City of Boulder Climate Action Plan Analysis Report

Final Report for City of Boulder
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Prepared by: Rocky Mountain Institute
Roy Torbert, James Newcomb, Ellen Franconi, Mathias Bell, Kendra Tupper

Executive Summary

Since 2007, the City of Boulder has been progressively implementing a Climate Action Plan (CAP) to lower greenhouse gas emissions and meet Kyoto Protocol goals by 2012. Boulder offers a variety of programs to reduce electricity use in commercial and residential buildings, improve building standards and codes, install renewable energy, and optimize transportation options.

Through a mix of significant efficiency savings and increased community purchases of RECs since 2007, Boulder is expected to achieve 43% of the total reductions targeted for 2011-2012[1]. Boulder now possesses data regarding the costs and results of each individual program comprising the larger Climate Action Plan (CAP), and can strategically reshape the initiative to cost effectively reach future targets.

To assist in determining the optimal approach to program design, Rocky Mountain Institute (RMI) worked with the City of Boulder to conduct a thorough analysis of all Boulder demand side management (DSM) programs funded through the Climate Action Plan Tax[2]. Specifically, RMI examined 19 residential, commercial, and renewable energy programs using a modified utility cost test (UCT) approach to determine their full lifetime emissions reductions and the cost/benefit ratio for each program. This analysis differed from the current City of Boulder approach of calculating year-to-year emissions impact and cost-effectiveness.

The most cost-effective emissions reductions come from residential lighting programs, commercial lighting programs and audits. Yet these emissions reductions produced by existing programs thus far will not be enough to reach current CAP targets. Even with the full cumulative (25 years) of savings from all examined CAP programs, Boulder would not reach the 2012 Kyoto based emissions reduction target. The focus on potential shift in energy supply, which led to the current exploration of municipalization, could significantly augment Boulder's ability to meet its CAP goals in conjunction with ongoing and enhanced energy efficiency efforts.

Key Findings:

1. As compared to previous city calculations of savings, which have typically been annual, the life-cycle assessment of program savings projected considerably more savings for each program.
2. Within the current portfolio of CAP programs, those above average in cost effectiveness include residential lighting programs, Commercial and Residential EnergySmart, and 10 for Change.
3. Boulder has generated significant carbon savings at reasonable cost. Compared to other municipal programs in Connecticut and Oregon, Boulder's lighting programs are slightly less cost effective, Residential EnergySmart is considerably less cost effective, Commercial EnergySmart is similarly cost effective, and renewables programs are far more cost effective. The city also uses a different approach to

[1] Discrepancies exist between City of Boulder carbon inventory accounting and deemed savings due to programs. Further examination is required to merge carbon accounting and program savings.
[2] The CAP tax bill was passed in 2006, took effect in April 2007 and expires March 31, 2013.

calculating savings based on program investment than Connecticut or Oregon, and still has many programs that compare favorably in terms of cost effectiveness (see Appendix A for comparisons)[3].

   a. Commercial and Residential EnergySmart are still maturing as programs, and can be expected to improve over time. A sensitivity analysis of the likely future of these programs predicts improved cost effectiveness, which would make Boulder's programs significantly more cost effective than other, more mature municipal programs (such as Connecticut's programs).[4]
      i. The sensitivity analysis projects that with a maturation of EnergySmart, Residential EnergySmart cost effectiveness will improve from 100.7 to 21.5 $/mton of CO2e and Commercial Energy Smart will improve from 69.1 to 13.9 $/mton CO2e.

4. Boulder has attained impressive energy savings and emission reductions, and is well positioned to achieve future emissions reduction targets.
5. Ongoing programs should continue to be comprehensive (such as the existing Commercial and Residential EnergySmart), and become increasingly coordinated across sectors (i.e., recognizing interrelationships between emissions reductions from energy efficiency, renewable energy systems, and transportation technologies).
6. Boulder must push beyond the simple and easy programs and begin additionally encouraging residents and businesses to think longer term about their buildings, investment choices and energy use.
7. The City of Boulder needs to extend an overarching demand side program (which considers interactions with the supply mix) to hit future emissions reductions targets.

Recommendations for Tracking and Measuring Performance

The city far exceeds municipal standards for tracking data and assessing program performance. However, some improvements can be made to existing procedures:

1. The city should track yearly and lifecycle emissions reductions across all programs, and continue to estimate any potential double counting between programs. This analysis should include the demand implications of efficiency and renewable programs. Demand implications will prove a topic of singular importance if Boulder chooses to municipalize the energy provider role.
2. Boulder should determine disaggregated costs for each program to continue optimizing the programs selected to reach emissions reductions goals. Funding for programs from different city sources, external funding, and payments from residents should be categorized. This process will become significantly easier as ARRA funding expires, and would be crucial if Boulder decides to municipalize.
3. Investments in a comprehensive program database (including cost and savings data) will facilitate both of the prior recommendations. Data analysis will support

[3] Connecticut's examination of life-time saving from programs did not parse savings by cost contribution (CT also received ARRA funds to support some programs). Disaggregating savings by cost contribution makes Boulder's programs appear less cost effective.

[4] The sensitivity analysis also forecasted Boulder funding a higher percentage of EnergySmart and being able to take full credit for savings (based on the cost attribution approach discussed in Appendix B).

not only the selective investment in programs or program activities, but also the optimization of ongoing programs.

4. Boulder should focus on improving carbon accounting to better understand the contribution of program-related savings[5] to the citywide carbon inventory. Improvements to calculations can be attained using macroeconomic factors (such as GDP growth, population growth, and population density), more detailed tracking and measurement procedures and improved data collection throughout CAP programs.

[5] Currently CAP programs have a mix of unverified deemed, verified deemed, and actual savings. See Tables 2 and 3 for more.

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Cumulative Impact of CAP Programs

Progress Since 2007

In 2002, the City of Boulder passed Resolution 906, setting the goal to reduce greenhouse gas (GHG) emissions by seven percent compared to 1990 levels by 2012. The bulk of these reductions were to come from commercial, transportation, and residential sectors (comprising 90% of Boulder's 2007 total emissions[6]).

However, despite impressive program performance, Boulder has not met the initial ambitious emissions reductions targets. For the time period of 2011-2012, projections indicate that Boulder has achieved 42.6%[7] of intended carbon reductions, and only 11.2% of commercial and residential energy use reduction targets stated in the 2006 CAP Report. As noted in the 2010-2011 CAP Progress Report – to meet 2012 emissions goals would require an immediate 25% decrease in the carbon intensity of Boulder's supply mix. Many of the programs assessed in relation to Kyoto targets have long timescales and accrue efficiency benefits over a number of years. Assessing programs over one or two-year timescales distorts the long-term benefits of certain programs. Due to the limitations of a short-term analysis, RMI and the City of Boulder allocated each program the realistic carbon reduction potential by examining savings over the useful life of the program[8].

Process

To assess lifetime carbon reductions, RMI created a model[9] to forecast program savings over the useful life of each program, disaggregate costs based on program funding, and determine cost effectiveness for each program. The cost effectiveness approach used was a modified utility cost test (UCT)[10], which incorporated the lifecycle costs and benefits of each program, to determine a net present value (NPV) and a dollar value per metric ton of CO2e avoided.

RMI and the City of Boulder also reviewed each of the pre-existing methods for calculating savings for programs, identified areas for improvement, and incorporated certain aspects in

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[6] Figures include emissions from the industrial sector, which recent Boulder analyses have included in the commercial category.

[7] In 2011-2012, Boulder reduced an estimated 222,701 $mtCO_2e$ versus 521,032 $mtCO_2e$ required to meet Kyoto targets for 2011-2012.

[8] The useful life of the program was defined either by the recorded types of equipment installed, by an average of equipment recommended, rebated, or installed, or by industry standards.

[9] The model is publicly available

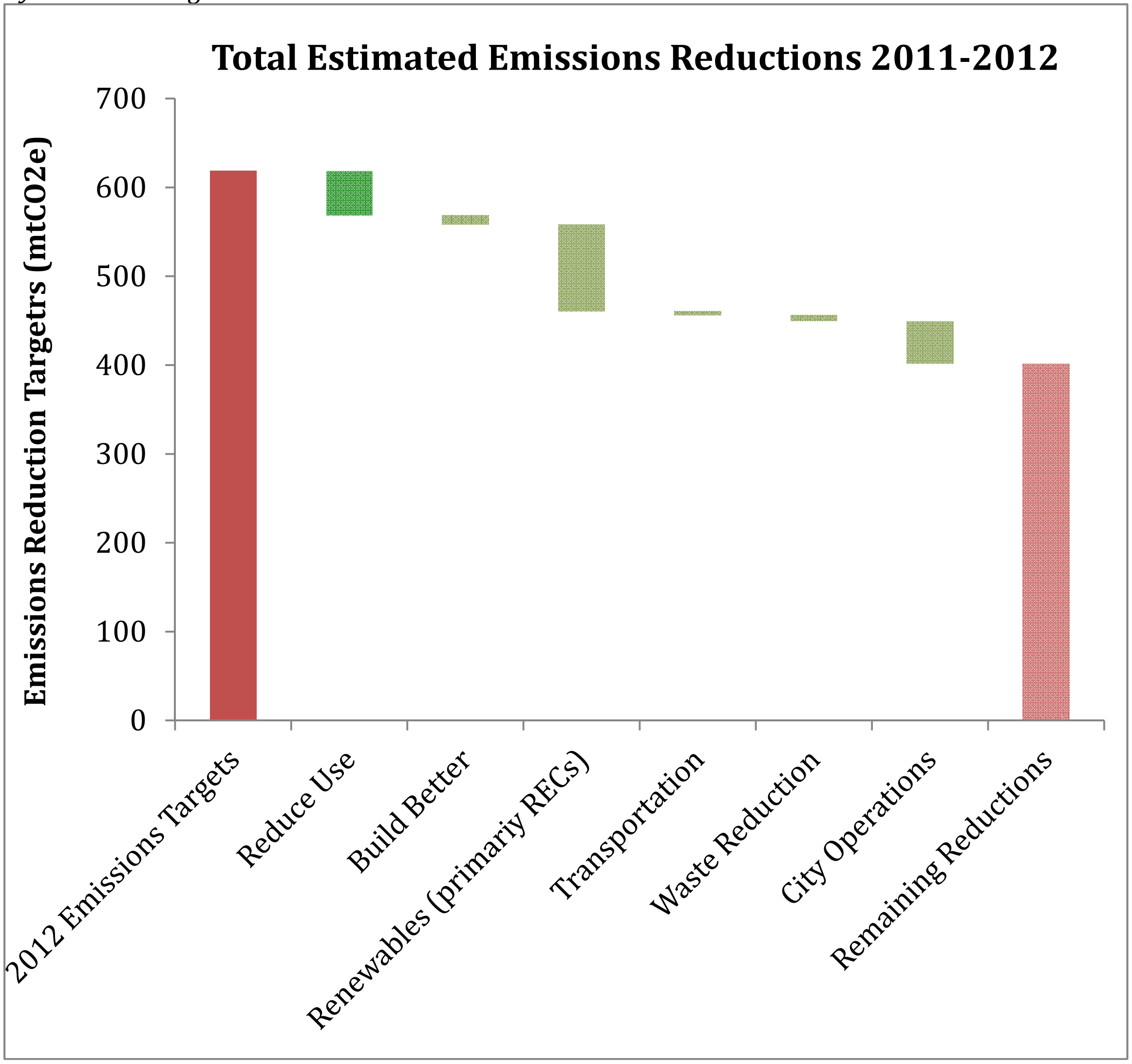
[10] The approach was categorized as 'modified' because demand implications were not considered (demand implications are essential for a utility and should be incorporated if Boulder municipalized). The analysis also disaggregated the costs to determine the impact of specifically CAP taxes (a method not commonly used by utilities). Lastly the end benefits were expressed in GHGs avoided as well as simplified cost avoidance. The analysis otherwise corresponded to standard industry UCT calculations, as specified by the Ontario Energy Board. Link: http://www.ontla.on.ca/library/repository/mon/11000/255871.pdf

the new savings calculation methodology. As compared to previous city calculations of savings, which have typically been annual, the life-cycle assessment of program savings projected considerably more savings for each program.

