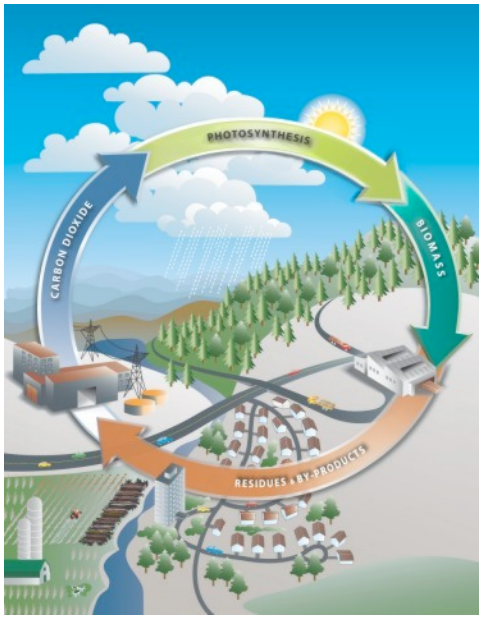
CLIMATE NEUTRAL BONDING:
BUILDING GLOBAL WARMING SOLUTIONS
AT THE STATE AND LOCAL LEVEL



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The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information to city and state governments, citizen organizations and industry.

Since 1974, ILSR has researched the technical feasibility and commercial viability of environmentally sound state-of-the-art technologies with a view to strengthening local economies. The Institute works to involve citizens, governments and private enterprise in the development of a comprehensive materials policy oriented toward efficiency, recycling, and maximum utilization or renewable energy sources.

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Climate Neutral Bonding:
Building Global Warming Solutions at the State and Local Level

John Bailey, Institute for Local self-Reliance
February 2006

I. Introduction

> "Sometimes doing the right thing is almost too simple. Requiring publicly funded construction projects to produce no net increase in greenhouse gas emissions is one example: it's hard to find the down side."
>
> David Morris, Vice President
> Institute for Local Self-Reliance

An avalanche of public opinion polls validate Americans' deep seated willingness to take responsibility for any adverse environmental impact resulting from our use of energy.

According to an August 2005 Harris Poll 74 percent of people agreed that, "Protecting the environment is so important that requirements and standards cannot be too high, and continuing environmental improvements must be made regardless of cost." A September 2005 ABC News/ Washington Post Poll found that 41 percent of Americans believe that global warming requires immediate government action; an additional 47 percent thought longer term action is necessary. In 2004, a nationwide poll by the Global Strategy Group found that 70 percent of Americans consider global warming a "very serious" or "somewhat serious" problem.[1]

Individuals can take responsibility in a number of ways.

- As consumers we can make smart purchases: buying energy efficient appliances and furnaces, installing ground source heat pumps, buying fuel-efficient vehicles or green electricity.
- As citizens we can advocate in our legislative and regulatory arenas for policies that maximize efficiency and the use of renewable resources.
- As taxpayers we can demand that the government use our money efficiently, a demand that can often be met by minimizing its energy expenditures.

This memo proposes a strategy that can begin to allow us, as citizens and taxpayers, to make concrete our desire to live lightly on the earth. That strategy is to convince all tax exempt bond issuing agencies at the state and community level to adopt a climate neutral bonding policy.

II. Municipal Bonds

Tax-exempt municipal bonds are issued to finance a variety of development and public works projects. These bonds are dubbed "munis" even though they are issued by a wide array of public entities, from state and local governments to school boards, public agencies and public authorities.

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1 Polling information from PollingReport.com [http://www.pollingreport.com/] and Yale University's Center for Environmental Law and Policy [http://www.yale.edu/envirocenter/].

Making the projects funded with municipal bonds climate neutral offers an attractive opportunity for people in virtually all communities to make concrete their commitment to environmental protection and efficient use of resources.

