

Discussion Draft

Assessment of the Gunnison Community's 2020 CO₂ Emissions Targets

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Abstract

This discussion draft provides an assessment of the likelihood the Gunnison Community will be able to reduce carbon dioxide (CO₂) emissions 20% below its 2005 emissions by 2020. This report uses two methodologies to assess the likelihood that 2020 CO₂ emissions targets can be met; a top-down analysis that uses the Kaya Identity to compare historic rates of energy use and carbon emissions with the rates required to achieve the target, and a bottom-up analysis that models energy use and CO₂ emissions through 2020 and that presents examples that may help policy makers better understand the nature and degree of changes required to achieve targets. Based on the analysis provided, this report concludes that it is highly unlikely the Gunnison Community's 2020 CO₂ emissions target will be met.

Part of the purpose of this discussion draft is to fix mistakes and hear suggestions. Comments are always welcome at rhudson@western.edu.

The work on this report began last March in a quantitative analysis course at Western State College. We eventually stumbled into the quicksand of missing data and could not complete the analysis by the end of the term. Thank You to the students in BUAD 485 for their hard work and insight on this analysis. Special thanks to Tyler Rasmussen and Hilary Boscovick for their work on agriculture and elk emissions respectively, to Isaac Phillips for his work modeling transportation, to Aaron Warehime and Reid Edwards for their work on EI and CI, and to Brett Henderson for being a persistent data hound.

Introduction

In 2006 and 2007 the Councils of the City of Gunnison and the Town of Mount Crested Butte signed the US Conference of Mayors Climate Protection Agreement pledging to cut greenhouse gas (GHG) emissions to the level set by the [Kyoto Protocol](#); a 2012 target for emissions at 7% below 1990 emissions. Similar action was taken by 15 other Colorado cities, including Denver, Westminster, Boulder, Dillon, Aspen, Telluride, Durango and Pagosa Springs. There are over 1,000 US mayors on the [Conference of Mayors List](#) today. In September 2007 the Gunnison County Commissioners and the councils of Crested Butte, Mount Crested Butte, and Gunnison, agreed to work collaboratively to meet the Kyoto Treaty goal and to establish goals for future GHG reductions. This was followed by the creation of volunteer groups that developed a [GHG Baseline Inventory](#) and Energy Action Plans for the Upper Gunnison River Watershed (UGRW). Many communities developing a response to energy and climate concerns developed “Energy Action Plans” (EAPs), with most adoptions appearing about the same time local EAPs were adopted. The EAPs often set a target of reducing CO₂ emissions in 2020 to level 20% below emissions in 2005, or the 20% by 2020 target. The UGRW, or Gunnison Community as used here, and for which the EAPs were prepared, consists essentially of Gunnison County with the exception of the small, geographically separate town of Marble. The cities of Gunnison and Mount Crested Butte eventually adopted Energy Action Plans that set GHG emission targets for 2020 at 20% below CO₂ emissions in 2005. Gunnison County government considered the EAP prepared for it but opted to pursue a different approach. In August 2009 a plan that focused on reducing the CO₂ emissions resulting from county government activities was adopted [\[County EAP\]](#) and the County appears to be exploring [policy alternatives](#) that further indicate a commitment to emissions reductions.

The Gunnison Community is a particularly good community to test whether the 20% by 2020 target is likely to be met, regardless of whether all of the controlling legal authorities have adopted the target or not. Adoption of the 20% by 2020 target is through a patchwork of cities, counties, regions and states, and in many cases it will be impossible to accurately sort out energy consumption and CO₂ emissions within political boundaries anyway. The Gunnison Community appears more committed to climate action than most of its neighboring communities, so its progress toward achieving the 20% by 2020 target ought to be further along than in less committed communities. The Gunnison Community is geographically isolated and cold, driving transportation and heating costs higher but the isolation also making it easier to track energy consumption and CO₂ emissions in the community. It would be impossible to test the 20% by 2020 targets set by any of the towns or cities in the Gunnison Community because energy consumption and CO₂ emissions are hopelessly muddled together through transportation. But the Gunnison Community inclusive is a particularly interesting candidate

for testing whether the 20% by 2020 target is achievable, so this analysis will treat the 20% by 2020 target as the de facto emissions target for the community.

Assessment Methodologies

This paper uses two methodologies to assess the likelihood that CO₂ emissions in the Gunnison community can be reduced to a level 20% below 2005 emissions by 2020; a top-down analysis that uses the [Kaya Identity](#) to compare historic rates of energy use and carbon emissions with the rates required to achieve the target, and a bottom-up analysis that models energy use and CO₂ emissions through 2020 and that presents examples that may help policy makers better understand the nature and degree of changes required to achieve targets.

The first method to be discussed was developed by Pielke ([2009a](#) and [2009b](#)) to evaluate the United Kingdom’s Climate Change Act and the Japanese “Mamizu” climate policy. The Kaya Identity is a simple formula that is used to determine CO₂ emissions from the use of energy. Two forces drive the Kaya Identity; economic growth represented by gross domestic product (GDP) and changes in technology represented by CO₂ emissions per unit of GDP. Each of these two factors can be broken down into two subcomponents. GDP is determined by changes in population and in per capita GDP. Carbon dioxide emissions per unit of GDP are determined by multiplying Energy Intensity (EI), which is the amount of energy per unit of GDP, and Carbon Intensity (CI), which is the amount of CO₂ per unit of energy. The Kaya Identity is shown as an equation below:

$$CO_2 \text{ Emissions} = Population * Per \text{ Capita } GDP * Energy \text{ Intensity } (EI) * Carbon \text{ Intensity } (CI)$$

$$Population = Total \text{ Population},$$

$$GDP / Population = Per \text{ Capita } GDP$$

$$Energy \text{ Intensity } (EI) = Total \text{ Energy Consumption} / GDP = TE / GDP$$

$$Carbon \text{ Intensity } (CI) = CO_2 \text{ Emission} / Total \text{ Energy Consumption} = CO_2 / TE$$

$$Carbon \text{ Dioxide Emissions} = CO_2 = P * \frac{GDP}{P} * \frac{TE}{GDP} * \frac{CO_2}{TE}$$

CO ₂ Emissions	=	Economic Growth	*	Technological Change
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The Kaya Identity shows in simple form that CO₂ emissions and carbon accumulations in the atmosphere can only be moderated by reducing (a) population, (b) per capita GDP, (c) energy

intensity (conservation), or (d) the carbon intensity of our energy mix. It seems unlikely that countries or communities would publicly admit to the adoption of CO₂ emissions policies based on reducing population, although countries that limit or discourage population growth might find that aggressive CO₂ emissions targets easier to achieve as a result. In the Gunnison Community a reduction in population growth might take the form of policies or attitudes to discourage new comers and tourists, with tourists counting as short term residents in terms of energy consumption and CO₂ emissions. Emission policies based on shrinking per capita GDP would seem equally unattractive but may be politically acceptable to some in the Gunnison Community based on a history that includes efforts to stop projects likely to have spurred growth. Most national CO₂ reduction strategies will focus on reducing the amount of energy used per dollar of GDP (Energy Intensity) or by reducing the CO₂ content of the energy consumed (Carbon Intensity). Examples of the latter, Carbon Intensity (CI), include substituting less carbon intensive forms of energy, such as wind, solar, hydro and geothermal for more carbon intensive sources of energy, such as fossil fuels, bio fuels and biomass. Examples of the former, Energy Intensity (EI) or conservation, can be achieved under two strategies; performing energy consuming activities more efficiently (e.g.; a more fuel efficient auto) or reducing the number or amount of energy consuming activities (e.g.; driving fewer miles per year).

Examples of Energy Intensity and Carbon Intensity

A few examples of EI and CI may help readers appreciate the relative importance of these two CO₂ drivers. In Exhibit 1 below, [energy Intensity](#) is shown for the U.S. and Canada (two advanced North American economies), the United Kingdom and France (two advanced European economies that are committed to deep CO₂ emission reductions), and Brazil and India (two developing countries with millions of citizens who have insufficient energy). The USA is frequently portrayed as an energy hog and it is true that China has only recently surpassed the U.S as the world's largest energy consumer and CO₂ producer. Yet Canada uses substantially more energy per unit of GDP than the U.S. and Canada's smaller negative value for EI growth rate (shown as a percent rate in the legend for each country) indicates that Canada has been less successful at achieving conservation efficiencies than the U.S. It is worth bearing in mind that geography, population size and density, economic condition, natural endowments and history each plays an important role in a nation's energy intensity.

European countries have lower EI measures but the rate at which the UK is reducing energy intensity only barely exceeds that of the US and France's rate of EI reduction significantly lags that of the other developed nations shown. Both the UK and France have a more moderate climate with lower heating and cooling demands, and both countries have suffered a loss in manufacturing. Size and population density are also important, allowing the UK and France to rely more on mass transit than the USA and Canada. Brazil and India provide examples of the

difficulty faced by developing countries with growing populations, growing economies and a large portion of the population hungry for more energy.

