

Appendix A: Emissions Inventory, Baseline, and Projections Methodologies

This appendix summarizes the methodologies and assumptions used contained within the greenhouse gas (GHG) emission inventory, baseline, and projections.

Emissions Inventory

This section describes methods used by ICLEI – Local Governments for Sustainability (ICLEI) to develop Albany’s GHG emissions inventory. The methodology for each emission sector (i.e., energy, transportation, waste) is discussed below.

Methodology

ICLEI’s Clean Air Climate Protection (CACP) Software is an emissions inventory computer program that uses activity data (e.g., energy consumption, vehicle miles traveled [VMT]) to calculate GHG emissions associated with each emission sector. ICLEI used California-, Alameda County-, and/or Albany-specific activity data and emissions factors when possible, which generated a more accurate estimation of GHG emissions for the City. The methods and assumptions used for each sector are summarized as follows.

Energy Consumption

The emissions inventory used natural gas and electricity consumption data for residential, commercial, and industrial land uses for the year 2004 from Pacific Gas and Electric (PG&E). The energy consumption data separated private from City-operated facilities. Due to PG&E’s 15/15 Rule, discussed below in the GHG Emissions Baseline section, energy consumption data for commercial and industrial land uses were combined together for both natural gas and electricity.

To calculate GHG emissions from natural gas and electricity consumption, ICLEI obtained California-specific emission coefficients from PG&E. For natural gas consumption, a 2005 PG&E-specific emission factor (kilograms of CO₂ per million British thermal units [kg CO₂/MMBtu]) for natural gas delivery was used within CACP for both community-wide and government-related natural gas consumption. A 2005 natural gas delivery coefficient was used because no verified 2004 coefficients were available. The PG&E-specific natural gas coefficient was verified by California Climate Action Registry (CCAR) and the California Energy Commission (CEC). Similar to natural gas consumption, a 2005 PG&E-specific emission coefficient (pound of CO₂ per kilowatt [lb CO₂/kWh]) was used for electricity delivery, which is also verified by CCAR. The 2005 electricity coefficient was used because no verified coefficients were available for operational year 2004. The PG&E-specific electricity emission coefficient accounts for the cleaner (i.e., less carbon intensive) electricity portfolio used by PG&E relative to the nation-wide average.

Transportation

Metropolitan Transportation Commission (MTC) and the California Department of Transportation (Caltrans) provided VMT data for local roadways within the City limits. Public transit activity data (i.e., Bay Area Rapid Transit [BART] and Alameda and Contra Costa [AC] Transit) were embedded within the community-wide data.



Caltrans also provided VMT data for state highways located within the City limits. Lastly, the City provided detailed vehicle and VMT data for the government (i.e., City) vehicle fleet.

ICLEI used the California Air Resources Board's (ARB) Emission Factors model (EMFAC2007) to obtain Alameda County-specific emission coefficients for vehicle fuel distribution, vehicle fuel efficiencies, and emission factors. Alameda County-specific EMFAC2007 data were only used for community-wide transportation data. The City provided municipal vehicle fleet data with specific information regarding fuel and vehicle types. ICLEI also used EMFAC2007 to generate emission factors for the City vehicle fleet.

Solid Waste

The California Integrated Waste Management Board (CIWMB) provided solid waste disposal data. Alameda County-specific waste categorization percentages were obtained from the *Alameda County Waste Characterization Study 2000*. Due to the differences in the *Alameda County Waste Characterization Study's* waste categories and the categories contained within CACP, the *Waste Characterization Study* categories were combined to better match CACP categories. For example, waste categories from the *Alameda County Waste Characterization Study* such as plastic, glass, metals, and other waste were combined together to account for an "all other waste" category within CACP. For Government-related waste categories, standard state waste percentages from CIWMB were used.