Utility analyses typically account for free ridership of programs (program participants may already have been intending to purchase upgrades), but not the impacts of jointly funded programs (between the utility and the state or federal government). Due to project scope constraints, this analysis assessed free ridership only for programs highly impacted by it (rebates, renewable energy systems, and 10 for Change). For programs that were funded in large part by non-CAP tax sources (such as federal grants, GEO funding, and Xcel funding), the analysis parsed out savings by cost contribution – which reduced the share of emissions reductions attributable to city investment, and made certain programs rank as far less cost effective. This analysis most accurately estimates the cumulative impact of CAP tax funding, but is atypical when compared to standard utility or municipal analyses (which take full credit for savings independent of funding sources). This approach accounts for CAP tax funding only as far as it directly funded programs, however some of the programmatic funding from the CAP tax was used to attain other funding sources.

These comparisons based on funding source are limited, as Boulder's climate action goals go beyond the programs funded by the City, and include a number of other reductions sources: city operations (not assessed in this examination), impacts of building codes, non-City directed renewable installations, transportation programs, waste programs, and urban forestry. For a more accurate comparison – the chart below shows the modeled savings from CAP funded programs, as well as other projected savings from the 2011-2012 CAP Update.

*Chart 1: Modeled and estimated savings as compared to amount of reduction needed to reach Kyoto 2012 Targets**



**All programs except 'Reduce Use' used City of Boulder 2010-2011 CAP Progress Report estimates.*

When compared to current Boulder emissions reduction targets, both projected savings decreased by CAP tax cost share – as well as total emissions reductions prior to attribution by financial share – do not reach 2012 emissions targets. Reductions on the scale of ~400,000 metric tons of carbon dioxide equivalent (mtCO_2e) remain to be instituted for Boulder to reach climate goals as currently defined. However, Boulder has attained impressive energy savings and emission reductions, and is well positioned to achieve future emissions reduction targets.

Opportunity to Continue Successful Programs

In 2007, Boulder began implementing laudable and aggressive strategies, based on adoption of Kyoto targets (Boulder adopted Kyoto targets in 2002). These targets, and the ensuing programs, make Boulder a nation-leading city in climate action. Despite not achieving the overall emissions targets, Boulder has attained significant energy and carbon savings. Boulder now has an opportunity to refocus and clarify the strategy for meeting and exceeding climate targets. The first step in this process will be an examination of prior programs, to help inform a future strategy.

The programs listed below have all yielded significant carbon savings, though more recent programs (such as Commercial and Residential EnergySmart and SmartRegs) have not had multiple years of recorded savings, and, through learning curves, will become more effective at producing savings. A sensitivity analysis of these three programs (see Appendix F) shows that projected savings from Commercial EnergySmart, SmartRegs, and Residential EnergySmart will (with projected continuation of existing, early-stage programs) be the largest source of reductions.

Table 1: The ten largest analyzed programs*

PROGRAM	MtCO2e	Useful Life
Energy Assessments (REAP)	8,097.78	10 years
Commercial EnergySmart	6,785.13	16 years
Neighborhood Sweep Kits	6,733.25	9.5 years
10 for Change	5,105.22	8 years
LED Holiday Light Exchange	3,498.95	25 years
EnergySmart/SmartRegs	2,982.01	15.5 years
Multifamily Performance Program (MPP)	2,687.26	9.2 years
Residential EnergySmart	2,025.34	15.5 years
ClimateSmart at Work Audits	1,862.75	9 years
Efficient Lighting Coupons	1,809.85	9.5 years

**Programs are listed by cumulative greenhouse gas reductions summed over the useful life[11] of the program. Adjustments were made to narrow savings to those attributable to CAP tax expenditures. Actual savings to Boulder are higher than those displayed above (See Chart 3).*

Cost Effectiveness Study

Approach

RMI and the City of Boulder completed an intensive cost effectiveness analysis built upon two core concepts: 1) Disaggregation of all CAP tax funding by program, and 2) Allocation of program savings based on technical potential, participation, and/or share of Boulder CAP tax expenses to the total program funding. The technical derating method is a standard approach for utilities, but the funding disaggregation is non-standard among utilities. The

[11] For certain programs (largely lighting programs), data collection was specific enough to forecast savings from each specific piece of equipment installed. In these cases, each category of equipment was given a useful life specific to that sort of equipment. For other programs, average useful lives were determined either through industry standards, or averages of typical equipment used in the program. These average useful lives were used to calculate lifetime emissions reductions.

funding disaggregation was applied to this analysis primarily to better compare between programs[12].

1. Funding Disaggregation

Boulder spent between $700,000 and $1,600,000 of CAP tax funding per year since 2007 to achieve these results. Actual subsequent expenditures have closely followed original CAP tax projections. As part of the cost-effectiveness analysis, RMI and the City of Boulder disaggregated the total CAP tax expenditures to each of the 19 programs (See Appendix C for a description of the cost disaggregation methodology).

This cost disaggregation helped to clarify the CAP tax-funded costs of each program (listed as a cumulative figure below in Table 4) and allowed a cost comparison. However this cost attribution may be misleading for a number of reasons:

- Some programs were structured as pilot programs and had significant research purposes or were implemented for social sustainability goals (such as Small Building Tune-Up Program and Weatherization[13]). These programs have benefits beyond energy savings, and can be used to strengthen other programs.
- Some programs were only embarking on a long-term plan for producing energy savings and required significant design and start up costs (Commercial and Residential EnergySmart and SmartRegs). Savings from these programs will be understated at this point in their lifecycle – as initial costs for the program are generally higher, some of the specifically energy-saving elements of the program may not have begun, and learning curves are just beginning to appear.
- As seen below in Chart2, the analysis forecasts a sharp decrease in attributable emissions reductions in 2016. This is due to the beginning of the expiration of savings from lighting programs, 10 for Change, and ClimateSmart at Work – according to their projected useful lives. However, residents and businesses can be expected to learn from the efficiency measures implemented, and will likely continue to make purchasing and investment decisions emphasizing energy efficiency. This effect was not modeled as part of this analysis.

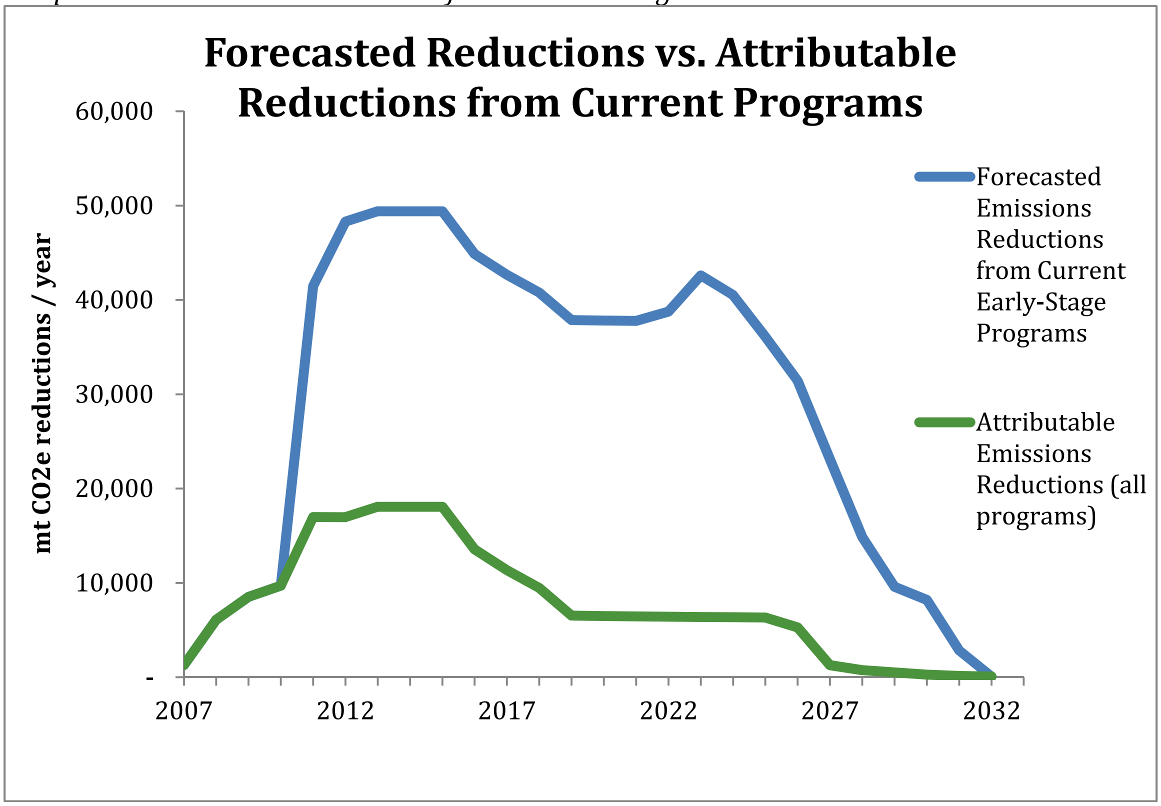
However, the programs so far contributing to emissions reductions in Boulder have often been funded from a variety of sources, such as federal grants and private sources. To determine with some precision the impact of CAP tax dollars, the team allocated savings for programs incorporating a majority of external program funding (this would include Xcel, federal funding, or GEO funding) based on CAP funding's share of total funding. For some programs, specifically Commercial and Residential EnergySmart, this apportioning removed 82-88% of total savings (see Appendix B and E for more details on costing) and dramatically impacts the cost-effectiveness.