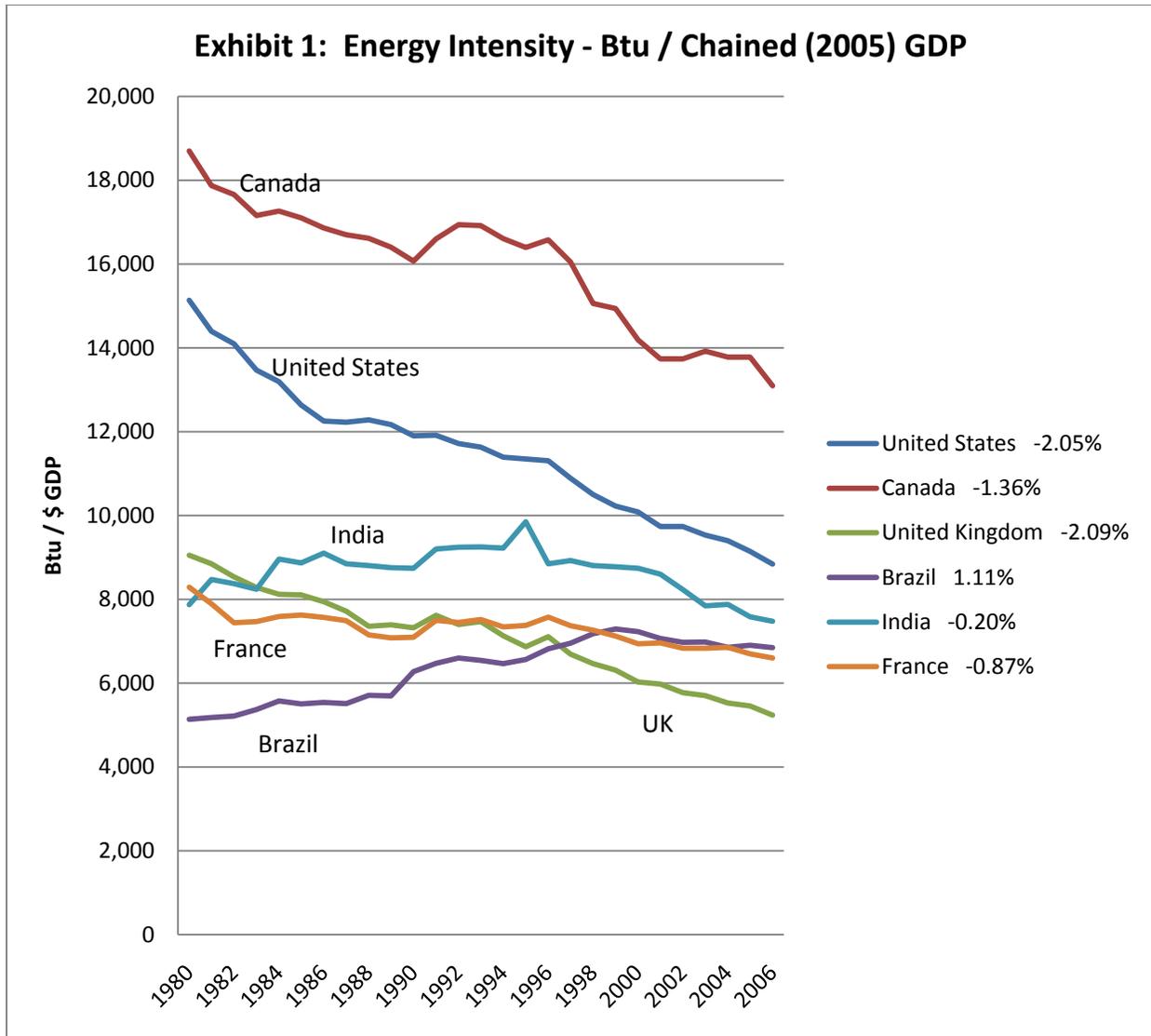
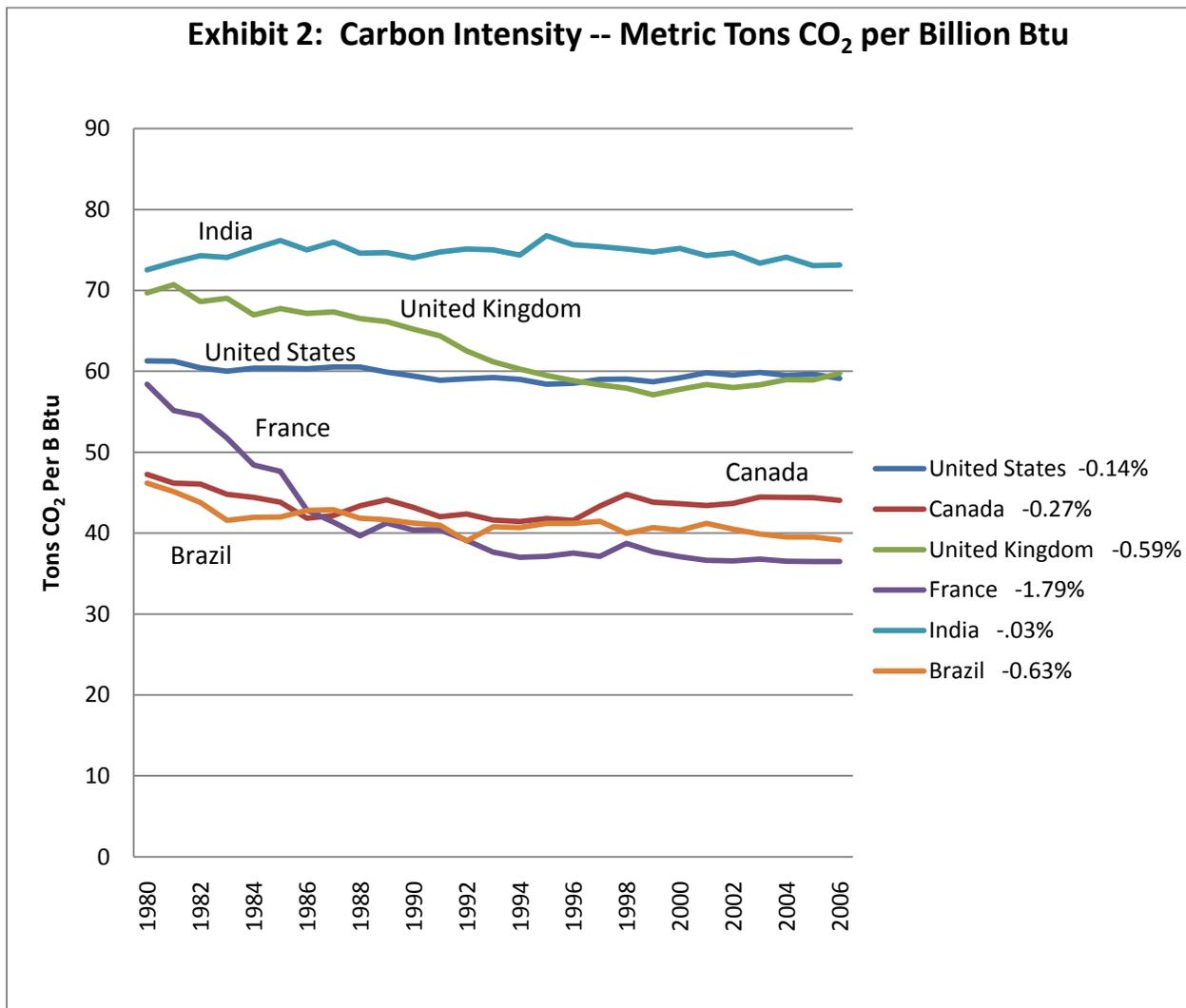