CACP provides GHG emission factors for various solid waste categories. These factors, which are based on national emission data, were used to calculate GHG emissions associated with solid waste disposal. The only alteration of the factors was to remove credit for carbon captured in landfilled solid waste, because the method does not include responsibility for carbon emissions from production and consumption of materials that later become solid waste.

Emissions Baseline

To refine the 2004 emissions inventory to establish an effective baseline for the Climate Action Plan (CAP), the City requested that EDAW conduct a peer review of the inventory. This effort resulted in modifications to the 2004 GHG emissions inventory to remove GHG emissions associated with travel on state highways and add GHG emissions associated with water consumption. Table A-1 identifies the City's GHG emissions baseline for the year 2004 for purposes of the CAP. Albany's reduction target of 25% below baseline emissions by 2020 applies to these baseline emissions, which include the government-related emissions presented in Table A-1.

Methodology

Transportation

Albany's community-wide transportation sector includes emissions generated from VMT on local streets and state highways. State highway traffic is responsible for 79% of the GHG inventory's total transportation emissions. The City has no control over the vehicles passing through Albany on state highways and their associated GHG emissions. Thus, the 2004 GHG emissions baseline does not include these emissions. The community-wide transportation sector contains only VMT on local roadways, which can be directly influenced by City policy and action.

**Table A-1.
Albany Baseline GHG Emissions and Percent Contributions**

Community Sector	Final Inventory Emissions	
	Metric Tons CO ₂ e	Percent
Residential Energy Use	20,495	29%
Commercial/ Industrial Energy Use	20,788	30%
Transportation¹		
Local travel	23,703	34%
Waste	3,652	5%
Water Consumption	1,190	2%
Total	69,830	100%

Source: Data compiled by EDAW 2008 from ICLEI's CACP inventories.

Notes: Totals may not appear to add exactly due to rounding.

¹ Transportation emissions occurring in the City's limits also include state highway VMT, which accounts for 89,049 metric tons CO₂e per year. These emissions are not included in the calculation of the City's baseline emissions due to the inability of City policies to control or affect state highway VMT patterns.

Water Consumption

Energy use associated with water consumption accounts for approximately 20% of California's total energy use (CEC 2006). However, the 2004 GHG inventory did not include emissions associated with water consumption. In order to more accurately portray existing conditions, water-related GHG emissions in Albany were added to the 2004 baseline. The East Bay Municipal Utility District (EBMUD) provided historical water consumption data (1976-2008) for Albany. The 2004 water consumption data were used to calculate the City's GHG emissions associated with water consumption.

CEC has estimated the level of electricity use associated with water supply and conveyance, water pre-treatment, water distribution, and wastewater treatment in both Northern and Southern California (CEC 2006). Assumptions used to estimate water-related electricity consumption for Albany are specific to Northern California. CCAR's *General Reporting Protocol* Version 3.1 GHG emission factors for electricity use were then used to calculate MTCO₂e associated with water-related electricity use. As discussed above, residential and commercial/industrial GHG emissions associated with energy consumption were calculated using PG&E-specific assumptions. However, due to range of utility providers potentially engaged in the water delivery process, California statewide-average GHG emission assumptions were used to project emissions associated with water-related energy consumption in Albany.

Energy Consumption

As mentioned above, PG&E provided energy use (i.e., natural gas and electricity) data for both community-wide and government-related operations. Based on PG&E's 15/15 Rule, any aggregated information provided by the utilities must be made up of at least 15 customers and a single customer's load must be less than 15% of an assigned category. If the number of customers is below 15, or if a single customer's load is more than 15%, PG&E must combine certain data categories (e.g., commercial and industrial energy consumption) prior to

release to protect the privacy of individual users. The 15/15 Rule was triggered for both electricity and natural gas consumption data provided to the City. Thus, PG&E aggregated both commercial and industrial energy consumption as a single sector.

