

A P P E N D I X F

GREENHOUSE GAS EMISSIONS
INVENTORY AND FORECAST
METHODOLOGY



Appendix F: Greenhouse Gas Emissions Inventory and Forecast Methodology

Greenhouse Gas Inventory and Forecasts for 2020 and 2030

GHG emissions were inventoried from the unincorporated areas of Butte County. The forecast years of 2020 and 2030 were chosen to be consistent with the State’s GHG reduction goals and the Butte County General Plan 2030, respectively. Table F-1 summarizes greenhouse gas emissions in unincorporated Butte County for the inventory year 2006 and Table F-2 summarizes projected emissions in 2020 and 2030 assuming buildout of the General Plan 2030.

Table F-1 Butte County Greenhouse Gas Emissions Estimate, 2006

Source	GHG Emissions (metric tons CO2e)	% of Total
Transportation :On-Road Vehicles	295,570	49.2
Transportation: Off-Road Vehicles/Equipment	40,939	6.8
Natural Gas	62,241	10.3
Electricity	106,977	17.8
Stationary Sources	4,093	0.7
Waste -Landfills (waste in place)	14,247	2.4
Waste -Single Year (future waste commitment) ¹	17,873	Not included
Agricultural Vehicles/Equipment	77,019	12.8
Total	601,266	100

¹ Provided for informational purposes only. Uses 2008 data and assumes all waste was deposited at facilities with a gas capture system.

Table F-2 Butte County Greenhouse Gas Emissions Estimate, 2020 and 2030

Source	2020 GHG Emissions (metric tons CO2e)	% of 2020 Total	2030 GHG Emissions (metric tons CO2e)	% of 2030 Total
Transportation: On-Road Vehicles	355,386 (281,466) ¹	49.7	394,258 (312,252) ¹	49.1
Transportation: Off-Road Vehicles/Equipment	51,105 (47,681) ²	7.2	63,695 (59,428) ²	7.9
Natural Gas	75,668	10.6	87,167	10.9
Electricity	130,055(110,157) ³	18.2	149,819(126,896) ³	18.6
Stationary Sources	4,906	0.7	5,540	0.7
Waste-Landfills (waste in place)	21,295	3.0	27,232	3.4
Waste-Single Year (future waste commitment)⁴	21,729	Not included	25,030	Not included
Agricultural Vehicles/Equipment	76,025 (70,931) ²	10.6	75,870 (70,787) ²	9.4
Total	714,440	100.0	803,582	100.0

¹ Accounts for Pavley I, II and Low Carbon Fuel Standard and assumes no strengthening of these standards between 2020 and 2030.

² Accounts for Low Carbon Fuel Standard.

³ Accounts for the adopted SB 1078/SB 107 Renewables Portfolio Standard.

⁴ Provided for informational purposes only and assumes all waste deposited at facilities with a gas capture system.

The baseline year 2006 was chosen based on availability of information. In cases where 2006 data was unavailable, 2007 or other recent-year data was substituted. Community wide GHG emissions were estimated for the following sectors: on-road transportation vehicles; off-road transportation vehicles and equipment; electricity and natural gas consumption related to current and new residential, commercial, and industrial development; stationary sources, waste; and agricultural vehicles. The future waste commitment of a single year’s waste is shown for informational purposes only. GHG emissions forecasts were performed for the years 2020 and 2030. Each forecast assumes “business as usual” (BAU) conditions, which essentially scales current emissions on population or other appropriate data, and does not account for any control measures or policies being implemented in the future. The projected 2030 buildout for the proposed General Plan 2030 and Zoning Ordinance indicates that by 2030 the population of Butte County will increase by 33,800 persons. This number was used to scale emissions from all sources except stationary sources where specific data was available from the General Plan and transportation which was modeled by the traffic engineer for future years. The assumptions inherent to those models (largely based on state-wide data) are included in the forecast. For informational purposes only, the impact of adopted State measures (AB 1493, Executive S-1-07, and SB 1078/SB 107) was included in the forecast in parentheses. Examples include the low carbon fuel

standard and the renewable portfolio standard. A summary of emissions from each category in the inventory for 2006, 2020 and 2030 is provided below and the methodology for each is provided in the following section.