1. Opportunities exist in all communities. The majority of munis are issued by state and local agencies. Many bonds are either voted on directly (e.g. school bonds) or are issued because of a decision of a legislative body, agency or city council whose members have been elected and therefore should be receptive to citizen influence

2. Opportunities occur frequently. More than 9,000 projects, from police stations and schools to water treatment facilities and power plants were financed in 2004 by municipal bonds. That comes to about 150 per week.

3. The potential impact is vast. Collectively, municipal bonds finance projects that will consume large amounts of energy over the life of the bond. In 2004, local and state governmental bodies issued about $230 billion in municipal bonds (not including bond refinancing).

4. Successes can spread rapidly. States and local entities adopting climate neutral bonding policies can learn what works and what doesn't. Each can learn from the others' experiences. Successes can be quickly imitated. And once adopted by the public sector, climate neutral buildings can serve as models for privately financed buildings. Local architects and engineers, trained to design climate neutral buildings, can market their expertise to private construction projects.

Long-Term Municipal Bond Issuance

	New Capital (excludes refinancing)	
	$ Million	# of issues
2000	165,386.6	9,960
2001	197,335.2	10,112
2002	236,960.4	9,794
2003	262,343.7	9,682
2004	229,474.8	8,995

Source: Thomson Financial Securities Data

III. Climate Neutral Bonding

As of December 2005, nearly 200 U.S. municipalities have formally declared their intention to achieve the greenhouse gas (GHG) reduction goals of the Kyoto Protocol. Concretely, that means reducing global warming pollutants generated by city agencies and local businesses and residents by 7 percent below 1990 levels.

With no action at the Federal level, some States are also taking a leadership role in addressing global warming by enacting innovative policies. In December 2005, seven Northeastern states have committed to cut their CO2 emissions 10 percent by the end of 2018 (includes Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont). California has a goal to reduce its statewide GHG emissions by 80 percent compared to 1990 levels by 2050.

These are welcome and potentially far reaching developments. But it will take time to have an impact. For most states and communities, before implementing GHG reduction policies, they will have to gather data: estimates of the base level of emissions in 1990, determination of the current emissions level and estimates of the future growth rates of community-wide GHG emissions. This can be a time consuming and lengthy process. There is no need to wait for the studies to be completed to act.

A climate neutral bonding policy can be implemented immediately, without the need for an extensive survey of GHG emissions data. Determining the baseline emissions under climate neutral bonding is simple. It's zero, period. A baseline of zero means that any greenhouse gases emitted after the bond-financed project becomes operational will have to be offset.

How Climate Neutral Bonding Works

Climate neutral means that there is no net increase in greenhouse gas emissions within the bond issuing agency's geographical jurisdiction after the project becomes operational. Several elements of this definition might require further elaboration and justification.

1.*Why a zero net increase standard? Shouldn't we do better than that?*

> Of course. The zero net increase standard was chosen because of its simplicity. All of the methodologies and procedures developed to implement this policy could be used to apply a more stringent policy. For example, one might adopt a policy that for every 1-pound increase in CO2-equivalent GHG emissions from a bonded project, there must be a 1.5-pound decrease elsewhere.

2. *Why require the offsets to occur within the bond issuing agency's jurisdiction? Wouldn't it be less expensive if offsets in other states or countries were allowed?*

> It may be less expensive to do offsets elsewhere. But we view climate neutral bonding as an initiative of community responsibility. It becomes the first step in what should be a truly comprehensive process of addressing a global problem at the state and local level. Responsibility is undermined if we can continue to generate pollution simply by planting trees in a far off region of the planet. We also believe that architects and engineers will find a treasure trove of opportunities for improving efficiency and tapping into renewable energy within the state or local jurisdictions. Moreover, the effectiveness of local GHG offsets can be more easily monitored than remote projects.

With this said, each jurisdiction will frame its own rules. Some may allow, for example, the purchase renewable energy certificates from projects in other parts of the country. Although not a hard or fast rule, we believe that in most cases, local energy efficiency improvements will be a cheaper offset option than the purchase of regional or national green electricity.

The Benefits of Climate Neutral Bonding

Communities and states that require climate neutral bonding will enjoy a variety of benefits.