The lack of detailed information resulting from the 15/15 Rule limits the ability of planners and decision-makers to target major energy use sector contributors. Various methods were employed to attempt to separate the commercial and industrial energy consumption data, including using CEC average energy consumption rates with existing land use quantities, extracting information from the Bay Area Air Quality Management District's (BAAQMD) GHG inventory, and examining criteria air pollutant emission inventories. None of these methods provided sufficient information to accurately separate commercial and industrial energy use data. Therefore, the energy use portion of the GHG inventory with aggregated commercial and industrial energy consumption is used as the basis for baseline conditions.

Projections

To determine the GHG emission reductions necessary to achieve Albany's target (i.e., a 25% reduction in emissions relative to 2004 emission levels by 2020), the City's GHG emissions were projected for the years 2020 and 2050 under a trend scenario. The trend scenario assumes that historical data and trends would be representative of future year consumption rates for energy, water, and waste. It should be noted that the purpose of this CAP is to address the City's 2020 target. The City recognizes the 2050 goal (i.e., 80% below 1990 levels) established by Executive Order S-03-05. However, due to the uncertainty of projecting 2050 activity and emission levels, this CAP focuses on the 2020 goal. As 2020 approaches, the City will reevaluate its GHG reduction target to better represent progress towards the 2050 goal.

Assuming that the same type of current emissions-generating practices continue to occur within Albany, the City's GHG emissions would be anticipated to increase from 69,830 MTCO₂e in 2004 to about 71,995 MTCO₂e in 2020, and about 85,106 MTCO₂e in 2050. This represents a 3% and 22% increase over the 2004 baseline level in 2020 and 2050, respectively. In comparison, the City's projected population is expected to increase 4% by 2020 and 16% by 2050 from 2004 (ABAG 2002). Therefore, if current practices continue, Albany's GHG emissions are expected to increase at a higher rate than its population by 2050. This trend can be explained by increases in per capita activity levels (i.e., energy consumption, waste disposal, water consumption, and vehicle miles traveled).

A description of the methods and sources of information used to project the City's 2020 and 2050 GHG emissions for each end-use sector (e.g., energy, transportation, waste, water) is provided below. All GHG emissions have been calculated in MTCO₂e, which accounts for the global warming potential of nitrous oxide and methane. A summary of Albany's GHG emissions for the baseline year (2004), 2020, and 2050 is shown below in Table A-2.

Methodology

Energy Consumption

As shown above in Table A-2, GHG emissions associated with residential energy consumption in Albany are projected to increase by 3,070 MTCO₂e in 2020 and 8,050 MTCO₂e in 2050, a 15% and 39% net increase from baseline (2004) levels, respectively. GHG emissions associated with commercial/industrial energy consumption in Albany are projected to increase by 822 MTCO₂e in 2020 and 4,825 MTCO₂e in 2050; a 4% and 23% net increase from baseline levels.

Table A-2.
Albany GHG Baseline (2004) and Projected 2020 and 2050 Emissions

Emissions Sector	2004 Baseline MTCO ₂ e (Percent of Total Emissions)	2020 Projected MTCO ₂ e (Percent of Total Emissions)	2050 Projected MTCO ₂ e (Percent of Total Emissions)
Residential – Natural Gas	14,567 (20.9%)	17,079 (23.7%)	20,794 (24.4%)
Residential – Electricity	5,929 (8.5%)	6,487 (9.0%)	7,752 (9.1%)
<i>Subtotal Residential</i>	<i>20,496 (29.4%)</i>	<i>23,566 (32.7%)</i>	<i>28,546 (33.5%)</i>
Commercial – Natural Gas	8,139 (11.7%)	8,299 (11.5%)	8,883 (10.4%)
Industrial – Natural Gas	4,009 (5.7%)	3,660 (5.1%)	4,261 (5.0%)
Commercial/Industrial – Electricity	8,641 (12.4%)	9,651 (13.4%)	12,470 (14.7%)
<i>Subtotal Commercial/Industrial</i>	<i>20,789 (29.8%)</i>	<i>21,610 (30.0%)</i>	<i>25,614 (30.1%)</i>
Transportation	23,703 (33.9%)	23,028 (32.0%)	29,975 (35.2%)
Waste	3,652 (5.2%)	2,813 (3.9%)	¹
Water Consumption	1,190 (1.7%)	977 (1.4%)	971 (1.1%)
Total	69,830	71,995	85,106

Sources: ICLEI 2008; EDAW 2009.

