City of Boulder SmartRegs Case Study
Final Report

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Submitted to

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INTRODUCTION

The City of Boulder retained Populus Sustainable Design Consulting ("Populus") and What's Working, Inc. to perform a SmartRegs case study to provide energy analysis, quantify the tested impacts and costs of energy efficiency measures and to provide policy recommendations in relation to the City of Boulder's proposed SmartRegs program for rental housing.

EXECUTIVE SUMMARY

Based upon this SmartRegs case study and the cost data provided in this report, achieving a Home Energy Rating System ("HERS") Index Score of 120, (or the equivalent of 20% less efficient than the 2004 International Energy Conservation Code ("IECC")), is both realistic and obtainable for most properties in the City of Boulder.

In order to provide both a performance (HERS rating) and prescriptive pathway to SmartRegs compliance, Populus developed a prescriptive points pathway that is weighted such that achieving 100 points is roughly equivalent to achieving a HERS Index Score of 120 or 20% *less efficient* than the 2004 IECC (with some variations because the prescriptive pathway is more carbon-focused than HERS rating). A proposed home size adjustment has also been included in this report, which helps normalize the prescriptive pathway based upon overall carbon emissions. If a home size adjustment is adopted, the performance pathway should be adjusted as well (since small and large homes can achieve HERS 120 while having radically disparate carbon emissions).

SUMMARY OF POLICY RECOMMENDATIONS

- While a prescriptive pathway is recommended due to cost considerations, an energy audit (including at least a blower door test and a duct blaster test) should be mandatory under the SmartRegs program. Requiring energy audits not only provides a benefit to the homeowner, but also provides data to the City of Boulder for measuring energy savings attributable to the program.

- Our recommendation is to phase-in the implementation of the SmartRegs program prescriptive pathway by capping the total number of improvement points that would be required during any given rental cycle (the performance pathway could likewise cap the maximum HERS score improvement in any rental cycle).

- While carbon offsets are generally disfavored as a policy approach, they may be useful as a "bridge" to phase-in program implementation. For example, the City of Boulder could require that any initial rental cycle prescriptive point's deficit (below 100) be "made up" with the purchase of carbon offsets. The Colorado Carbon Fund provides high quality carbon offsets to consumers as a way to support new energy efficiency and renewable energy projects.

- In regards to financing, many programs such as Boulder County's ClimateSmart Loan Program, the proposed Home Star program and private loans may be available to help property owners pay for upgrades. There are currently utility and governmental rebates for efficiency upgrades available as well. In addition, renters may be eligible for low-income weatherization funding, which would defray landlord costs. Even with these programs available, there needs to be a financial hardship waiver that landlords can use to request a reduction or a "pass" for the first rental cycle (or at least allow the landlord to purchase offsets instead of upgrades).

- To address concerns regarding occupant behavior, landlords could be given one prescriptive point towards SmartRegs energy efficiency compliance if their tenants attend an energy conservation workshop. In addition, an energy conscious lifestyle handbook should be developed in conjunction with the University of Colorado that will help tenants understand the importance of energy conservation.

- To encourage market-based incentives to energy efficiency, the City of Boulder's rental policy should require landlords to disclose average utility bills when renting a property. Landlords should be encouraged to insert a standard clause into all future rental leases that permits the City of Boulder or some other entity access to utility data in order to compare past energy consumption with that of post-improvement to allow tracking of SmartRegs program effectiveness.

METHODOLOGY

In connection with development of its SmartRegs program for rental housing, the City of Boulder allocated funds to be used for a retrofit case study to test the impact of energy efficiency upgrade measures in five Boulder rental properties. From a group of over 120 applicants, five case study homes were selected. The homes represent some of the major rental housing typologies in the City of Boulder: single-family detached (one early 20th century bungalow style and one 1960's ranch style), townhome-style (one inside unit and one end unit), and one apartment-style multifamily unit.

Factors that were evaluated in selecting the case study properties included:

- Energy use – Higher energy users were preferable
- Housing type – Single family vs. apartment
- Location – Projects in different neighborhoods
- Age

Property	Total btu/sf/day	Housing Type	Year Built
3035 Ash	390.97	Single Family (1960's Ranch)	1955
642 University	230.27	Single Family (20th Century)	1909
2230 Walnut	209.72	Five –Plex (converted single Family)	1934
301 Pearl St	147.11	Duplex (Townhouse)	1972
805 29th St.	94.75	Condo (Inside Unit)	1966
1700 22ND St.	NA *	Condo (End Unit)	1972

* Information not gathered. This property was not part of the original submission and was chosen at a later date.

In order to establish the existing conditions on-site, in-depth energy audits were performed on each case study home including an insulation audit, air infiltration testing, differential pressure analysis, duct leakage testing, infrared thermography, HVAC equipment audit, appliance audit and lighting audit. Further, building area take-offs and photos were gathered to aid in the creation of computer simulated "energy models" that would be used to analyze each case study home.

In order to extract the greatest amount of useful data from a relatively small sample set of homes, Populus applied the following methodology for information gathering, modeling of energy efficiency permutations and analysis. First, each home was modeled in its present condition to establish the current HERS Index. Initial energy modeling was performed using REM/Rate software from Architectural Energy Corporation. In addition to determining the baseline HERS Index, the REM/Rate software also estimated annual energy consumption for end-uses including space heating and cooling, domestic water heating, lighting, appliances, and plug loads. Further, REM/Rate made an

estimate of the carbon dioxide emissions associated with each end-use, including source emissions for electric consumption. This information was compiled as the "base case" performance for each individual home.

In order to evaluate the effect of a variety of energy efficiency improvement measures (including air infiltration reduction, duct leakage reduction, insulation, high-efficacy lighting replacement, appliance replacement, and HVAC equipment replacement) each base model was permuted to reflect a given improvement and the resultant impacts on HERS Index and CO_2 emissions were recorded. In this way, each potential improvement for each property was modeled as an independently installed measure. (*See Phase I Progress Report).* When more than one measure is installed in a property, the resultant effect can be less than the sum of the modeled impacts of the individual measures. That is to say, there can be a diminishing impact when more than one measure is installed. In order to compensate for this effect, "packages" of energy efficiency improvements performed to the case study properties were modeled collectively to determine the overall impact on energy efficiency.

When the broad spectrum of rental housing units were analyzed, several factors other than building typology were found to alter the impact of installing energy efficiency improvement measures. These factors included, but were not limited to, building size, percentage of shared (adiabatic) versus exterior wall, and the number of occupants. In the case of shared walls, ceilings and floors in multi-family housing, there is no temperature differential to cause heat loss through adiabatic surfaces. Thus, the prescriptive pathway was designed to account for adiabatic surfaces by awarding the highest level of points to shared walls, ceilings and floors. While building size and number of occupants does not have a profound impact on Home Energy Rating Index scores (because the actual house is always being compared to a geometric twin reference house), building size and number of occupants is one of the most profound factors that influence building energy consumption and carbon emissions. For example, a typical 5,000 square foot, HERS 120 house with three bedrooms uses roughly twice as much energy and has twice the carbon footprint of a 2,000 square foot three bedroom home (with the same specifications). A home size adjustment table is proposed as part of the SmartRegs program to help account for this disparity.

While each project was unique, the study found that the following three measures typically resulted in the greatest savings:

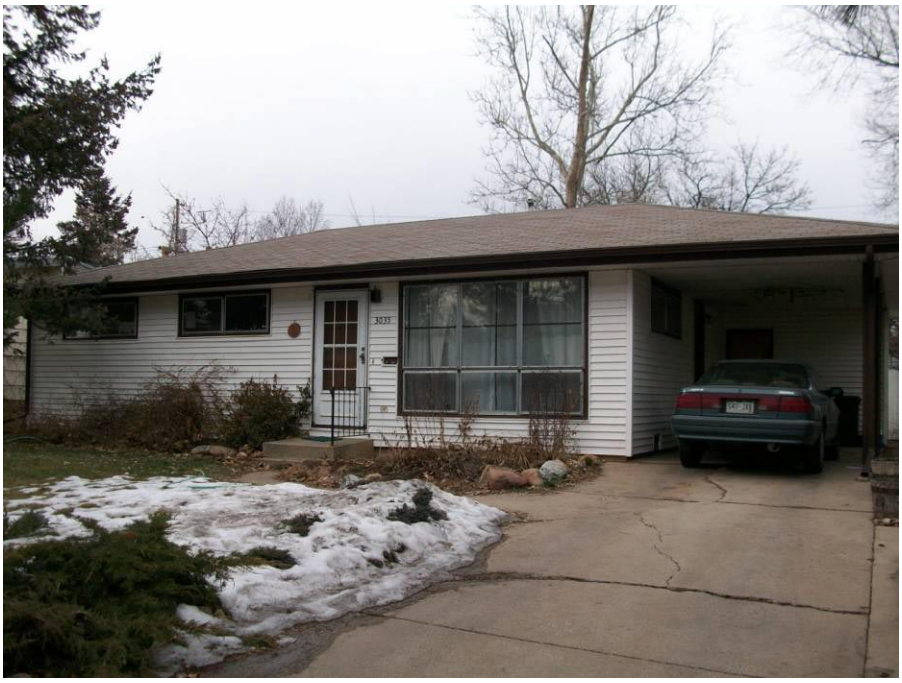
- Insulation: Crawlspace, Attic and Walls
- Duct Sealing
- Air Sealing

With this information, a list of improvement measures was compiled for each project and sent out to bid. Each project was bid by three insulation/air-sealing companies. Additionally, window and furnace bids were also sought where appropriate. While the bids varied in price, it was interesting to see the unique approaches that each contractor brought with their bid to improve the property. Each approach was tested in the energy model to confirm that the selected measures would result in the greatest carbon reduction.

In addition to pricing and deliverables, it was also a consideration of the project to spread the work over several different companies. This was determined to be the fairest approach that would also provide a broad comparison of work product among the different contractors.

The proposed prescriptive pathway was developed and refined during the case study using eQUEST energy modeling software. To align the prescriptive pathway with a performance pathway, the 2004 IECC was used as a reference and the approach was tested and applied using the case study homes. A further description of the prescriptive pathway approach is provided below.

CASE STUDY HOMES



Ash (1960's Ranch)

Ash is a single family home built in 1955 in the Martin Acres neighborhood. This home is typical of hundreds of single family homes in Boulder, of which many are rental units. The home consists of a single floor with three bedrooms. The furnace (80% AFUE) and ducts are located in the unconditioned crawlspace. The walls have minimal insulation (none in the wood frame cavity) and have single pane metal frame windows. The attic is insulated to R-22. This unit also has an evaporative cooler that is introduced through the dining room window.

