installing PV is weighted so heavily and gains 44 points on the SmartRegs checklist. Installing PV results in bigger reductions in greenhouse gases per MMBtu saved than measures that reduce natural gas use.

Reductions in Energy Use and Emissions





Reduction Compared to As-Is Case	Package 1	Package 2
Utility Bills	33%	10%
Emmissions	34%	23%
Annual Energy Consumption	38%	7%
Tons of CO_2/MMBtu Saved	0.07	0.15

[1] *http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11*
[2] *http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf*

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This property is owned by the foundation of a local church. One of the board members assisting with the management of the rental was interviewed to determine the board's feelings and concerns about Boulder's new SmartRegs ordinance. A summary of his 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 board of this foundation chose to participate now to take advantage of free inspections and to start the planning process in the case that improvements would need to be made.

Q. How long has the owner owned this property?

A: This property has been owned for approximately 15 years by a foundation for a local church. They own a total of 2 rental properties.

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

A: There is no tenant education at this time. The church board is evaluating its improvement options and has yet to make any decisions.

Q. What's the vacancy rate for your property?

A: Like most other rental property owners in Boulder, these owners indicated that they have no problems with vacancy.

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

A: The foundation performs maintenance as necessary every 4 years upon their rental license renewal.

Q. Concerns?

A: The owner's biggest concern is the cost to improve the property when the land the house sits on is worth so much more than the house. The board feels that SmartRegs is disconnected from the point that the people paying the bills are not the people improving the house.

SmartRegs representatives explained that this is the purpose for the ordinance. That without it, rental property owners would not improve the energy efficiency of these units given that they are not paying the bills, and therefore, have no incentive to make any improvements to reduce energy consumption.

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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