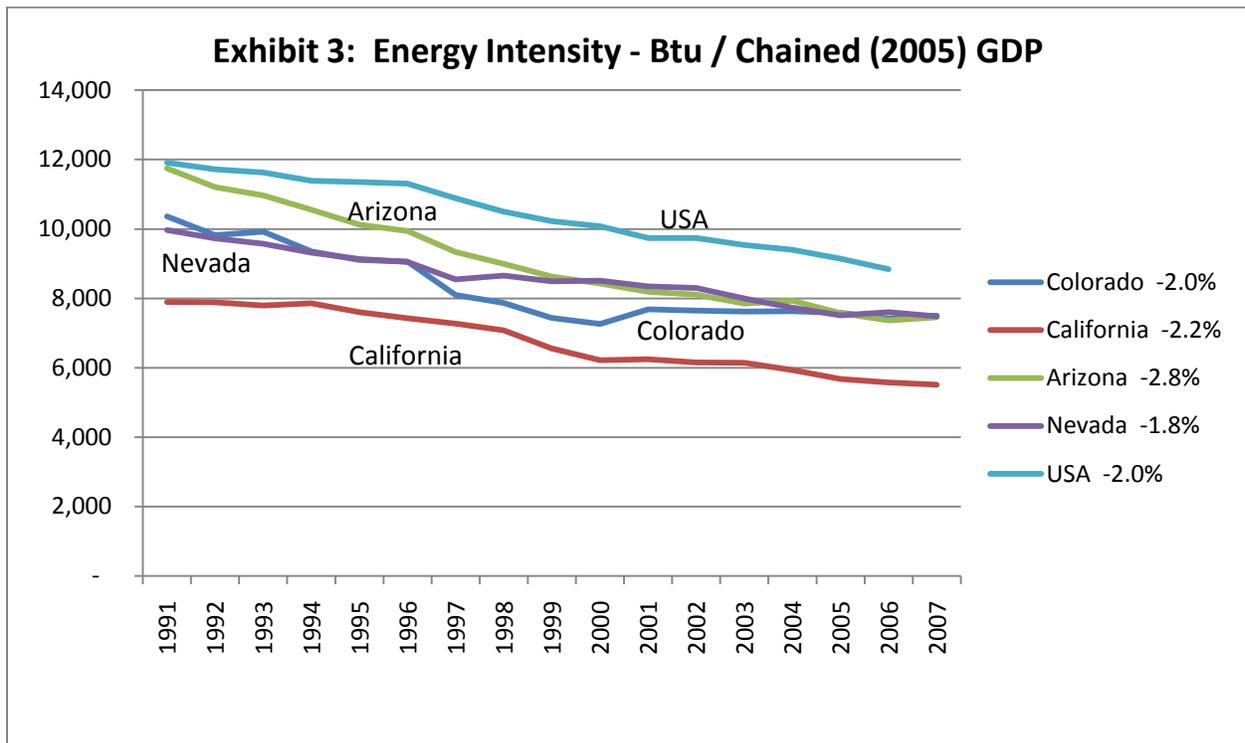
Exhibit 2 provides illustrations of [carbon intensity](#) for the same set of countries. To a great extent, a nation's CI is also driven by its natural energy endowments; e.g., coal, petroleum and natural gas in the USA versus geothermal power in Iceland. But energy policy and politics also come to fore. France dramatically leads the other nations shown in Exhibit 2 due to De Gaul's decision in the aftermath of the Suez Canal Crisis to set France on a nuclear track for electricity and greater energy independence. However, France's rate of decline for carbon intensity does not appear to be greatly different than that of other countries over the most recent decade.

The overall lesson from Exhibit 2 ought to be that for all the talk about the imperative of switching to zero and lower carbon fuels, actually making the transition is proving to be very difficult. Alternative fuels such as wind and solar are labeled as such because current technologies are expensive and not easily integrated into the existing electrical grid. Nuclear power may be so politically unpopular that only authoritarian countries such as China will be able to pursue a significant nuclear alternative strategy. Alternative transportation fuels, such as ethanol and bio fuels may be renewable but in many cases they don't significantly reduce current CO₂ emissions, and hence have only a small impact on CI.

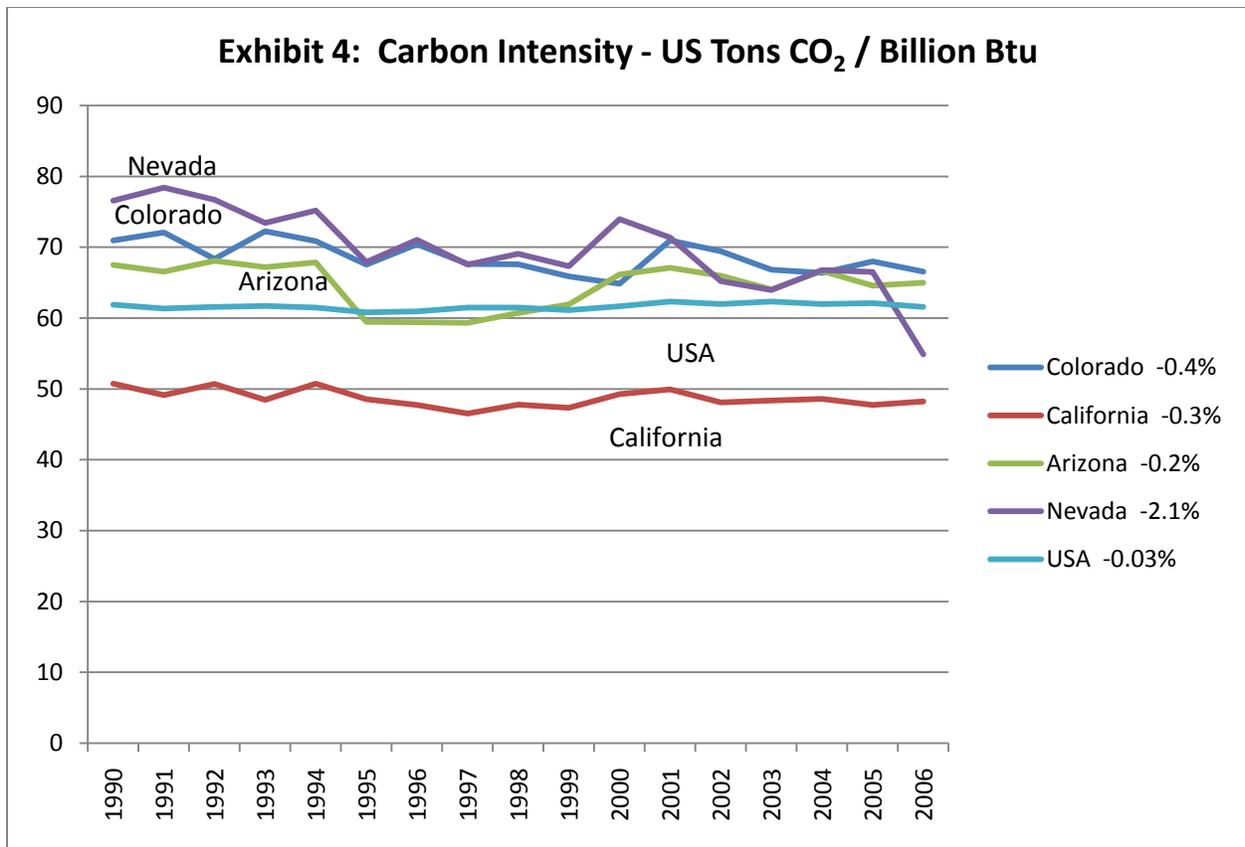


Within the United States, the rates of decline in energy intensity for western states do not vary as much as among nations. As shown in Exhibit 3 below, energy intensity rates of decline for

this set of western states average roughly -2.2%, about the same as for the US overall at -2% (the US EI rates of decline in Exhibits 1 and Exhibit 3 vary slightly due to the different time periods over which the rates are calculated). California is often cited as an example of a state with a more proactive energy and emissions strategy but its rate of energy intensity decline is only modestly better than Colorado's, albeit starting at a much lower level in 1991. [Several sources were needed to build the data for state energy intensity, including the [Bureau of Economic Analysis](#) and the [Energy Information Agency](#).]



Reducing carbon intensity in the USA and by western states has proven to be as difficult as for countries. As shown in Exhibit 4, Nevada easily leads the set of western states for the rate of CI decline, although California leads the pack considerably for the absolute level of CI. As was the case for energy intensity, note that the small difference in the US rates of CI decline in Exhibits 2 and 4 results from using different time periods when calculating the rates; in addition, carbon intensities are shown in US tons of CO₂ in Exhibit 4 and metric tons in Exhibit 2.



A Top Down Look at Energy Consumption and CO₂ Emissions in the Gunnison Community

Projecting energy consumption and the resulting CO₂ emissions in the Gunnison community using the Kaya Identity is somewhat more challenging than for nations due to the lack of historical data on which to base projections. The Kaya Identity requires data for population growth rate, per capita GDP growth rate, energy intensity and carbon intensity. Only one of these parameters, the population growth rate, is readily available for the Gunnison Community. In addition to growth rates, (or more commonly, rates of decline for EI and CI), baseline energy consumption and carbon emissions are required. In this report we are able to take advantage of the work performed by community volunteers, who produced the 2005 baseline [Emissions Inventory](#) that was used to set Gunnison Community emission targets for 2020 and that will be used in this report as the starting point for projecting energy use and emissions. As shown in Exhibit 5, after adjustments the Gunnison community was responsible for roughly 375,000 tons of CO₂ emissions in 2005, excluding CO₂ equivalencies from waste and agriculture. How do we

know that? The baseline estimates were broken down into five categories, residential buildings, commercial buildings, transportation, waste and agriculture.

Exhibit 5: 2005 Energy Consumption and CO₂ Emissions for Gunnison County						
CO ₂ Emission Allocation Activity	2005 Emissions (Tons CO ₂)	% Total	Fuel or Energy Consumed	Unit of Consumption	Consumption in Billion Btus	% Total
Residential Buildings						
Electricity	78,758	21%	1 102,743	MWh	2 351	9%
Non-renewable fossil fuels	39,462	11%	3 634	Billion Btu	634	16%
Total Residential	118,221	31%			984	25%
Commercial Buildings						
Electricity	62,893	17%	1 82,047	MWh	2 280	7%
Non-renewable fossil fuels	14,893	4%	3 253	Billion Btu	253	7%
Total Commercial	77,787	21%			533	14%
Total all Buildings	196,007	52%			1,517	39%
Transportation						
Gasoline	164,118	44%	4 18.0	Gal of gasoline (M)	5 2,176	56%
Diesel	15,707	4%	6 1.4	Gal of diesel (M)	7 194	5%
Total	179,825	48%	19.4	Total Gallons (M)	2,370	61%
Subtotal Buildings & Transport	375,832	100%			3,887	100%
Waste	30,924					
Agriculture and Other						
Methane	19,561					
Fertilizer	139					
Total	19,700					
Total All Uses	426,456				3,887	100%

This analysis omits the two smaller categories, waste and agriculture. Both activities release methane rather than CO₂ and methane is not part of the Kaya Identity. Methane is about 20

times more potent a GHG than CO₂ and it often accounted for in CO₂ equivalencies. But there appears to be some uncertainty about the amount of methane released from waste activities [[GC Energy Action Plan](#)] and methane omissions can be held off line without affecting the results of this analysis. Agricultural methane emissions are similarly excluded from the analysis but it is worth mentioning that methane emissions from agricultural activity and large elk herds in the Gunnison Community are likely to be closely scrutinized at some point.