For this property, the level of duct leakage reduction actually achieved in the home was far below the projected estimates (which assumed ENERGY STAR level of duct leakage). This resulted in the home not achieving the desired HERS Index of 120. In order to achieve this level of energy performance, the attic insulation would need to be increased from R-22 to R-38, which would result in a HERS Index of 118. This measure is estimated to cost approximately $900 and would yield an estimated $55/year energy savings.

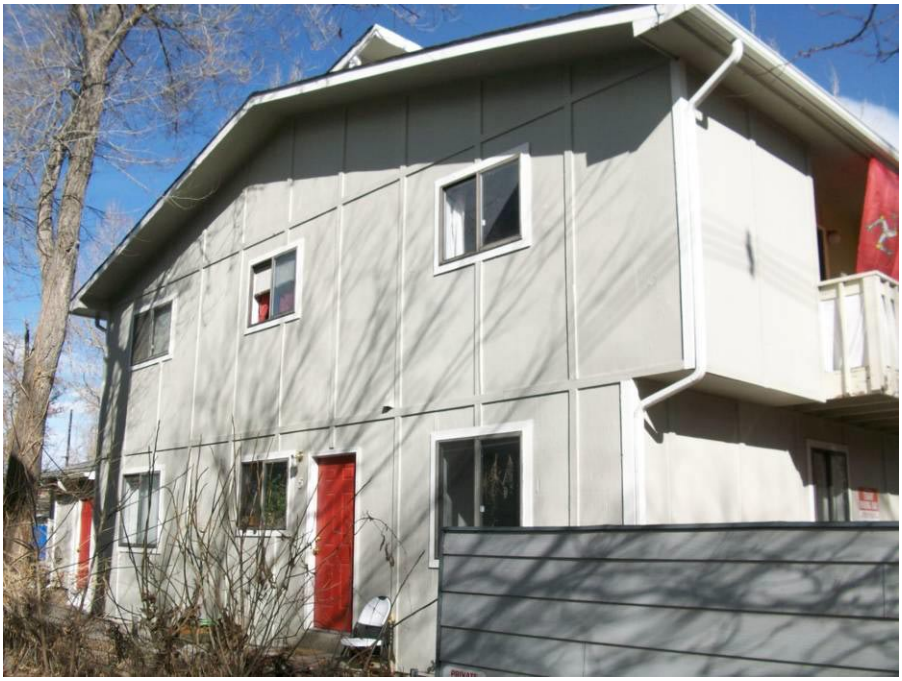
- Floor Area: 988 sq ft
- Bedrooms: 3
- Baseline Infiltration: 2,374 cfm @ 50 Pa
- Final Infiltration: 1,911 cfm @ 50 Pa
    - 19.5% reduction in overall air infiltration
- Duct Leakage: 88 cfm/100 sq ft @ 25 Pa
- Final Duct Leakage: 44 cfm/100 sq ft @ 25 Pa
    - 50% reduction in duct leakage

Ash Case Study Summary	
HERS Before	170
HERS After	126
Prescriptive Points Before	67
Prescriptive Points After	101
Total Improvement Cost	$2,872.64
Estimated Annual Energy Cost Before	$1,650.00
Estimated Annual Energy Cost After	$1,346.00
Estimated Annual Savings	$304.00
Estimated Average Monthly Savings	$25.33
Monthly Improvement Payment Financed at 6% for 15 Years	-$24.24
Cost Neutral from Day One?	YES
Total CO2 Before (mt)	11.88
Total CO2 After (mt)	9.47
Estimated CO2 Reduction (mt)	2.41
% CO2 Reduction	20%
CO2 per Bedroom (mt)	3.16
Cost per mt CO2 Reduction / year (over 30 years)	$39.73
Average Cost per Prescriptive Point Reduction	$84.49
Average Cost per HERS Point Reduction	$65.29

Ash Summary of Individual Improvements and Impacts							
Improvements	Cost	HERS Reduction	Additional Prescriptive Points	Projected Energy Reduction (MMBtu/yr)	Projected CO2 Reduction (metric tons/yr)	Percent CO2 Reduction	Notes
Air seal ledger board w/ expanding foam gun in crawlspace between floor joists	$125.00	2	2	1.8	0.09	0.7%	Includes all air leakage reduction

Air seal w/ mastic and foil tape *accessible* return, supply ducts and air handler in crawlspace	$230.00	8 (50% reduction in duct leakage)	16	7.2	0.64	5.3%	Includes duct sealing and duct location
Install 6 mil poly vapor barrier on crawl space floor; poly with be fastened with a VOC adhesive, 16"-18" above grade on all foundation walls	$889.20	N/A	N/A	N/A	N/A	N/A	
Insulate interior crawl space walls with R-19 draped white vinyl fiberglass insulation	$517.50	15	4	8.8	0.55	4.1%	
Add R-19 kraft faced fiberglass batts between floor joists of ledger board	$125.00	6	Included in crawl space above	6.2	0.36	2.7%	
Drill & Fill non insulated finished 2x4 walls w/ eco friendly cellulose insulation to R15	$835.90	14	12	13.3	0.82	6.2%	
Finish work for holes cut in drywall for drill and fill	$462.00	N/A	N/A	N/A	N/A	N/A	

Company: Advanced Air Sealing



Walnut (Converted Single Family)

Walnut is a five unit townhome complex built in 1977. This townhome shares nearly half of its walls with other units and as a result only has south and west exposure. The furnace (80% AFUE) and ducts are located in the semi-conditioned crawl space. The framed walls are insulated to R-11 with fiberglass batts. The windows are single pane with metal frames. The roof is insulated to R-13 in the attic section and insulated to R-30 in the vaulted section.

For this property, the level of duct leakage reduction actually achieved in the home was far below the projected estimates (which assumed ENERGY STAR level of duct leakage). This resulted in the home not achieving the desired HERS Index of 120. Based on the actual final duct leakage achieved, the following improvement measures would need to be implemented to reach HERS 120: increase CFL's from 25% to 100%, install a programmable thermostat and replace the electric water heater with a gas 0.65 EF unit. These measures are estimated to cost approximately $1,250 and would yield an estimated $281/year energy savings.

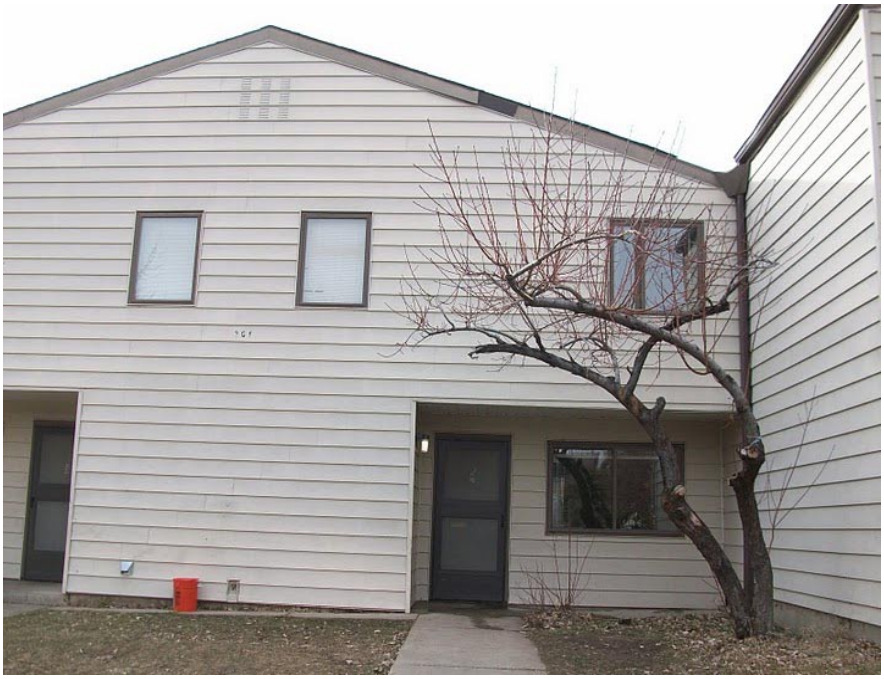
- Floor Area: 1,074 sq f
- Bedrooms: 3
- Baseline Infiltration: 2,457 cfm @ 50 Pa
- Final Infiltration: 2,161 cfm @ 50 Pa
    - 12% reduction in overall air infiltration
- Baseline Duct Leakage: 70 cfm/100 sq ft @ 25 Pa
- Final Duct Leakage: 42.8 cfm/100 sq ft @ 50 Pa
    - 39% reduction in duct leakage

Walnut Case Study Summary	
HERS Before	146
HERS After	128
Prescriptive Points Before	79
Prescriptive Points After	97
Total Improvement Cost ($2800 / 4 units benefiting from crawlspace improvements)	$700
Estimated Annual Energy Cost Before	$1,675.00
Estimated Annual Energy Cost After	$1,529.00
Estimated Annual Savings	$146.00
Estimated Average Monthly Savings	$12.17
Monthly Improvement Payment Financed at 6% for 15 Years	-$5.91
Cost Neutral from Day One?	YES
Total CO2 Before (mt)	12.65
Total CO2 After (mt)	11.48
Estimated CO2 Reduction (mt)	1.17
% CO2 Reduction	9%
CO2 per Bedroom (mt)	3.83
Cost per mt CO2 Reduction / year (over 30 years)	$19.94
Average Cost per Prescriptive Point Reduction	$38.89
Average Cost per HERS Point Reduction	$38.89

Walnut Summary of Individual Improvements and Impacts							
Improvement	Cost	HERS Reduction	Additional Prescriptive Points	Projected Energy Reduction (MMBtu/yr)	Projected CO2 Reduction (metric tons/yr)	Percent CO2 Reduction	Notes
R-19 unfaced batts in crawl space rim joist, with R-19 perforated vinyl faced fiberglass batts to crawlspace foundation walls	920.00	6	6	6.2	0.36	2.6%	Includes infiltration reduction
2” of urethane foam install in crawl space rim	395.00	4	Included in crawl space above	4.3	0.27	2.0%	

joist							
10-mil black poly sealed over the crawl space ground	885.00	NA	N/A	N/A	N/A	N/A	
Seal leaks in the ducts with mastic or foil tape	$600	6	12	5.7	0.45	3.6%	Includes duct sealing and duct location

