Efficacy of Public Expenditure in Avoiding Global Warming Pollution

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The Clean Energy Progress Fund will raise approximately $180 million per year to be invested in renewable energy, energy efficiency, and agricultural soil sequestration. The efficacy of this investment in reducing Colorado's global warming pollution hinges critically on how effectively public spending can be used to avoid emissions. In this document we review the data available and arrive at an average figure of $10/mtCO2e[1]. While there is a wide range around this number, Clean Energy Progress believes that this represents a minimum; as we ascend the learning curve the cost of avoiding global warming pollution should go down.

Net cost savings

The focus of this document is how much *public expenditure* must be made to avoid global warming pollution. However, we must emphasize in the strongest terms that almost all energy efficiency measures and many renewable energy projects lead to a *net savings*. That is, a small amount of public expenditure results in a large savings to the private sector. Thus, the Clean Energy Progress Fund truly is an investment with a very large return on investment. Figure 1 from the McKenzie and Company report on the cost of reduction GW pollution [1] shows the net cost of reducing global warming pollution. Bars below the horizontal zero line represent net savings and above are a net cost. The horizontal axis is the net amount of GW pollution avoided in billions of metric tons per year. As a point of reference, the annual emissions of the United States are about six billion tons CO2e per year. McKenzie and Company, in this graph, clearly show that about 25% of our GW pollution emissions can be avoided at a net savings. And that we can extend to nearly 50% reduction before we are paying more than we pay in a business as usual scenario. From the figure we can see that the most cost effective solutions will only require small policy adjustments in building codes and transportation standards.

GW Pollution Reduction Options and Cost

This section lists the best available documentation on the cost of reduction of GW pollution. We are not advocating any particular options here. Rather we are surveying the available data.

1. Chicago Climate Exchange (CCX) [2]

The CCX is a voluntary trading system in GW pollution gases with hundreds of members. CCX members make a voluntary but legally binding commitment to meet annual GHG emission reduction targets. Those who reduce below the targets have surplus allowances to sell or bank; those who emit above the targets comply by purchasing CCX. On February 5, 2008, carbon was trading for **$2.60/mtCO2e**. While Clean Energy Progress does not advocate sending our

[1] "mtCO2e" represents metric tons (1000 kg or 2200 lb) of carbon dioxide equivalent. Since different forms of global warming pollution have different global warming potentials, they are put on a level basis using CO2e. For example, one metric ton of methane would represent 23 metric tons of CO2e because methane is such a powerful global warming gas.

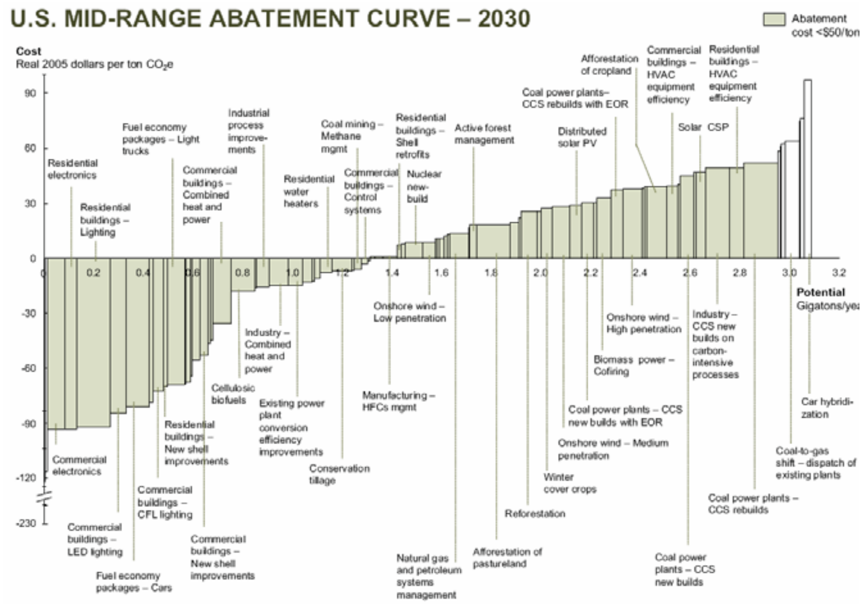

Figure 1. The net cost of reducing global warming gases. Ref 1.

revenues out of state to the CCX, the trading figure represents a valuable benchmark for the price avoiding GW pollution in real-world markets.

2. Agricultural Soil Sequestration

CSU researcher Paustian and coworkers, in their report "Agriculture's Role in Greenhouse Gas Mitigation" [3] have estimated that between 5 and 14 percent of the nation's global warming pollution could be sequestered in agricultural soils if we provide incentives to farmers of **\$13/mtCO2e** to modify their practices. In many cases these changes lead to improvements in soil productivity as well.