1. Financial. The savings from reduced operating costs in almost all cases is significantly greater than the modest increase in capital costs, over the life of the bond.

2. Job creation. Climate neutral bonding will nurture expertise among architects, engineers and builders in terms of efficient design and construction. This expertise will be increasingly marketable at home and abroad in a world where the Kyoto Protocol is now in effect.

3. Environmental. Climate neutral bonding will result in buildings that will generate less pollution, improve air and water quality, and healthier occupants.

4. Psychological. Citizens will have the satisfaction and pride that comes from being a member of a truly responsible community.

Climate Neutral Initiatives on the Rise

With growing awareness and concern about global warming, many state and local initiatives are moving ahead. Below find a selection of some interesting models that we are aware of at this time.

University of British Columbia Reducing CO2 Despite Student Expansion

The University of British Columbia (UBC) is in the midst of the largest energy and water infrastructure upgrade ever to take place on a Canadian campus. The $32 million initiative will be entirely paid for through guaranteed energy savings using a "performance-based contract" with an energy service company. Despite a 24 percent increase in students since 1999, UBC has reduced energy use in buildings by 10 percent and CO2 emissions from buildings was reduced by 11 percent. Despite building expansions to accommodate new students, there have been reductions of CO2 emissions per square meter of building area by 27 percent since 1990.
More: http://www.sustain.ubc.ca/

Seattle City Light's Zero Greenhouse Gas Emissions Goal

In 2001, Seattle committed its municipally owned utility to a well-defined policy (Resolution Number 30359) to become the first major utility in the country to achieve zero net GHG emissions. In November 2005, the city announced that the utility had met this goal.

Seattle City Light (SCL) estimates that GHG emissions in 2005 will be about 200,000 metric tons of carbon dioxide (CO2) equivalent. SCL's emissions are associated with the production and purchase of electricity and utility operations including the use of vehicles and heating of facilities. SCL has avoided and decreased its GHG emissions through energy conservation programs, divesting from a coal plant and purchasing renewable energy.

SCL has also purchased GHG emissions offsets from other organizations that have the ability to reduce their emissions more economically than the utility could on its own. SCL has budgeted about $750,000 per year for 2005 and 2006 to cover the cost of emissions offsets. That breaks down to about $2 per customer annually, according to the utility.
More: http://www.cityofseattle.net/light/conserve/globalwarming/default.asp

OTHER CLIMATE CHANGE INITIATIVES

U.S. Mayor's Climate Protection Agreement
This initiative spearheaded by Seattle's Mayor, has enlisted nearly 200 cities around the country to adopt the goals of the Kyoto Protocol to reduce GHG pollutants by 7 percent compared to 1990 levels.
More: http://www.seattle.gov/mayor/climate/

Cities For Climate Protection Campaign
In 1993, the International Council for Local Environmental Initiatives (ICLEI) developed the Cities for Climate Protection (CCP) campaign. As of late 2005, ICLEI's CCP program has 675 participants in 30 countries.
More: http://www.iclei.org/index.php?id=800

California Goal of Reducing GHG Emissions by 80 Percent by 2050
In June 2005, California's Governor signed an Executive Order that calls for a reduction of GHG emissions to 2000 levels by 2010; a reduction to 1990 levels by 2020; and a reduction to 80 percent below 1990 levels by 2050.
More: http://www.climatechange.ca.gov/

University Efforts to Address Climate Change
A growing number of colleges and universities are weaning themselves from carbon technologies and reducing energy consumption on their campuses. The University Leaders for a Sustainable Future are tracking these developments.
More: http://www.ulsf.org/

Woking's Climate Neutral Development Policy

Woking (pop. 90,000), a borough just outside London has adopted a comprehensive climate change strategy. The plan covers the whole spectrum of Woking's energy uses: power, heat, water, waste disposal and transport for the

city, homes and businesses. Woking believes that it is the only city in the United Kingdom with a plan that is likely to meet targets of 60% reductions of CO2-equivalent emissions by 2050 and 80% by 2100.