Transportation (On-road vehicles) – Emissions from mobile sources were estimated using Unincorporated County vehicle miles traveled (VMT) as provided by the traffic engineer and the EMFAC model, which includes in its model outputs emissions and fuel economy for passenger vehicles, light and medium duty trucks, heavy duty trucks and buses, motor homes and motorcycles. Total emissions of CO₂, CH₄ and N₂O resulting from the combustion of gasoline or diesel fuel used to power on-road vehicles in the County were 295,570 metric tons CO₂e in 2006. On-road transportation accounted for 49.2% of total County GHG emissions in 2006. Based on data provided by the traffic engineer, VMT for the unincorporated County is expected to increase by roughly 35% by 2030, resulting in a corresponding increase of roughly 35% in GHG emissions from this sector. 2030 transportation related emissions are forecast to be 394,258 metric tons of CO₂e and to comprise 49.1% of the forecast 2030 GHG budget. 2020 VMT was not provided by the traffic engineer, and thus an estimate for 2020 VMT was made from the 2006 and 2030 values. GHG emissions from on-road transportation in 2020 are estimated to be 355,386 metric tons of CO₂e. Emissions reductions resulting from Pavley I and II and the Low Carbon Fuel Standard (LCFS) are estimated to be approximately 14% and 7% below BAU conditions for the transportation sector by 2020 (CARB 2008) according to the AB 32 Scoping Plan. Emissions projections for 2020 and 2030 including reductions achieved through these state measures are shown in parentheses in Table F-2. Data provided by the traffic engineer included pass-through trips in estimates of VMT. These are VMT on Butte County roads that are likely not due to Butte residents and do not originate or terminate at a destination within Butte County.

Transportation (Off-Road vehicles) – GHG emissions also result from the burning of fossil fuels to power off-road vehicles and equipment in the County such as construction and lawn and garden equipment. The California Air Resources Board's OFFROAD model was used to estimate emissions from these sources for the entire County and results scaled to the unincorporated portion based on the 2009 population distribution. Only the agricultural equipment category was excluded in these model runs. This category is treated separately below. In 2006, total emissions of CO₂, CH₄ and N₂O resulting from the combustion of fossil fuels used to power off-road vehicles and equipment in the County were 40,939 metric tons CO₂e. Off-road vehicles and equipment accounted for 6.8% of total County GHG emissions in 2006. GHG emissions from off-road equipment in 2020 are projected to be 51,105 metric tons CO₂e, or 47,681 metric tons CO₂e if the LCFS is taken into account. OFFROAD model outputs for the year 2030 indicate that emissions from this sector will amount to 63,695 metric tons CO₂e, or 7.9 % of the 2030 budget. Assuming the LCFS is fully implemented in 2030, off-road vehicles and equipment will produce 59,428 metric tons CO₂e.

Natural Gas (Residential, Commercial and Industrial Energy Use) – The on-site combustion of natural gas for heating, cooking or other purposes releases CO₂, CH₄ and N₂O. In 2006, natural gas consumption by residential, commercial and industrial customers resulted in 62,241 metric tons of CO₂e emissions.

Approximately 60% of these emissions are due to natural gas use by residential customers and the remainder to commercial and industrial customers. Future projections (2020 and 2030) of natural gas consumption were obtained by scaling the current year's estimate by population estimates as provided in the General Plan and assumed no decrease in per capita natural gas consumption through energy efficiency or conservation efforts. Population was assumed to grow linearly out to the 2030 population projection provided in the GP (117,700 persons). In 2020, natural gas consumption is projected to result in 75,668 metric tons of CO₂e and 2030, 87,167 metric tons of CO₂e. These emissions represent roughly 10% of the future year's budgets, similar to current conditions.