Company: RG Insulation



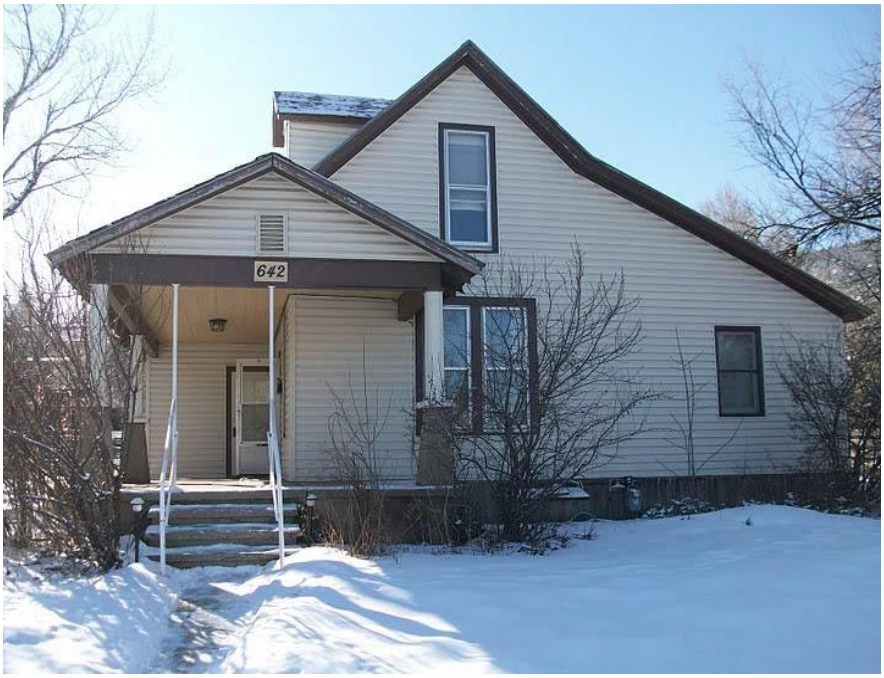
Pearl (Townhouse)

Pearl is a townhome near the intersection of 9th and Pearl. The complex was constructed in 1972. This townhouse shares (nearly) half of its walls with the adjacent units and as a result receives no southern exposure. The furnace (80% AFUE) and ducts are located inside of the building except for a duct-run in the attic. The walls are insulated to R-11 with fiberglass batts. The windows are double pane with vinyl frames. The attic is insulated to R-38 with blown fiberglass insulation.

Because the baseline HERS Index for this property was below HERS 120, it did not receive any energy efficiency retrofit upgrades. However, during Phase I, the unit owner performed simple air sealing measures and the resultant air infiltration reduction lowered the HERS score by ten points. (*See Phase I Progress Report, Appendix: Pearl: Air-Sealing Case Study*).

- Floor Area: 1,089 sq ft
- Bedrooms: 4
- Infiltration: 1,273 cfm @ 50 Pa

- Duct Leakage: 21 cfm/100 sq ft @ 25 Pa



University (20th Century)

University is a single family home built around 1900. This home is typical of many of the old single family homes in Boulder. The furnace (80% AFUE) and ducts are located in the unconditioned crawlspace. The walls have varying insulation levels due to numerous remodels. The various wall types include: wood framing with bricks laid in the cavity, various fiberglass insulation levels, and areas with additional rigid foam insulation on the exterior of the home. Windows are both single and double pane with wood frames. Though partially finished, the second story of the building is considered an attic space as it is unconditioned and inaccessible. The attic's insulation levels also vary. In some areas there is no insulation and in other areas there is fiberglass insulation (up to R-38).

- Floor Area: 1,231 sq ft
- Bedrooms: 3
- Baseline Infiltration: 2,982 cfm @ 50 Pa
- Final Infiltration: 2,798 cfm @ 50 Pa
    - 6.1% reduction in overall air infiltration
- Baseline Duct Leakage: 31 cfm/100 sq ft @ 25 Pa
- Final Duct Leakage: 29 cfm/100 sq ft @ 25 Pa
    - 6% reduction in duct leakage

University Case Study Summary	
HERS Before	162
HERS After	117
Prescriptive Points Before	73

Prescriptive Points After	101
Total Improvement Cost	$2,079
Estimated Annual Energy Cost Before	$1,688.00
Estimated Annual Energy Cost After	$1,293.00
Estimated Annual Savings	$395.00
Estimated Average Monthly Savings	$32.92
Monthly Improvement Payment Financed at 6% for 15 Years	-$17.54
Cost Neutral from Day One?	YES
Total CO2 Before (mt)	12.1
Total CO2 After (mt)	9.03
Estimated CO2 Reduction (mt)	3.07
% CO2 Reduction	25%
CO2 per Bedroom (mt)	3.01
Cost per mt CO2 Reduction / year (over 30 years)	$22.57
Average Cost per Prescriptive Point Reduction	$74.25
Average Cost per HERS Point Reduction	$46.20

University Summary of Individual Improvements and Impacts							
Improvement	Cost	HERS Reduction	Additional Prescriptive Points	Projected Energy Reduction (MMBtu/yr)	Projected CO2 Reduction (metric tons/yr)	Percent CO2 Reduction	Notes
Seal ducts using mastic	79.00	1	5	.6	0.05	0.4%	Only achieved 6% reduction in duct leakage
Wrap heat runs with fiberglass	249.00	1	7	2.2	0.18	1.4%	Duct location
Place vinyl backed fiberglass around interior side of exterior crawlspace walls. Cut edges to insulate rim joist as well.	462.00	8	3	9.5	0.55	4.1%	
Seal furnace flue with tin and red	40.00	N/A	N/A	N/A	N/A	N/A	

fire rated caulking							
Seal all air leak areas in attic North of South addition and South of original structure with energy complete.	211.20	2	0	2.2	0.09	0.7%	10% overall reduction in infiltration
Insulate above 1st level making the thermal boundary the floor of the second level. Loose fill above floor using cellulose	843.20	26	13	26.4	1.55	11.6%	Attic insulation to R-38
Install foam board above stairway	130.00	4	Included in attic insulation above	3.7	0.18	1.4%	

Company: Bestway Insulation

29th Street (Inside Unit)

This is an apartment located in the Spanish Towers complex on 29th Street near Baseline. The complex was constructed in 1969. This apartment has less than 200 sq ft of wall exposed to the outside, accounting for less than 20% of the total wall area. The furnace (60% AFUE), air conditioning condenser (6.1 SEER) and ducts are located inside the building. The walls have minimal insulation (none in the wood frame cavity). The windows are double pane with metal frames. A portion of the ceiling is uninsulated concrete which is exposed to a balcony above.

- Floor Area: 812 sq ft
- Bedrooms: 1
- Baseline Infiltration: 1,159 cfm @ 50 Pa
- Final Infiltration: 1047 cfm @ 50 Pa
    - 10% reduction in overall air infiltration
- Baseline Duct Leakage: 21 cfm/100 sq ft @ 25 Pa
- Final Duct Leakage: 21 cfm/100 sq ft @ 25 Pa

Spanish Towers Case Study Summary (w/o window replacement)	
HERS Before	167
HERS After	120
Prescriptive Points Before	84
Prescriptive Points After	98
Total Improvement Cost	$800
Estimated Annual Energy Cost Before	$1,031
Estimated Annual Energy Cost After	$859
Estimated Annual Savings	$172

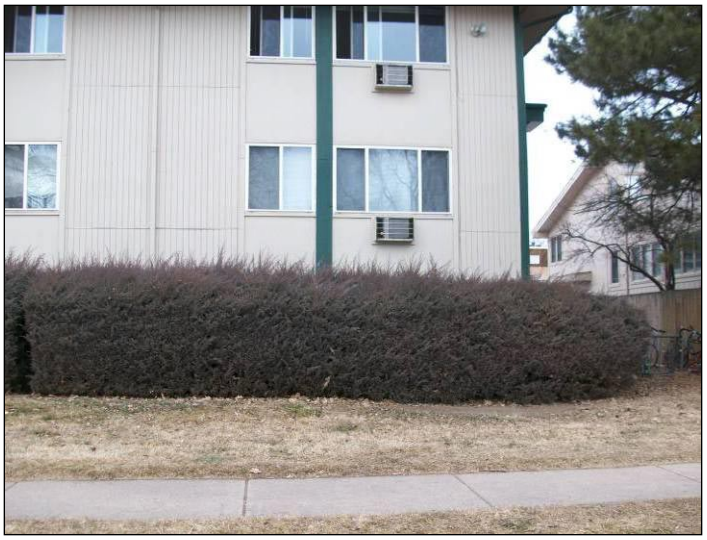
Estimated Average Monthly Savings	$14.33
Monthly Improvement Payment Financed at 6% for 15 Years	-$6.75
Cost Neutral from Day One?	YES
Total CO2 Before (mt)	6.96
Total CO2 After (mt)	5.6
Estimated CO2 Reduction (mt)	1.36
% CO2 Reduction	20%
CO2 per Bedroom (mt)	5.6
Cost per mt CO2 Reduction / year (over 30 years)	$19.61
Average Cost per Prescriptive Point Reduction	$57.14
Average Cost per HERS Point Reduction	$17.02

Spanish Towers Case Study Summary (w/ window replacement)	
HERS Before	167
HERS After	107
Prescriptive Points Before	84
Prescriptive Points After	107
Total Improvement Cost	$3,254
Estimated Annual Energy Cost Before	$1,031
Estimated Annual Energy Cost After	$814
Estimated Annual Savings	$217
Estimated Average Monthly Savings	$18.08
Monthly Improvement Payment Financed at 6% for 15 Years	-$27.46
Cost Neutral from Day One?	NO
Total CO2 Before (mt)	6.96
Total CO2 After (mt)	5.25
Estimated CO2 Reduction (mt)	1.71
% CO2 Reduction	25%
CO2 per Bedroom (mt)	5.25
Cost per mt CO2 Reduction / year (over 30 years)	$63.43
Average Cost per Prescriptive Point Reduction	$141.48
Average Cost per HERS Point Reduction	$54.23

Spanish Towers Summary of Individual Improvements and Impacts							
Improvement	Cost	Projected HERS Reduction	Additional Prescriptive Points	Projected Energy Reduction (MMBtu)	Projected CO2 Reduction	Percent CO2 Reduction	Notes
Seal duct boots where they terminate	75.00	N/A	N/A	N/A	N/A	N/A	All ducts in conditioned space
R10 Rigid Foam Board under balcony	160.00	18	6	8.5	0.55	7.4%	
Insulate exterior walls	435.00	8	8	3.8	0.27	3.7%	Includes air infiltration reduction
R7- Foam board glued to CMU closet walls and ceiling	165.00	8	Included in exterior walls above	4.3	0.18	2.5%	
Ceiling finish	100.00	N/A	N/A	N/A	N/A	N/A	
Fiberglass windows and door	2454.00	11	9	4.6	0.27	3.7%	

Company: Thermal Craft

*HERS 120 achieved through insulation measures alone. Landlord covered any additional costs above $3,000 limit.