To account for these differences, RMI ran a sensitivity analysis on these six difficult to quantify programs[14] – to determine possible Boulder savings if Boulder assumed the full

[12] Otherwise programs funded largely outside of the CAP tax mechanism would appear far more cost-effective.
[13] Other examples (not modeled) include the Home Energy Makeover and Utility Bill Analysis programs
[14] These six programs were: Commercial and Residential EnergySmart, SmartRegs, REAP, Weatherization, and the Small Building Tune-Up Program.

costs of these programs and if newly instituted programs are allowed to mature. See Appendix F for the results of this sensitivity analysis).

Chart 2: Forecasted Reductions (including sensitivity analysis of early-stage programs) Compared Total Boulder Reductions from Current Programs

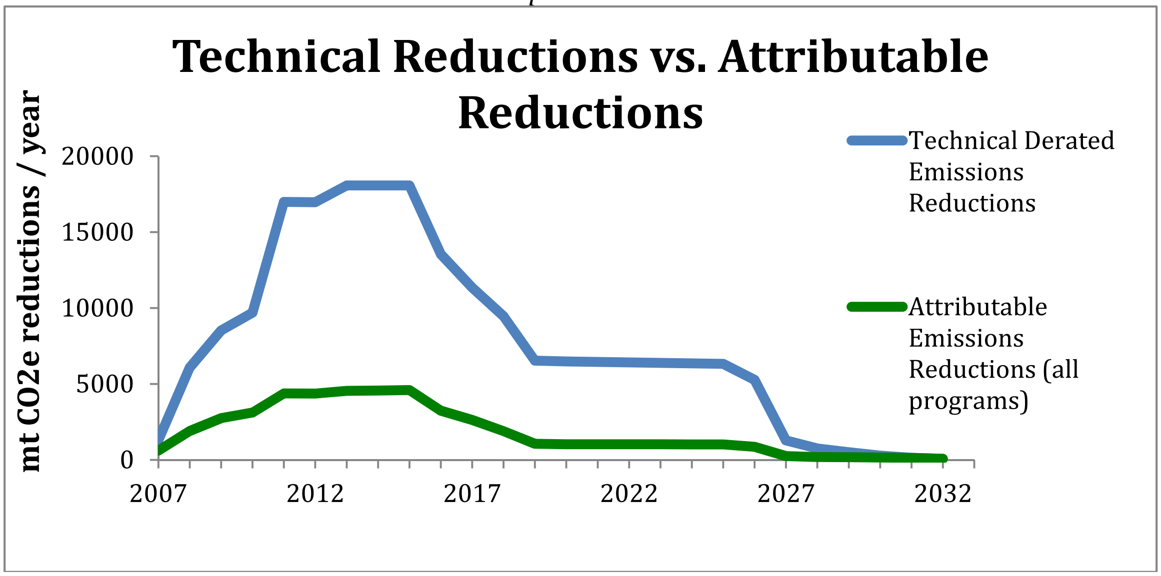


2. Derating Process

Technical factors (adjustment made to programs due to predicted savings not showing up or not remaining for the full useful life) also negatively impacted the predicted savings. The largest derating due to technical factors was for programs (such as REAP and MPP) that needed to incorporate a participation rate (based on the likelihood of participants pursuing efficiency measures). For technical derating processes, only very minor decreases in estimated savings occurred, largely because the city used accurate procedures to estimate program savings. See Appendix E more.

RMI and the city maintained a conservative approach throughout the methodology of attributing savings. This approach, when in doubt, underestimated the total emissions reductions of CAP funded programs, but provides clearer insights for comparison between programs. The largest impact on forecasted savings occurs when savings are strictly limited to those attributable to the CAP tax expenditures (see Chart 3 below).

Chart 3: Technical Possible Reductions Compared to Attributable Reductions[15] [16]



For certain programs (such as Solar Grants, Solar Rebates, Lighting Coupons, and other rebate only programs) an attribution adjustment was made to reflect that the rebate was a small portion of the total price paid (and likely did not incent every participant or purchaser). The allocation approach primarily affected programs that are largely externally funded or rebate or coupon programs which provide only a small portion of incentives (EnergySmart, SmartRegs, and Rebate Programs). See Appendix B for the full description of cost disaggregation.

Results

The examined CAP programs range across Residential, Commercial, and Renewable Energy sectors. Nineteen programs were examined, with five of them primarily lighting programs (Neighborhood Sweeps, CU Green Teams, Lighting Coupons, LED Holiday Light Exchange, and LED Exit Sign Exchange (commercial). These programs generally handed out efficient light bulbs (either directly in light exchanges or through home visits called "Sweeps"). Audit programs included REAP (provided by Xcel and supplemented by the City[17]), the Multifamily Performance Program, the Small-Building Tune-Up Program, and ClimateSmart at Work (provided by Xcel and supplemented by the City). 10 for Change is a commercial program that sets goals for commercial partners and provides resources to help them meet

[15] Unadjusted refers to the full technical potential of all programs and full attribution to Boulder. Attributable refers to the share to which CAP funding is responsible for achievable emissions reductions. Essentially – attributable savings are unadjusted savings after removing some program savings that are not expected to appear due to technical reasons (such as participation, free ridership, and removing portions of program savings due to programs largely funded by sources other than the CAP tax.

[16] As described earlier, this analysis is an industry standard analysis – with the exception of the derating based on cost participation.

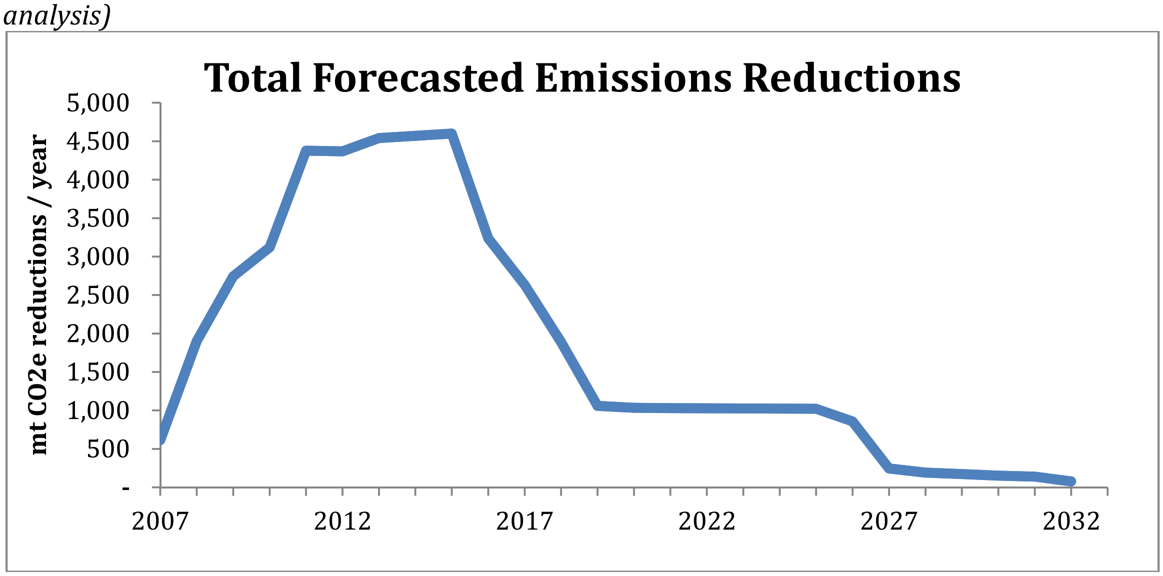
[17] Starting in 2008, Xcel had contractors perform the audits and the City of Boulder contracted with those auditors to add natural gas (not just electricity) audits and offer follow-up services. In 2007, the city provided the audits for those programs (prior to Xcel's program start).

their goals. Rebates were provided for solar thermal, insulation, and solar photovoltaic (PV) systems (as well as rebates associated with EnergySmart). Weatherization was a small-scale residential offering which provided free weatherization and included limited data tracking (pre- and post- installation).

Residential EnergySmart has become the centralized program to offer rebates for deeper retrofits, audit to action, and simple upgrades. Residential EnergySmart now programmatically encompasses Neighborhood Sweeps and other lighting offerings, and equipment rebates. SmartRegs is supported by EnergySmart, which offers a track for rental owners (subject to SmartRegs energy efficiency requirements) to upgrade their buildings to meet codes. The SmartRegs EnergySmart track provides assistance and rebates to promote regulatory compliance[18]. Commercial EnergySmart provides services to commercial and industrial buildings including Discover (low and no-cost equipment and education), Optimize (providing contractors to tune-up systems and provide simple new components), and Upgrade (offering energy advising services and assisting with equipment replacement). Commercial EnergySmart is the successor to the Small-Building Tune-Up program and the ClimateSmart at Work Audits program (and also encompasses free lighting upgrades and rebates).

RMI also examined renewable energy programs include Solar Grants (providing direct payments to install solar for verified non-profits and affordable housing) and Solar Rebates (refunding 15-16% of city sales tax paid for solar PV systems).

Chart 4: Derated and Attributable Reductions from Modeled CAP Programs (no sensitivity analysis)



[18] Includes programmatic responsibility for some rebates.

Table 2: Cost Effectiveness Results for Emissions Reductions over the Lifecycle of each Program (derated based on technical and cost factors).
This is the modified UTC approach

RESIDENTIAL PROGRAM	kWh	TH	Cost	mtCO2e	$/GHG reduced
Residential EnergySmart*	893,891	262,948	$204,006	2,025.34	$100.73
SmartRegs*	1,322,367	386,323	$519,896	2,982.01	$174.34
Neighborhood Sweeps*	8,509,119	138,500	$153,277	6,733.25	$22.76
Energy Assessments (REAP)	5,201,506	835,104	$413,187	8,097.78	$51.02
Multifamily Performance Program	2,488,569	175,835	$93,909	2,687.26	$34.95
Weatherize*	217,844	53,091	$82,747	435.27	$190.11
CU Green Teams & Greek Sustainability	453,102	-	$33,705	319.41	$105.52
Lighting Coupons*	2,567,409	-	$22,612	1,809.85	$12.49
LED Holiday Light Exchange*	4,963,518	-	$49,025	3,498.95	$14.01
Rebates - Solar Thermal*	-	28,568	$23,940	151.58	$157.93
Rebates - Insulation*	17,954	104,764	$133,058	568.53	$234.04
ReNew Our Schools PTO Fundraiser	1,052,476	116,020	$45,275	1,357.53	$33.35
Average	*2,307,313*	*175,096*	*$147,886*	*2,555.56*	*$57.87*
BUSINESS PROGRAM					
Commercial EnergySmart*	9,508,941	15,446	$468,763	6,785.13	$69.09
Small-Building Tune-Up Program*	718,200	130,800	$336,082	1,200.31	$280.00
ClimateSmart at Work Audits	2,680,273	(5,025)	$453,841	1,862.75	$243.64
10 for Change	4,216,779	401,935	$207,170	5,105.22	$40.58
LED Exit Sign Exchange*	279,620	-	$3,705	197.11	$18.80
Average	*3,480,763*	*108,631*	*$293,912*	*3,030.11*	*$130.42*
RENEWABLES					
Solar Grants*	1,778,450	-	$112,813	1,253.7	$89.98
Solar Rebates*	815,308	-	$100,452	574.74	$174.78
Average	*1,296,879*	-	*$106,633*	*914.21*	*$116.64*

*Savings from these programs are based on verified implementation data collected by the City of Boulder (others use assumed implementation rates)[19].