Electricity (Residential, Commercial and Industrial Energy Use) – Electricity generation requiring the combustion of fossil fuels results in the release of CO₂, CH₄ and N₂O. This fuel is combusted at the location of electricity generation, which may be outside of the jurisdictional boundary of Butte County. These emissions are attributed to the County, as activity within the County defines the amount of electricity that must be produced to meet demand. In 2006, electricity consumption in Butte County resulted in 106,977 metric tons of CO₂e. 66% of these emissions are due to residential electricity consumption. GHG emissions from this sector are projected to be 130,055 metric tons CO₂e and 149,819 metric tons CO₂e in 2020 and 2030, respectively. SB 1078 and SB 107 (The Renewables Portfolio Standard) set forth a requirement that by 2020, 33% of the state's power portfolio will come from renewable sources. If this target is met, a reduction of roughly 15.3% will be realized in the electricity sector (AB 32 Scoping Plan). GHG emissions accounting for full realization of the RPS in 2020 and 2030 are shown in parentheses above. Table F-2 does not take into account improvements in building energy efficiency as required by Title 24, other increases in efficiency or increases in voluntary energy conservation by consumers. It is likely that by 2020 and/or 2030 these factors will add additional reductions to those shown in Table F-2.

Stationary Sources- In 2006, fuel consumption (excluding natural gas and automotive gasoline) by industrial sources resulted in 4,093 metric tons of CO₂e. Stationary sources in Butte County compose less than one percent of the 2006 GHG inventory and are largely focused around agricultural post-processing, storage and transport. 2020 and 2030 stationary source emissions were obtained by scaling the 2006 emissions based on projections of industrial growth as outlined in the EIR Project Description (Chapter 3). GHG emissions from stationary sources in 2020 and 2030 are projected to be 4,906 and 5,540 metric tons of CO₂e respectively, or 0.7% (2020) and 0.7% (2030) of the County's total.

Waste – GHG emissions associated with waste are due to methane generated in the breakdown of solid organic material under anaerobic conditions typical of landfills. GHG emissions from solid waste were estimated from two sources: 1) the methane emitted in a single year from waste in place at the Neal Road Recycling and Waste Facility and 2) the methane generation potential over the degradation period of the waste for the total amount of waste produced in unincorporated Butte County for a single year (inventory or forecast year), also known as the "future waste commitment". The future waste commitment is provided for informational purposes only and is not included in the inventory total.

Waste (Landfills, waste in place) -The Neal Road Recycling and Waste Facility accepts waste from numerous jurisdictions, including Butte County, and will continue to generate methane emissions

regardless of the County's current and future inputs to the facility due to waste deposited in the facility between 1965 and 2009. Based on yearly depositional data and the most recent total waste in place estimate obtained from the California Integrated Waste Management Board (CIWMB),¹ the Neal Road Facility was estimated to contain roughly 2,749,105 tons of waste in place in 2008. 2006 waste in place information data was not available. The IPCC First Order Decay model was used to estimate yearly methane emissions from waste in place. Assuming 75% efficiency from flaring technology at the facility, GHG emissions due to waste in place at the Neal Road Facility were 14,247 metric tons of CO₂e in 2008. This accounts for 2.4% of Butte County's inventory. The Neal Road Facility was opened in 1965 and is scheduled to close in 2033. For the 2020 and 2030 forecasts, it was assumed that the annual waste deposited in the landfill would follow population growth trends for Butte County as projected in the General Plan (1.5% per year) and by the California Department of Finance (1.6% per year). Assuming that per capita waste generation does not decline in the future the Neal Road facility is projected to contain 4,859,157 tons of waste in 2020 and 6,969,927 tons of waste in 2030. Assuming that flaring technology maintains 75% efficiency, waste in place emissions will result in 21,295 metric tons of CO₂e in 2020 and 27,232 metric tons of CO₂e in 2030. Landfill emissions account for 3.0% of Butte County's forecasted 2020 inventory and 3.4% of Butte County's forecasted 2030 inventory. Modifications to the flaring system or gas to energy system that result in greater efficiency or increased waste diversion in future years would reduce this estimate. Additionally, reductions in per capita waste generation due to increased recycling, composting or other waste diversion would also reduce these forecasts.

