Carbon Taxes: A Case Study

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With sea levels rising, ice caps melting, native animal species becoming endangered while invasive species are thriving – all as a result of global warming – scientists and policy makers alike are attempting to find a way to stop the release of greenhouse gases (GHGs) into the atmosphere (8). One measure that legislators have begun to use is that of a carbon tax. In particular, the City of Boulder in the State of Colorado was the first city in the United States to implement a carbon tax (9). First, this paper will demonstrate the need for climate regulation policies, then discuss the theory of carbon taxes, and finally look at the case of Boulder specifically and analyze whether the carbon tax was effective there.

A Need for Climate Regulation

Scientists around the world have almost unanimously agreed that the Earth's climate is changing and humans are a major cause. According to NASA, "Multiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities" (8).

Humans are responsible for the greenhouse effect. This effect occurs when gases – such as carbon dioxide, methane, water vapor, and nitrous oxide – trap and retain heat that is emitted from the Sun rather than allowing it to bounce back into space (2). These gases,

commonly referred to as greenhouse gases or GHGs, keep the warmth on Earth thus causing the temperature of the planet to rise (2). Since the Industrial Revolution began in 1750, humans have increased the release of greenhouse gases exponentially; from the 1500s to the 2000s, the concentration of methane in the atmosphere has increased from approximately seven hundred parts per billion (ppb) to two thousand ppb and the concentration of carbon dioxide has also increased from approximately 280 parts per million (ppm) to four hundred ppm (2). However, before 1750, the levels of methane and carbon dioxide were stable with methane fluctuating from about six hundred to seven hundred ppm and carbon dioxide hovering in a range from 270 to 280 ppm (2). This means that the levels of methane of and carbon dioxide increased by a factor of approximately 2.86 and 1.43, respectively, in only 250 years.

This quick and drastic increase of GHGs is mostly due to the burning of fossil fuels. The use of fossil fuels as a power source began during the Industrial Revolution and has continued on today. Burning these fuels releases some of the main gases contributing to the greenhouse effect and climate change: carbon dioxide, methane, nitrous oxide, and various others (2). In 2014, of the total GHGs emitted in the United States eighty-one percent of them were carbon dioxide, eleven percent were methane, six percent were nitrous oxide, and the other three percent were fluorinated gases – gases like hydrofluorocarbons that are released by industrial processes (7).

Climate change has numerous effects that harm individuals physically and economically. These effects include: hotter temperatures, variations to the location and amount of

precipitation, increased amount of extreme weather events, decreased availability of water, destruction of ecosystems, and higher sea levels (4). All of these events negatively impact economies whether it is due to the destructive force of a tornado, the forced migration of peoples from now unlivable areas, or the physical harm that puts people out of work and in need of expensive medical care.

It is clear that carbon dioxide is a greenhouse gas that is contributing to the greenhouse effect and, therefore, climate change. The emissions of carbon have increased drastically in recent years as a result of increased human use of fossil fuels. Carbon-induced climate change is hurting the global population physically and economically. Currently, it is the responsibility of the individuals who are injured to pay for the damage climate change is wreaking on their lives. However, many government officials and economists would like to shift the cost burden from those effected to those who are actively advancing climate change – in other words, those who are using fossil fuels and releasing carbon dioxide into the atmosphere. This has led to the creation of new economic policies, such as carbon taxes.

What is a Carbon Tax?

A carbon tax is one of the systems that attempts to correct the misallocation of the costs for emitting carbon dioxide. It forces those who create pollution to pay for its damaging effects through a fee per metric ton of carbon dioxide released (12). The tax can be collected either upstream or downstream. This means that either the producers of greenhouse gas emitting fuel can be taxed when they produce the fuel or the consumers can be charged when

they purchase the fuel (12). Depending on the severity of the tax, a carbon tax can not only fix the market so that the creators of the economic and environmental damage are the ones who pay for it, but also encourage less production and/or consumption of the harmful fossil fuels. If the tax is implemented using a downstream approach, the increased price from the tax of gas or coal, for example, could cause consumers to switch from environmentally harmful to greener and cheaper energy sources, such as wind or solar. If the tax is instead placed on producers using an upstream approach, the increased production costs could cause energy firms to focus on manufacturing more environmentally friendly forms of energy which do not incur the carbon tax and have higher profit margins.