[19] This is a crucial distinction for clarifying the actual emissions reductions (particularly in light of differences between deemed savings and carbon accounting).

Table 3: Cost Effectiveness Results for Emissions Reductions over the Lifecycle of each Program (<u>only derated on technical factors</u>)

This is the unmodified UTC approach

RESIDENTIAL PROGRAM	kWh	TH	Cost**	mtCO2e	$/GHG reduced***
Residential EnergySmart*	7,449,095	2,191,237	$204,006	16,877.83	$12.09
SmartRegs*	6,611,833	1,931,615	$519,896	14,910.05	$34.87
Neighborhood Sweeps*	8,509,119	138,500	$153,277	6,733.25	$22.76
Energy Assessments (REAP)	5,779,451	927,894	$413,187	8,997.54	$45.92
Multifamily Performance Program	2,488,569	175,835	$93,909	2,687.26	$34.95
Weatherize*	217,844	53,091	$82,747	435.27	$190.11
CU Green Teams & Greek Sustainability	453,102	-	$33,705	319.41	$105.52
Lighting Coupons*	8,558,029	-	$22,612	6,032.85	$3.75
LED Holiday Light Exchange*	4,963,518	-	$49,025	3,498.95	$14.01
Rebates - Solar Thermal*	-	228,544	$23,940	1,212.65	$19.74
Rebates - Insulation*	128,983	752,614	$133,058	4,084.29	$32.58
ReNew Our Schools PTO Fundraiser	1,052,476	116,020	$45,275	1,357.53	$33.35
Average	*3,851,002*	*542,946*	*$147,886*	*5,595.57*	*$26.43*
BUSINESS PROGRAM					
Commercial EnergySmart*	63,392,940	102,971	$468,763	45,234.22	$10.36
Small-Building Tune-Up Program*	718,200	130,800	$336,082	1,200.31	$280.00
ClimateSmart at Work Audits	17,868,485	(33,502)	$453,841	12,418.34	$36.55
10 for Change	42,167,789	4,019,353	$207,170	51,052.20	$4.06
LED Exit Sign Exchange*	279,620	-	$3,705	197.11	$18.80
Average	*24,885,407*	*843,924*	*$293,912*	*22,020.44*	*$13.35*
RENEWABLES					
Solar Grants*	9,441,571	-	$112,813	6,655.69	$16.95
Solar Rebates*	1,242,869	-	$100,452	876.14	$114.65
Average	*5,342,220*	-	*$106,633*	*3,765.91*	*$28.32*

*Savings from these programs are based on verified implementation data collected by the City of Boulder (others use assumed implementation rates)

**This cost is specific to CAP tax expenditures on programs. Actual program costs are much higher. See Appendix E for more.

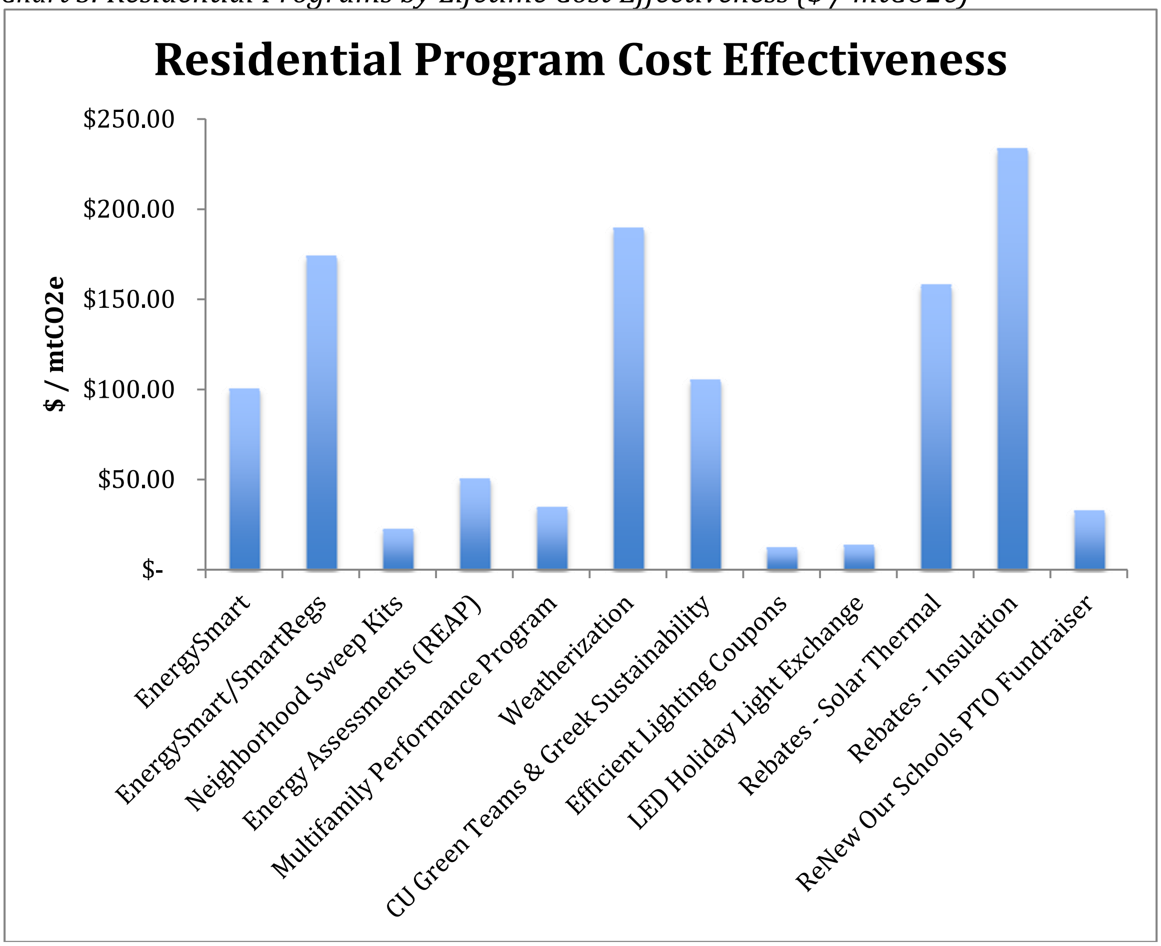
*** This $ per GHG reduced is also based on CAP tax expenditures per program, and not on full program costs.

Program Insights

Lighting programs clearly offered the most cost effective savings. These programs produce clear and straightforward benefits and have savings that persist as long as the equipment is operational. Efficient lighting coupons are highly cost-effective (largely due to low total program expenditures), but may only be rewarding buyers already intending to purchase efficient lighting, a problem utility analysts call free-riding, (Weaver, et. al).

Clear behavior change is difficult to establish for many of the lighting programs. One exception to this is the Neighborhood Sweeps Program – which offered the third best return on investment ($23 in program costs for each $mtCO_2e$ reduced) -- directly installed more-efficient lights, water saving equipment, and provided information about other Boulder energy programs. This program has now been incorporated into Residential EnergySmart and now improves the effectiveness of the larger program – while gaining the programmatic benefits from being part of a more comprehensive program. The least effective lighting program examined was the CU Green Teams and Greek Sustainability (classified as lighting because most savings came from lighting upgrades) with $234 / $mtCO_2e$ saved. This program should be examined, and possibly reframed with additional metrics to measure success in persistent behavior change to ultimately attain more significant direct savings.

Chart 5: Residential Programs by Lifetime Cost Effectiveness ($ / mtCO2e)

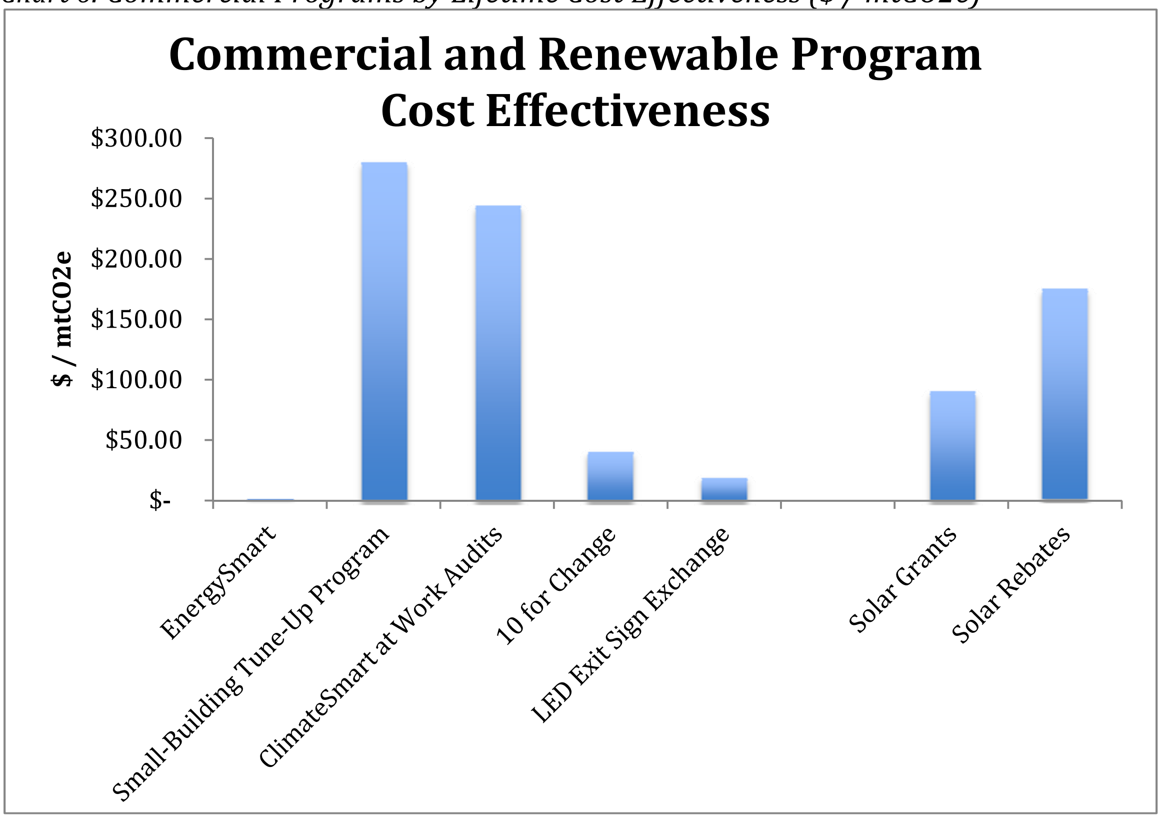


EnergySmart, SmartRegs, Sweeps, and Weatherization are verified deemed savings, vs. assumed deemed savings for REAP, the MPP, and other lighting programs.