Waste (Single Year, future waste commitment) - In 2008, Butte County produced 66,467 tons of solid waste, all of which was buried in landfills in California.² 2006 data was not available through the CIWMB. In 2008, 79% of Butte County's waste was deposited at the Neal Road Facility, with lesser amounts going to the Ostrom Road Facility, Sacramento Facility (Kiefer) and others in that order for tons deposited.³ The Neal Road, Ostrom Road and Sacramento (Kiefer) facilities all have methane flaring systems currently installed and it was assumed for the purposes of this analysis that all waste was deposited in facilities with some type of gas capture system. Resulting methane emissions reflect the fact that flaring systems can have in excess of 75% efficiency.⁴ For waste generated in 2008 in Butte County, 17,873 metric tons of CO₂e are expected to be emitted over the degradation time of the waste. Based on projected population growth described in the EIR Chapter 3, and assuming that per capita waste generation remains constant at the 2008 level, it is estimated that Butte County will produce 80,806 tons of solid waste in 2020 and 93,085 tons of solid waste in 2030. Waste deposited in 2020 will produce 21,729 metric tons of CO₂e over the degradation period of the waste and waste deposited in 2030 will

¹ California Integrated Waste Management Board. 2009. *California Waste Stream Profiles Homepages*. Last revised: 2008 year data. Available: < <http://www.ciwmb.ca.gov/Profiles/> > . Accessed: September 15, 2009.

² California Integrated Waste Management Board. 2009. *California Waste Stream Profiles Homepages*. Last revised: 2008 year data. Available: < <http://www.ciwmb.ca.gov/Profiles/> > . Accessed: September 15, 2009.

³ Mannel, Bill, pers. Comm. Manager, Waste Management Division. Butte County Public Works, Butte, CA. September 16, 2009—phone conversation with Margaret Williams, ICF Jones & Stokes.

⁴ ICLEI-Local Governments for Sustainability. 2008. *Local Governments Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions*. August 2008 version.. Adopted by California Air Resources Board August 12, 2008. Sacramento, CA.

yield 25,030 metric tons of CO₂e. Emissions from this source are included for informational purposes only and are not counted in the inventory and forecast totals. These emissions are included because this sector may offer more opportunities for implementing GHG reduction measures at the local level than the landfills that already have gas flaring or gas to energy systems installed.

Agriculture- GHG emissions from agriculture are related to fuel use for equipment and vehicles, fertilizer use, methane emissions from livestock, rice cultivation, agricultural practices and embodied emissions associated with water usage. Only emissions from agricultural equipment and vehicles were quantified in this inventory. OFFROAD model runs indicate that agricultural equipment and vehicles resulted in 77,019 metric tons of CO₂e in 2006 and are projected to result in 76,025 and 75,870 metric tons CO₂e in 2020 and 2030 respectively. This decrease likely reflects improvements in emissions technologies for equipment and vehicles in the future.

Methane is produced during flooded rice cultivation by the anaerobic (without oxygen) decomposition of organic matter in the soil. Flooded soils are ideal environments for methane production because of their high levels of organic substrates, oxygen-depleted conditions, and moisture. Nationwide, rice cultivation resulted in release of 6,200,000 metric tons of CO₂e in 2007.⁵ Rice is one of the three most land-intensive crops in Butte County, which, along with walnuts and almonds, account for a third of the County's total agricultural acreage. According to a U.C. Davis study on rice cultivation in California,⁶ Butte County had nearly 100,000 acres devoted to rice in 1996. Emissions vary considerably depending on soil conditions, farming practices and climate. Emissions from this source were not quantified for this inventory since accurate estimates would require site specific information that was not available at the time of this analysis. This source should be considered to the extent feasible in subsequent inventories.

Quantitative estimates of emissions from fertilizer, livestock and water usage require detailed information regarding fertilizer type and usage, as well as the day to day practices that vary substantially from farm to farm depending on size, location and primary crops or livestock. These emissions are not included in the inventory presented here but should be considered in future inventories as methodology for assessing these emissions improves and as site specific data becomes available. In the United States, agriculture represents 8.6% of the nation's total greenhouse gas emissions, including 80% of its nitrous oxide emissions and 31% of its methane emissions.⁷

Summary: In 2006, on-road vehicles (49.2%), energy usage (28.1%, natural gas and electricity) and agricultural equipment (12.8%) accounted for the majority of Butte County's emissions. Emissions from off-road equipment, waste in place at the landfill and stationary sources contributed 6.8%, 2.4% and 0.7% respectively. Total emissions in Butte County for 2006 were 601,266 metric tons CO₂e. Total

⁵ U.S. Environmental Protection Agency. 2009. U. S. Greenhouse Gas Inventory –Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2007. Released April 2009.