Case: Boulder, CO

Why Boulder Chose a Carbon Tax

Boulder is a city located at the base of the Rocky Mountains' foothills with an approximate population of 100,000 people; it is also home to the University of Colorado Boulder Campus and numerous federal laboratories (1). This city became the first in the United States to implement a carbon tax on April 1, 2007 (9).

The journey to this tax began back in 2002 in response to the Kyoto Protocol. Resolution 906, also known as the Kyoto Resolution, was passed by the city's council in May 2002 (11). Reducing Boulder's emissions to a level that is seven percent below the emissions level in 1990 by the year 2012 was the goal set by this resolution (11). Then began the city's search for ways to reach this target. The City of Boulder's Office of Environmental Affairs (OEA)

and the local volunteer working group Boulder Renewable Energy and Energy Efficiency (BREEE) investigated different options for reaching the emissions goal and possible sources of funding for programs to help reach this goal (1). In 2004, an outside company, Econergy, was hired to determine what type of reductions were necessary to meet the goal and to create a comprehensive greenhouse gas inventory system that used available data to record emissions from the past through 1990 and to track annual emissions by the city (1). At the time it was created, data were available for the years before and including 2003, therefore the past data were used to forecast emissions through 2012 (11). This GHG Inventory considered only methane and carbon dioxide emissions since the city believed these gases made up the majority of their emissions (11). In addition, the inventory only took into consideration those sources of emissions that were significant or that could be changed by government actions (11). The figures below are taken from the City of Boulder's Climate Action Plan; they show the quantity of emissions in metric tons of carbon dioxide equivalents (mtCO2) from 1990 to 2012 given off first by source then by sector.

Figure -1: Boulder's Forecast Inventory

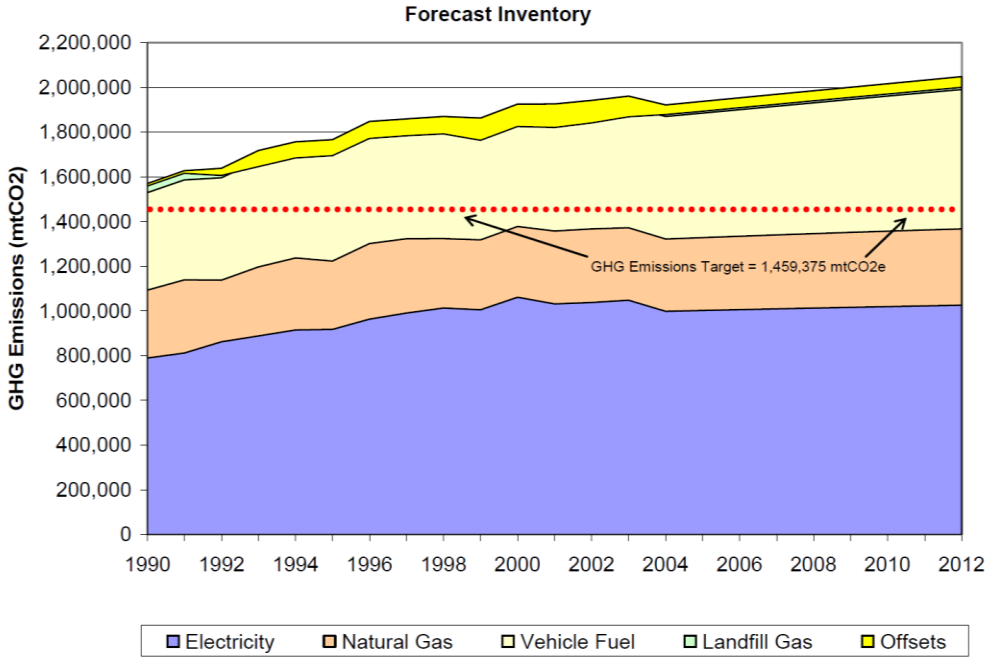
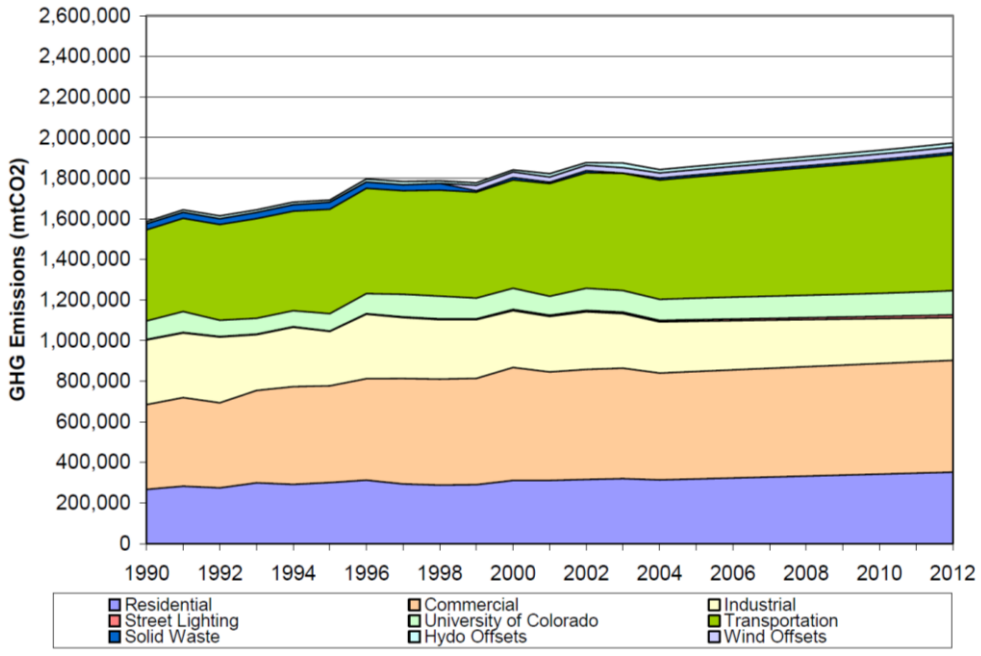