After excluding waste, agriculture and wildlife, this analysis estimates 2005 baseline CO₂ emissions at a little over 375,000 tons and a 2020 CO₂ target of about 330,000 tons, or 20% below the 2005 baseline. The focus of [Emissions Inventory](#) was almost exclusively on CO₂ emissions while the methodology used in this report focuses more on energy consumption, with CO₂ emissions treated as a consequence of energy use. As a result, it was necessary to identify the types and amounts of fuel consumed, both directly (natural gas, propane, gasoline and diesel fuel) and indirectly through the production and consumption of electricity (coal, natural gas, hydro and wind). Appendix C of the Plans [Community Emissions Inventory](#) lists CO₂ emissions and related energy consumption in Btus. In most cases there was only moderate correspondence between these values. In other words, there was not always good equivalency using accepted standards between energy consumption in Btus, the fuel volumes corresponding to these Btu values, and the CO₂ emitted from consuming these volumes of fuel. The methodology used in this report for non-electrical energy calculates (1) fuel consumption from Btus and (2) CO₂ emissions from fuel consumption. In the case of electricity, accurate consumption measures were available from the City of Gunnison and GCEA, so Btu equivalents and CO₂ emissions were calculated directly from electrical usage. Based on these adjustments, the estimate for 2005 CO₂ emissions decreased from roughly 460,000 tons in Appendix C to roughly 375,000 tons in Exhibit 5 of this report, or about 19%. Tables and calculations used to estimate fuel quantities and emissions, such as tables showing the fuels and CO₂ emissions for the production of electricity in Gunnison, are available for review on request. Even after these adjustments were performed, the carbon intensity for Gunnison was still roughly 40% higher than for the state of Colorado and the USA. Without these adjustments, carbon intensity for Gunnison would have been roughly double that of other entities using a similar fuel mix.

Three Top-Down Scenarios for Gunnison

The Kaya Identity uses four independent variables and as a consequence presenting the results of the analysis can be difficult without a flurry of graphs that sometimes only add to the confusion. In this paper we will present 2020 CO₂ projections under three scenarios; each scenario is built from a set of four parameter input values that combine to tell a coherent scenario story. The four parameters being used, population, per capita GP, EI and CI, require initial values and growth rate assumptions. Gunnison community historic population growth

rates have varied considerably [[Gunnison Population](#)] and the projection used in this analysis must cover a 15 year period, long enough for considerable ups and downs to affect estimates. CO₂ emissions are very sensitive to population growth because each new person represents another demand on energy, which in turn produces CO₂. From 1970 to 2005 there were 21 periods spanning 15 years; from 1970 to 1985, from 1971 to 1986, etc. The minimum 15 year CAGR between 1970 and 2005 was 0.55%, the maximum was 2.47% and the average CAGR for the 21 periods was 1.54%. The three scenarios will be built on population growth assumptions of 0.5%, 1.5% and 2.5%.

Gross product is not calculated for Gunnison County but Colorado Gross Product (GP) and per capita GP growth rates (chained, 2005 dollars) can be calculated from available data [[BEA State GP](#)]. The 2005 per capita gross product in Colorado was \$39,810 and the average CAGR rate for the 5 available historical 15 year periods was 2.3%. However, like Gunnison, Colorado experienced slow economic growth from 2000 to 2005 and the state per capita gross product growth rate during this period fell to 1.8%. Gunnison's economic growth rate was probably even lower. The three scenarios will show per capita GDP growth rates of 0.75%, 1.5% and 2.25%, with a 2005 gross product of \$30,000, the latter value being just a guess. The value selected for Gunnison's per capita GP does not affect the relationship between emission targets and projections but it does determine, in part, Gunnison's initial energy intensity (Btu / GP). At \$30,000 per capita GP, Gunnison's 2005 energy intensity was 8,996 Btu/\$ GP, compared to 7,583 and 9,146 respectively for Colorado and the USA. Gunnison leaves a heavy carbon footprint due to its climate, with roughly 40% more heating and cooling days than Denver, and because almost all goods and services are trucked in over long distances and fuel-hungry mountain passes. Colorado's EI compound average growth rate is a fairly stable -2% and this rate will be used as the lower estimate in the three scenarios, with -3% and -4% used in the moderate and higher growth scenarios. It is highly unlikely given current attitudes and policies that Gunnison's EI growth rate will appreciably reverse and move the wrong direction (we won't give up conservation efforts), so current conditions provide the basis for the low estimate scenario.

As shown in Exhibit 4, Colorado's and the USA's carbon intensities in 2005 were 71 and 66 tons of CO₂ per billion Btu respectively, with Colorado's compound average growth rate at -0.4% and the USA's at -0.03%. Colorado uses more electricity from coal than the USA overall and Colorado has no nuclear power. Gunnison's carbon intensity in 2005 is estimated at nearly 97 tons of CO₂ per billion Btus based on Exhibit 5, significantly higher than Colorado's CI, whose already high CI score ought to have adequately accounted for the region's high reliance on coal for electrical generation. The three scenarios presented below will use carbon intensity growth rates of -0.4%, -0.8% and -1.2%; the lower scenario CI rate will be set at the Colorado average rate and the high scenario CI rate will be 4 times the current Colorado rate.

The three scenarios analyzed in this report can be described as (A) an undesirable continuation of current trends, (B) a more sustainable middle course, and (C) a challenge to manage higher growth. The slow growth scenario, Scenario A, combines lower rates of population growth and economic growth, 0.5% and 0.75% respectively, with Colorado's historic rates of decline for EI and CI, -2% and -0.4 respectively. This is a worst case because it implies 15 years bordering on economic recession and little population growth (e.g., Western State College's enrollment does not grow), with historic rates of improvement in energy efficiency and a very slow transition from carbon intensive fuels (coal and petroleum) to low carbon fuels. The struggling economy makes it difficult for consumers to invest in energy improvement strategies or purchase more expensive low carbon fuels. Scenario C represents a high growth future, with more financial resources to undertake conservation strategies but more people burning fuel and generating CO₂. The middle option is the more likely future for Gunnison, with moderate population and economic growth and a significant improvement in its energy and carbon intensity.

Each of the three Scenarios, A, B and C, are shown respectively in Exhibits 6, 7 and 8. The top one-third of each exhibit shows the growth rates for population, per capita gross product, energy intensity and carbon intensity. The top one-third of each exhibit also shows the emissions target and projected CO₂ emissions for 2020 using the Kaya Identity. The variance between target and projected emissions is shown in tons of CO₂ and as a percent of the target. The bottom two-thirds of each exhibit shows projected CO₂ emissions for various combinations of EI and CI growth rates depending on the population and economic growth rates shown in the top section. The bottom section may be useful to planners who are anxious to know projected CO₂ emissions under "what if" conditions. Combinations of EI and CI growth rates that lead to goal attainment are highlighted in green or use a shaded fill in Exhibits 6, 7 and 8.

Under Scenario A the Gunnison Community population and economy grow very slowly and the community is only able to achieve rates of decline in energy and carbon intensity similar to that achieved by Colorado over the past 10 years. Targeted CO₂ emissions are not achieved, with projected emissions falling about 5% above the target. This 'close, but no cigar' outcome is really about three quarters of the way toward meeting the 2020 CO₂ emissions target. As the bottom section of Exhibit 6 illustrates, it would appear that a modest improvement in energy or carbon intensity rates would result in goal achievement. But keep in mind that under this scenario Gunnison is a poor community, perhaps slipping in and out of recession, and cash strapped consumers may have to defer extensive weatherization upgrades even though they face rising energy costs.