⁶ J.E. Hill, S.R. Roberts, D.M. Brandon, S.C. Scardaci, J.F. Williams, R.G. Mutters. 1998. Rice Production in California. Last updated September 23 1998. Available at < <http://www.plantsciences.ucdavis.edu/ucrice/PRODUCT/rpic01.htm> > . Accessed September 30, 2009.

⁷ U. S. Global Change Research Program. 2009. *Global Climate Change Impacts in the United States*. Released June 16, 2009.

emissions for the state of California in 2006 were 483,900,000 metric tons of CO₂e. In 2020, total emissions for Butte County are estimated to be 714,440 metric tons of CO₂e. Assuming full implementation of the Pavley standards (AB1493), low carbon fuel standard (S-01-07), and renewables portfolio standard (SB 1078/SB 107), Butte County emissions would be reduced by 14.3% as compared to the BAU projection. Executive S-03-05 sets forth a statewide goal of achieving 1990 GHG emissions levels by 2020 or 28.4 % below the State's 2020 BAU forecast. According to Table F-2, additional action is required at the local level in order for Butte County to reach a reduction percentage in 2020 commensurate with the State's goals. 2030 total emissions for Butte County are estimated to be 803,582 metric tons of CO₂e. On-road transportation is estimated to be 49.1% of the total GHG inventory. Residential, commercial and industrial energy consumption is forecast to account for 29.5% of the County's GHG 2030 inventory. In 2030, GHG emissions from agriculture, off-road sources, stationary sources and waste account for comparable percentages of the County total as in 2006. Although Executive Order S-03-05 articulates GHG reduction targets out to 2050, the state has not adopted a specific reduction target for 2030. Therefore, projected 2030 emissions for Butte County were not assessed for conformity with the state's GHG reduction goals. Sources that were not included in this inventory and forecast due to analytical constraints include: embodied emissions associated with water usage; emissions due to rice cultivation and agricultural practices; emissions associated with the conversion of forested, grass or agricultural lands to urban uses; and embodied emissions of materials.

Methodology

GHG emissions are quantified in terms of CO₂ equivalents. Each GHG has a different Global Warming Potential (GWP) that represents its infrared absorption strength relative to a reference gas. CO₂ is used as the standard for GHG emissions because it is most abundant in the atmosphere and has the lowest GWP. It is assigned a GWP of 1. Emissions of GHGs quantified in this inventory are reported in metric tons of CO₂e based on the GWP of the gas, as reported in the IPCC Second Assessment Report (SAR) (2001). Although GWPs reported in the most recent IPCC assessment, the Fourth Assessment Report (2007), differ slightly from those in the SAR, the SAR GWPs are recommended for use in inventories to be consistent with state and national inventories, regardless of the inventory year. The EPAⁱ recommends using the older values despite more recent scientific data so that all inventories will be calculated on the same scale. The unincorporated Butte County GHG inventory includes GHG emissions from direct and indirect sources. A direct emission source is defined as an on-site source of emissions such as the combustion of fossil fuel in a vehicle engine. An indirect emission source is defined as an emissions source generated off site as a result of County operation, such as electricity consumption.

Transportation (On-road vehicles) - The EMFAC model⁸ was used to estimate the 2006, 2020 and 2030 Butte County vehicle fleet mix by vehicle class and vehicle fuel type. The County-wide distribution of VMT by vehicle type was assumed to be representative of the vehicle distribution in the unincorporated portion of Butte County. The EMFAC was also used to generate fuel economy (mpg gasoline and mpg diesel) in the inventory and forecast years for vehicles in 5 mile speed bins that matched the designation

⁸ California Air Resources Board. 2007a. *Emission Factors Model (EMFAC)*. Last revised: February 5, 2009. Available: < http://www.arb.ca.gov/msei/onroad/latest_version.htm > . Accessed: September 17, 2009.