Figure-2: Boulder GHG Inventory Profile, 1990 – 2012



It is clear from this chart that the main source of emissions is electricity usage and the main sectors responsible for releasing emissions are Commercial and Transportation.

With this inventory information, the city began developing program options to reduce emissions and search for funding for those programs. The focus was on three main goals: increase energy efficiency, switch to renewable energy sources, and reduce vehicle miles traveled (11). Numerous projects were to achieve these goals, from expanding the city's preexisting program of distributing compact fluorescent light bulbs to residents at no cost to improving and enlarging city bike pathways and walkways, but all of this came at a cost (11).

The proposed budget for the new programs necessary to achieve the emissions reduction goal started from $860,265 in 2007 to $1,074,873 in 2012 (11). Therefore, a funding source was necessary to finance this venture. The City Council narrowed down its options to either a fee or a tax on carbon (1). They decided on the carbon tax because not only was this revenue source closely tied to the goal of its use, but also taxes needed voter approval, and the council wanted to make sure this proposal had public support (1). This tax, called the Climate Action Tax (CAP), would be collected through the city's utility company, Xcel Energy (3). Each customer's energy bill would add in any tax owed, be collected by Xcel Energy, and then given to the city (3).

Specifics of the Climate Action Tax

The details of CAP now needed to be decided on. Planners took the following into account when crafting the tax: lower income residents would be hit hardest and probably have

the least ability to change their energy consumption; economic growth and production correlates with higher energy use which they did not want to punish; those utilizing renewable energy should not be charged for the portion of energy they use from that source; and some industrial users' corporations have emissions goals of their own (1). In addition, the City Council wanted the reductions and private and public investment distributed to the residential, commercial, and industrial sectors in the following way:

	Residential	Commercial	Industrial
Percent of Total Emissions (2005)*	27	53	19
Percent of Total Reductions	31	41	22
Percent of Total Private Investment	19	76	5
Percent of Total Public Investment	58	39	3

*Other contributing sectors include transportation and solid waste. These emissions were distributed equally among the residential, commercial and industrial sectors.

