CHAPTER 2:
BERKELEY'S GREENHOUSE GAS EMISSIONS ESTIMATES

A. WHY CONDUCT A GHG EMISSIONS INVENTORY?

Measure G targets an 80 percent greenhouse gas emissions reduction below 2000 levels by the year 2050. This target is in absolute terms, meaning that it is independent of population or workforce growth. To ensure that Berkeley stays on course to meet this long-term target, it makes sense to set interim, short-term targets and to track emissions reduction progress over time by conducting regular, community-wide greenhouse gas emissions inventories.

It helps to think of an emissions inventory as a "snapshot" of community emissions for a given year. This "snapshot" is a useful policy tool because it quantifies the main sources of heat-trapping emissions for which the community is responsible. Equipped with this knowledge, we can better target policies and actions to address those sources.

The emissions inventory is useful for another important reason: it helps to remind us that we are both part of the global warming problem and part of the solution. The GHG emissions that the inventory captures are the result of *our* energy consumption in *our* homes, businesses, industries and institutions and in *our* motor vehicles. We are sources of global warming pollution, known as anthropogenic sources. Fortunately, we are also the source of solutions. By driving less, creating more energy efficient buildings, shifting to renewable sources of energy and by committing as a community to the actions laid out later in this plan, we can collectively start to turn this problem around. One city cannot solve the problem on its own. But if Berkeley leads, as it has done so often in the past, others will follow.

B. INVENTORY METHODOLOGY

The International Council for Local Environmental Initiatives (ICLEI) conducted Berkeley's GHG emissions inventory for the year 2005. ICLEI provides the accepted community-level inventory methodology for over 700 local governments throughout the world. City staff conducted inventories of Berkeley's 1990[9] and 2000 emissions using ICLEI's inventory methodology and emissions analysis software tool (Clean Air & Climate Protection software).

To estimate Berkeley's emissions, ICLEI and City of Berkeley staff persons collected data from a number of different sources. PG&E provided electricity and natural gas consumption data for community-wide energy consumption. This energy consumption data is applied to an emissions factor in order to arrive at an estimate for tons of GHG emissions.[10] The Metropolitan Transportation Commission (MTC) and the Bay Area Air Quality Management District (BAAQMD) provided transportation-related data. MTC provides an estimate for total vehicle miles traveled (VMT) within City limits and BAAQMD provides an estimated breakdown of the vehicle types that are responsible for Berkeley's VMT.

When calculating Berkeley's emissions inventory, all electricity and natural gas consumed in the City is included. This means that, even though the electricity used in Berkeley buildings is produced elsewhere,

[9] Berkeley's 1990 GHG emissions inventory is incomplete due to lack of available transportation-related data.
[10] The emissions factor for electricity was provided through ICLEI by PG&E and is 0.49 lbs. CO_2e per KWh. The emissions factor for natural gas was provided through ICLEI by the U.S. Department of Energy and is 12.3 lbs. CO_2e per therm.

the emissions associated with it appear in the inventory. The decision to calculate emissions in this manner reflects the philosophy that a community should take full ownership of the impacts associated with its energy consumption, regardless of whether the generation occurs within the geographical limits of the community.

However, the emissions that result from energy consumption at UC Berkeley (UCB) and Lawrence Berkeley National Laboratory (LBNL) are not included in the inventory. ICLEI's inventory methodology assumes that local governments have little ability to influence the operational decisions of autonomous institutions in a community, such as universities and buildings owned and operated by other levels of government. Both UCB and LBNL are developing and implementing strategies to reduce their own greenhouse gas emissions.

For the transportation sector, Berkeley's GHG inventory estimates the emissions that result from vehicles driven within City limits. While the intent of ICLEI's inventory methodology is to measure emissions that a local government can influence through municipal policy, setting the boundaries of the inventory at the city limits leads to a less than complete picture of how a community may influence those emissions. First, the current methodology under-reports community transportation-related emissions. For example, Berkeley's inventory does not currently capture sources of emissions such as people driving to or from Berkeley by interstate (e.g., on I 80); the emissions that result from Berkeley citizens driving outside of Berkeley; and the emissions that result from citizens of other communities driving to Berkeley (until they reach City limits) for jobs and other services. In short, *Berkeley is responsible for significantly more transportation-related emissions than what is reported in the emissions inventory.*

Second, because the current inventory methodology only captures vehicle travel within city limits, it does not capture how local land use decisions can affect *regional* motor vehicle travel. For example, focusing mixed-use development near transit stations in Downtown Berkeley may increase passenger vehicle miles traveled (and the associated emissions) in Berkeley in the short-term by increasing Berkeley's population. But such a land use strategy would ultimately reduce the *region's* greenhouse gas emissions by enabling more individuals to drive less because they can now live in a more compact, pedestrian-friendly, transit-oriented neighborhood such as Downtown Berkeley.