Residential programs outperformed commercial programs (weighted average $/$mtCO_2e$ reduced for residential was 58 versus 97 for commercial). This is largely due to comprehensive lighting programs (most influentially the Neighborhood Energy Sweep program) being large and highly effective. Less comprehensive residential lighting programs (such as lighting coupons and LED light exchanges) were also very effective, but had smaller total savings. The PTO Fundraiser, despite being seemingly unique among municipal programs, serves as a cost effective measure, and appears an effective method of engagement.

However, some commercial programs appear highly cost effective. EnergySmart and 10 for Change[20] are both extremely cost effective. ClimateSmart (and now EnergySmart) audits provide clear and actionable recommendations and plans, and will see improved cost effectiveness as programs continue. 10 for Change provided less actionable tools, but was performed at much lower cost. Both of these programs are also excellent conduits into the business community for further programs. Developing strong connections and instituting processes to disseminate information is critical to the success of an integrated program with aggressive goals. As the commercial/industrial sector produces the largest share of Boulder's emissions, significant emissions reductions require participation from businesses.

Chart 6: Commercial Programs by Lifetime Cost Effectiveness ($ / mtCO2e)



Renewable energy systems, incented through rebates and grants, offer below average returns. Despite long system lives, accounting for system degradation over time and non-CAP funding made the programs appear less cost-effective. Of the two programs, solar grants appear to be the more cost effective approach[21] – based entirely on the share of savings attributed to the influence of the program. Solar rebates – though persuasive, are likely not as impactful as solar grants on the decision-making of possible participants. The

[20] 10 for Change savings proved particularly difficult to quantify – however the results of a survey of 10 for Change participants provided valuable insights into the degree to which 10 for Change was inspiring participants to improve energy efficiency.
[21] Solar grants are only available to 501(c)(3)s and affordable housing.

renewable energy sector, predicted to be a major component of reaching Boulder's 2012 goals, resulted in the largest total gap between predicted CAP reductions and actual CAP reductions. Transitioning beyond purchases of RECs to significant distributed renewables will be a crucial part of the long-term emissions solution for Boulder.

Certain programs displayed less than average cost-effectiveness, in part because they were short-term pilots. Most of an early-stage program's costs can be expected to be administrative, and while the cost attribution did not allocate a higher level of administration, it can be expected that the billed expenses for the program were often not directly leading to savings. These programs provided significant research benefits and would be expected to improve total savings and cost effectiveness dramatically if scaled up (See Appendix F for more).

Programs displaying less than average cost effectiveness include the Small Building Tune-Up Program, Weatherization Program, and Solar Thermal and Insulation Rebates. The Small Building Tune-Up Program was structured as a pilot program, and never reached the scale necessary to show significant savings at reasonable cost[22]. The Weatherization Program also reached few homes and would see improvement if scaled up.

Commercial and residential EnergySmart, as well as SmartRegs, appear less cost effective than the average program. Yet EnergySmart institutes some long-lasting and high-saving equipment, while incorporating prior (and proven) programs. The RMI project team determined that EnergySmart will be far more cost effective in the future than the current analysis shows. As discussed above, this underrepresentation is due to a confluence of factors:

- The programs are early in their programmatic cycle,
- Significant (>75%) derating factors have been assigned to the cost effectiveness analyses due to external funding sources.

It is important to note that savings from these programs did impact Boulder, by benefitting businesses and residents, improving buildings, and reducing emissions. However, not all of the resulting emissions reductions can be directly attributed to CAP tax funding.

After funding from the American Recovery and Reinvestment Act (ARRA) expires, Boulder could move to more fully fund EnergySmart, at which point the program would appear far more cost-effective, without any significant changes in programmatic approach. EnergySmart should also dramatically improve due to learning curves and procedural efficiency as the programs mature.

Commercial and residential EnergySmart offer major emissions reductions, a simple and compelling conduit for businesses and residents, and represent a cost-effective future for Boulder's climate action. Apparent higher than average costs at such an early stage should not detract from the convincing value of EnergySmart. The sensitivity analysis projects that with a maturation of EnergySmart, Residential EnergySmart cost effectiveness will improve from 100.7 to 21.5 $/mton of CO2e and Commercial Energy Smart will improve from 69.1 to 13.9 $/mton CO2e.

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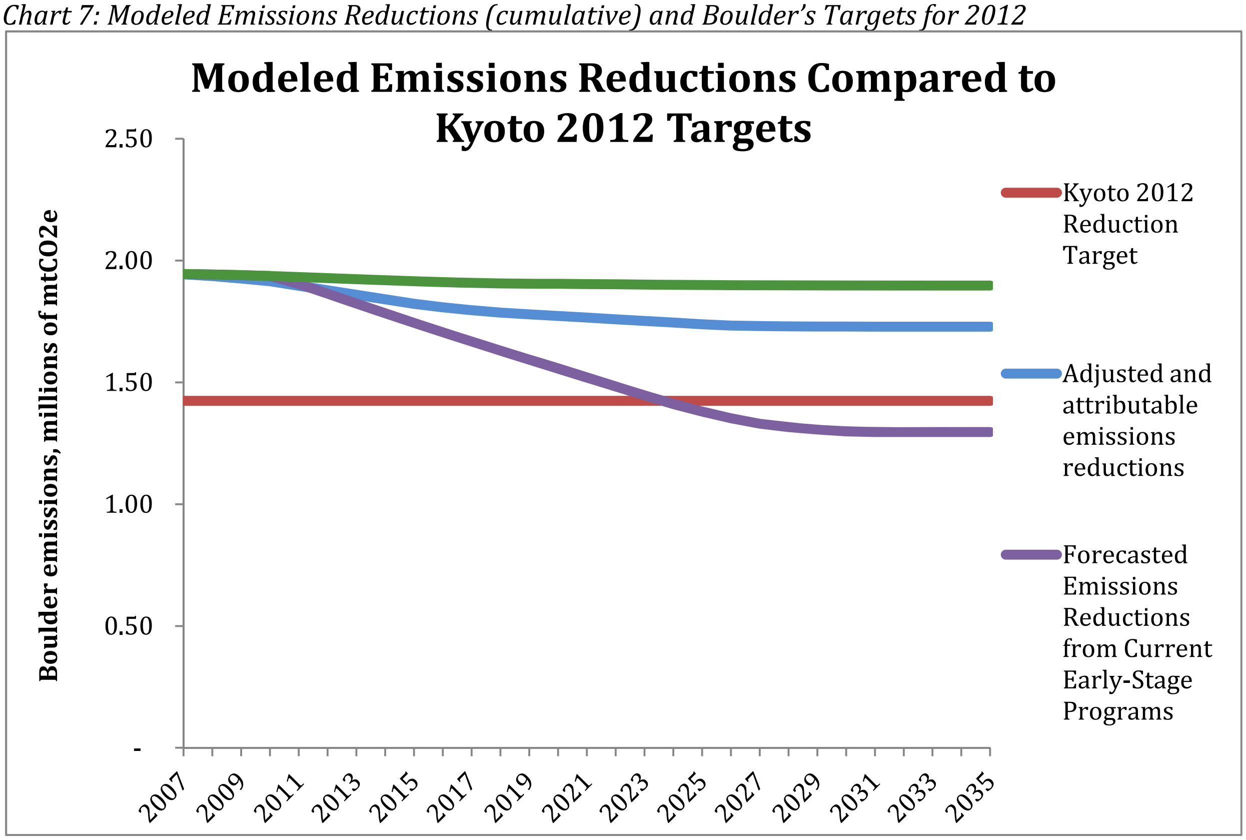
22 The Small Building Tune Up Program also served as the precursor to Commercial EnergySmart and much of learning is currently being implemented.

A deliberate progression of the CAP program requires further analysis into the projected returns from additional investment into each of these programs. Some programs may be reaching saturation, and others may improve as the program progresses. Programs (such as various lighting programs and the Multifamily Performance Program), which have been incorporated into EnergySmart, are excellent candidates for particular emphasis and investment.

Preliminary Recommendations for Action Beyond 2012

RMI's model indicates that Boulder's current programs are insufficient to reach the Kyoto goal by 2012, or even by the year 2035. Additional programs (such as Boulder's municipalization, Xcel's DSM or supply mix changes, transportation savings, RECs purchases, and others) can dramatically improve or degrade these modeled emissions reductions. However, as projections include no forecasted energy increases due to GDP growth, the model likely understates the underlying growth in Boulder emissions.

Chart 7: Modeled Emissions Reductions (cumulative) and Boulder's Targets for 2012



No saturation rates for programs were assumed.

The Boulder CAP must be modified to reach climate action targets designed for a more reasonable timeframe. This means that the city should adopt a longer-term approach to calculating savings and allocating funding to reduce emissions from the CAP tax and other funding sources. The city will likely continue to jointly fund programs and partner on program and service delivery, while inspiring private investment to reach a greater potential carbon savings. The CAP program must also be expanded. When attributing all program savings to the Boulder community, the model projects that 2012 targets will not be met.

However, when (as described in the sensitivity analysis) Boulder continues Commercial and Residential EnergySmart and SmartRegs[23] the model shows that 2012 emissions reductions targets will be met in 2023.

Recommendations for Future Action

The city must balance prudent financial stewardship with public demands for emissions reductions. A future strategy to optimally reduce emissions requires in-depth analysis. However, RMI has provided some initial recommendations for the future of Boulder's community climate action.

Scaling and Sorting:
Existing Boulder programs require additional resources and marketing to reach significant levels of implementation. Lighting programs have been effective and widely used, and may in the future require scaling back if Boulder approaches market saturation[24]. However, EnergySmart (including realistic future projections) and 10 for Change are clearly cost-effective options for expansion. Weatherization and Insulation Rebates have been more expensive, but larger programs will improve return on investment.

Investment and Continuity
Programmatic investments may need to be longer-term to create more prominent programs engaging a wider range of businesses and residents. Larger and better-funded programs will better tap into learning curves and gain momentum. In particular, residential and commercial EnergySmart offer the largest potential future savings, but must be funded without the support of ARRA (See Sensitivity Analysis – Appendix F). These programs have only just begun to accrue savings, and the learning curves of carrying out the program should dramatically improve costs (see Appendix D).