3. City of Boulder Climate Action Plan [4]

In November 2006, Boulder became the first city in the nation to voluntarily agree to impose a fee on GW pollution to support energy efficiency and renewables. The Climate Smart campaign is part of Boulder's effort to become Kyoto compliant by 2012. That is, the city seeks to reduce its GW pollution emissions 7% from a 1990 baseline. The reductions Boulder seeks will be 350,000 mtCO2e/yr relative to the baseline.

Boulder prepared a Climate Action Plan in advance of the November 2006 vote which laid out the costs of GW pollution mitigation. In this report we will separate the energy efficiency aspects from the renewable energy part.

<u>Energy efficiency (EE):</u> Boulder estimates that it can avoid over 75,000 mtCO2e per year with EE at an annual cost of \$425,000/yr (p. 57), for a specific cost of less than **\$6/mtCO2e**. The biggest avoided GW pollution will be in the commercial/industrial sector (54%) but residential also makes a big contribution (40%).

<u>Renewable energy (RE):</u> Boulder's plan for RE is primarily to encourage commercial, industrial, and residential energy users to install photovoltaics and to purchase wind renewable energy

credits (RECs). The purchase of wind credits costs **$12/tonCO2e** although most of that cost will be borne by the private sector. The city will also purchase a large amount of RECs in the final year if needed to meet the Kyoto target. Looking only at the public expenditure, the plan is to spend $930,000 on RE to avoid over 200,000 mtCO2e for a specific cost of less than **$5/tonCO2e**.

4. California Energy Commission.

California has been the clear leader in the nation in implementing energy efficiency measures. As a result their per capita electricity consumption is just about half the national average, resulting in a $40/month savings (**[5]**, slide 8). The data on the public cost of this program are elusive, but we could find these figures from Art Rosenfeld of the CEC **[5]**, slide 12:

Electricity savings due to utility efficiency programs:	20,000 GWh/yr
Cost of this program:	1% of electric bill

If we crunch these numbers with the Colorado grid average carbon intensity (1.75 lb/kWh) and the cost of electricity in California ($0.14/kWh), we derive a cost of **$20/mtCO2e** avoided. Note the "1% of electricity bill" has very little precision.

5. Lawrence Berkley Laboratory.

Bolinger and Wiser of LBL examined the impacts of "clean energy funds" by 14 states [6]. In most cases, these funds are generated through public benefit charges on electricity. The total collected is over $500 million/yr and is directed toward renewable energy. The types of projects supported include biomass, geothermal, waste tires, and biogas/landfill gas with the largest sector (by far) being wind. There is a wide range of costs per energy for the incentives, but the average is close to $15/MWh. Assuming that we displace a typical grid average mix (e.g., Denver), the cost will be **$15/mtCO2e** for renewables.

6. Purchasing compact fluorescent bulbs.

CEPF could offer 100% buydowns of compact fluorescent (CFL) light bulbs. If we use these assumptions:

Time on:	4 hrs/day
Wattage:	CFL = 13 W, standard = 60 W
Bulb cost:	$2.50
Lifetime:	12,000 hrs
Carbon intensity of electricity:	1.75 lb/kWh

CFL bulbs avoid 0.055 mtCO2e at a cost of $0.30/yr for a specific cost of **$5.50/mtCO2e** avoided.

Summary

Method	Cost ($/mtCO2e)
Chicago Climate Exchange	<$3
Agricultural Soil Sequestration	$13
Boulder Climate Action Plan – EE	$6
Boulder Climate Action Plan - RE	$5
Wind REC purchase (Boulder CAP)	$12
California Energy Commission - EE	$20
Lawrence Berkley Laboratory – RE	$15
CFL 100% buydown	$5

References

[1] Creyts, J.; Derkach, A.; Nyquist, S.; Ostrowski, K.; Stephenson, J. *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Greenhouse Gas Mapping Initiative*; McKenzie and Company: 2007; www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf.

[2] *Chicago Climate Exchange*; www.chicagoclimatex.com.

[3] Paustian, K.; Antle, J. M.; Sheehan, J.; Paul, E. A. *Agriculture's Role in Greenhouse Gas Mitigation*; Pew Center on Global Climate Change: 2006; www.pewclimate.org/docUploads/Agriculture's%20Role%20in%20GHG%20Mitigation.pdf.

[4] *Boulder Climate Action Plan*; 2006; www.bouldercolorado.gov/files/Environmental%20Affairs/climate%20and%20energy/cap_final_14aug06.pdf.

[5] Rosenfeld, A. *Energy Efficiency for California, the US, the World, No. 1 in the California "Loading Order"*; 2007; www.energy.ca.gov/2007publications/CEC-999-2007-030/CEC-999-2007-030.PDF.

[6] Bolinger, M.; Wiser, R. *The Impact of State Clean Energy Fund Support for Utility-Scale Renewable Energy Projects*; Lawrence Berkeley National Laboratory: 2006; http://eetd.lbl.gov/ea/ems/cases/LBNL-56422.pdf.