Exhibit 6: Scenario A, CO₂ Emission in 2020 for EI and CI Growth (Decline) Rates										
Growth Rates and Emission Projections										
Population Growth Rate			0.50%		Chained GDP per Capita Growth Rate			0.75%		
Energy Intensity Growth Rate			-2.0%		Carbon Intensity Growth			-0.4%		
Projected CO ₂ Emissions 2020 (Tons)			315,095		Target CO ₂ Emissions 2020 (Tons)			300,666		
Emissions Above (Below) 2020 Target (Tons)			14,430		Percent Above (below) target			4.8%		
Tons of CO₂ for Energy Intensity and Carbon Intensity Growth Rates										
		Energy Intensity Growth Rates								
		-5.0%	-4.5%	-4.0%	-3.5%	-3.0%	-2.5%	-2.0%	-1.5%	-1.0%
Carbon Intensity Growth Rates	-2.00%	155,026	167,727	181,393	196,093	211,898	228,887	247,140	266,744	287,793
	-1.75%	161,066	174,261	188,459	203,732	220,153	237,804	256,768	277,136	299,004
	-1.50%	167,324	181,032	195,782	211,648	228,707	247,043	266,744	287,904	310,622
	-1.25%	173,809	188,048	203,369	219,850	237,571	256,618	277,082	299,062	322,660
	-1.00%	180,527	195,317	211,231	228,349	246,754	266,537	287,793	310,622	335,132
	-0.75%	187,488	202,847	219,375	237,153	256,268	276,814	298,889	322,598	348,054
	-0.50%	194,698	210,648	227,811	246,273	266,123	287,459	310,383	335,004	361,439
	-0.25%	202,166	218,728	236,550	255,720	276,331	298,486	322,289	347,855	375,303
	0.00%	209,901	227,097	245,600	265,504	286,904	309,906	334,620	361,164	389,662
	0.25%	217,912	235,764	254,973	275,636	297,853	321,733	347,390	374,947	404,533

Exhibit 7: Scenario B, CO₂ Emission in 2020 for EI and CI Growth (Decline) Rates										
Growth Rates and Emission Projections										
Population Growth Rate		1.50%		Chained GDP per Capita Growth Rate		1.50%				
Energy Intensity Growth Rate		-3.0%		Carbon Intensity Growth		-0.8%				
Projected CO ₂ Emissions 2020 (Tons)		329,781		Target CO ₂ Emissions 2020 (Tons)		300,666				
Emissions Above (Below) 2020 Target (Tons)		29,116		Percent Above (below) target		9.7%				
Tons of CO₂ for Energy Intensity and Carbon Intensity Growth Rates										
		Energy Intensity Growth Rates								
		-5.0%	-4.5%	-4.0%	-3.5%	-3.0%	-2.5%	-2.0%	-1.5%	-1.0%
Carbon Intensity Growth Rates	-2.00%	201,011	217,479	235,199	254,259	274,753	296,781	320,448	345,867	373,159
	-1.75%	208,842	225,951	244,361	264,164	285,456	308,342	332,931	359,341	387,696
	-1.50%	216,957	234,730	253,856	274,428	296,548	320,323	345,867	373,304	402,760
	-1.25%	225,365	243,827	263,694	285,063	308,040	332,737	359,272	387,771	418,369
	-1.00%	234,076	253,252	273,887	296,083	319,948	345,599	373,159	402,760	434,541
	-0.75%	243,101	263,017	284,447	307,498	332,284	358,924	387,547	418,289	451,295
	-0.50%	252,450	273,132	295,386	319,324	345,062	372,727	402,451	434,375	468,651
	-0.25%	262,134	283,609	306,717	331,572	358,298	387,024	417,888	451,037	486,627
	0.00%	272,163	294,460	318,452	344,259	372,007	401,832	433,877	468,294	505,246
	0.25%	282,550	305,697	330,605	357,397	386,204	417,167	450,435	486,166	524,528

Exhibit 8: Scenario C, CO₂ Emission in 2020 for EI and CI Growth (Decline) Rates										
Growth Rates and Emission Projections										
Population Growth Rate			2.00%		Chained GDP per Capita Growth Rate			2.25%		
Energy Intensity Growth Rate			-4.0%		Carbon Intensity Growth			-1.2%		
Projected CO ₂ Emissions 2020 (Tons)			319,425		Target CO ₂ Emissions 2020 (Tons)			300,666		
Emissions Above (Below) 2020 Target (Tons)			18,759		Percent Above (below) target			6.2%		
Tons of CO₂ for Energy Intensity and Carbon Intensity Growth Rates										
		Energy Intensity Growth Rates								
		-5.0%	-4.5%	-4.0%	-3.5%	-3.0%	-2.5%	-2.0%	-1.5%	-1.0%
Carbon Intensity Growth Rates	-2.00%	241,653	261,450	282,752	305,666	330,304	356,785	385,237	415,796	448,606
	-1.75%	251,066	271,635	293,767	317,574	343,171	370,684	400,245	431,994	466,082
	-1.50%	260,822	282,189	305,181	329,913	356,505	385,087	415,796	448,780	484,192
	-1.25%	270,930	293,125	317,009	342,699	370,321	400,011	431,911	466,172	502,957
	-1.00%	281,403	304,456	329,263	355,946	384,636	415,474	448,606	484,192	522,399
	-0.75%	292,252	316,195	341,958	369,670	399,466	431,492	465,903	502,860	542,540
	-0.50%	303,491	328,355	355,108	383,886	414,828	448,086	483,820	522,199	563,405
	-0.25%	315,133	340,950	368,730	398,611	430,741	465,274	502,378	542,230	585,016
	0.00%	327,190	353,995	382,838	413,862	447,221	483,076	521,600	562,976	607,399
	0.25%	339,677	367,504	397,448	429,657	464,289	501,512	541,506	584,461	630,579

Under Scenario B, the rates of population and economic growth are more consistent with historic patterns while the rate of EI decline exceeds that which any of the countries shown in Exhibit 1 or states shown in Exhibit 3 have been able to sustain. Scenario B calls for a Gunnison CI rate of -0.8%, again significantly more ambitious than those sustained by nearby states (Exhibit 4), the US, Canada, France or the UK (Exhibit 2). Under Scenario B, CO₂ emissions drop roughly one-half the extent needed (9.7% compared to the 20% target reduction) to achieve the 2020 CO₂ emission target in the Gunnison Community. The bottom portion of Exhibit 7 can be used to identify combinations of EI and CI growth rates that achieve the 2005 target.

Scenario C, Exhibit 8, represents yet higher population and the economy growth rates coupled with extremely ambitious strategies to reduce EI and CI. The 2020 emission target is missed again, this time by 6.2%, leaving about one-quarter of the 20% decline unachieved. High population and economic growth means more people in the community using more energy while at the same time the community attempts to cut emissions 20% from the 2005 level. The two forces work at cross-purposes, and high growth forces the community to use ever more aggressive conservation strategies. It remains to be seen if the Gunnison community has the capability of to achieve an EI decline rate twice as good as that of USA and most surrounding states. At -1.2% in Scenario C, the selected rate of CI reduction is 3 times better than that of other states. Even more, these rates are insufficient to achieve CO₂ targets. As shown in the bottom section of Exhibit 8, reaching the 2020 target would require an EI rate of about -4.5% and a CI rate of about -1.75%.

All three scenarios show the challenges of carbon mitigation policies – reducing CO₂ emissions is a difficult business and the 20% by 2020 emission target used around the world may be a bridge too far. Rates of decline for energy intensity and carbon intensity would need to change by an order of 2 or 3, and there is no historic precedent to justify a belief that it can happen.

Three Bottom-Up Scenarios for Gunnison

A top down look at Gunnison asks “what EI and CI rates of decline are required to reach the 2020 targets and what is the likelihood Gunnison will be able to achieve them?” A bottom-up look at Gunnison asks “What would it take to achieve these EI and CI rates in Gunnison?” How will CAFE [citation needed] standards affect fuel consumption, what will we have to do to our buildings to make them more efficient, and what energy standards ought to apply to new buildings? The three bottom-up scenarios are the reverse faces of the previous scenarios, with the same starting points and same growth rates. Readers can compare Exhibits 6, 7 and 8 for a top-down look with Exhibits 9, 10 and 11 for a bottom-up look at the same three scenarios.

A simple model of Gunnison’s energy consumption and CO₂ emissions has to account for energy consumption in buildings and in transportation, the sources of CO₂ shown in Exhibit 5. The

building component of the model is the more difficult because it includes electricity and the proportions of fuels used in electrical generation will change over time. In the simple model used in this analysis, all buildings are treated as an average building, with a building energy efficiency index (BEI) set at 100. As shown in the left columns of Exhibit 9, Scenario A, 75 inefficient buildings with building efficiencies averaging 130 are weatherized, insulated and otherwise upgraded in 2005. The energy efficiency for these buildings improves by 30% after completion of work, or to a BEI of 91; it is as if a very inefficient building has been replaced with a better building, one that is 9% more efficient than the average building instead of 30% less efficient than the average building. The number of buildings weatherized, or 'fixed,' grows over time and the energy index value for the buildings undergoing a fix drops over time as the worst offenders are dealt with. New buildings are simply added to the existing portfolio of buildings, albeit with a lower and improving level of efficiency relative to the average 2005 building. In addition to major projects, every building owner is assumed to undertake larger and smaller efficiency upgrades, such as replacing an aging hot water heater or substituting fluorescent lights for incandescent light, which will improve the efficiency of the average building by 1% per year.

As the amount of energy used in buildings declines over time, the relative shares for electricity and gas (natural gas and propane) remain the same. At the same time, wind and other renewable sources of electricity are required to increase to the extent that they account for 30% of the electricity produced in 2020, as shown in Exhibit 9. Coal will be the loser, with only 49% of the community's electricity coming from coal in 2020, down from 63% in 2005; replacing coal with wind helps the Gunnison CI rate considerably but it also drives up the cost of electricity. Building related emissions drop by nearly 165,000 tons of CO₂ by 2020, a 16% decline from 2005 and still a little short of the 20% decline rate called for in the CO₂ target.