Comprehensive and Integrated Programs
Boulder's investments thus far appear cost-effective and well managed. Programs in other municipalities have had similar results, and often focus on lighting and short-payback improvements. Results from Oregon and Connecticut show similar reductions. However, predicted emissions do not reach 2012 goals or match up with carbon inventories. Further analysis is required to make clear determinations of how programs are affecting Boulder as a whole. Boulder must push beyond the simple and easy programs and begin encouraging residents and businesses to think longer term about their buildings, investment choices, and energy use. EnergySmart advisors can be trained on the processes of deep retrofits and whole-systems thinking, to better analyze and propose integrated solutions that offer

[23] With projected increases in each program's savings and decreased costs due to learning curves
[24] Although RMI did not forecast the impact of new technology, lighting technologies in particular appear to be improving – allowing for updated programs to support newer systems and greatly reduced wattages. This effect would avoid the possibility of market saturation.

greater than 30% energy savings[25]. Incentives specific to deep energy savings, combined packages of improvements (bundling), and load-reducing efficiency measures[26] can improve the financials of more comprehensive energy retrofits for deeper savings.

The possible municipalization of the city's energy supply is an excellent example of an aggressive effort that can fundamentally reshape Boulder's relationship to energy and emissions. Citizens would have an unprecedented stake in efficiency projects (as efficiency in the portfolio will lower the costs and barriers to municipalization) while distributed renewable energy generation and storage would become a shared priority. A municipalized system would make a net-zero or off-grid home program (such as the Connecticut Zero Energy Challenge) far more valuable.

As efficiency and renewable programs become more aggressive and aim for larger savings, they necessarily become multi-tiered and interactive. For example, implementing more efficient lighting has a small impact on lowering cooling loads in the summer – but daylighting and proper shading reduces not only lighting energy, but also cooling (and possibly heating) loads, while contributing to documented health and productivity benefits. When combined with better insulation, these improvements can dramatically lower HVAC loads – possibly avoiding major capital expenditures or required home renovations. And when a highly efficient house also implements solar PV, system impacts become more complex with larger impacts on daily load profiles, and periodically exporting electricity to the grid. The city needs to train EnergySmart auditors on the implications and possibilities of deep savings for program participants, while examining the system-wide implications of more aggressive programs. These analyses will deepen savings for residents, and reveal possible programmatic efficiencies across sectors.

RMI's analysis of Boulder's program was thorough in determining cost allocations and likely savings from programs; however, there are a number of strategically important factors that were not addressed. Future cost analyses, as well as demand reduction program, would ideally include consideration of these factors. These factors would support programs aiming for deeper energy reductions and include:

i. Additional benefits specific to the program
    1. Social benefits from specific programs (such as Neighborhood Sweeps, Weatherization).
    2. Societal benefits from lower utility costs
    3. Societal benefits from changes in awareness and behavior that contribute to compounded actions and improvements over time
    4. Health benefits from residential programs
    5. Health and productivity benefits from highly efficient commercial spaces

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[25] For industrial facilities – integrative energy-focused workshops can help convince recalcitrant energy managers, and explore collaborative arrangements (often for reuse of waste streams) with other businesses. For the city as a whole - strategic audits and incentives can help reduce energy use, while improving the economics of investment in Boulder industries. RMI research in other communities indicates industrial facilities can reduce energy use by 27% (Reinventing Fire, RMI) at significant profit.

[26] Daylighting, insulation, and thermal storage are good examples – and are often not cost-effective unless considered as a bundle.

6. Increased economic opportunities for businesses and job creators

ii. Risk mitigation shared due to cumulative CAP action
    1. Improved environment (waste, urban forestry, water conservation)
    2. Reduced costs from fuel price volatility
    3. Improved economic growth (reinvestment due to utility savings, lower future capital expenditures on energy-intensive equipment, and positive impressions of Boulder)

With a longer term and more comprehensive approach, many more programs will appear as viable alternatives for emissions reductions. These programs should also utilize a life-cycle costing approach (instead of simple payback) to evaluate and recommend possible measures (whenever appropriate). Boulder's programs, particularly audit to action programs, should focus on assessing and recommending deeper and integrated energy savings[27] in homes and businesses. Training, integrative workshops, and collaborative (multi-resident or multi-business) working groups can facilitate more comprehensive energy efficiency and reuse of waste streams. Numerous case studies (many here in Boulder) have documented the attractive financial returns from highly efficient offices or residences. RMI estimates that comprehensive energy retrofits (addressing multiple systems) leads to easily achievable and cost effective energy savings of 38%[28], with far greater savings available through integrative design. This would address Boulder's largest source of greenhouse gas emissions by inspiring residents and leveraging existing programs.

RMI also supports the transition to distributed renewables, and sees municipalization as one attractive path to that future. Boulder businesses from Serious Energy, Namaste, Tendril, juwi, and many more are already betting on a future of clean, renewable, and distributed energy. Boulder has an opportunity to not only engage citizens, but also develop a sustainable, dependable, model for other municipalities and make Boulder businesses the first innovators in a major distributed energy system. Efficiency projects, particularly more aggressive projects that include controls, peak load management, and thermal storage, will make the prospect of muncipalization a less expensive proposition. Likewise, distributed renewables can support the sort of major building renovations to allow net-zero buildings and major efficiency savings.

To reach climate targets, Boulder must transition a variety of programs, as well as new programs, into a cutting-edge, multi-sector and long-term plan. This will require taxpayer funding – but also offer significant economic and societal savings on that investment. Cities have increasingly begun to address climate change and greenhouse gas emissions, and a significant and integrated climate action framework would make Boulder a global leader.

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27 Deep savings primarily come from integrated design, where a diverse team first assesses needs, reduces loads, right sizes equipment, and maintains a whole-systems approach.

[28] Primary energy use, or energy before it is converted into useful forms (such as heat or electricity). See RMI's book Reinventing Fire for more: http://www.rmi.org/Reinventing_Fire

Appendix A: Similar Programs to Boulder's CAP Programs

Results of the comparative study – comparison of energy and GHG of city-selected Boulder demand-side and supply-side programs to other municipal programs:

Table: Programs Similar to CAP Programs

Program:	Similar Programs
RESIDENTIAL PROGRAM	
EnergySmart	"Connecticut Energy Efficiency Fund, Connecticut Light & Power, United Illuminating Connecticut Efficient Healthy Homes Initiative D.C. District Department of the Environment Free Home Energy Rating Program Commonwealth Edison Home Assessment National Grid Free in-home energy evaluation: EnergyWise"
EnergySmart/SmartRegs	"Focus On Energy (WI) Apartment and Condo Programs and Services Center for Energy and Environment Rental Energy Loan Program "
Neighborhood Sweep Kits	"-Pacific Power Energy Efficiency Education -Gainesville Regional Utilities Home Fix Rebate -Southern California Edison, Southern California Gas Community Language Efficiency Outreach (CLEO) Program"
Energy Assessments (REAP)	"Connecticut Energy Efficiency Fund, Connecticut Light & Power, United Illuminating Connecticut Efficient Healthy Homes Initiative D.C. District Department of the Environment Free Home Energy Rating Program Commonwealth Edison Home Assessment National Grid Free in-home energy evaluation: EnergyWise"
Multifamily Performance Program	"Efficiency Vermont Multifamily Housing Program New York State Energy Research and Development Authority Multifamily Performance Program Energy Trust of Oregon, Northwest Natural Gas, Pacific Power, Portland General Electric Incentives for Small Multifamily Properties"
Weatherization	Efficiency Vermont Affordable Housing Weatherization Services
CU Green Teams & Greek Sustainability	Avista Utilities Power Down, Add Up
Efficient Lighting Coupons	"Arizona Public Service ENERGY STAR(R) Residential Lighting Program Puget Sound ENERGY STAR(R) Residential Lighting Program Pacific Gas & Electric Upstream Lighting Program"
LED Holiday Light Exchange	Nova Scotia Power LED Holiday Light Exchange
Rebates - Insulation	"New York State Energy Research and Development Authority Home Performance with ENERGY STAR(R) NSTAR & Electric Berkshire Gas Company Home Performance with ENERGY STAR(R) MassSAVE Program"
Rebates - Solar Thermal	"Hawaiian Electric Company Honolulu Solar Roofs Initiative Loan Program Iowa Energy Center Alternate Energy Revolving Loan Program (AERLP)"
ReNew Our Schools PTO Fundraiser	
BUSINESS PROGRAM	

EnergySmart	"Energy Trust of Oregon, Northwest Natural Gas, Pacific Power, Portland General Electric Building Tune-Up and Operations Program Center for Energy and Environment (MN) Commissioning/Retrocommissioning BC Hydro Continuous Optimization For Commercial Buildings"
Small-Building Tune-Up Program	"Pacific Gas and Electric East Bay Energy Partnership NYSERDA Technical Assistance Program NSTAR Engineering Services"
ClimateSmart at Work Audits	"Southern California Gas ""Energy Challenger"" Energy Savings Finder Xcel Energy Analysis Connecticut Energy Efficiency Fund, Connecticut Light & Power, United Illuminating Small Business Energy Advantage"
10 for Change	Southern California Edison 20/20 Summer Savings Program"
LED Exit Sign Exchange	MassSAVE, National Grid Existing Facility: Lighting & Controls Puget Sound Energy Commercial rebates - LED Exit Sign Consolidated Edison C&I High Efficiency Equipment Upgrades - Lighting & Lighting Controls
MISCELLANEOUS	
Solar Grants	Vermont Department of Public Service Clean Energy Development Fund: Grants
Solar Rebates	Connecticut Clean Energy Fund CCEF Solar PV Rebate Los Angeles Department of Water & Power Commercial Solar Power Incentive Energy Trust of Oregon Government/Nonprofit Solar Electric Incentives

Connecticut Municipal Electric Energy Cooperative Program Results:
This program serves 14,000 customers.

Program	Lifetime kWh Savings	Program Budget	Lifetime mtCO2e Reduced	$/ mtCO2e avoided
Residential Home Energy Savings Program	54,824,153	$1,666,500.00	38,647.42	**$43.12**
Efficient Products (Lighting)	24,216,731	$250,400.00	17,071.20	**$14.67**
Efficient Products (Appliances)	820,849	$223,600.00	578.64	**$386.42**
Commercial - Prescriptive Equipment Replacement	965,365	$49,600.00	680.52	**$72.89**
Commercial and Industrial Existing Facility Retrofit	48,005,319	$3,154,800.00	33,840.59	**$93.23**
Renewables	782,640	$940,000.00	551.71	**$1,703.79**

Oregon's Results (general reporting across programs):

Oregon Energy Trust's programs report energy efficiency reductions and new renewable energy generation of 3777 MWh and 17.8 million therms (between 2002 and 2010) and six million tons of carbon dioxide. Estimated program costs for 2010 were $123 million. Based on these figures, Oregon Energy Trust's programs estimated $ per tons of carbon reduction (lifecycle) is likely between $40 and $80 $/ton. Oregon Energy Trust serves over 400,000 customers.

Portland General Electric Building Tune-Up and Operations Program shows levelized cost of 4¢ per kWh saved (double their target for the program). A rough estimate of Commercial EnergySmart also yields 4¢ per kWh saved. However, this is not an appropriate comparison to Boulder's programs because typical levelized cost assessments (based on the total resource cost approach) include the cost to the ratepayer, which this analysis did not.