Since energy efficiency and environmental policies were implemented in 1990, Woking's city operations of have achieved a reduction in energy consumption of 44 percent and a reduction in CO2 emissions of 72 percent. It is estimated that Woking's residents and businesses produced about 1 million metric tonnes of CO2 equivalent emissions in 1990. Woking's Climate Change Strategy aims to reduce this to 200,000 tonnes a year by 2090.

To address future development pressures and their associated GHG emissions, Woking will be encouraging policies that result in a lower level of CO2 emissions on each site. Woking's overall objective is that any new land use must see a reduction of CO2 emissions by 80% compared to the previous use. This would mean that if an office building were replaced with a housing estate, the housing estate would have to incorporate energy uses that result in significantly lower CO2 emissions that were produced by the office building.
More: http://www.woking.gov.uk/council¡planning/publications/climateneutral2

IV. Climate Neutral Bonding: Implementation, Costs and Benefits

An October 2003 comprehensive report to California's Sustainable Building Task Force, The Costs and Financial Benefits of Green Buildings, confirmed that minimal increases in upfront costs of about 2 percent to support green design results, on average, in 20 year savings of 20 percent of total construction costs – more than ten times the initial investment. For example, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of $1 million in today's dollars over 20 years.

A June 2005 report prepared by The Weidt Group for the Minnesota Office of Environmental Assistance, High Performance Building Design in Minnesota, found that buildings designed to use 30-40 percent less energy than required to meet the state's energy code will typically payback the increased cost in less than 2.5 years.

Based on case study data, minimizing energy consumption during the design stage of a new building is the most cost-effective way to reach toward a zero net increase in global warming pollution. Further offsets will likely be most cost-effective by improving energy efficiency within the community.

Measuring GHG Emissions

Architects and engineers will be familiar with building analysis software tools that will allow them to model the expected energy consumption in the building (i.e. electricity, heating, air conditioning and hot water). Once the energy consumption estimates are known, a calculation of greenhouse gas emissions can be made directly using known GHG coefficients based on the projected fuel consumption and type of fuel used.

See the appendix to this report find more information on measuring GHG emissions.

Minimizing the Need for GHG Offsets and Offset Options

Once the building is designed in the most economically and energy-efficient manner, additional offsets will occur off-site but within the bond issuer's jurisdiction. At the local level, since electricity is often generated outside the community's borders, some cities may view the purchase of green power from the local utility to be a reasonable approach to obtain GHG offsets. We'd prefer to see GHG offsets related to electricity, natural gas or other fuel consumption be done as part of energy conservation within the community but this will be up to the individual bond issuing entity to decide.

Energy Efficiency - The most cost effective GHG offsets within the state or local jurisdiction will likely be energy efficiency measures in other buildings. A school, state department or city hall could be a candidate for new energy efficient lighting, new boilers, motors or air conditioners. From extensive studies of utility-sponsored energy conservation programs, the American Council for an Energy Efficient Economy concludes that it costs about 2.9 cents to save a kWh of electricity. Therefore the city can spend 2.9 cents to eliminate a kilowatt-hour (kWh) and the associated GHG emissions. An additional benefit is that the city will no longer be paying for that kWh it otherwise would have been using (e.g. 5-8 cents).

Energy services companies (ESCOs) often work under performance contracts where they will install and oversee energy conservation strategies and are paid from all or a portion of the savings that are realized. After a pre-determined number of years the economic savings are passed on directly to the building owner.

Renewable Energy Development - A community or state could install their own renewable energy project as a way to offset their GHG emissions. For example, according to the American Wind Energy Association, a single 750-kilowatt (kW) wind turbine (~$1 million) produces roughly 2 million kilowatt-hours (kWh) of electricity annually. Based on the U.S. average fuel mix, approximately 1.5 pounds of CO2 is emitted for every kWh generated. This means that an average wind turbine prevents the emission of about 1,500 tons of CO2 each year.