As a result, the city chose to use a city funding allocation model or a revenue recycling model (1). This model is structured so that taxpayers receive an amount of city funds, through programs and services, that is equivalent to the amount they had paid through the tax (1). Therefore, industries do not lose their incentive to produce and stimulate the economy. Also, the programs the city created addressed the other issues they had been concerned with, such as the impact to low income residents and excluding the taxing of renewable energy sources.

Finally, the CAP's rate needed to be set. Since the Council had previously determined their budget, they simply set the rate such that they would have the correct amount of funds utilizing forecasted energy usage (1). Initially, the rate was set at $.0022 per kilowatt hour (kwh) for residential customers, $.0004 per kwh for commercial customers, and $.0002 per kwh for industrial customers (3). The Council did allow for this rate to be increased to $.0049 per

kwh for residential customers, $.0009 per kwh for commercial customers, and $.0003 per kwh for industrial customers (3).

The Climate Action Tax was put to a vote on November 7, 2006 and passed with sixty percent of voters in favor of it (1). The tax has been raised to its maximum level since 2009 (3). This has resulted in an average annual tax payment of $21 for residential customers, $94 for commercial customers, and $96,000 for industrial customers (3).

Results

In 2012, when a renewal of the carbon tax was put to a vote, the City of Boulder hired the Rocky Mountain Institute to evaluate the effectiveness of the nineteen programs funded by CAP (10). The report issued by the Institute found that Boulder had not come close to hitting the emissions goal they set in 2006 (10). Instead, they had only achieved 42.6% of intended reductions in carbon emissions and only 11.2% of the reductions in energy use for the commercial and residential sectors (10).

The tax did its job in that the correct amount of funds were received from taxpayers to finance the original plan the city came up with; however, not all of the programs were as effective in the first five years as planners had thought and the goal was ambitious to begin with. Since not all of these programs were financed wholly by the Climate Action Plan Tax, but used other sources like federal grants or private donations, the Institute had to use a modified approach to calculate exactly how effective the tax itself was (10). Using a modified Utility Cost Test (UCT), the Rocky Mountain Institute determined the cost effectiveness of each of the

nineteen programs the city had in place by disaggregating the amount that was funded by the CAP tax and derating the savings over the lifetime of the program (10). The results showed the most cost effective program were the Lighting Coupons with a cost of $3.25 per metric ton of greenhouse gases reduced and the least cost effective program was the Small Building Tune-Up Program with a cost of $280 per metric ton of greenhouse gases reduced (10). An analysis of the effectiveness of residential and commercial programs can be seen below in the charts taken from the Rocky Mountain Institute's report.