Appendix B: Program Cost Disaggregation Methodology

The team first identified all the billable expenses for each of the nineteen programs. These, along with the total CAP tax revenues, total administrative expenses (not including salaries), total marketing and education expenses, residential and commercial sub-totals, and residential and commercial personnel allocations, served as the inputs to the team's disaggregation of the total CAP tax expenditures.

The components were combined in the following weighted shares:

Expense Component	Allocation Method
Billable Expenses	Directly allocated (already identified by program and recorded yearly)
Total administrative expenses	Allocated at 10% of total billable expenses for that year. (i.e. the ReNew Our Schools PTO Fundraiser had $10,863 in billable expenses in 2011 – making the estimated overhead expenditure for the program $1,086).
Total marketing and education expenses	First the team defined a subset of all programs, which incorporated marketing and education. Then the yearly total education and marketing expenses were allocated to each program at a rate of 20% of expenses for that year (only for programs in the subset).
Residential and commercial personnel allocations	The City of Boulder had already divided expenses between the residential and commercial programs (as well as minor expenses for transportation and special projects). All personnel expenses were strictly divided between residential and commercial. For this analysis, each program's share of billable expenses in the relevant category (residential or commercial) determined the allocation of residential and commercial personnel expenditures. Then City of Boulder staff reviewed the figures and made adjustments based on their understanding – which were directly incorporated into the allocations.
Residential and commercial Remaining Admin	The residential and commercial sub-totals are composed of billable expenses and personnel costs. However – some additional carry-over (the sum being greater than the parts) occurred. This was allocated to programs based on each program's share of billable expenses in the relevant category (residential or commercial).

The formula to determine allocated CAP funding per program is:
Total Cost =Billable Expenses + .1 *{for administrative purposes}* * Program Billable Expenses + (Program Billable Expenses/Total Sector Billable Expenses)*Sector Personnel Costs + .2 * Program billable expenses *{for outreach – only applicable to programs that used outreach funding}* + (Program Billable Expenses/Total Sector Billable Expenses)* Remaining Residential or Commercial Admin Personnel Time.

For the marketing, education, administrative, and personnel expense components – the final figures were reviewed and adjusted by City of Boulder personnel. When comparing program totals (estimates from all assessed CAP programs) to the total CAP tax (for each year 2007-2001), there is a discrepancy. This discrepancy averages $215,000 per year, and can be attributed to general research, admin, and other general organizational expenses. This can be considered a minor source of uncertainty in determining cost-effectiveness, but serves a crucial service in planning, program evaluation, awareness, data collection, and other administrative tasks.

Appendix C: Utility Cost Test for CAP Programs

The Utility Cost Test for Boulder's programs was an abbreviated analysis and only included the life cycle costs of utility expenses (electricity and natural gas). This should not be used as a definitive cost analysis for the future economic impacts of Boulder's climate programs. This report focuses on the greenhouse gas emissions potential of CAP program funding – and not on the economics of efficiencies within each program.

RESIDENTIAL PROGRAM	**kWh**	**TH**	**Cost**	**NPV**	**Benefit/ Cost**
EnergySmart	893891	262948	$204,006.41	$40,562.99	0.20
EnergySmart/ SmartRegs	1322367	386323	$519,895.89	$(159,788.61)	-0.31
Neighborhood Sweep Kits	8509119	138500	$153,276.85	$749,822.32	4.89
Energy Assessments (REAP)	5,201,506	835,104	$413,187	$673,459	1.63
Multifamily Performance Program	2488569	175835	$93,909.06	$269,830.75	2.87
Weatherization	217844	53091	$82,746.56	$(30,687.41)	-0.37
CU Green Teams & Greek Sustainability	453102	0	$33,704.93	$9,076.25	0.27
Efficient Lighting Coupons	2567409	0	$22,611.78	$219,621.42	9.71
LED Holiday Light Exchange	4963518	0	$49,025.25	$353,943.57	7.22
Rebates - Solar Thermal	0	28568	$23,939.51	$17,337.59	0.72
Rebates - Insulation	17954	104764	$133,057.89	$65,836.98	0.49
ReNew Our Schools PTO Fundraiser	1052476	116020	$45,275.35	$192,928.84	4.26
Average	*2,307,313*	*175,096*	*$147,886*	*$200,162*	*$1.35*
BUSINESS PROGRAM					
EnergySmart	9508941	15446	$468,763.44	$360,528.15	0.77
Small-Building Tune-Up Program	718200	130800	$336,081.90	$(169,119.95)	-0.50
ClimateSmart at Work Audits	2680273	-5025	$453,841.26	$(203,522.46)	-0.45
10 for Change	4216779	401935	$207,169.80	$486,559.97	2.35
LED Exit Sign Exchange	279620	0	$3,705.21	$22,662.61	6.12
Average	*3,480,763*	*108,631*	*$293,912*	*$99,422*	*$1.66*
RENEWABLES					
Solar Grants	1,778,450	-	$112,813	$38,898	0.34
Solar Rebates	815,308	-	$100,452	-$30,521	(0.30)
Average	*1,296,879*	-	*$106,633*	*$4,188*	*.002*

The analysis used a discount rate of 3.2% (standard for municipal analyses).
The analysis also incorporated forecasted electricity prices increases according to Xcel and natural gas price increases according to EIA.

The analysis does not include:
-Comprehensive household benefits
-Ratepayer benefits (or ratepayer expenses)
-Societal benefits
-Social benefits

-Future generation costs
-Future supply mix
-Demand curves

The project team did not discount future energy savings (as Boulder's emissions targets are focused around carbon reductions – not the cost implications of energy savings). For the limited UTC analysis, the cost impacts of those energy savings were discounted. ORNL standard for this is 3.2% per year.

A much more thorough analysis could accurately determine the cost impacts of each program on the city, Xcel or a municipal utility, and ratepayers/taxpayers. A comprehensive TRC test (including demand charges and ideally including social and societal costs) as well as life-cycle assessments of Boulder's carbon intensity, economic growth, and emissions external to city limits would more accurately examine programs' effectiveness and provide guidance for future emissions reduction plans. Depending on Boulder's path concerning municipalization, this may become a necessity.

Appendix D: Strategic Recommendations for CAP Program Management

Data management:
The City has done a laudable job of collecting and managing the data from their emissions reductions programs. However – this process could be improved by instituting better knowledge management (storage and labeling of specific reports, data sets, and conclusions) – specifically to file documents under the specific name of the program. Contractors should be subjected to a more stringent set of requirements for data collection and methodology. Similar to the reporting instituted for EnergySmart, each program can be structured to undergo a periodic review to assess program performance, ideally including data gathering and reporting.

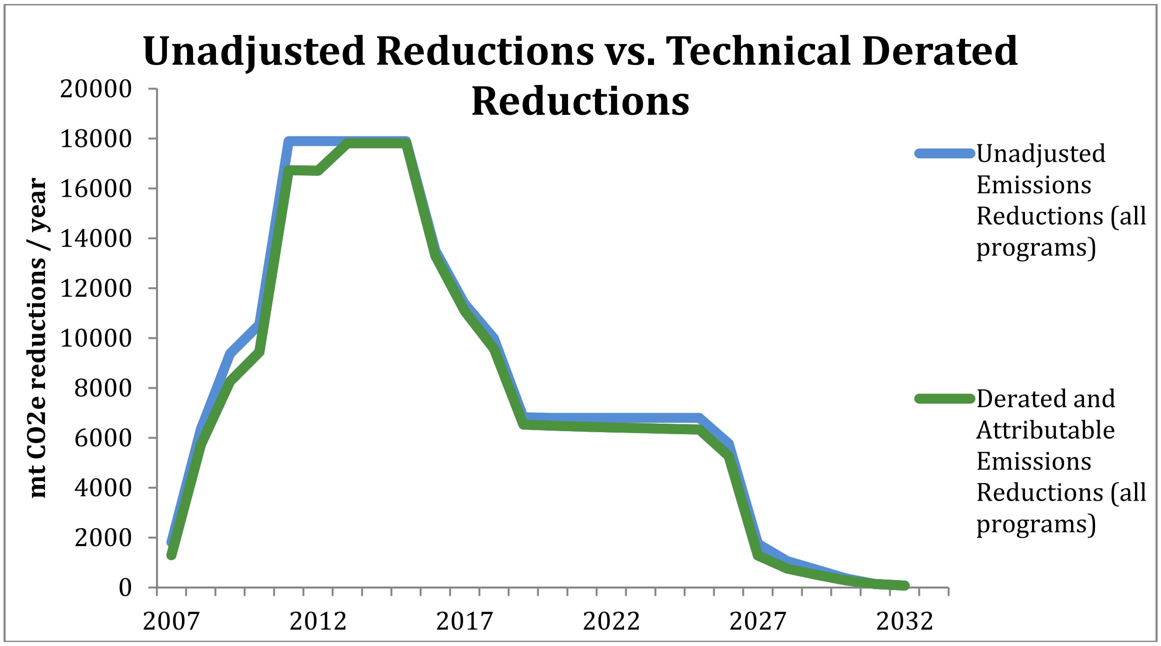
Centralized databases of measures, audits, or rebates applied will help with the calculation of savings. Databases require some investment to manage, but yield results –particularly when more comprehensive programs are in operation.

Improve on cost effectiveness analysis:
Ideally the City would focus data collection for efficiency projects on the identification of energy savings for each program (and element of the program). Building upon the Salesforce system, programs should track the recommendations for each participant, any verified upgrades, and iteratively improve the predictive elements of the programs.

Data collection can do more than help guide program selection and investment. Operationally, the data collected during the programs and at the time of engagement for new program participants can yield significant improvements to the process of turning potential participants into efficiency proponents. Simultaneously, data analysis can help to lower costs and best apply segments of programs to the most appropriate audience. For example, data collected on Neighborhood Sweeps already provides basic conversion rates for neighborhoods – but could also include cross-comparisons with applications to other programs and success indicators for inspiring broader efficiency efforts.

Appendix E: Allocation and Useful Lives by Program

Technical factors (adjustment made to programs due to predicted savings not showing up or not remaining for the full useful life) also negatively impacted the predicted savings. The largest derating due to technical factors was for programs (such as REAP and MPP) that needed to incorporate a participation rate (based on the likelihood of participants pursuing efficiency measures).



Many efficiency programs have documented decreases in energy savings over the life of the program (or persistence). The team adjusted for these either using industry averages (where research was available) or by taking a more conservative approach to the life of the program than equipment manufacturers and industry observers forecast.