Renewable Energy Purchases - A bond issuer could decide to do GHG offsets by subscribing to a utility-sponsored renewable energy program (known as green-pricing) or purchasing certified renewable energy certificates. There are hundreds of green-pricing programs offered around the country that allow residential and business customers to pay a surcharge to get a portion or all of their electricity from renewable energy developments. In Minnesota, for example, Xcel Energy's Windsource® program charges an extra $0.02 per kilowatt-hour for wind energy.

A comprehensive listing of green pricing programs in each state is available at the Green Power Network web site - http://www.eere.energy.gov/greenpower/.

We should keep in mind that using green pricing for GHG offsets will not eliminate an existing kWh of energy. Therefore, when comparing green pricing with efficiency as a GHG offset option, the full cost of the green electricity must be used. The full cost of the GHG offset with green pricing might be 7 cents per kWh or more when comparing it to energy efficiency. The green pricing option will likely represent the cost ceiling in terms of possible GHG offsets.

Tree Planting in the Community - Tree planting in the community is another possible option for GHG reductions. To offset 1-ton of CO2/yr. requires the planting of approximately 3 trees each year, according to the nonprofit organization, American Forests [see http://www.americanforests.org/resources/ccc/]. There is some level of uncertainty surrounding how well and for how long trees can "sequester" carbon dioxide. Tree planting and a variety of other possible options for carbon sequestration are currently under intense scientific scrutiny.

Switching to Renewable Fuels – Switching from high carbon fuels to cleaner or renewable fuel is a possible option for GHG offsets. The City of Seattle's municipal owned utility is obtaining GHG offsets by paying for local fleets and a local ferry to use biodiesel blends in their vehicles and ships. The utility has also signed an offset agreement with Princess Cruise Lines by switching two ships from diesel to electricity during their stay in Seattle. The utility found these options to be a more economical approach when compared to other GHG offset options.

V. Climate Neutral Bonding Economics: A Case Study Building

The case study below demonstrates that making a building as energy efficient as possible is a cost-effective way to reduce global warming pollution compared to renewable energy purchases. In the example below, 43 percent of the emissions compared to a standard building are reduced through high-performance design elements for an upfront additional cost of $64,166 (~$9.50 per ton of CO2 over 20 years). This is repaid through energy cost savings in less than 3 years. For comparative purposes, if we were to assume that an expensive GHG offset option is used (e.g. green electricity purchase), the remaining GHG emissions offsets will cost $175,822 over 20 years (~$20 per ton of CO2). This would increase the payback period of the climate neutral building to nearly 10 years. Even at 10 years, this should still be acceptable payback period for public sector buildings.

Case Study: High-performance Police/Fire Station in Minnesota

Building Type	**Police/Fire Station**	
Building Area	39,510	sq. feet
Upfront Electric Savings	372,127	kWhs
Upfront Electric Savings	47%	
Net Expected Electric Use	419,633	kWh
Upfront Natural Gas Savings	1,189	Million Btu
Upfront Natural Gas Savings	33%	
Net Expected Natural Gas Use	2,414	million Btu
Net Expected Natural Gas Use	2,344	Mcf
Upfront Energy Cost Saving	$ 24,572	
Upfront Energy Cost Savings	39%	
Upfront CO2 Savings	678,406	lbs
Upfront CO2 Savings	43%	
Upfront Total CO2	1,577,688	lbs
CO2 Offset needed	899,282	lbs
CO2 Offset needed	449.64	tons
Incremental Upfront Costs w/out additional CO2 offsets	$ 64,166	
Simple Payback	2.6	years
CO2 Offset Calculation		
Cost of CO2 Offset on electric - green pricing	$ 0.02	per kWh
Cost of CO2 Offset on natural gas - Green Tag	$ 0.17	(per Mcf natural gas)
Annual Cost of CO2 Offset for Electricity	$ 8,393	per year
CO2 Offset Costs - 20 years for Electricity	$ 167,853	20 years
Annual CO2 Offset Cost of Natural Gas	$ 398	per year
CO2 Offset Costs - 20 years for Natural Gas	$ 7,969	20 years
Total Annual CO2 Offset Costs	$ 8,791	per year
CO2 Offset Costs - 20 years	$ 175,822	20 years
Total Increased Cost over 20 years	$ 239,988	20 years
Simple Payback including Offsets (not including non-energy operational savings)	9.8	years