of traffic data as supplied by the traffic engineers. EMFAC model runs require inputs of local ambient temperature and relative humidity as engine performance and thus emission factors depend on environmental conditions. Yearly temperatures for four Butte County weather stations⁹ were averaged to yield a value of 60°F. A value of 53% annually average RH was obtained from two Butte County monitoring stations.¹⁰

Daily VMT in 5 mile speed bins was supplied by the traffic engineers for the inventory and forecast years. This data does not disaggregate pass-through trips in the County. Daily VMT was multiplied by 365.25 days per year to obtain annual VMT by speed. Annual VMT in each speed bin was apportioned to vehicle type using the Butte County fleet mix. VMT of each vehicle type and speed was then divided by the appropriate fuel economy to give fuel consumption as a function of speed, vehicle type and fuel type. Gallons of gasoline and diesel fuel were summed for the inventory and forecast years and multiplied by carbon dioxide emissions factors (kg CO₂/gallon fuel) provided by the California Climate Action Registry General Reporting Protocol.¹¹

The Environmental Protection Agency provides emission factors for CH₄ and N₂O (g/mile) for on road vehicles¹² according to vehicle class and fuel type. VMT by fuel and class were summed and multiplied by the appropriate emission factor to yield grams CH₄ or grams of N₂O per year. Yearly emissions of CH₄ and N₂O were converted to metric tons of CO₂e using the respective global warming potentials of each gas as provided by the SAR IPCC report.^{13,14}

The State of California has set forth a three-pronged approach to reducing emissions from on-road vehicles which includes: 1) increasing the fuel economy of cars, 2) decreasing the carbon content of fuels, and 3) decreasing overall VMT. The State has adopted AB1493 (see Section A.2.b of EIR Chapter 4.15, Pavley I), which sets standards for fuel economy for passenger cars and light trucks through 2016. The passage of an addendum to this program, Pavley II, which will strengthen these standards even

⁹ Desert Research Institute. 2009. Western Regional Climate Center. Last updated April 11, 2006. Available at < <http://www.wrcc.dri.edu/> > . Accessed September 25, 2009.

¹⁰ National Oceanographic and Atmospheric Administration. 2002. National Oceanographic and Atmospheric Administration. National Climate Data Center. Average Relative Humidity. Last revised: Data through 2002. Available: < <http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgrh.html> > . Accessed: September 15, 2009.

¹¹ California Climate Action Registry . 2009. General Reporting Protocol. Version 3.1. Released January 2009.. Los Angeles, CA.

¹² Environmental Protection Agency. 2009. 2009 U.S. Greenhouse Gas Inventory Report – Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2007. Released April 2009. Climate Change Division. Washington, D.C.

¹³ IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

¹⁴ GWPs from the IPCC Second Assessment Report (SAR) are used as recommended by EPA and UNFCCC inventory protocols. Although more recent scientific research has provided updates to these values, utilizing the older values allows all inventories and reductions to be assessed on the same scale. The California GHG Inventory was performed using the SAR values and thus the Butte County Inventory is consistent with state accounting protocols.

more beginning in 2017 is highly anticipated. The Air Resources Board recently adopted a low carbon fuel standard (LCFS) and is in the process of implementing a program for this standard. The AB 32 Scoping Plan provides estimates of the expected reduction from these measures and these percentage reductions were applied the 2020 and 2030 forecasted emissions.

Transportation (off-road equipment and vehicles) - The OFFROAD¹⁵ model was used to estimate emissions of CO₂, CH₄ and N₂O from off-road equipment and vehicle exhaust for the inventory and forecast years, including: recreational equipment, lawn and garden equipment, construction and mining equipment, light commercial equipment, industrial equipment, airport ground equipment, equipment associated with rail yards and oil drilling, and pleasure crafts. County-wide emissions from the OFFROAD model were scaled to the unincorporated portion of the County using 2009 population distribution. The OFFROAD model provides direct emissions of CH₄ and N₂O (tons/year) for each class of equipment. Emissions of CH₄ and N₂O were converted to CO₂ equivalents using the global warming potential of each gas as provided by IPCC SAR.¹⁶ CO₂ emissions were estimated based on annual diesel, gasoline and natural gas fuel usage as provided by the OFFROAD model and converted to CO₂ (kg CO₂ / gallon fuel) using emission factors from the California Climate Action Registry General Reporting Protocol.¹⁷