22nd Street (End Unit)

22nd Street is a single story, garden level unit in a multi-family affordable housing building. This unit has 50% of its wall area exposed to outside, with the remaining 50% consisting of shared walls. The windows were recently replaced with double pane, vinyl-framed units. The exterior walls (partially below grade) are insulated with fiberglass batts. The building has a shared district hydronic boiler which provides heat and domestic hot water for the units (80% AFUE boiler with side arm).

Because the baseline HERS Index for this property was below HERS 120, it did not receive energy efficiency retrofits.

- Floor Area: 464 sq ft
- Bedrooms: 1
- HERS Index: 114
- Prescriptive Points: 107
- Infiltration: 1439 cfm @ 50 Pa
- Duct Leakage: N/A - hydronic

SMARTREGS PROPOSED PRESCRIPTIVE PATHWAY

Because homes operate as a system, in an ideal world, every energy efficiency code would be performance-based. This means that energy modeling of baseline conditions would be required and the quantification of the energy savings and greenhouse gas emissions would demonstrate the impact of improvement measures. However, in the case of existing homes, or a rental housing energy efficiency ordinance, a performance-only pathway is not practical due to the cost associated with having a HERS rating performed both before and after improvements.

In order to craft a prescriptive compliance pathway, there were two main barriers that had to be overcome: (1) accounting for the lack of a "baseline home," since existing homes start at varying levels of energy performance and (2) accounting for the differences in housing typology, since energy performance varies by housing type (e.g. multi-family vs. single-family).

In addition, it was important that this prescriptive pathway provide much-needed guidance for landlords to prioritize the energy efficiency impact of various improvement measures and to understand how improvement measures work together. Currently, most homeowners make improvement decisions relying upon the advice of home energy auditors. A home energy audit usually includes air leakage and infiltration testing, but varies from a HERS rating in that it does not include energy modeling and house-specific improvement analysis. Without this energy modeling, most energy auditors make recommendations and prioritize energy efficiency improvements solely on the basis of observation and experience. Oftentimes the inability to prioritize improvements results in many homeowners failing to turn their energy audits into action or mistakenly implementing misguided improvement measures.

Approach

The prescriptive pathway functions as a decision-making tool for homeowners, auditors and retrofitters to identify the home-specific "low-hanging" fruit and turn "audits into action." The performance-based prescriptive pathway for existing homes is able to account for "baseline" energy performance and variances in housing typology.

Currently, most home energy efficiency programs for existing homes only award points for making improvements, but do not reward a home's existing conditions that enhance home energy performance. Under such a program, many homeowners would have to increase the energy efficiency of an already well-performing home to receive the same certification as a less-efficient home that made the same improvements. Because to date, there has been no accounting for the "baseline" or starting point, homes can achieve the same number of points under these programs, but have very disparate overall energy performance and carbon emissions.

This proposed prescriptive pathway is fundamentally different: it functions as a simple "checklist audit," awarding and weighting points in much the same way as a performance-based approach. The benefits of such an approach are profound: the system is equitable because every home gets points for the performance of its existing systems and components. In addition, with the small cost of a checklist audit (compared to a full HERS rating) and simple air infiltration and duct leakage testing, homeowners can clearly see the areas where energy upgrades are most needed. The design of the prescriptive pathway also allows homeowners to weigh the potential impact and prioritize various improvement measures by comparing the cost and the additional points that would be earned. The formula is simple: the more points that a home can earn for a measure, the more impact that measure has on the home's overall carbon emissions.

While the prescriptive pathway is simple, it can account for complex differences in housing types. For example, by assigning points for shared walls, the proposed prescriptive pathway can address multi-family housing under the same system as single-family homes. By awarding points for square footage and bedrooms, the prescriptive pathway helps account for the carbon impact of big homes versus small homes. In addition, because the proposed system is not rigidly prescriptive, common obstacles in multi-family, HOA-controlled and historic housing can be overcome. For example, units in multi-family housing with a central heating system can choose other, more feasible upgrades that have comparable overall impact on improved efficiency. The same logic holds true for historic housing or homes with HOA control that have more limited improvement options.

Finally, the SmartRegs prescriptive pathway is weighted by carbon emissions and accounts for the carbon-intensity of source energy. Since the electricity in Colorado is especially carbon-intensive (given the prevalence of coal generation), the prescriptive pathway accounts for the high carbon emissions resulting from electric heating and effectively rewards carbon-friendly fuel switching behaviors from electric heating to natural gas.

The proposed SmartRegs prescriptive pathway for existing homes encompasses many of the benefits of performance-based codes: (1) it incorporates a whole-house approach to energy consumption; (2) it prioritizes energy efficiency upgrade measures for each home; and (3) it provides the flexibility to choose your own compliance pathway based on cost, personal preference, aesthetics or structural limitations.

Overview of Points Allocation

As discussed above, the prescriptive pathway is weighted based on carbon intensity. The point allocation is based on the percent reduction of CO2 emissions attributable to each improvement as modeled by eQuest energy modeling software, with each improvement modeled independently. While there is no “reference house” used for the point allocation, the baseline home used to determine points met the prescriptive requirements of the 2009 IECC. Given the envelope performance values for the 2009 IECC, the impact of mechanical equipment had to be multiplied independently to account for the lower levels of insulation in the existing housing stock.

In all cases, the baseline home used natural gas for both heating and domestic hot water. This approach resulted in penalization of more carbon intensive heating fuels, such as electric and oil. Initially, the prescriptive pathway significantly penalized these fuels with negative points due to their carbon intensity. However, in light of the potential fluctuation of future energy prices and the hardship of heavily penalizing electric heating, all of the point values that would otherwise have been negative points have been adjusted to zero. This approach still rewards a fuel switch by making points available for switching to natural gas, but does not create a deficit of points that must be overcome.

Following the determination of the percent reduction of CO2 emissions for each measure, the system was adjusted to align 100 prescriptive pathway points with approximately 20% less efficient than the 2004 IECC. This adjustment seeks to equate the prescriptive pathway with a HERS Index of 120. Because the prescriptive pathway does not involve energy modeling and operates on a fixed set of assumptions, 100 prescriptive points will not always align with a HERS 120 house. In such cases, owners have the option of pursuing the performance pathway instead of the prescriptive pathway if they believe it would yield a more advantageous result.

Proposed Adjustment for Home Size / Housing Density

Neither the proposed performance pathway nor the prescriptive pathway currently provides a means to normalize carbon dioxide emissions for homes. Without accounting for home size and housing density, homes that comply with the SmartRegs program could still have vastly different carbon dioxide emissions. To address this disparity, the prescriptive and performance pathway could be adjusted to account for carbon dioxide intensity by bedroom.

A suggested approach for the prescriptive pathway is provided below. The proposed point adjustments are based on a threshold of 5 metric tons of CO2 emissions per bedroom (for the SmartRegs case study homes, the average post-improvement carbon dioxide emissions averaged 4.54 metric tons per bedroom).

Initially, Populus calculated the number of points that would be required to normalize average homes (each scoring 100 prescriptive points) of varying square footages to the equivalent of 5 metric tons of CO2 emissions per bedroom. The resultant point adjustments ranged from 50 additional points to 250 additional points. Given the harshness of this approach, the additional points in the table below reflect only 10% of the points that would be needed to normalize carbon dioxide emissions to 5 metric tons per bedroom under the prescriptive pathway.

PRESCRIPTIVE POINT HOME SIZE ADJUSTMENT

Square Footage

Beds\Unit	500	1000	2000	3000	4000	5000
1	0	8	13	17	21	25
2	0	0	6	8	11	13
3	0	0	0	6	7	8
4	0	0	0	0	5	6
5	0	0	0	0	0	5

Compliance Process Overview

- Initial blower door testing and duct leakage testing (where applicable); qualified inspector/auditor completes the baseline SmartRegs prescriptive pathway worksheet to determine baseline points
- Owner considers costs and benefits of various available improvement options; determines compliance pathway to 100 points
- Following implementation of improvements, inspector/auditor revisits and completes post-improvement prescriptive pathway worksheet and retests air infiltration and duct leakage (only if the owner is trying to achieve more points in these categories)

Safety and Health Issues / Combustion Testing

When implementing home energy efficiency upgrades, it is important that contractors understand the fundamentals of building science and the health and safety implications of making changes to a home. Common issues that may arise from weatherization work include interior moisture (potentially mold), poor indoor air quality, soil gas intrusion, lack of adequate combustion air and carbon monoxide risks associated with atmospherically vented combustion appliances. To reduce these risks, the City of Boulder should encourage contractors to receive weatherization training that addresses building science issues. In addition, third-party testing should be encouraged to promote safety and health after energy efficiency upgrades are made. For example, where air-sealing results in reduction of

combustion air to atmospherically vented combustion appliances, combustion appliance zone safety testing should be performed. In addition, where air-sealing results in a "tight" house (less than .35 nACH), ventilation per ASHRAE 62.2 should be required.

Lead Based Paint

New Lead based EPA requirements come into effect on April 22nd 2010. Federal law will require contractors to be trained and certified under the U.S. Environmental Protection Agency's 2008 Lead Renovation, Repair, and Painting Program. Any renovation activity that disturbs at least 20 square feet of lead paint on the outside, or 6 square feet on the inside of a house, built before 1978 will be subject to the regulations in the EPA. These new regulations will really hamper all remodeling projects throughout the country. Fines to contractors will be $37,000 if they are found working and are not certified. While this regulation is intended to protect the public from the dangers of lead paint, it will greatly increase the cost of most improvements suggested under this program. Landlords need to be aware that if they disturb more than 6 sq. ft. of a wall, they too will have to meet EPA regulations. There is a strong concern that these new regulations will erase any cost effectiveness of saving energy. Certification classes are available in Boulder at a cost of $180 for an 8 hr class.

RESPONSES TO CITY OF BOULDER'S RESEARCH QUESTIONS

How Realistic is a HERS score of 120 or Prescriptive 100 points?

ADDRESS	Housing Type	Existing HERS	Existing Points	Final HERS	Final Points
Ash	Single Family	170	67	126	101
University	Single Family	162	73	117	101
Walnut	Five-Plex	146	79	128	97
Spanish Towers (w/o windows)	Condo	159	84	120	98
22ND St.	Condo	114	107	N/A	N/A
Pearl St.	Duplex	105	110	N/A	N/A

A HERS score of 120 is both realistic and obtainable for most properties based on this study. The highest drop in the HERS score was obtained by simple measures such as air-sealing and adding insulation. The cost of reaching the HERS 120 (or 100 prescriptive points), will vary by project and housing type. In order to create an objective method of quantifying how many points a property should receive; points will be allocated for existing improvements and conditions. The intent is to reward landlords who have already upgraded features of their properties and to not penalize landlords for conditions that are beyond their control and create undue hardship.