Notes: Totals may not appear to add exactly due to rounding.

¹ The 2050 solid waste sector has been omitted due to uncertainty inherent in future-year data.

In order to estimate GHG emissions associated with energy consumption in Albany in 2020 and 2050, an annual average growth rate was applied to baseline (2004) electricity and natural gas consumption rates. The U.S. Department of Energy (DOE) Energy Information Administration (EIA) publishes an annual Energy Outlook Report that forecasts electricity and natural gas consumption by land use type (i.e., residential, commercial, and industrial) for regions throughout the U.S. For Albany's 2020 and 2050 energy projections, the Pacific region forecasts from the 2009 Annual Energy Outlook were used to calculate the annual average growth rate in electricity and natural gas consumption for residential, commercial, and industrial land uses (EIA 2009). The Pacific region includes California, Oregon, Washington, Alaska, and Hawaii. Although this data includes a large geographical area, EIA data represents an accurate source of data for forecasted energy consumption in Albany.

As a result of PG&E's 15/15 Rule, the baseline inventory included aggregated commercial and industrial electricity consumption. Therefore, commercial and industrial electricity consumption was projected using the average of the commercial and industrial annual average growth rates from EIA. The 15/15 Rule also affected the commercial and industrial natural gas consumption rates. However, natural gas consumption for commercial and industrial uses can be separated using information provided in the BAAQMD regional emissions inventory (Tholen, pers. comm., 2009). For 2020 projections, annual average growth rates were developed from EIA forecasts from 2007 to 2020. For 2050 projections, annual average growth rates were developed from EIA forecasts from 2007 to 2030, which is the farthest year for which EIA forecasts energy consumption. These growth rates were applied to the baseline 2004 energy consumption levels to project 2020 and 2050 electricity

and natural gas consumption for residential and commercial/industrial land uses. Table A-3 presents the annual average growth rates for land uses and energy sources between 2007–2020 and 2007–2030 provided by EIA.

Baseline (2004) emissions calculations were based on PG&E-specific emission factors for both electricity and natural gas consumption. Although electricity, and to a lesser extent, natural gas delivery emission factors would be anticipated to decrease with time and improved technology, these factors represent the most accurate emission factors available describing Albany's future energy consumption trends.

Transportation

As shown in previous Table A-2, Albany's transportation-related GHG emissions are expected to decrease by 675 MTCO₂e by 2020, and increase by 6,272 MTCO₂e by 2050, a 3% net decrease and 27% net increase relative to the 2004 baseline, respectively. The projected decrease in 2020 transportation-related emissions can be attributed to lower emission rates of GHGs from newer vehicles. In 2020, decreased emissions from individual vehicles would likely to outweigh expected increases in VMT. However, in 2050, the projected increase in transportation-related emissions occurs largely because projected increases in VMT outweigh decreased vehicle emissions resulting from improved fuel efficiency.

Table A-3.
Summary of Emission Sector Growth Rates

Emission Sector	Average Annual Growth Rate (2007–2020) ¹	Average Annual Growth Rate (2007–2030) ²
Residential Energy Consumption – Natural Gas	1.05%	0.79%
Residential Energy Consumption – Electricity	0.60%	0.60%
Commercial Energy Consumption – Natural Gas	0.17%	0.21%
Industrial Energy Consumption – Natural Gas	-0.52% ³	0.15%
Commercial Energy Consumption – Electricity	0.92%	0.91%
Industrial Energy Consumption – Electricity	0.54%	0.72%
Average Commercial/Industrial Energy Consumption – Electricity ⁴	0.73%	0.82%
Transportation – Vehicle Miles Traveled ⁵	0.73%	0.73%
Water Consumption – Gallons Consumed ⁵	-0.02%	-0.02%

Source: EIA 2009.