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

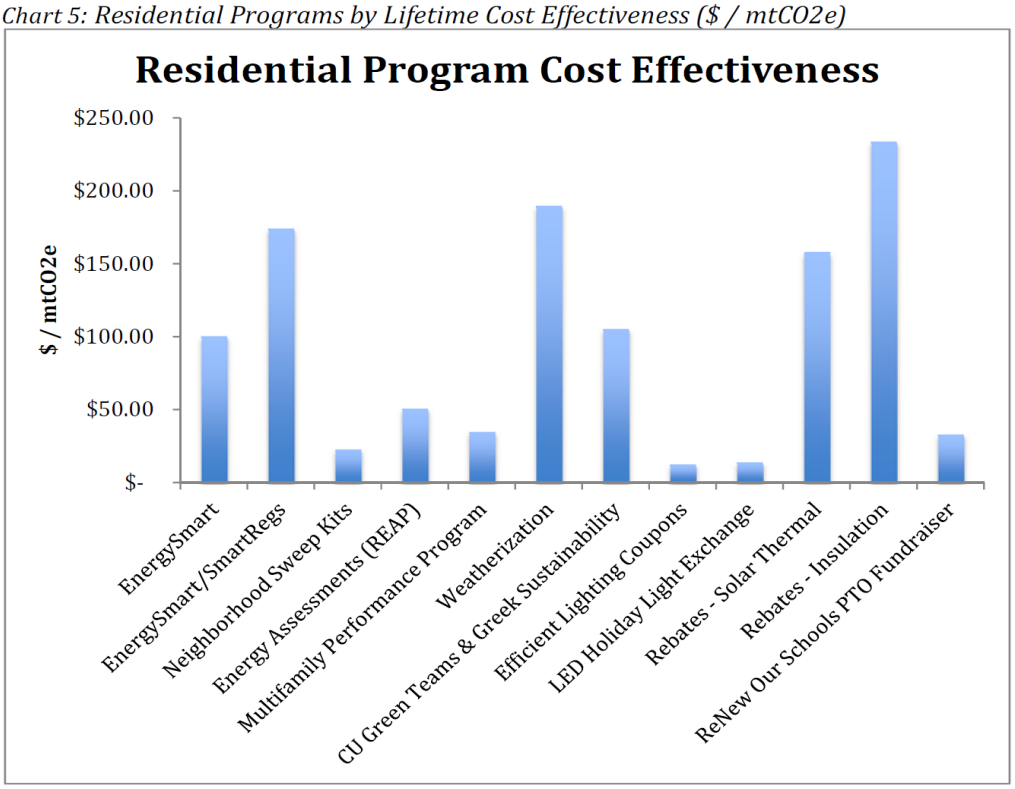
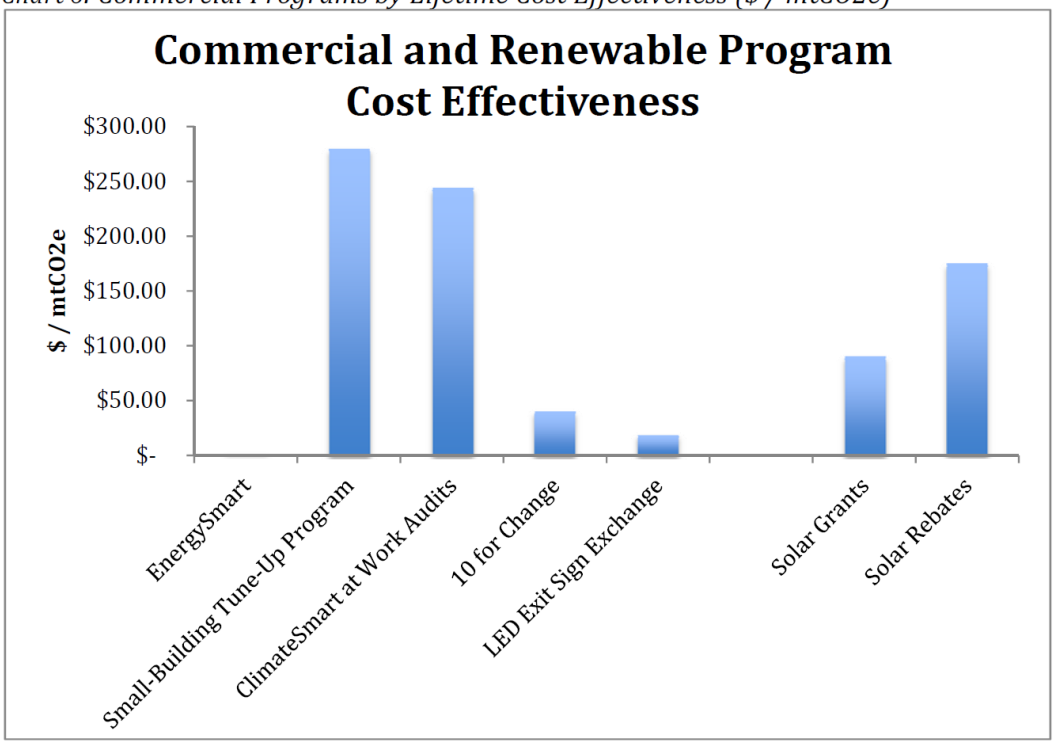


Chart 6: Commercial Programs by Lifetime Cost Effectiveness ($ / mtCO2e)



Overall, the Rocky Mountain Institute found that "Boulder has attained impressive energy savings and emission reductions, and is well positioned to achieve future emissions reduction targets" (10). However, the Institute's projections showed that Boulder will still have not hit their initial Kyoto emissions' reduction goal by the year 2035, if they continue to only use the programs they had in place at the time (10). The recommendation by the group in order to speed up the reduction timeline was to begin creating more complex and interrelated programs to lower emissions even further; an example of this would be to not only have a program that provides energy efficient lightbulbs, but to also show individuals how to take advantage of shade and daylight to lower the usage of both lighting and cooling systems (10). In addition, the Rocky Mountain Institute strongly believed that municipalizing the energy source

would give residents a stake in energy efficiency and, therefore, cause everyone to be much more involved and supportive of green efforts in this area (10). Lastly, many of the programs in use had room for improvements; the Institute believed that the city should take advantage of learning curves and experience to increase the efficiency and results from these programs (10).