As described further in the Sustainable Transportation & Land Use chapter, Berkeley's land use and transportation decisions occur in a regional context. Therefore, the community must consider other indicators beyond the community-level emissions inventory when making policy decisions. ICLEI is currently updating its inventory protocols to enable communities to better capture and report transportation-related GHG emissions. In addition, City staff is working to develop more specific estimates for the scale of emissions generated as a result of vehicle miles driven to and from Berkeley.

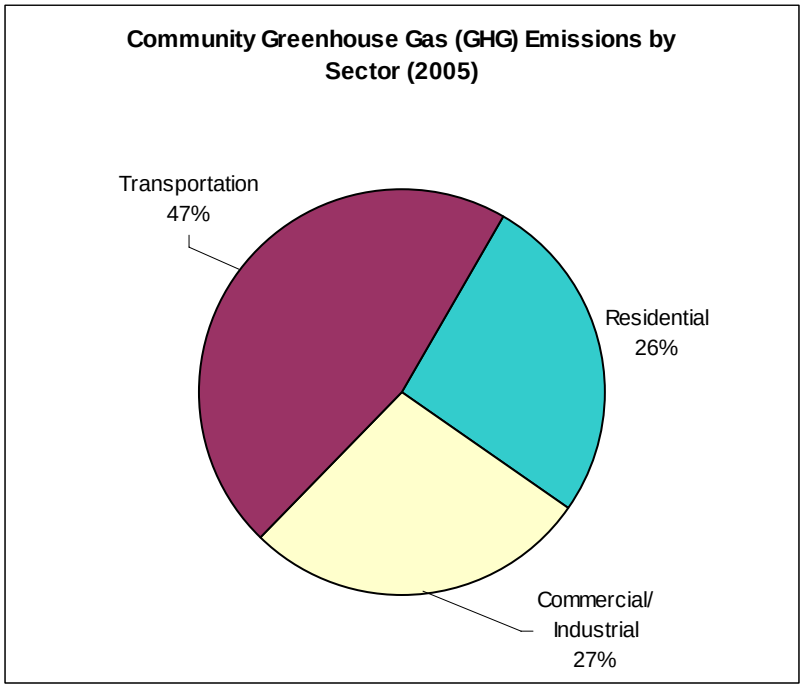
An additional limitation of note to the current community level emissions inventory methodology is that, despite the fact that the beneficial effects of waste diversion on greenhouse gas emissions are well documented, the Berkeley greenhouse gas emissions inventory *does not* include the emissions that result from the waste our community sends to the landfill. This is not an oversight but, rather, is indicative of the difficulty in accurately measuring solid waste-related emissions. This limitation notwithstanding and in light of the known GHG reduction potential of solid waste diversion, this plan contains a series of solid waste diversion strategies, as well as the potential GHG reductions associated with them. Further, ICLEI is currently partnering with the Alameda County Waste Management Authority & Recycling Board (known as StopWaste.Org) to update Berkeley's emissions inventory to include solid waste-related emissions.

Despite the limitations mentioned above, ICLEI's emissions analysis assistance is sophisticated and useful. But calculating the emissions that result from energy consumption with precision is inherently difficult. The model depends upon numerous assumptions and is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by the model as a rough approximation rather than an exact value.

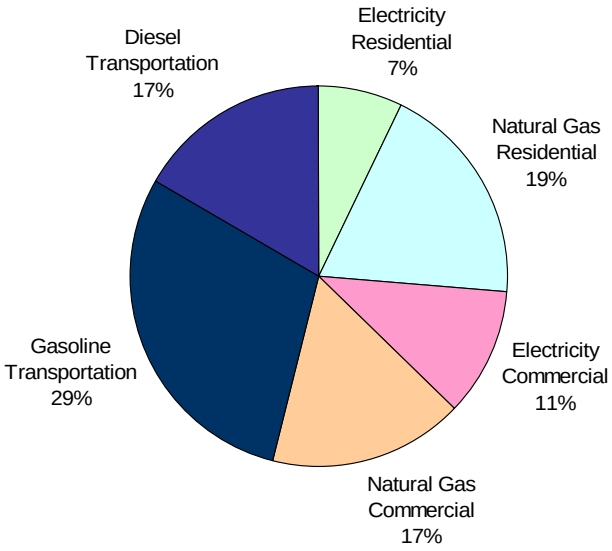
C. BERKELEY'S EMISSIONS PORTFOLIO

The table and charts below depict Berkeley's most recent emissions "snapshot," year 2005.