RESIDENTIAL PROGRAMS	Useful life of program	Allocation Factor	Average Derating (% decrease)	Notes
EnergySmart	15.5 years	Share of savings based on funding	88%	CAP taxes fund only 12% of the program The useful life of the program was derated by 6% to account for persistence of savings
EnergySmart/ SmartRegs	15.5 years	Share of savings based on funding	80%	CAP taxes fund 20% of the program
Neighborhood Sweep Kits	~9.5 years	NA		
Energy Assessments (REAP)	10 years	Neutral	50% 10%	-Based on participation rates (benchmarked from EnergySmart) -Based on 10% overhead costs for Xcel (standard in cost attribution approach). *The useful life of the*

				program was derated by 8% to account for persistence of savings.
Multifamily Performance Program	9.2 years	Customer Behavior	61%	Data from Ingrid Rohmund and Greg Winkler (Assessment of Achievable Potential)
Weatherization	20 years	Persistence of savings	14%	Data from ORNL (Non-energy Benefits from Weatherization)
CU Green Teams & Greek Sustainability	9.126 years			
Efficient Lighting Coupons	9.126 years	Share of savings based on rebate value	70%	Based on the prices of bulbs purchased and average rebate value
LED Holiday Light Exchange	25 years	NA		
Rebates – Solar Thermal	20 years	-Share of total funding -Share of savings based on rebate value -Persistence	50% 75% 8%	-GEO funded half of the project costs. -The rebates were a small share of total solar thermal system prices -Solar thermal systems typically degrade over time
Rebates - Insulation	20 years	-Share of total funding -Share of savings based on rebate value -Persistence	52% 71% 5%	-GEO funded more than half of the program. -The rebates were a small share of total insulation expenditure -Data on persistence from ACEEE
ReNew Our Schools PTO Fundraiser	5 years	Participation	20%	Some portion of listed participants may not take action – 20% was the estimate
BUSINESS PROGRAMS				
EnergySmart	16 years	-Account for the 'Optimize' Program -Double counting -Share of savings based on funding	+1% 5% 85%	-The 'Optimize' program was not accounted for and corresponded to ~1% of all projects -Some double counting occurred with 10forChange -Federal funding (85%) -EnergySmart derated 10% for persistence
Small-Building Tune-Up Program	6 years	Neutral		The useful life of the program was derated to account for persistence of savings
ClimateSmart at Work Audits	9 years	Neutral	85%	- To account for the total percentage of Xcel's audit costs paid for by Boulder (estimated by Xcel) *10% useful life derating for persistence*

10 for Change	8 years	-Free ridership -Efficiency programs reported in survey	- 90% - +20% kWh and +15% natural gas	-Based on survey results, 10 for Change only initiated a small portion of commercial partners' efficiency projects. -Reported efficiency projects saved more than the average of reported utility bills
LED Exit Sign Exchange	10 years	NA		Life provided by City – could be higher
RENEWABLE				
Solar Grants	20 years	-Dirt/Snow -Panel degradation -Attributable savings -Share of savings based on funding	-5% -13% -20% -76%	-PV Watts can underestimate Dirt/Snow/Inverter/Wiring losses -Panels steadily degrade in performance -Based on size of grant vs. average PV prices -Based on total grant funding (external to CAP) vs. CAP expenses
Solar Rebates		-Dirt/Snow -Panel degradation -Attributable savings -Share of savings based on funding	-5% -13% -99% -33%	-PV Watts can underestimate Dirt/Snow/Inverter/Wiring losses -Panels steadily degrade in performance -Based on size of rebate vs. average PV prices -Based on total grant funding (external to CAP) vs. CAP expenses

The derating approach is a high-level assumption for all programs that does not quantify the granular investments, personnel time, outreach, and elbow grease that make these efficiency programs work. In general, the City of Boulder has contributed far more than the simple calculation of percent share of total funding indicates. However, to keep programs treated the same, cost attribution was kept standard between all jointly funded programs.

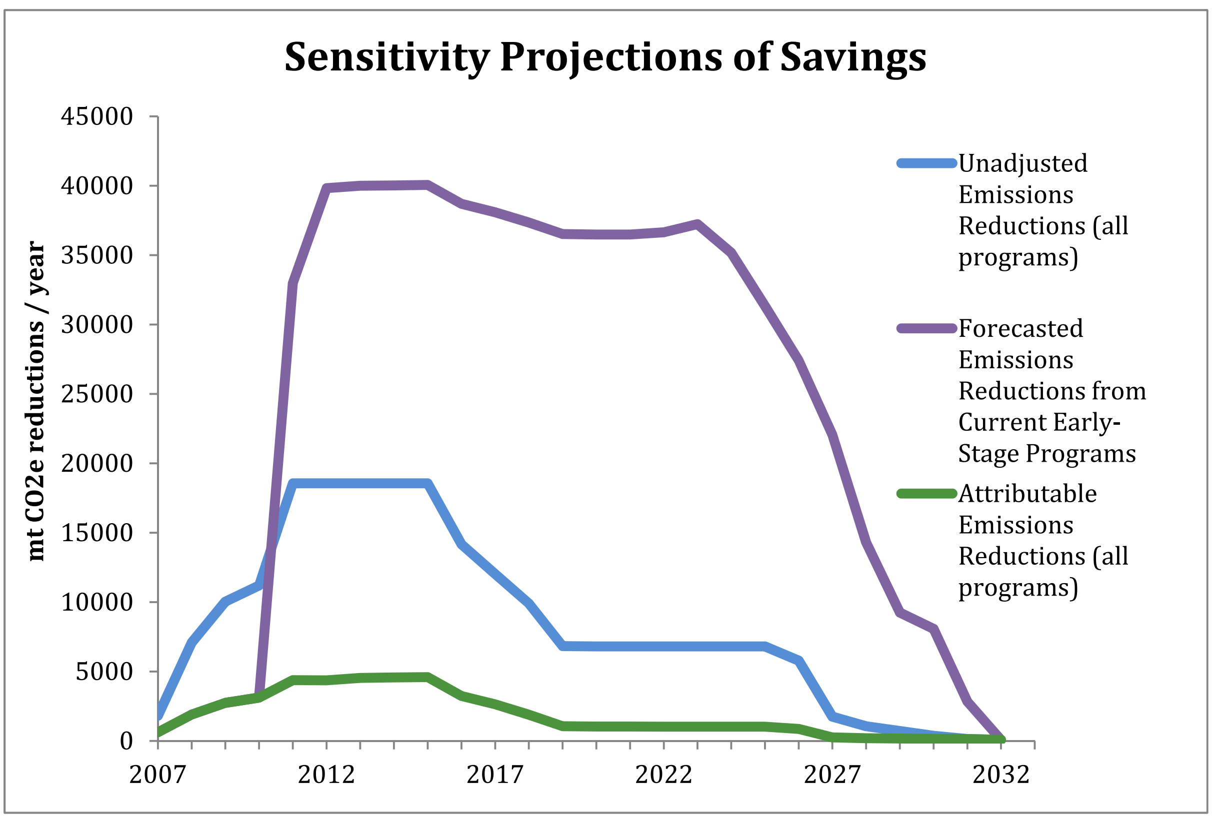
Appendix F: Sensitivity Analysis for Certain Programs

The Sensitivity analysis was conducted for the following programs:

1. Residential EnergySmart
2. SmartRegs
3. Commercial EnergySmart

SmartRegs and Residential and Commercial EnergySmart were examined with five additional years of savings (savings in future years projected to increase to 110%, 120%, 130%, 140%, and 140% of 2011 savings). These projections are conservative in light of the City's goals for project expansion. This resulted in a six-year duration (years in which the program operates) for each of the three programs.

a. The sensitivity also allocated 100% of the savings to Boulder (due to projections of Boulder primarily funding the program in future years).
b. The sensitivity increased the average useful life to 17 years (from 15.5 years) – which was the original estimate based on installed equipment. That estimate was downgraded to estimate the impact of the persistence of savings. With EnergySmart continuing as a comprehensive program – more advanced and durable equipment (beyond lighting) will be installed, thereby increasing the useful life of the program.
c. Costs in future years were estimated based on current costs and expected learning curves (RMI internal estimates included below). Costs of the longer, larger, and fully funded Boulder program were 15 times higher than current program data.



Appendix G: Program Specific Notes

REAP
- City values did not take savings credit for the program, because implementation was not tracked.
- Revised value shows electric and gas savings for 2009 (based on the proportional shares of the kWh and therm savings in the REAP 2009 report).
- Revised value gives credit for 269 homes

Updates
- Set weighted-average measure life to be 10 years since comprised of behavior, lighting, HVAC and envelope improvements.
- Set all derating factors to 1
- Used savings calculations for action program and audits from the 2008 and 2009 REAP reports.
- 2009: 269 action consultations = 629 mtC02e and 560 audits
- 2008: 433 audits in Boulder
- No other savings data available – may be understating.
- Action program included 269 participants (assume these are a subset of the 465 audits). Could apply an overall program implementation factor of 269/465 = 0.58 or 58%. However, not all participants in the action program took action.
- Separate estimate found 56.25% (based on action results from EnergySmart). This factor was selected to account for some action participants not taking action. It is an encouraging sign that both estimates were extremely close. Downgraded to .5 to adjst for non participation from action program participants.
- A cost derating factor was inputted = .8 (based on 10% - using Boulder's overhead calculations) to estimate Xcel's impact on overhead.

Renew Our Schools PTO Fundraiser
- Savings taken in City Program spreadsheet equals 54,327 kWh
- Difficult to make the connection between the data presented on the PTO Spreadsheet and this value.

Updates
- Per the PTO spreadsheet, it appears that the total possible savings for all check list items are 1851 kWh (note possible use of mixed energy units in spreadsheet). Using the reported average household electric use of 7620 kWh, this represents an opportunity for ~ 25% energy use reduction.
- Assumption: Completing the checklist would have an impact of reducing electric and gas use by 3% each. This was not verified. Based on 1151 households participating, this totals 263,119 kWh and 29,005 therms of savings. This is significantly more savings than the 54,327 kWh originally reported.

Small Building Tune-Up Program
- City reported savings per program report, which total 119,700 kWh and 21,800 therms for the 15 pilot program projects

Updates
- Weighted average measure life assumed to be 5 years for tune-up program. Could be as high as 7.
- Savings are based on pilot program results. To evaluate program cost-effectiveness moving forward, the costs should be adjusted. Pilot program costs include one-time costs for program research and design. Per the program report Table 14, page 33, estimated costs for

the full scale program with 72 projects are $200,000. Total full scale savings (based on 10,060 kWh and 1834 therms per project) are 724,320 kWh and 132,048 therms.

ClimateSmart at Work Audit

- City is takings savings credit for audits (verified) resulting in implemented recommendations from the ClimateSmart at work program offered in 2007 – 2009. No savings credit is being taken for the PACE Program offered in 2007 – 2008.
- ClimateSmart at Work Program was reformulated as the Small Building Tune Up Program in 2010.

Updates

- Set weighted average measure life to be 10 years for program based on mix of ECMs listed in program spreadsheet.
- No de-rating factors applied. Savings values already account for difference between identified savings and actual savings based on measures implemented.
- Could change RMI savings spreadsheet so that measures die out after 10 years and get credit for a few more years of the 2008 and 2009 program benefits.
- Modifications could be made for PACE accounting (e.g. apply same % actual based on savings identified) but none were because the PACE contribution is small and program will not continue in this form anyway.

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