As mentioned above, two of the projects needed no improvements to comply. One was the Pearl duplex built in 1972 with a HERS score of 105. The building had existing wall insulation, vinyl windows, and good attic insulation which helped achieve the HERS score. In addition, the 22nd Street property also complied with no additional work. The 500 square foot garden level apartment scored a HERS 114 and has a central heating source and insulated walls. It was refreshing to see that two fairly average properties could meet the standard with no additional work. This may be the case for many properties, especially those that already have reasonable levels of insulation and efficient heating equipment.

Some properties may find greater difficulty in reaching the required 100 prescriptive points. While the prescriptive pathway has many features that are intended to further the implementation of an equitable SmartRegs program, there will inevitably be cases where a financial hardship (or structural impediment) warrants special consideration. For this reason, the prescriptive pathway provides a hardship provision that allows for the limited purchase of carbon offsets in lieu of improvements where the City, in its discretion, determines that a hardship exists.

What is the fee to get a HERS rating?

A full HERS rating can cost between $600 and $1000 depending on the size and complexity of the home. Although it is a fairly expensive procedure, the results are very useful and will assist a homeowner in making the right energy upgrades. In the context of existing homes, HERS rating fees could be more cost effectively spent insulating the property or making other improvements. While mandating HERS rating for every property would provide valuable energy data to the landlord and to the City, is not realistic or financially feasible at this time.

Under the proposed prescriptive code, components of a HERS rating would be required, consisting of a whole house infiltration (blower door) and duct leakage testing. An energy audit with blower door testing can be obtained

for as little as $90 through the Xcel Energy audit program. Current market rates in Boulder for blower door and duct leakage testing range from $100-$250 for each test. Many home weatherization contractors often build the cost of blower door and duct leakage testing into the cost of improvement services.

What is the cost of getting a HERS score of 120 or 100 Prescriptive Points?

While the cost of getting to HERS 120 or 100 prescriptive points will vary with each property, this study demonstrated that condos could reach this level by spending as little as $800. (*See Case Study Homes, above, for summary of cost data).* In addition, this study found that some units already complied with no improvements at all.

A dollar cap on each project would assist landlords with properties that have unusually high HERS scores. Single family homes will be the hardest hit financially, as they have many more variables that have to be addressed. While a cap of $3,000 might be welcomed by landlords, this may have the unwanted affect of rewarding contractors who don't produce quality work and penalizing those who do.

As an alternative to a "cap" on total improvement cost, a more equitable approach may be to phase in the implementation of the prescriptive pathway by capping the total number of improvement points that would be required during any given rental cycle. As an example, the City could provide that a property must make no more than a 50 point improvement during any rental cycle. Such a system would phase in the SmartRegs program and provide for full compliance with the 100 point prescriptive system over two rental cycles. Thus, where a rental property scored only 20 baseline prescriptive points, the owner would only have to earn 70 total prescriptive points during the first rental cycle (gaining 50 points) and earn the additional 30 points during the second rental cycle. For carbon emission reduction purposes, the City may wish to use carbon offsets as a "bridge," requiring that the initial rental cycle prescriptive point deficit be "made up" with the purchase of carbon offsets.

What financial incentives are available?

Many programs such as ClimateSmart, the proposed HomeStar program and private loans may be available to help property owners pay for upgrades. In addition, Xcel Energy, as well as the Governor's Energy Office, will be offering rebates for energy efficiency upgrades during 2010.

Energy regulations sometimes present an issue of "free ridership" that can affect the availability of rebates. However, one advantage to having a performance-based prescriptive code is that there are no "mandatory upgrades," as each owner will chose their own compliance pathway. For example, some owners may chose to comply with the program by increasing wall insulation, while others may replace mechanical equipment or windows. The hope is that the lack of a "one size fits all" mandate will prevent or mitigate the impact of any free ridership issues.

The Longs Peak Energy Conservation (LPEC) Weatherization Program

LPEC has an income qualified weatherization program available in Boulder County. This program, funded by GEO, makes repairs to the homes of qualified residents to improve a home's energy conservation, and the health and safety of its occupants. Renters as well as homeowners may qualify (see qualification guidelines below). With the assistance of the CU Environmental Center, many students have already taken advantage of this opportunity. Landlords can assist the renter in applying for the grants.

FY 2008 Income Limit Category	One Person	Two Person	Three Person	Four Person
200% Poverty Level	$21,660	$29,140	$36,620	$44,100

Federal Tax Incentives

Improvements must be for taxpayer's principal residence and therefore are not applicable for this project.

Governors Energy Office Rebates

Beginning on April 19, the Governor's Energy Office (GEO) will offer rebates to Colorado residents and businesses who install energy efficiency or renewable energy measures in their home or rental.

The GEO will offer rebates for the following:

- ENERGY STAR Clothes washers - $75
- ENERGY STAR Dish washers - $50
- ENERGY STAR Refrigerators - $100 w/ proof of recycling, $50 w/out proof of recycling
- ENERGY STAR Water heaters (gas high performance and gas condensing) - $200
- ENERGY STAR Tankless water heaters (gas) - $300
- ENERGY STAR Boilers (gas) - $400
- ENERGY STAR Furnaces (gas condensing) - $500
- Whole-house energy audit – tiered rebate of $25 to $100 depending on cost of audit
- Insulation and air sealing measures – 20% of cost up to $400 (will not exceed $600 if combined with an existing local utility rebate taken by the consumer)
- Duct sealing – 20% of cost up to $75 (will not exceed $125 if combined with an existing local utility rebate)
- Whole house energy monitors – $50 (will not exceed $100 if combined with an existing local utility rebate)
- Solar Electric - Photovoltaic (PV) – 20 to 30%. In some cases, rebates combined with local incentives will result in a 50 % reduction in costs. Xcel and Black Hills Energy customers are excluded due to existing residential photovoltaic rebates offered through those utilities.
- Solar domestic hot water- 30% of the cost
- Solar thermal and/or hot water - approx. 30 % of the cost of the system (commercial only – no pools, spas or snowmelt)
- Small wind - up to 10 kW – approx. 30% of the cost of the system for residential, approx. 15 to 20% of the cost of the system for commercial

Program information:

- These rebates will be reserved online on a first-come, first-served basis through 2012 or until funds are exhausted, whichever occurs first.
- Information about specific product requirements is available for all products. Qualifying makes and models will be available upon program launch.
- Consumers are reminded that no rebates are guaranteed until all documentation is provided to the GEO. Consumers that are interested in energy efficiency appliances should consider the savings that are immediately available to them through retailer, utility or manufacturer incentives. Many retailers are currently offering sales that exceed what will be available in the rebate program.

- Not all products and services will qualify for a rebate. You should not choose a product or service for purchase until the program has launched and you and your contractor (if applicable) have reviewed and understand all of the program criteria.
- Only existing homes qualify (with the exception of the ENERGY STAR New Homes rebate for homebuilders).
- Appliance rebates must be used to replace an existing appliance in working order.
- One appliance rebate per type of appliance per residential consumer.
- One non-appliance rebate per type per property.
- Landlords (business applicants) and individuals can qualify for rebates. Local governments and non-profits are ineligible
- Rebates for renewable energy measures, such as solar hot water or solar electric systems, will require a home energy audit before applying. Audits that have been conducted after Dec. 31 2006 but before program launch can be accepted. After April 19, however, the audit must be performed by a Building Performance Institute (BPI) or Residential Energy Services Network (RESNET) certified auditor. Rebates are available for home energy audits performed after April 19.

Xcel Energy Rebates

Air Source Heat Pumps: $250 - $500, varies by efficiency rating
Evaporative Coolers: $200 - $500
Air Conditioners: $250 - $500, varies by efficiency rating
Natural Gas Furnace: $80 - $120, varies by efficiency rating
Natural Gas Boilers: $120
Natural Gas Water Heater: $40 - $80, varies by efficiency rating
Natural Gas Tankless Water Heater: $100
Attic and Wall Insulation: 20% of cost up to $300

Home Performance with ENERGY STAR Rebates

Improvement Rebates:	Regular	Promotion
Required Air Sealing & Weatherstripping	$100	$150
Attic Insulation & Bypass Sealing	$150	$225
High Efficiency Lighting* CFLs	$40	$40
Optional: Chose at least two:		
Wall Insulation (Above Grade)	$250	$325
ENERGY STAR Set Back Thermostat	$10	$15
92% AFUE High Efficiency Furnace	$80	$120
94% AFUE High Efficiency Furnace	$120	$160
84% AFUE (or higher) Boiler	$120	$160
Electrically Efficient Furnace	$100	$130
.82 EF Tankless Water Heater	$100	$130
Power Vented Water Heater	$60	$80
ENERGY STAR Refrigerator/Primary	$10	$15
ENERGY STAR Dishwasher	$10	$15
ENERGY STAR Clothes Washer	$50	$70

Recycle your old, working SECOND refrigerator and receive a $35 check

Solar*Rewards (solar photovoltaic (PV) system) is available for rental properties.
System Size: .5 kW to 10 kW Rebate payment: $2.00 per watt DC capacity.

Xcel Energy's Solar*Rewards Program provides two separate incentives for customers who install grid-connected photovoltaic (PV) systems sized up to 120% of the average annual load of their homes and facilities. Customers will receive an upfront rebate payment, plus a separate payment for the renewable-energy credits (RECs) produced by their system. For systems between 0.5 kilowatts (kW) and 500 kW DC, Xcel will provide a rebate at the time of installation of $2.00 per installed watt (W).

All REC purchases are for a period of 20 years unless other legal provision supersedes. The size of the REC payment depends on the size of the system and the owner of the system as shown below:
Customer-owned systems 0.5 kW - 10.0 kW DC: $0.70/W DC up-front
Third-party-owned systems 0.5 kW - 10.0 kW DC: $0.11/kWh of actual production (paid monthly)

City of Boulder Rebates

Water Conservation Rebate
Rebates are available to City of Boulder water customers including landlords
- Rebates are currently limited to purchases made in 2010, one rebate per category per customer.
- Eligible measures include: Clothes Washers (CEE Approved)
- High efficiency toilets (1.28 gal. /flush and dual flush)

Solar Sales Tax Rebate
- Rebate is approximately 15% of the city sales tax paid
- Available for photovoltaic or solar thermal systems installed within the city of Boulder.

What is the ROI for each of these measures?