In the transportation portion of the bottom-up model, Exhibit 9, new vehicles with higher MPG performance enter the existing fleet and older cars with much lower MPG performance leave the fleet. The number of initial vehicles in the Gunnison fleet is based on county vehicle registrations and the average miles each vehicle is driven per year is based on the number of vehicles and the amount of fuel consumed multiplied by the fleet MPG performance. Due to tourists and other visitors, more vehicles operate in Gunnison County than are registered in Gunnison County. In the model, the transportation affect of tourism are borne in a much higher than usual average vehicle miles per year, which starts at over 16,000 in 2005. This analysis assumes a 1% decline in average vehicle miles each year. The net results of improving CAFE mileage standards and reduced driving results in a CO₂ emissions drop of nearly 445,000 tons by 2020, a 25% decline from 2005 (Exhibit 9).

Exhibit 9: Scenario A, Bottom Up Parameters and Projections, 2005 - 2020

Scenario A		
	Initial Value	Change Rate
Gunnison community population	14,403	0.5%
Per Capita Gross Product (\$1000)	\$ 30.0	0.75%
Building Assumptions		
Number of Building Renovated / Weatherized	75	14.0%
Initial Energy Index of Buildings Renovated	130	-1.0%
% BEI Improvement from Renovation	30%	0.0%
New Building Construction	70	1.0%
BEI for New Buildings	60	-1.0%
General Building Energy Efficiency Improvement		1.0%
Percent Electricity from Wind	0.9%	21.0%
Taylor Dam Hydro Option		No
Geothermal Option		No
Transportation Assumptions		
Rate New Vehicles Enter Fleet	923	4.5%
Rate Old Vehicles Leave Fleet	513	2.5%
MPG of New Vehicles Enter the Fleet	28	2.0%
MPG of Old Vehicles Leaving the Fleet	12	2.0%
Average Vehicle Miles Per Year	16,644	-1.0%

Building Energy and CO2 Projections	
<p>By 2020, 3288 of the initial buildings, or about 30% of the initial buildings, will have received upgrades that improve their efficiency by 30%. By 2020, these 'fixed' buildings are 26% more efficient than the average building in 2005 and are being fixed at a rate of 470 per year. By 2020, new buildings use 48% less energy than the average building in 2005 and the average building efficiency has improved by 26% in 15 years. Hydro power generates 15% of total electricity and wind electricity has increased from 1% to 16%. Electricity from coal has dropped from 63% to 49%. Geothermal is at 0%. Building related CO2 emissions have dropped from 196007 tons in 2005 to 164720 tons in 2020, a decrease of 31287 tons, or a 16% decline from 2005.</p>	
Transportation Energy and CO2 Projections	
<p>The average fleet efficiency has increased from 18 MGP in 2005 to 26 MGP in 2020 but the number of vehicles has risen by 32%. Total miles travelled has increased by 16%, from 341 million miles to 395 million miles. The average annual miles per vehicle has dropped from 16644 miles to 14314 miles. 2016 CAFÉ performance for new vehicles is at 34 MPG. Transportation related CO2 emissions have dropped from 179825 tons in 2005 to 135351 tons in 2020, a decrease of 44474 tons, or a 25% decline from 2005.</p>	
Gunnison Community Energy and CO2 Projections	
The energy intensity rate of decline from 2005 to 2020 has reached	-2.4%
The carbon intensity rate of decline from 2005 to 2020 has reached	-0.34%
<p>Total energy consumption has dropped from 3887 B Btu in 2005 to 3269 B Btu in 2020, a decrease of 619 B Btu, or a 16% decline from 2005.</p> <p>Total CO2 emissions have dropped from 375832 tons in 2005 to 300070 tons in 2020, a decrease of 75762 tons, or a 20% decline from 2005.</p>	

Exhibit 10: Scenario B, Bottom Up Parameters and Projections, 2005 - 2020

Scenario B		
	Initial Value	Change Rate
Gunnison community population	14,403	1.5%
Per Capita Gross Product (\$1000)	\$ 30.0	1.50%
Building Assumptions		
Number of Building Renovated / Weatherized	75	22.0%
Initial Energy Index of Buildings Renovated	130	-1.0%
% BEI Improvement from Renovation	40%	0.0%
New Building Construction	70	2.0%
BEI for New Buildings	50	-1.0%
General Building Energy Efficiency Improvement		1.0%
Percent Electricity from Wind	0.9%	21.0%
Taylor Dam Hydro Option		No
Geothermal Option		No
Transportation Assumptions		
Rate New Vehicles Enter Fleet	1,128	5.5%
Rate Old Vehicles Leave Fleet	615	3.0%
MPG of New Vehicles Enter the Fleet	28	2.7%
MPG of Old Vehicles Leaving the Fleet	12	2.0%
Average Vehicle Miles Per Year	16,644	-1.0%

Building Energy and CO2 Projections

By 2020, 6389 of the initial buildings, or about 58% of the initial buildings, will have received upgrades that improve their efficiency by 40%. By 2020, these 'fixed' buildings are 42% more efficient than the average building in 2005 and are being fixed at a rate of 1214 per year. By 2020, new buildings use 57% less energy than the average building in 2005 and the average building efficiency has improved by 42% in 15 years. Hydro power generates 15% of total electricity and wind electricity has increased from 1% to 16%. Electricity from coal has dropped from 63% to 49%. Geothermal is at 0%. Building related CO2 emissions have dropped from 196007 tons in 2005 to 169278 tons in 2020, a decrease of 26730 tons, or a 14% decline from 2005.

Transportation Energy and CO2 Projections

The average fleet efficiency has increased from 18 MGP in 2005 to 29 MGP in 2020 but the number of vehicles has risen by 41%. Total miles travelled has increased by 25%, from 341 million miles to 425 million miles. The average annual miles per vehicle has dropped from 16644 miles to 14314 miles. 2016 CAFÉ performance for new vehicles is at 36 MPG. Transportation related CO2 emissions have dropped from 179825 tons in 2005 to 131973 tons in 2020, a decrease of 47852 tons, or a 27% decline from 2005.

Gunnison Community Energy and CO2 Projections	
The energy intensity rate of decline from 2005 to 2020 has reached	-4.1%
The carbon intensity rate of decline from 2005 to 2020 has reached	-0.31%
Total energy consumption has dropped from 3887 B Btu in 2005 to 3265 B Btu in 2020, a decrease of 622 B Btu, or a 16% decline from 2005.	
Total CO2 emissions have dropped from 375832 tons in 2005 to 301250 tons in 2020, a decrease of 74582 tons, or a 20% decline from 2005.	

Exhibit 11: Scenario C, Bottom Up Parameters and Projections, 2005 - 2020

Scenario C		
	Initial Value	Change Rate
Gunnison community population	14,403	2.0%
Per Capita Gross Product (\$1000)	\$ 30.0	2.25%
Building Assumptions		
Number of Building Renovated / Weatherized	75	26.0%
Initial Energy Index of Buildings Renovated	130	-2.0%
% BEI Improvement from Renovation	40%	0.0%
New Building Construction	70	3.0%
BEI for New Buildings	50	-1.0%
General Building Energy Efficiency Improvement		1.0%
Percent Electricity from Wind	0.9%	21.0%
Taylor Dam Hydro Option		No
Geothermal Option		No
Transportation Assumptions		
Rate New Vehicles Enter Fleet	1,230	6.0%
Rate Old Vehicles Leave Fleet	820	4.0%
MPG of New Vehicles Enter the Fleet	28	2.7%
MPG of Old Vehicles Leaving the Fleet	12	2.0%
Average Vehicle Miles Per Year	16,644	-1.0%

Building Energy and CO2 Projections	
<p>By 2020, 8951 of the initial buildings, or about 81% of the initial buildings, will have received upgrades that improve their efficiency by 40%. By 2020, these 'fixed' buildings are 48% more efficient than the average building in 2005 and are being fixed at a rate of 1907 per year. By 2020, new buildings use 57% less energy than the average building in 2005 and the average building efficiency has improved by 48% in 15 years. Hydro power generates 15% of total electricity and wind electricity has increased from 1% to 16%. Electricity from coal has dropped from 63% to 49%. Geothermal is at 0%. Building related CO2 emissions have dropped from 196007 tons in 2005 to 182692 tons in 2020, a decrease of 13315 tons, or a 7% decline from 2005.</p>	
Transportation Energy and CO2 Projections	
<p>The average fleet efficiency has increased from 18 MGP in 2005 to 31 MGP in 2020 but the number of vehicles has risen by 32%. Total miles travelled has increased by 16%, from 341 million miles to 395 million miles. The average annual miles per vehicle has dropped from 16644 miles to 14314 miles. 2016 CAFÉ performance for new vehicles is at 36 MPG. Transportation related CO2 emissions have dropped from 179825 tons in 2005 to 115256 tons in 2020, a decrease of 64569 tons, or a 36% decline from 2005.</p>	
Gunnison Community Energy and CO2 Projections	
The energy intensity rate of decline from 2005 to 2020 has reached	-5.4%
The carbon intensity rate of decline from 2005 to 2020 has reached	-0.18%
<p>Total energy consumption has dropped from 3887 B Btu in 2005 to 3166 B Btu in 2020, a decrease of 722 B Btu, or a 19% decline from 2005. Total CO2 emissions have dropped from 375832 tons in 2005 to 297948 tons in 2020, a decrease of 77884 tons, or a 21% decline from 2005.</p>	

Combining the building and transportation components in Scenario A shows Gunnison achieving the 20% emission reduction through an EI rate of -2.4% and a CI rate of -0.34. Readers can compare these rates with those shown in the top-down look at Scenario A in Exhibit 6.