Berkeley Greenhouse Gas Emissions (2005)			
Sector	**Source**	**Metric Tons CO_2e**	**Percent**
Residential		**152,599**	**26%**
	Electricity	40,822	
	Natural Gas	111,777	
Commercial		**157,746**	**27%**
	Electricity	61,302	
	Natural Gas	96,444	
Transportation		**265,544**	**47%**
	Gasoline	169,031	
	Diesel	96,512	
TOTAL EMISSIONS		**575,889**	**100%**



Berkeley's community-wide greenhouse gas emissions totaled 575,889 metric tons of CO_2-equivalent ($MTCO_2e$)[11] in 2005. This is roughly the equivalent amount of emissions that result from 106,000 sedans traveling 12,000 miles per year.



Gasoline and diesel consumption by vehicles driving within the Berkeley City limits accounts for about 47 percent of Berkeley's total greenhouse gas emissions, approximately 265,500 $MTCO_2e$ per year as of 2005. The emissions that result from gasoline consumption, mostly in private vehicles, are nearly double the emissions that result from the diesel consumed in trucks and other large vehicles. Gasoline consumption is the single largest source of GHG emissions in Berkeley.

Commercial and residential buildings account for the remaining 53 percent of emissions. Natural gas use is by far a larger source of emissions than electricity in both the commercial and residential sectors. Natural gas is predominately used for space and water heating.

Municipal operations constitute about one percent of Berkeley's total emissions. These emissions are included in the commercial and transportation sector data.

The 2005 inventory reflects a significant decrease in greenhouse gas emissions in Berkeley: an almost nine percent decrease between 2000 and 2005, one of the largest reductions in GHG emissions documented by any U.S. city.

A portion of these reductions can be attributed to increased energy efficiency in Berkeley homes and businesses. This period also included the 2000 California energy crisis. Surveys conducted by utilities and community groups at that time show that many consumers turned to energy efficiency in order to reduce energy costs.

[11] Emissions are aggregated and reported in terms of carbon dioxide equivalent units, or CO_2e. Converting all greenhouse gas emissions to carbon dioxide equivalent units allows for the consideration of different greenhouse gases in comparable terms. For example, methane is 21 times more potent than carbon dioxide in its ability to trap heat, so ICLEI's emissions analysis software converts one ton of methane emissions to 21 tons CO_2e.

According to data provided by the Metropolitan Transportation Commission (MTC), transportation-related emissions remained steady during that same period. The table below shows a slight reduction, but given the approximate nature of the community emissions analysis, the reduction is considered to be within the margin of error.

Overall the reductions add up to approximately 56,000 fewer metric tons of greenhouse gas emissions in the atmosphere compared to 2000, or the emissions equivalent of taking over 12,000 sedans off the road.

Berkeley GHG Emissions Trend (in metric tons CO_2e): 2000 - 2005

	2000	2005	Percentage Change
Residential Sector			
Electricity	45,806	40,822	-10.9%
Natural Gas	129,971	111,777	-14%
subtotal	**175,777**	**152,599**	**-13.2%**
Commercial/Industrial Sector			
Electricity	70,636	61,302	-13.2%
Natural Gas	112,417	96,442	-14.2%
subtotal	**183,053**	**157,746**	**-13.8%**
Transportation Sector			
Gasoline	175,888	169,031	-3.9%
Diesel	97,145	96,512	-0.7%
subtotal	**273,033**	**265,544**	**-2.7%**
TOTAL EMISSIONS	**631,863**	**575,889**	**-8.9%**

While the reduction in GHG emissions in Berkeley between 2000 and 2005 is a remarkable accomplishment, a sustained, community-wide emissions reduction effort is necessary to continue this trend and achieve Berkeley's emissions reduction targets.

How does energy consumption translate into GHG emissions?

1 kWh of electricity = approximately 0.5 lbs. (0.22 kg) CO_2e

1 therm of natural gas = approximately 12 lbs. (5.6 kg) CO_2e

1 gallon of gasoline = approximately 20 lbs. (9.4 kg) CO_2e

D. EMISSIONS INVENTORY VS. CARBON FOOTPRINT

Not all of the greenhouse gas emissions generated by the community are included in Berkeley's emissions inventory. This does not mean that we limit our strategies to those that reduce the emissions we can currently quantify. It means, rather, that with the current state of emissions modeling, a community is limited in its ability to comprehensively measure and quantify its climate impact.