Calculations were derived from case study data from *High Performance Building Design In Minnesota* , The Weidt Group, June 2005 http://www.moea.state.mn.us/publications/highperformance-weidt.pdf

The case study below assumes that purchasing renewable energy from an electric utility for 2.0 cents per kWh offsets the global warming pollution from the building's electricity consumption. Since we are purchasing GHG offsets using green pricing instead of energy efficiency, the existing electricity consumption and costs remain unchanged. Similarly, GHG emissions from the building's natural gas usage are offset by purchasing renewable energy certificates (green tags) for 17 cents per Mcf and consumption remains unchanged.

Under this scenario, energy cost savings and carbon offsets will still result in a savings of $251,000 over 20 years (not including other operational savings as a result of energy efficiency investments).

VI. A Model Climate Neutral Bonding Resolution For Cities

If a city or other public agency is serious about reducing greenhouse gas emissions in their community, the following climate neutral bonding policy (tailored for each city's or other jurisdiction's specific needs) should be one of the tools in its global warming toolbox.

THE CLIMATE NEUTRAL BONDING RESOLUTION

WHEREAS, the [INSERT CITY NAME] wishes to adopt strong policy resolutions calling for a reduction of global warming pollution; and

WHEREAS, the Intergovernmental Panel on Climate Change (IPCC), the international community's most respected assemblage of scientists, has found that climate disruption is a reality and that human activities are largely responsible for increasing concentrations of global warming pollution; and

WHEREAS, on February 16, 2005, the Kyoto Protocol, an international agreement to address climate disruption, went into effect in the 141 countries that have ratified it to date; 38 of those countries are now legally required to reduce greenhouse gas emissions on average 5.2 percent below 1990 levels by 2012; and

WHEREAS, the United States of America, with less than five percent of the world's population, is responsible for producing approximately 25 percent of the world's global warming pollutants; and

WHEREAS, the Kyoto Protocol emissions reduction target for the U.S. would have been 7 percent below 1990 levels by 2012; and

WHEREAS, many cities throughout the nation, both large and small, are reducing global warming pollutants through programs that provide economic and quality of life benefits such as reduced energy bills, green space preservation, air quality improvements, reduced traffic congestion, improved transportation choices, and economic development and job creation through energy conservation and new energy technologies; and

WHEREAS, the city of [INSERT CITY NAME] has signed the U.S. Mayors Climate Protection Agreement which, as amended at the 73rd Annual U.S. Conference of Mayors meeting, commits the city to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and in the wider community:

NOW, THEREFORE, BE IT RESOLVED THAT:
Section 1: the city of [INSERT NAME] will require all future individual projects above $[INSERT AMOUNT OR SQUARE FEET] involving the issuance of municipal bonds to add no net increase in global warming pollution to community-wide emissions levels.

Section 2: the city of [INSERT NAME] will establish the criteria necessary to evaluate a proposed project's ability to offset increases in global warming pollution.

Section 3: the city of [INSERT NAME] will adopt a selection of acceptable global warming pollution reduction strategies within the community that may include but are not limited to energy efficiency, renewable electricity, passive solar, cogeneration, fuel switching, carbon sequestration, and purchases of carbon offset credits.

Section 4: the city of [INSERT NAME] will monitor global warming pollution reduction efforts and evaluate and quantify the emission reductions that occur related to the bonding projects.

This resolution becomes effective upon final approval.

The example resolution is targeted and written for the cities that have adopted the U.S. Mayor's Climate Protection Agreement and are making efforts to reduce GHG emissions in their community. This resolution will require that bonded projects result in no net increases in global warming pollutants within the community. It requires the city to adopt a selection of acceptable global warming pollution reduction strategies within the community such as energy efficiency, renewable electricity, passive solar, cogeneration conversion, carbon sequestration and purchases of carbon offset credits.