A bottom-up analysis of Scenario A shows what it would take to reach the emission target under low growth assumptions; lots of weatherizing and replacing hot water heaters, fewer tourists and less driving but in more efficient vehicles, and a migration from coal to wind generated electricity. The bottom-up effort in Scenario A shows that achieving emission objectives requires a substantial commitment to action by the community. Individuals in the Gunnison community would have to change their behavior (driving less and enduring fluorescent lights) and spend more money on their houses (replacing windows and the old boiler), all while tourism is down, salaries are low, and energy costs are going up. Will Gunnison be able to find 3,300 owners, 30% of all building owners, over the 15 years in the model period who have the money and the interest to substantially upgrade their building?

Under Scenario B, Exhibit 10, arguably Gunnison most likely future, rates of population and economic growth are moderate at 1.5%. With the moderate growth comes a growing use of energy that must be offset by more aggressive conservation measures. About 58% of buildings will have to be extensively modernized and new buildings in 2020 will use 57% less energy than the average building in 2005. More new cars will be purchased and old cars will leave the fleet, improving Gunnison's MPG average considerably. People will be driving less but there will be more people, so total transportation miles will be up by 25%. The bottom-up analysis of Scenario B shows Gunnison achieving the 2020 emission goal with an EI of -4.1% and a CI of -0.31%. It is worth noting that while Gunnison's EI rate of decline doubled between Scenarios A and B, the CI rates of decline stayed essentially the same. In all three scenarios, the Gunnison community is assumed to quickly exhaust the wind option and there are no other major CI reducing options left to explore. As a result, conservation has to carry a greater share of the reduction burden.

The bottom-up analysis of Scenario C, Exhibit 11, illustrates some of the consequences of still higher population and economic growth rates, 2% and 2.25% respectively. The increases in energy consumption must be offset with greater conservation alone because all opportunities to improve carbon intensity have been exhausted. About 81% of all buildings will have received a major energy renovation, and the effectiveness of the renovation has increased from Scenario B to Scenario C. Instead of 3,300 building owners completing upgrades in Scenario A, over 8,900 building owners will have completed even more extensive upgrades in Scenario C. People will drive a little less but this will be outpaced by growth in tourism and population, so total miles will have increased by 16%. Fortunately, under Scenario C some of the growth is

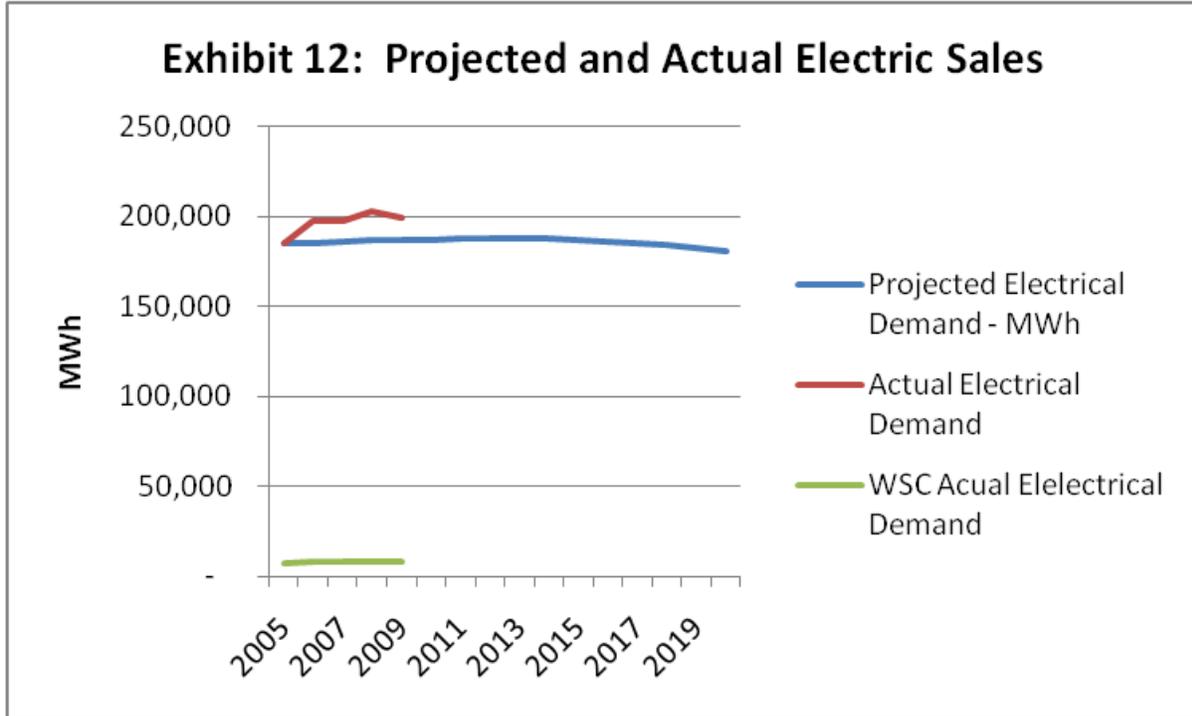
offset by an improving average MPG in the new cars a wealthier community can afford. The real story in Scenario C is that carbon intensity has actually gotten worse (all Btus added from Scenario 2 to Scenario 3 have carbon sources) and that opportunities to reduce CO₂ by improving buildings may be about tapped out. Any further efforts to reduce carbon emission will have to focus on transportation and it is worth speculating whether Gunnison can have both a thriving tourism industry and a large reduction in transportation energy; are the two compatible?

All three bottom-up scenarios illustrate the magnitude of change that meeting emission objectives entails. Scenario A, with the lowest population and economic growth rates, clearly sets a lower bar than Scenario C but even the relatively modest challenges in Scenario A look daunting enough. What is the likelihood that the people of the Gunnison community will be able to enact any of the three scenarios? The problem is not that we don't know how to upgrade a building to achieve a 30% efficiency improvement; in fact we can do better than that. But can we get 58% of building owners, 6,400 people, who are able and willing to invest so much in their buildings? It is hard to imagine use of coercion, except perhaps in the case of building codes, but will all this happen voluntarily? Perhaps these are some of the reasons that no country or state has been able to sustain the rates of EI and CI decline that are applied in the three scenarios.

How is Gunnison Doing?

When setting out to accomplish something that has never been done but for which you have a plan, it makes sense to compare actual performance with the plan's milestones, just to see if you are on track. How is the Gunnison Community doing five years into this 15 year model or plan?

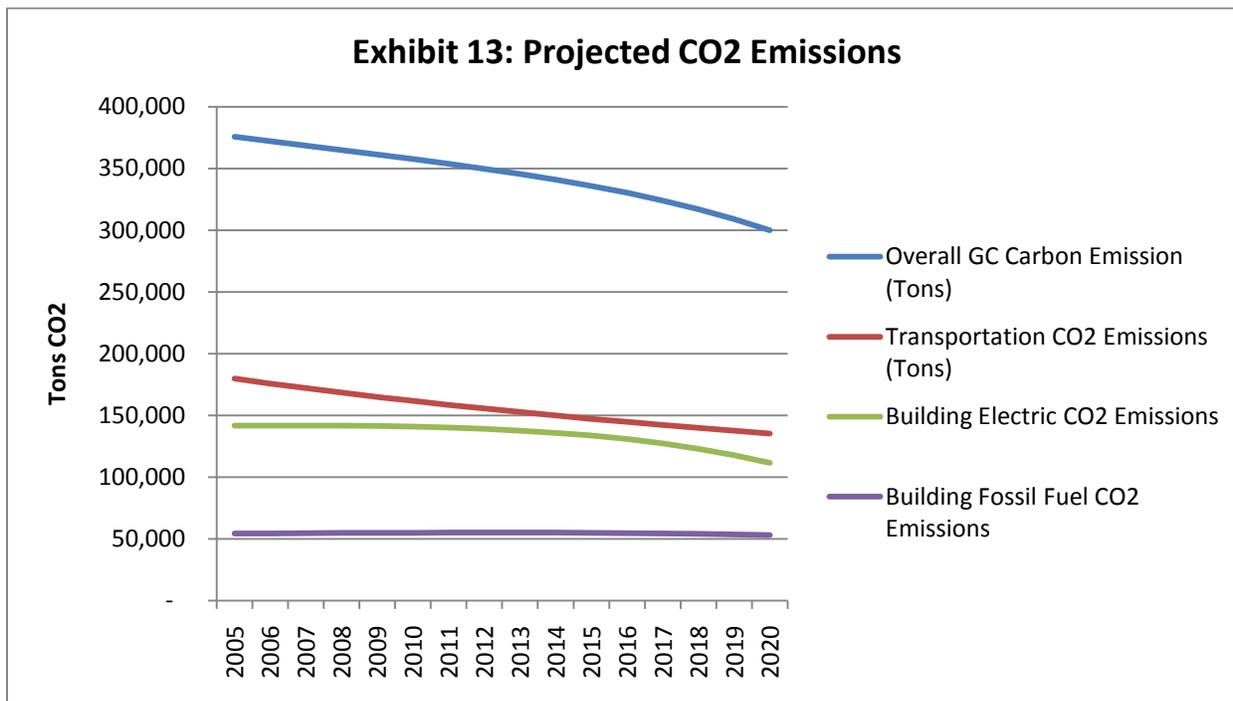
It ought to be easy to answer this question but it is not. Electrical information is readily available from the City of Gunnison and GCEA, but propane, natural gas and transportation fuel sales are not. Gasoline and diesel sales ought to be available from the state, since these fuels are taxed, but they are not readily available on line. Requests for gas records have not yet been fulfilled. Exhibit 12 answers the "How are we doing?" question based on electrical data only. The answer is, "not well." Instead of increasing slightly, as projected by the model, electricity sales increased from 2005 until 2008, when the recession likely drove energy consumption modestly down in 2009. The CAGR over the period was 2.5%. The trajectory that leads to meeting emission targets starts at a significantly higher level in 2010 than in 2005. What this implies is that future rates of decline in EI and CI, say from 2010 to 2020 instead of from 2005 to 2020, will have to be even more extreme than those used in the three scenarios if CO₂ emission targets are to be achieved.