¹ 2007-2020 average annual growth rates are used within the 2020 GHG projections.

² 2007-2030 average annual growth rates are used within the 2050 GHG projections.

³ The negative average annual growth rate indicates a decrease in natural gas consumption for industrial land uses.

⁴ Average commercial/industrial electricity growth rates are used to project commercial and industrial electricity use to account for limitations in the 2004 baseline due to the 15/15 Rule.

⁵ The same annual average growth was used to project 2020 and 2050 activities.

Albany's mobile source transportation activity for 2020 and 2050 was projected using historical Albany-specific VMT data from the Federal Highway Administration's (FHWA) High Performance Monitoring System (HPMS) published by Caltrans (Caltrans 2007). Based on historical VMT data on local public roads for Albany from 2001 to 2007, an annual average VMT growth rate of 0.7% (shown above in Table A-3) was applied to baseline 2004 VMT data to project Albany's 2020 and 2050 VMT.

An Alameda County-specific emission factor for gasoline and diesel fuel from EMFAC 2007 was used to calculate projected CO₂ emissions associated with projected VMT in Albany. Forecasted Alameda County population, VMT, and fuel consumption data for 2020 and 2050 by vehicle class were used to calculate weighted-average fuel efficiencies (i.e., miles per gallon) for both gasoline- and diesel-fueled vehicles. The 2020 and 2050 projected VMT data for both gasoline- and diesel-fueled vehicles was then divided by the weighted-average fuel efficiencies to calculate gallons of gasoline and diesel fuel consumed. The total gallons of gasoline and diesel fuel consumed were multiplied by the EMFAC2007 emission factors to calculate CO₂ emissions.

CCAR's *General Reporting Protocol* Version 3.1 provides N₂O and CH₄ emission factors for gasoline- and diesel-fueled vehicles by vehicle class (CCAR 2009). These factors were weighted using Alameda County-specific vehicle class population and distribution information, then multiplied by projected 2020 and 2050 VMT, respectively, to calculate projected N₂O and CH₄ emissions. The N₂O and CH₄ emissions were then weighted by their GWP and added to CO₂ emissions to obtain MTCO₂e.

Waste

As shown in Table A-2, Albany's waste-related GHG emissions are expected to decrease by 839 MTCO₂e by 2020, a 23% net decrease relative to the 2004 baseline. City waste disposal data was used to project Albany's 2020 solid waste disposal needs. The City has established a goal to reduce the amount of solid waste disposed from 1990 levels by 90% by 2030. The Alameda County Waste Management Authority and Source Reduction and Recycling Board (operating together as StopWaste.org) provided solid waste disposal data (i.e., tons of solid waste entering landfills) for multiple benchmark years, which were used to interpolate the City's 2020 solid waste disposal assuming a linear path to the 2030 90% reduction goal. This projection does not include 2050 waste-related GHG emissions, due to the uncertainty of solid waste disposal following achievement of the 2030 goal.

CACP was used to quantify GHG emissions associated with 2020 solid waste disposal levels of using nationally-averaged emission factors for various types of waste. The projected GHG emissions were calculated assuming the same percent distributions for solid waste disposal categories as used in the baseline inventory.

Water Consumption

As discussed above, EBMUD provided historical water consumption data (1976-2008) for Albany. Given the variability of annual water consumption growth rates during this period, water consumption for 2020 and 2050 was projected using the annual average water consumption growth rate from 1990-2008 in Albany. Table A-3 shows the annual average growth rate used to project Albany's 2020 and 2050 water consumption.

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