This point illustrates the difference between an emissions inventory and a "carbon footprint." Berkeley's inventory includes the emissions that we know how to measure and that result from actions taken within the City. Alternatively, a "carbon footprint" examines a broader range of emissions for which individuals and institutions are responsible. For example, a "carbon footprint" may examine lifestyle and consumption choices such as air travel; the energy required to grow and ship the food we eat; and the "embodied energy" in products, i.e., the energy associated with acquiring raw materials and

manufacturing, packaging, transporting, distributing, using and disposing of a given product. At this time, it is difficult to accurately calculate and assign responsibility for the emissions that result from this energy consumption at a community scale. Nonetheless, it is important that Berkeley residents and businesses do what is in their power to reduce their "carbon footprint" by buying local, reducing packaging and taking other climate-friendly behavioral steps outlined in this report.

E. EMISSIONS FORECAST AND TARGETS

Setting interim targets is essential in order to gauge community progress on the road to 80 percent by 2050. In fact, 10 - 15 years is about the longest timeframe over which defensible assumptions can be made about the impact on future emissions of things like technological change; future growth in population and housing; and future local, state, and federal legislation.

This plan focuses on actions our community can and should implement between now and 2020, but in the context of promoting the types of innovative approaches that will be necessary to achieve the ultimate 2050 target.

The 2020 target is to achieve a 33 percent absolute reduction below 2000 community-wide emissions levels, which equates to about a two percent reduction per year in total community-wide emissions.[12]

To accurately estimate the actual reduction in tons needed to achieve the 2020 target, it is necessary to estimate a forecast of how the community's future emissions may change in a "business-as-usual" scenario. A "business-as-usual" scenario assumes no community emissions reduction activities. It projects emissions based on applying basic housing unit and workforce growth factors to the energy consumption data used to conduct Berkeley's emissions inventory. The Association of Bay Area Governments (ABAG) provides projected workforce and housing unit data in its *Projections 2007*,[13] an estimate of how much Berkeley is forecasted to grow through 2035. Based on these data, City staff estimates that a 30 percent reduction from forecasted emissions levels is required to meet the absolute target. This equates to an annual GHG emissions reduction of over 188,000 metric tons CO_2e by the year 2020.[14]

Note that when establishing an emissions reduction target for the Berkeley community, it is important to not lose sight of the fact that climate change is a global issue and that GHG emissions know no boundaries. Meaning that even though Berkeley has its own local GHG reduction target (as do hundreds of local governments), it would be antithetical to the purpose of setting a climate protection target if that target were achieved in part by shunning its share of growth and shifting it to other communities. This is especially the case given the fact that Berkeley is a transit-rich, walkable community as compared to most communities in the region. Berkeley residents have generally excellent transit choices as well as extensive bicycle and pedestrian infrastructure.

It is important, therefore, that Berkeley assumes its share of the region's population growth and ultimately establishes a methodology for tracking progress toward the GHG reduction goals that

[12] The 2020 target was determined from a linear extrapolation from year 2000 emissions levels to 80 percent below 2000 levels by the year 2050.
[13] *ABAG Projections 2007* is available at http://www.abag.ca.gov/planning/research/projections_2007.html
[14] The targeted reduction from the 2020 growth forecast is lower than the 33 percent absolute reduction because there was a significant decrease in emissions between 2000 and 2005, which is greater than the forecasted growth between 2005 and 2020.

accounts for change in population or economic activity that is *inconsistent* with what has been assumed, i.e., an unexpected growth or reduction in Berkeley's population or economy. The outcome of the methodology, which City staff is currently refining, will provide a better accounting of regional transportation-related GHG emissions.

For example, if the Berkeley community were to absorb more household growth than what is forecasted by ABAG, then one could assume that that household growth is being displaced from somewhere else in the region. Because Berkeley is a relatively dense, transit-rich community, one could also assume that the average new household in Berkeley drives less and is responsible for fewer GHG emissions than the average household in the region. Given these assumptions, a new household in Berkeley is displacing some GHG emissions that would have occurred if that household was cited elsewhere, i.e., in a less dense and transit-rich community. In order to account for the regional nature of transportation and land use policy, this displacement of GHG emissions related to where household growth occurs must be captured and quantified. City staff is working to integrate a methodology for doing so in to ongoing efforts to track Berkeley's community-wide GHG emissions and emissions reductions.

In conclusion, greenhouse gas emissions from each of the various sources identified in Berkeley's emissions inventory must decrease steadily and significantly over the coming years to achieve the Measure G targets. This requires implementing an unprecedented array of strategies mainly geared toward reducing energy consumption in buildings and motor vehicles. A series of such strategies, as well as actions for reducing waste, is outlined in the remaining chapters of this report.