Discussion

Both the Top-Down and Bottom-Up analyses reveal that meeting Gunnison’s 2020 CO₂ emission target requires achieving rates of decline in EI and CI that are unlikely given historical precedent. It is likely that such rates have never been sustained by any nation or US state. Setting objectives that can not be achieved is a poor idea. An unachievable goal may appear to be inspirational, but it is more likely to lead to apathy and cynicism than to high achievement. Gunnison Community’s 20% by 2020 emission target is consistent with those adopted through international treaties and national and state policies, not to mention its adoption by perhaps thousands of communities across the USA, yet it appears highly likely that the target can not be met in the Gunnison Community, and one wonders if 20% by 2020 targets can be met by any community without accounting gimmicks.

As shown in Exhibit 13, most of the reduction in CO₂ emissions in the Gunnison Community is likely to come from transportation, at least based on the assumptions in the model used here. Most local opportunities to improve transportation EI are modest; more bus service, car pooling, bike riding, walking, etc. All are good opportunities and ought to be pursued, but all are modest in comparison to the affects of CAFE standards on vehicle efficiency. Technological innovation, in transportation, in buildings and in production processes, will ultimately determine whether we are able to hit future emissions targets.



Building energy conservation is the front line in the war on carbon emissions at the local level. It will require the ability and willingness by most building owners to invest in the longer term even when current financial constraints preclude thinking about the long term for many. Since building codes are one of the few strategic levers for local officials, there may be a temptation to over apply this lever, beyond economic rationale. In the Gunnison Community, discussion about a net carbon neutrality requirement for special projects may be an example of over application. It is possible that the cost of carbon neutrality will be so great that developers will take projects elsewhere, in which case the net result is not carbon neutral projects, but no projects at all (unless plenty of emissions accounting gimmicks are allowed) and retarded population and economic growth. Such a result may have a slight effect on carbon dioxide emissions but only by reducing population and economic growth, making it harder for young people to stay in the community and by making the community poorer.

Reducing energy consumption and carbon emissions is a difficult business because it requires that people change their behavior. It is also a frustrating business for policy makers, especially at the local level where there are few buttons and levers for applying strategies. CAFE standards, energy or carbon taxes, cap and trade, mandated purchases of green energy, etc., are the purview of federal and sometimes state governments. Local authorities have fewer buttons and levers. Building codes and standards will be improved, carpooling and bus use will

be encouraged, small and large improvements in building will be made, and so on; all to a noticeable effect but collectively insufficient to meet emissions targets. In the Gunnison Community, with few strategic buttons and levers remaining, there may be a strong temptation to slow population and economic growth, especially since this sentiment appears to resonate with some in the community already. Recent examples include resistance to the Snodgrass expansion and the latest molybdenum incarnation, the Lucky Jack Mine. The motives of those resisting these projects are not always clear, and there are multiple reasons to oppose these projects, but both efforts have the consequence of reducing population and economic growth. Is the Gunnison Community's historically slow population and economic growth bad luck or intentional, or is it the unintended consequence of a series of decisions where growth was of small concern? Will the recent economic disasters, follow by what appears to be a collapse of the kokanee salmon population in Blue Mesa Reservoir that will have a very noticeable affect on the local economy, tend to make population and economic growth more salient in future decisions?

Few communities have attractive opportunities to reduce carbon intensity. Switching from one transportation fuel to another has little consequence unless the switch is to electric vehicles, and that switch appears to be progressing slowly in the Gunnison Community. Two options appear possible for most communities. First, the community can add more wind in its electrical supply than required by state and federal policies. Yet wind power is expensive, intermittent and appears to be working not all that well where it has been tried extensively. Will wind power be the next ethanol? The second opportunity to reduce carbon intensity at the local level is to subsidize micro solar installations. In the Gunnison Community, thermal solar may have beneficial applications but clearly small scale photovoltaic projects are not economically competitive today. Taxing all of the people in a relatively poor community in order to subsidize a very few wealthier people to produce electricity inefficiently hardly seems like an attractive strategy. Few communities have substantive opportunities to reduce carbon intensity but the Gunnison Community has two which will be discussed later.

The challenge in the Gunnison Community is great but the challenge to others is far greater. Big players, such as India and China, and a host of smaller nations show little willingness to fully endorse significant CO₂ reduction targets, and who could expect otherwise? The world has nearly 1.5 billion people without electricity and Bangladesh, India and Pakistan together have 570 million without electricity [[EIA -- Access to Electricity](#)]. Any way it is measured, India and other developing countries need to give their citizens more energy at a lower cost if they are to improve the living standards of their people. For many rapidly growing economies, electricity from coal will be the cheapest or only affordable option, and even the wealthier countries appear to be encountering push back [Pew Research Center for the People & the Press – global warming 20th “top priority”](#) from citizens who fear rapidly rising energy costs on top of a

moribund economy and record high unemployment. The hurdles to meeting a 20% by 2020 target worldwide seem insurmountable.

Will a small community, such as Gunnison, impose very difficult sacrifices on itself if it is clear that state, national and world-wide emission targets will not be met and that their sacrifices will not be equally shared by others? It hardly seems likely, but it is equally improbable that national leaders will readily step forward to admit failure to achieve their emissions targets. Since the forces that brought first the US Conference of Mayors Agreement, followed by the 20% by 2020 target, are unlikely to dissipate, it would seem likely that new goals will be needed to supersede the 20% by 2020 targets.

Recommendations

1. It is impossible to have an effective energy or emissions plan without proper data about energy use. Gunnison Community's planners need energy consumption data to craft plans and to monitor trends in energy consumption. Annual sales data for electricity, natural gas, propane and transportation fuels ought to be routinely reported and posted for the community on line. Because of its geographic isolation and tourism, the Gunnison Community is an ideal site for studying energy consumption and emissions.
2. Gunnison County's approach to energy and emissions may prove wiser in retrospect than the approach adopted by the three larger cities in the Gunnison Community (setting 20% by 2020 targets). County government has not adopted specific emissions targets and instead focuses on reducing energy use in county buildings, in the county fleet, and in its infrastructure maintenance activities [[GC 2008 Strategic Plan](#)]. In doing so, the county gets valuable insight about what works well and not so well, it sets a good example for the community, and it isn't pledged to perform the impossible. More realistic, and more motivating goals, are likely to come out small wins and achieved milestones, not to mention the learning that will accrue. If all units of government and public entities, such as Western State College, regularly report the consequences of their conservation efforts, the improved knowledge base that will help everyone be a better energy planner and consumer.
3. Local governments need to develop analytical capabilities that can help guide their decision making, especially in terms of building codes and standards. For example, should the community require that future large facilities be carbon neutral? Government needs to be able to show the extent to which such a requirement will actually help achieve energy and emission goals before such policies are adopted.

Without proper analytical capabilities, the potential for green washing and poor decisions is very great. Who thinks ethanol as we do it now is a great idea?

4. The Gunnison Community is quite fortunate to have two potential opportunities to reduce its carbon intensity. The first potential opportunity is to install a modestly sized hydroelectric turbine in the Taylor Dam. Generating capacity installed in the dam might contribute an additional -0.14% to Gunnison's rate of carbon intensity decline, compared to a rate of around -0.3% without Taylor power. Few communities are blessed with a dam and penstock in place, just waiting for a turbine. The second possibility comes from geothermal power. If the Gunnison Community could obtain all of its electricity from hydro and geothermal power, it would be the energy strategy version of winning the lottery. Gunnison's rate of CI decline would drop from around -0.2% or so to -6.7%. Rather than badly missing the 20% by 2020 CO₂ target, Gunnison would achieve a 57% reduction in CO₂ by 2020. Perhaps equally important to many, Gunnison could likely use its supply of carbon free, dependable electricity as a lure for business growth and diversification of the Gunnison Community economy. With sufficient geothermal electricity, the surplus could be sold to offset transportation CO₂ and Gunnison could, in the accounting used today, be considered a carbon neutral community.