Property	Monthly Savings	Monthly Payment on Financed Improvements (15 years at 6% interest)	Annual Percentage Yield (over 15 year period)	Simple Payback
Ash	$25.33	-$24.24	3.1%	9.45
Spanish Towers (w/o window)	$14.33	-$6.75	8.1%	4.65
University	$32.92	-$17.54	7.2%	5.26
Walnut	$12.17	-$5.91	7.9%	4.79

The Payback Trap:

Payback is based on two variables

- How much energy will be saved
- The cost of the energy displaced
- The simple payback equation is:

  payback P = #btus X $/btu / cost of measure

The trouble is we can't know the variables over time. How much will electricity costs escalate over the life of a solar system? How much energy will be used in 5 years? What people are asking for is the "simple payback" of energy improvements.

What is Simple Payback?

Example:

- Cost of solar PV system = $10,000
- Cost of electricity* $.075 /kwh
- Kwh saved per year = 10,000
- $ saved/year = $750
- Payback 13.3 years*
- If electricity price doubles - payback is just under 7 years

*Assuming energy prices stay constant

Financing Improvements

A conventional mortgage is based on 4 factors:

- P- Principle
- I- Interest
- T- Taxes
- I- Insurance
- Monthly carrying cost = P+I+T+I

If the cost of energy or solar upgrades is included in the mortgage or a second mortgage, then only the increase in the monthly mortgage payment for the solar panels is relevant. If the solar panels save $1 more in utility costs than the increase in the mortgage payment then you have a net positive cash flow the first month. When electricity costs increase over time the monthly cash flow becomes greater. This is the number that people really care about. How much does the energy improvement actually cost me per month? Payback then becomes irrelevant.

This is where the tenant-landlord issue becomes difficult. If the landlord passes utility costs on to the tenant, there is no incentive for the landlord to improve the efficiency of the unit. For the tenant the issue is rent + utilities. The simple way to equalize this equation is for the Boulder rental policy to require landlords to disclose the average utility bills in the lease when renting the property.

How Does a Landlord Choose and Prioritize Measures?

The design of the prescriptive pathway is intended to allow homeowners to weigh the potential impact and prioritize various improvement measures by comparing the cost and the additional points that would be earned. The formula is simple: the more points that a home can earn for a measure, the more impact that measure has on the home's overall energy performance and carbon emissions. In order to complete the prescriptive pathway, air infiltration and duct leakage testing will be required. This will provide valuable information to a homeowner for prioritization of measures and will also assist the City of Boulder to quantify the program's impact.

In addition to using the prescriptive pathway checklist, an energy audit is often the smartest and cheapest way that a landlord can get advice on how to prioritize measures. Working with a BPI or RESNET energy auditor may provide helpful guidance that landlords can use to prioritize improvement measures for each individual unit. In addition, programs such as the Xcel home performance program are instructive in this regard.

Impact of Occupant's Behavior

There is no question that the tenant behavior makes a difference in energy use. While occupant behavior does play a major role in energy use, if the home is uninsulated, renters have no choice other than to turn up the thermostat in order to be comfortable.

Following the implementation of this project, tenant education workshops and energy conscious lifestyle handbook should be developed in conjunction with CU. These workshops will help tenants understand the importance of energy conservation. It is suggested the points be awarded to a landlord if their tenants attend one of these workshops.

Impact of Proposed Code on Rent

First, it is suggested that all licensed rental properties in Boulder be listed with average (three years) utility bills in addition to the rent. Secondly, since all properties are licensed, they would be listed in a searchable database for prospective renters that would be created by the City of Boulder. This database would include the cost of average utility bills per sq.ft. for each property. In the future, this will enable the public to use this information just as someone shopping for a car looks at the mpg before making a decision to buy.

Measuring Success of the Program

Blower door testing and home energy audits have become prevalent over the last few years, especially those subsidized through Xcel's program. A "before and after" audit using the SmartRegs prescriptive pathway checklist will provide improvement data as well as air infiltration and duct leakage reduction data to the City of Boulder. This data could be studied to measure the overall impact of the SmartRegs program.

Access to renter's utility data from Xcel will also be valuable in measuring energy reduction. Currently, utility data is not available to the general public and can only be released by the individual paying the utility bill. We propose entering a standard clause into all future rental leases that permits the City or some other entity access to this data in order to compare past energy consumption with that of post improvement. While energy usage will vary with tenant behavior, taking the average usage of a property over the past five years will help remove this variable and

provide a more normalized average utility use. While some tenants may refuse to release their energy usage data due to privacy issues, most tenants should feel comfortable in releasing this data.

Additional Projects

Other cities have implemented rental housing energy update programs. In California, these energy upgrades are triggered when the property is sold, or renovated. The majority of the measures that are suggested in each of these programs are similar to those proposed in this report such as insulation and air-sealing. None of the programs measured their results mostly due to budget constraints.

The following excerpts were taken from the report: RECO Analysis by Rachel Reiss 3/15/2010

- Residential Energy Conservation Ordinances (RECOs) are a policy tool for upgrading the energy efficiency and water usage of existing housing.

- Currently, programs are in place in; Berkeley CA, San Francisco CA, Burlington VT, Nevada and Madison, Wisconsin. (Other programs have been put in place, but have been repealed or simply not enforced).

- Cities and agencies have been reluctant to incorporate RECO with safety inspections because the inspectors only really know about the safety features of the building and not the energy features.

- All known RECO programs place a cap on the amount a homeowner must spend on upgrades. Some programs limit total expenditures to a certain percentage of the sales price.

- The actual expenses a homeowner will incur vary greatly depending on the existing condition of the building. In Burlington, the average cost is estimated to be about $650–$750 per apartment. In a January 2005 report, SWEEP estimated RECO upgrades would cost the average homeowner in Nevada $1,000 or more.

- Since homeowners pay for the inspections, there isn't much of an expense to the city or to other governing agencies. In most cases, cities have been able to recover all their costs through filing fees, which range from $15-50. Even in places where they've had to hire employees specifically for RECO purposes, the programs haven’t been budget drains.

- Despite all the inherent benefits of RECO programs, exact energy savings results are very difficult to come by. Most city and/or state agencies don't have the means or the time to analyze energy savings before and after RECO.

ADDITIONAL POLICY CONSIDERATIONS

Education/Training

Professional

Existing home inspectors will become useful allies in the rollout of this program. Currently, these inspectors test homes every four years for compliance with rental safety regulations. Training these inspectors to perform blower door and duct leakage tests would be relativity easy. Having one inspector to both test and certify compliance would be preferable to landlords. The private companies would likely cover the cost of the necessary equipment for these tests which would cost approximately $4,575 ($2,625 for blower door and $1,950 for duct blaster). The City of Boulder may wish to subsidize some of these costs to aid in the implementation of the program. There are currently many auditors and HERS raters in the City of Boulder who would also be available to perform SmartRegs testing and inspections.

Landlord

In order to save costs, many landlords have expressed interest in performing improvements themselves. While some improvement measures will require a professional, tasks such as air-sealing and insulation can often be performed by property owners. Installing insulation in an attic can yield consider energy savings and can be accomplished without much difficulty by a landlord over a weekend. "Best Practices & How To" workshops would ensure that landlords were getting the most out of their efforts and also ensure they were not violating any health and safety standards. Typically, over 50% of the cost of an improvement is spent on labor. With just the cost of materials to pay for, landlords can lower the cost of compliance with this program.

Occupant

Tenant behavior plays a large role in energy conservation. Education would help create awareness of the problem. In order to encourage attendance at these workshops, landlords would be given one prescriptive point towards their necessary energy improvements when their tenants attend a workshop. Workshops could be held by the City in collaboration with University of Colorado - Boulder. By collaboration with an existing educational entity such as CU, the City can expedite the rollout of these workshops and gain from their prior experience.

Financial Impact for Landlords

It is certainly not the intent of this program to place additional hardship on a property owner. Cost implications should be a consideration in the implementation of the SmartRegs program. While some landlords have asked that the implementation of this program be delayed until the country is through the recession, climate issues are affecting us now and we cannot delay action.

While the majority of landlords are in favor of this program, there are many landlords who oppose this program for a variety of reasons. The majority of those who oppose the SmartRegs program cite that they will be unable to recoup the cost of energy efficiency improvements and feel that the City of Boulder is unfairly singling out landlords in order to reach its environmental goals. According to local landlords surveyed during this case study, many are not making any profit or are just breaking even on their rentals in this difficult market. Many others rely on the rents generated for their retirement or even their sole income. Some property owners may even be close to foreclosure and the additional cost of energy improvements may put them over the edge. Recognizing the severity of these

challenges, it is suggested that a hardship waiver be made available so that landlords may request a reduction or a "pass" for the first rental cycle.

Colorado Carbon Fund

The Colorado Carbon Fund provides high quality carbon offsets to consumers as a way to support new energy efficiency and renewable energy projects to reduce greenhouse gas emissions in our state. Purchasing carbon offsets provides a reduction in greenhouse gas (GHG) emission levels caused by a specific GHG reduction project.

Many landlords are seeking low or no-interest loans in order to fund their improvements. Once a sufficient amount of money was collected by landlords purchasing carbon offsets, this fund would be used to provide additional home improvement loans. These loans would then be paid off in a short time (2-4 years) and the funds could then be re-loaned to another party. Although this system would be useful, it also has its drawbacks. The amount available to lend would depend on how much money was spent on carbon credits initially. At this time, the City is not encouraging landlords to purchase offsets so it will require time to build this surplus. One additional downside is that lending criteria would need to be established.

The deepest overall benefit for the carbon fund is in its ability to help pay for rental inspections and energy audits. Funds will be available on a first come, first served basis. These funds could then be used to pay private inspection contractors and/or to fund the "Two Techs & a Truck" program. This program will perform energy audits and upgrades will be conducted on properties through the city. Funds to assist this worthy program will help get it up and running and also help prolong its success. Of course, the amount of carbon funds purchased will greatly affect the impact of this plan. Unlike the proposal above to use the funds for loans, this plan would require less administration and would benefit the greatest number of people.

HOA's and Condo Buildings

A group approach via a Home Owners Association would be much more cost effective for all parties involved verses each landlord working with separate contractors to improve their individual units. HOA's are a vehicle that landlords can utilize to comply with the new regulations at a lower cost. Insulating a whole apartment building at once makes much more sense than each unit separately. For example, a case for HOA's might include multifamily homes that are heated by a single boiler or furnace system. Regularly, each unit splits the cost of the utility bill. It is common that these heating sources are old and inefficient. Replacing these units with a new high efficiency unit could save residents on their heating costs as well as bring a building into compliance.