VII. The Building's CO2 Emissions Must Be Monitored

Local or state governments making a commitment to climate neutral bonding should not forget the importance of measuring and disseminating the results of their efforts. Since upfront costs may increase because of the need to finance carbon offsets, the bond issuer will have to show that this policy produces long-term benefits through lowered energy and operating costs.

There are many software tools in use that analyze building energy performance and they do this in different ways. As a result, the conclusions from the various tools are often inconsistent with each other and comparisons are difficult unless the same tool has been used for each analysis.

To resolve this problem, DOE's Program on Energy Efficiency and Renewable Energy is developing standard methods of measuring and reporting the performance metrics of commercial buildings. Their work is available at http://www.eere.energy.gov/buildings/highperformance/performance_metrics/

An option that the U.S. Department of Energy recommends is the Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) volumes [http://www.evo-world.org/]. The IPMVP organization's documents can be used in the following ways:

- to develop a measurement and verification [M&V] strategy and plan for quantifying energy and water savings in retrofits and new construction,
- to monitor indoor environmental quality, and
- to quantify emissions reductions.

Appendix: Measuring GHG Emissions

The greenhouse gas emissions resulting from a bonded project will be calculated from the new buildings projected energy consumption. Energy use would include the energy used in generating electricity, heating, hot water production and air conditioning. Once the energy consumption estimates are known, a calculation of greenhouse gas emissions can be made directly based on the projected fuel consumption and type of fuel used.

Countries that have signed the Kyoto Protocol must meet reduction targets covering emissions of the six main greenhouse gases, namely:

- Carbon dioxide (CO2);
- Methane (CH4);
- Nitrous oxide (N2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride (SF6)

Typically the various greenhouse gas emissions are converted and measured in terms of their carbon dioxide equivalent (know as CO2e). The following definitions from the Pew Center on Global Climate Change (http://www.pewclimate.org/) illustrate the relationships.

- Carbon Dioxide (CO2): CO2 is a colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Of the six greenhouse gases normally targeted, CO2 contributes the most to human-induced global warming. Human activities such as fossil fuel combustion and deforestation have increased atmospheric concentrations of CO2 by approximately 30 percent since the industrial revolution.
- Carbon Dioxide Equivalent (CO2e): CO2 is the standard used to determine the "global warming potentials" (GWPs) of other gases. CO2 has been assigned a 100-year GWP of 1 (i.e., the warming effects over a 100-year time frame relative to other greenhouse gases). The emissions of a gas, by weight, multiplied by its "global warming potential."
- Global Warming Potential (GWP): A system of multipliers devised to enable warming effects of different gases to be compared. For example, over the next 100 years, a gram of methane (CH4) in the atmosphere is currently estimated as having 23 times the warming effect as a gram of carbon dioxide; methane's 100-year GWP is thus 23. Estimates of GWP vary depending on the time-scale considered (e.g., 20-, 50-, or 100-year GWP), because the effects of some GHGs are more persistent than others.

Unless the building generates all of its electricity on-site, it is slightly more complicated to calculate the precise amount of greenhouse gas emissions related to electricity consumption since the electricity is produced by a combination of fuels used by the city's electricity supplier. In general, the coefficient is about 2.3 lbs CO2 for each kilowatt-hour (kWh) of 100 percent, coal-fired electricity. To be precise, a city will have to contact their electricity supplier to determine the most accurate CO2 coefficient for their electric supply.

A fairly accurate, rough calculation could be made using statewide CO2 coefficients for electricity put out by the Energy Information Administration. [see http://www.eia.doe.gov/oiaf/1605/e-factor.html]. These coefficients range in value from a low in Washington of .03 lbs per kWh [Vermont and Idaho] to a high of 2.24 lbs per kWh [North Dakota]. The following table shows GHG emission coefficients for a variety of fuels and feedstocks. For a complete table of emission factors for various fuels see the U.S. Energy Information Administration at: http://www.eia.doe.gov/oiaf/1605/factors.html