Critics of the tax were not happy with how the money was spent. Only forty-one percent of the tax revenues made it back to taxpayers in the form of audits, rebates, or services (6). Meanwhile, thirty-two percent was spent on paying personnel, twelve percent was used for education and marketing efforts, five percent went to overhead costs, three percent covered the costs of transportation, and the remaining seven percent is unspent (6). Looking at this breakdown, many taxpayers felt as if the money was not being used for its intended purpose (6). However, this is too simple an evaluation to criticize the program.

Both the Rocky Mountain Institute's report and the analysis by the critics fall short of an overall cost benefit analysis of the tax for the community. The Institute stated in its report that it did not take into consideration the following: comprehensive household benefits, ratepayer benefits or expenses, societal benefits, social benefits, future generation costs, future supply mix, or demand curves (10). While the critics did not look at these considerations either, nor did they take into account the possible benefits from the tax money being spent on personnel, education/marketing, overhead, or transportation. To calculate the true value of this tax, one would need to quantify the intangible costs and benefits to the community.

Indirect costs and benefits of the tax are more difficult to calculate than the direct ones. Some of the neglected benefits of the tax include: cleaner air and water, decreased occurrence

of extreme weather events caused by global warming, long-term cost savings by individuals and businesses when they adopted higher efficient products, energy independence from the tumultuous oil market, increased availability of public transportation, increased health and social interactions from the creation of bike and walking pathways, and improvement of community relations and involvement through the new programs. If one were to attempt to quantify these benefits, he or she could possibly distribute a survey to the community asking individuals to rank or determine the value of these various benefits against the tax costs. Then the survey makers could see whether or not the citizens prefer the outcome of the tax more or less than the cost of the tax. Another way would be for him or her to look at the avoided costs of these benefits (5). For example, to quantify the value of clean air, an individual could total up the cost of hospitalization from the effects of bad air quality. A combination of these techniques could also be used.

Some indirect costs were also not taken into consideration, such as: loss of jobs or businesses involved in the creation of non-eco-friendly energy sources or inefficient products due to decreased demand, inefficiencies in the collection or use of the tax, and free-rider usage of tax-funded programs. For an individual to look at these costs, a variety of approaches would need to be used. To determine the unemployment and failed business increases, one would need to find the exact number of businesses that failed and people that lost their jobs as a result of the tax and determine their economic effects, such as heavier use of welfare systems or reduction in economic growth. How the costs of inefficiencies in either how the tax is collected or distributed would depend on what resources were used inefficiently. For example,

if workers' time was used inefficiently, one could total up the amount of wages paid to worker during the inefficient time period. For free-rider costs, one would have to determine how many people use tax-funded programs but do not pay the tax and then discover how much this burden is costing the city of Boulder and its taxpayers. It is important to note that discovering what job or businesses losses were directly attributable to the tax, what inefficiencies were incurred, and how many free-riders there are is not necessarily a feasible task.

Conclusion

Scientific research clearly shows legislation is needed to curb the spread of global warming. A fair way to do this is to shift the cost burden from those affected by global warming, to those who use the fuels and materials that contribute to global warming, through a carbon tax. Boulder, Colorado has had a carbon tax for ten years and has voted to continue this tax through the year 2020. A review of their program shows that the tax collected the correct amount of funds, but that the programs they were used on could become more efficient through learning curves and possible restructuring. In addition, a thorough economic cost-benefit analysis would need to be undertaken to prove whether or not the carbon tax was truly beneficial to the community; numerous indirect costs and benefits were neglected from the studies conducted for the program. It is possible surveys or cost-avoidance strategies could be used to calculate the value of benefits while in-depth cost analysis of the indirect effects of the tax would need to be conducted.

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