Marketing Opportunity for Landlords

While obtaining the 100 points may be challenging for many landlords, some may see the benefit of scoring even higher as a marketing tool. A rental energy rating system that ranked properties based on energy usage, would help reward landlords that went above the minimum required level. As energy costs continue to rise, more and more tenants will take into account the cost of utilities in their decision to rent. Many students have expressed an interest in a ranking system (CU Environmental Center). In addition to students, many properties are rented by professionals, families and the elderly. These groups are more sensitive to utility costs and as a result will respond favorably to some type of rating system. Homes that can demonstrate that they will save tenants money on their utility bills will become more popular among savvy renters. A rating system, such as Bronze, Silver or Gold, will guide tenants towards renting more energy efficient properties and thus lower their monthly bottom line.

As landlords continue to make energy efficiency improvements they will find their properties easier to market and rent. They will find that there is a quicker turnaround from vacant to rented as they rise in the rating system. Also there will be those landlords who are motivated to continue making improvements just to rise from Bronze to Gold in the rating system.

Conclusion

The City of Boulder is considering the adoption of a proposed rental housing energy conservation ordinance. This program, known as "SmartRegs," is intended to reduce the greenhouse gas emissions associated with the City of Boulder's rental housing stock. The purpose of this case study was to determine the financial cost and the energy efficiency improvements necessary to achieve a HERS score of 120 in a typical rental property. The driving force of the study was to achieve the highest energy savings with as little cost as possible. The improvements that were implemented at each property were chosen on the basis of the greatest energy return per dollar. While the study only looked at six properties, the numerous bids that were received for each property gave a broader understanding of the costs associated with energy efficiency improvements and the scope of services that are available to landlords.

If the proposed SmartRegs program is adopted by Boulder's City Council, it will affect more than 50% of the residential properties in Boulder. Implementation of this new rental policy may be challenging, especially in light of the new EPA lead certification mandates, but the majority of the public surveyed supports the SmartRegs program and its goals. The financial impact to landlords was carefully considered during this case study and the proposed SmartRegs program is intended to be equitable to landlords while still furthering the City's Climate Action Plan goals.

APPENDIX A: LANDLORD RESPONSES TO QUESTIONAIRE

3035 Ash Single Family

1. Do you feel that the City's Smart Regs. Program will reduce green house gases?

Yes. But the city should also require stores to shut their doors to save air conditioning and heating energy and have offices shut their lights off at night. Even I would use the bus if it didn't cost more than driving. Right now we only use the bus to the airport.

2. If this program was not in place, had you any plans to improve the energy consumption yourself?

No. We have two kids in college and the rent on this house ($1400) already does not cover expenses. We bought this house in 1989 when our second child was born. We live half a mile away near Martin Park now. The tenants pay electricity and we pay water and garbage. We felt if the tenants paid their own electricity and heat they would try harder to conserve.

3. What advice would you give to the City as they begin to implement this program?

Take the whole carbon footprint of the property into account, not just the Xcel bill. This house has never been remodeled (50 years of same doors, cabinets, bathtub, flooring is very efficient use of resources). This house is only 988 square feet – very efficient use of space and materials for several students. No dogs are allowed in our rental – dogs have a large carbon footprint. The house has shade trees in the summer to keep it cool and a covered patio in the back. The students compost, recycle and have very little garbage. They have old cars and never wash them. Most of the furniture is used – reuse then recycle. The house has only one story and a good 2 foot roof overhang – shading the windows when the sun is high in the summer and letting in sunshine when the sun is low in the winter. All the windows have window coverings. There is no air conditioner, just a swamp cooler. The students grow grapes, raspberries, tomatoes and herbs.

4. What is your opinion on buying carbon credit offsets?

If you agree with them, how long should Landlords be able to purchase offsets? I think this is for feel good rich people to throw money at the problem so they don't feel guilty.

5. What improvements do you think your property needs?

Windows, attic insulation, furnace, washer, dryer, fridge, insulate crawl space

6. How much money would you expect to spend on energy improvements?

$3000

7. When would you like to see this program implemented?

As soon as possible.

8. Are you aware of the subsidized energy audits through Xcel Energy?

Yes

9. Should there be different standards for different housing types?

Yes, definitely.

10. How could this program benefit you or other landlords?

It is hard to have much control over a house after you rent it out. We had paid $60 for plastic for the north windows in this rental – the nice kind that you blow dry taut and it had not been installed. The window coverings are left open at night. Three of the windows weren't even latched. The fridge was nearly empty which is inefficient – even if you put your canned goods in the fridge to take up air space it helps. All three of the students computers were on and their cell phone chargers were plugged in. When we rent out the house, most of the light bulbs are efficient fluorescents and when students move out the house is usually full of regular light bulbs.

I feel that the amount the kids spend on Xcel is so small compared to their other expenses, that doing the little things to save energy doesn't seem to matter to them. Think of what cell phone, wireless internet, cable TV, car insurance, food, textbooks, tuition and the rent itself costs. The Xcel bill is really one of the smallest. They always take the bus to campus, so are saving energy that way.

642 University Landlord Questionnaire

1. Do you feel that the City's Smart Regs. Program will reduce green house gases?

One can always hope! The other side of the coin is that it is certain to raise the cost of renting in Boulder. Some landlords will use this as an excuse to raise the rent, protecting (or even enhancing) profit margins or maintaining cash flow.

2. If this program was not in place, had you any plans to improve the energy consumption yourself?

We just purchased the property, and we have spent nearly a quarter of a million dollars to purchase it, make it habitable, and keep it a relatively affordable rental at around 100% of AMI. Any additional improvements would be in small increments over the next ten years.

3. What advise would you give to the City as they begin to implement this program?

Consider grants for improvements, or exceptions to the required upgrades, for any rental property that is affordable to between 80 and 120% of AMI. We spent a lot of money to buy down the principle, thus keeping the mortgage (and the rent) as low as possible. We do not have funding available for any improvements this program would require.

4. What is your opinion on buying carbon credit offsets? If you agree with them, how long should Landlords be able to purchase offsets?

Attractively-priced offsets are appealing. A ten-year timeframe would be very helpful for our situation.

5. What improvements do you think your property needs?

Three new windows, two new doors, duct tape, a water heater jacket and a lot of caulk and insulation.

6. How much money would you expect to spend on energy improvements?

We could easily spend $20K, but we need a new roof and a strategy to deal with some significant maintenance deferred by the previous owners before any money would be available for further energy improvements.

7. When would you like to see this program implemented?

The farther out the better, for our situation.

8. Are you aware of the subsidized energy audits through Xcel Energy?

Yes. But audits don't lower energy use unless there is money available to make the necessary changes. The county loan program is too expensive (6% interest?) and simply encourages people to borrow money against the value of their homes. Have we learned nothing from the collapse of the housing bubble?

9. Should there be different standards for different housing types?

There should be different standards for affordable and market rate houses.

10. How could this program benefit you or other landlords?

While we all (collectively) benefit from lower energy use, it's hard for us to see the particular benefits we might derive in our situation. This program is going to drive up the cost of housing in Boulder, offsetting any gains made in energy savings. Our priority is to provide non-subsidized, affordable housing to a market niche not addressed by Boulder's housing programs. While we have made improvements in as energy/water conscious a manner as possible, it is still an old, single-family house in need of significant repair. Had we not purchased it, it would have been razed and replaced with a McMansion. In the trade-off between affordable housing and energy efficiency, some consideration needs to be given to acknowledging the value to the community of providing market-rate affordable housing (80-120% of AMI). Grants instead of loans for improvements; waiving some of the requirements in exchange for lower rent levels; lower compliance standards in exchange for lower rents; these and other ideas should be considered when crafting this policy and ordinance.

3325 Walnut St. Landlord Questionnaire

Could the City pick a short list of contractors to choose from for the Landlords to use. It would be easier for Landlords to do the improvements if the City vetted contractors first.

While the contractors are doing the work, would the landlords be able to do some more work on the other units too? The results from the energy audit would be useful in directing other improvements.

Disagree with the carbon credits, a "shell game" not helping to reach the goals.

805 29th St Landlord Questionnaire

1. Do you feel that the City's Smart Regs. Program will reduce green house gases?

Yes, I feel all efforts will help.

2. If this program was not in place, had you any plans to improve the energy consumption yourself?

If my work and income stabilized I was hoping to replace the windows.

3. What advice would you give to the City as they begin to implement this program?

I'm happy with the procedure so far.

4. What is your opinion on buying carbon credit offsets? If you agree with them, how long should Landlords be able to purchase offsets?

I need more education about carbon credit offsets to formulate an opinion.

5. What improvements do you think your property needs?

New windows, energy efficient furnace and air conditioner.

6. How much money would you expect to spend on energy improvements?

I expect to spend $5000-$7000.

7. When would you like to see this program implemented?

ASAP

8. Are you aware of the subsidized energy audits through Xcel Energy?

No I'm not, but will check into them now.

9. Should there be different standards for different housing types?

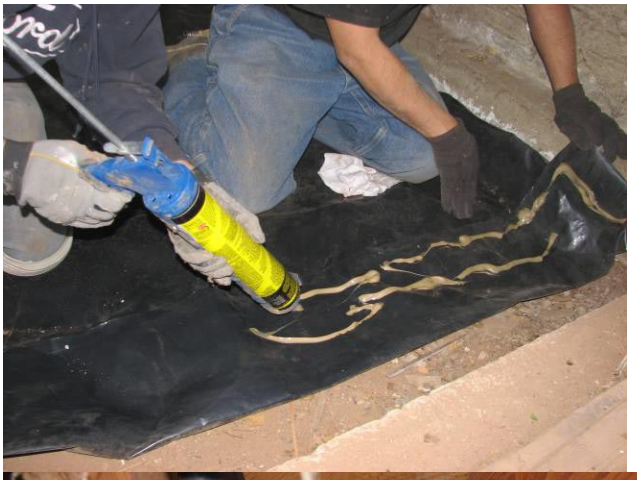
No opinion.

10. How could this program benefit you or other landlords?

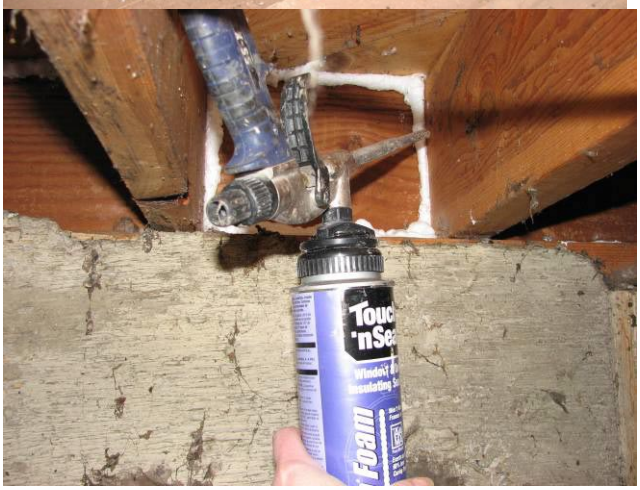
Times are tough and any help in improving the energy efficiency of my rental is greatly appreciated. I feel like this process has empowered my tenant to care about utilities and our environment.

APPENDIX B: PROJECT IMAGES

ASH

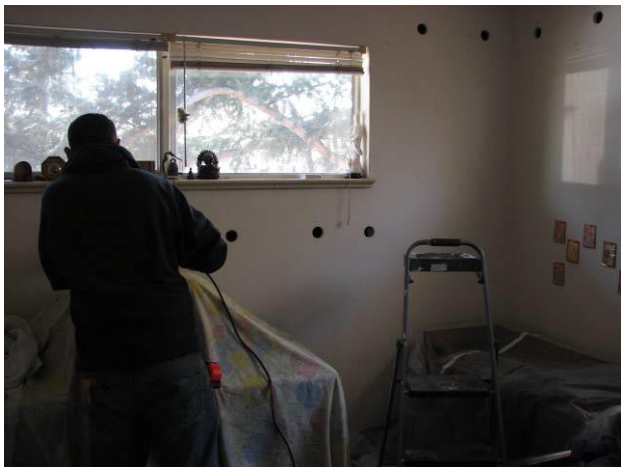


Vapor barrier



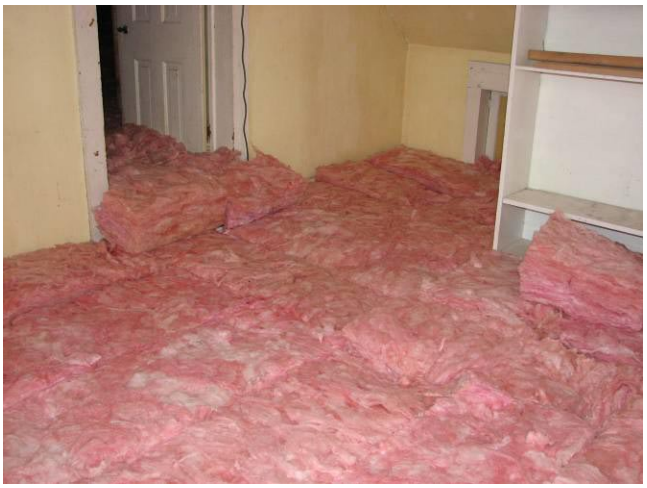
Rim Joist Air Sealing

Crawl Space Wall Insulation

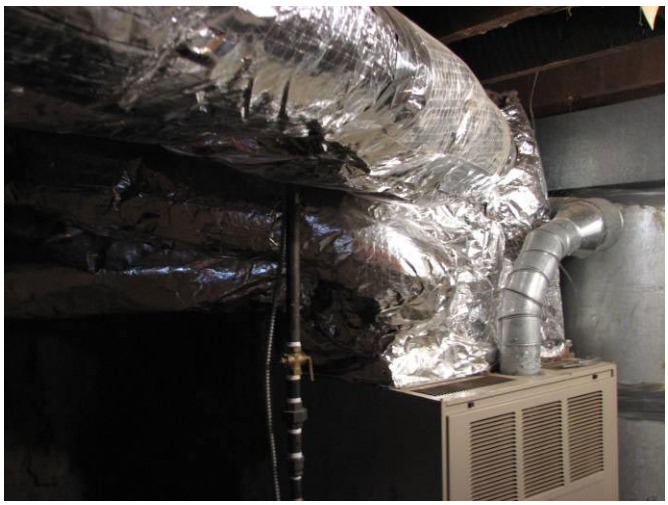


Drill & Fill Wall Insulation

University

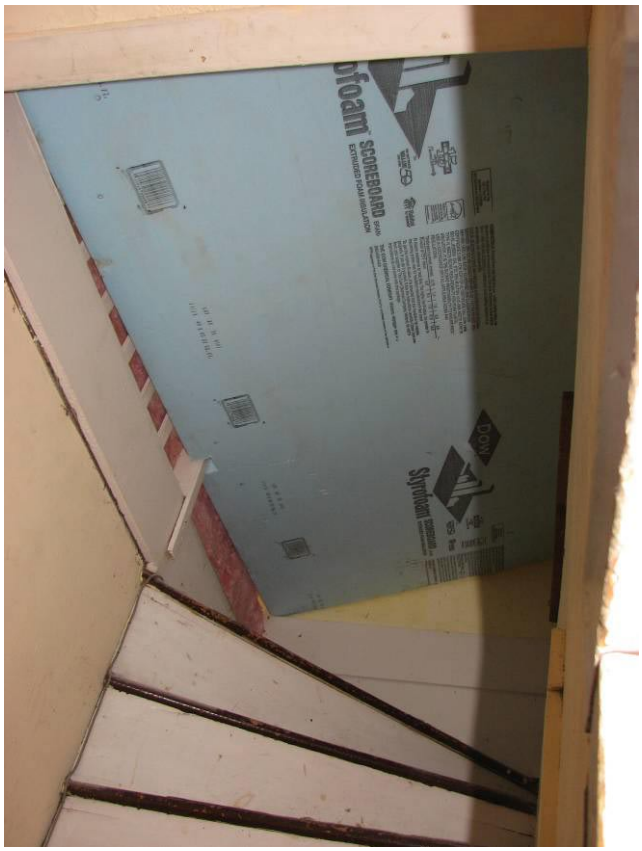


Fiberglass insulation in Attic



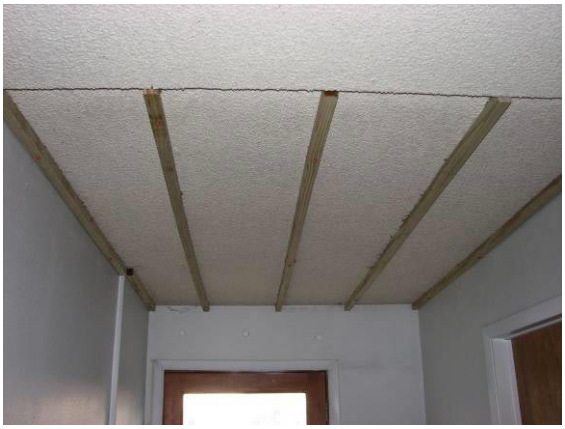
Duct Insulation

Loose Cellulose in Attic

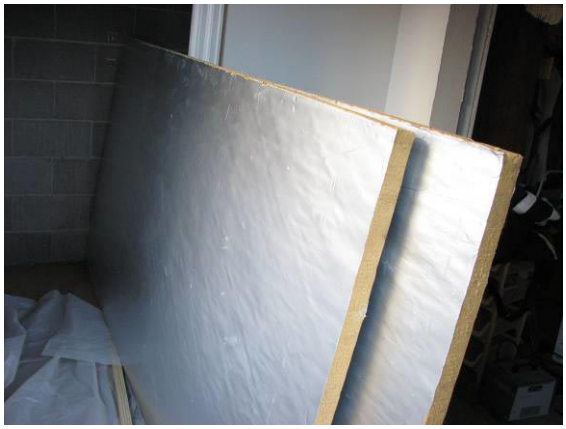


Rigid Foam Insulation Barrier

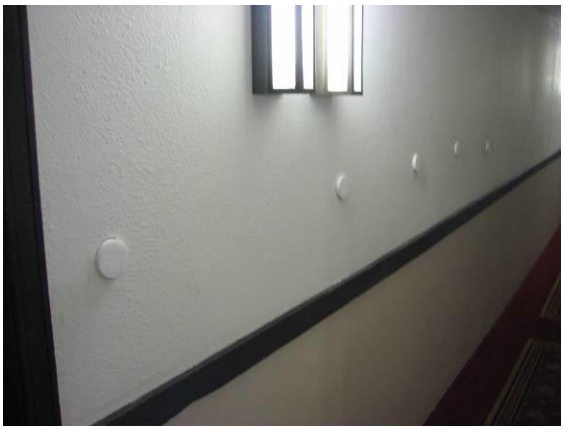
29th



Ceiling Preparation

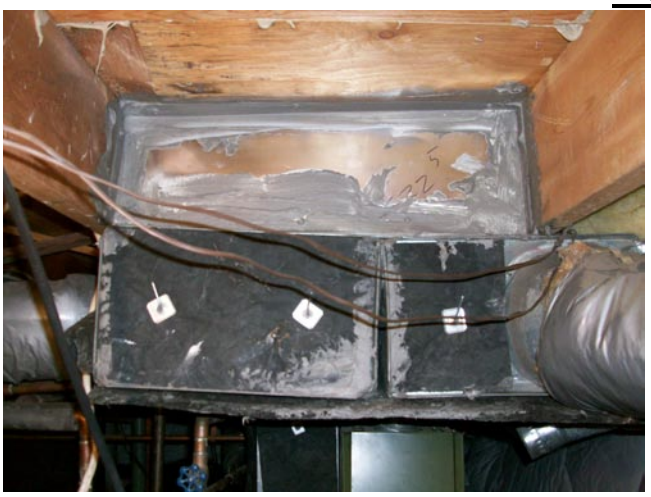


Rigid Insulation

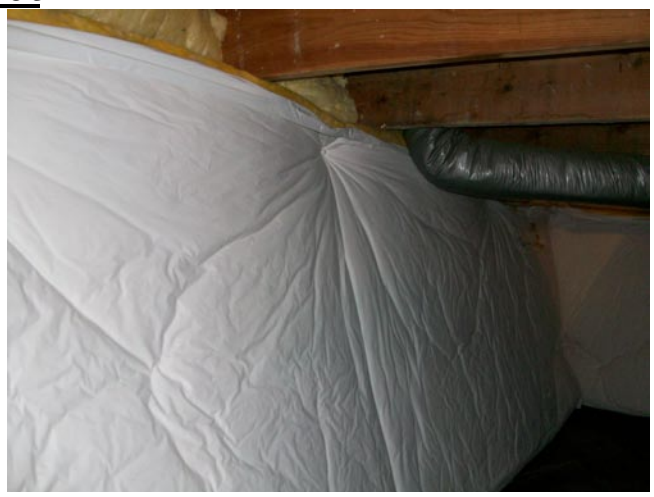


Drill & Fill Wall Insulation

Walnut



Duct Sealing



Crawlspace Foundation Wall Insulation

Crawlspace Vapor Barrier