Natural Gas and Electricity (Residential, Commercial and Industrial Energy Use) – Pacific Gas and Electric provides electricity and natural gas to all of unincorporated Butte County. Annual consumption (KWH and therms) were provided by PG&E for residential, commercial and industrial sectors in the unincorporated County. PG&E also provides calculations of the associated CO₂ emissions for an individual year’s electricity and natural gas usage. These estimates are based on the CCAR verified emissions factors and were used directly in this analysis. The CCAR is a nonprofit organization that cooperates with the CARB to facilitate voluntary reporting and certification of GHG emissions. For non-CO₂ GHGs, emission factors derived from national averages (EPA, 2005) were used. Electricity and natural gas for 2020 and 2030 were estimated based on population and the current per capita usage. 2006 emission factors for natural gas and electricity were applied to the 2020 and 2030 forecasts. Because the production and delivery of electricity in California vary from year to year based on a variety of factors including peak demand and precipitation, the GHG emission factors change significantly from year to year. Thus, the amount of GHGs emitted per KWH delivered may be more or less in a given year and the forecast assumes that GHGs emitted per KWH or therms remain constant in future decades. The Renewables Portfolio Standard sets forth a goal to increase the procurement of renewable energy sources by California power companies to 33% of their annual sales by 2020. The associated reductions

¹⁵ California Air Resources Board. 2007b. off Road Emissions Inventory – OFFROAD Model. Last revised: version released 2007. Available: < <http://www.arb.ca.gov/msei/offroad/offroad.htm> > . Accessed: September 17, 2009.

¹⁶ IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

¹⁷ California Climate Action Registry. 2009. General Reporting Protocol version 3.1. Released January 2009. Available: < <http://www.climateregistry.org/tools/protocols/general-reporting-protocol.html> > . Accessed: September 17, 2009.

expected from full realization of the RPS (AB32 Scoping Plan) are accounted for in the 2020 and 2030 forecasts. It was assumed that the percent of renewable power remained at 33% through 2030 and that PG&E was able to meet that goal by 2020.

Stationary Sources - GHG emissions from stationary sources within the County largely result from the burning of fossil fuels to power equipment at industrial facilities. Permitted sources report annual fuel consumption and fuel type to the Butte County Air Quality Management District (BCAQMD). This data was provided by the BCAQMD for permitted stationary sources emitting more than 0.01 tons/day of criteria air pollutants or greater. Data was provided for the inventory year 2006 or closest year available. This method captures the largest emitters and allowed the BCAQMD to compile and provide data in a timely fashion.¹⁸ Natural gas and electricity from these sources was not included in this estimate as it has already been accounted for in our estimate for direct and indirect energy usage above. Gasoline and diesel fuel usage for vehicles associated with the source was also excluded since these emissions are counted in either the on-road or off-road component of the model. Consumed fuel by type was summed and converted to metric tons of CO₂e using the appropriate emission factors for each GHG (CCAR).

Butte County currently has 1400 acres devoted to industrial use. The General Plan 2030 and Zoning Ordinance designate 1895 acres for industrial use. 2006 GHG emissions due to industrial sources were scaled based on this ratio for 2020 and 2030 emissions.

Waste - GHG emissions due to waste in Butte County were estimated from two sources: 1) CH₄ emissions from waste in place at the Neal Road Recycling and Waste Facility in the inventory year and projected waste in place for 2020 and 2030 (waste in place) and 2) potential GHG emissions over the lifetime of the waste generated in the inventory year, 2020 and 2030 (future waste commitment). Waste in place emissions are direct emissions from a specific landfill regardless of where the waste originated. The Neal Road Recycling and Waste Facility accepts waste from both unincorporated Butte County and other jurisdictions. Because the emissions occur within the jurisdictional boundaries of the County and the facility owns and operates the facility, these emissions are accounted for in the Butte County GHG inventory (ICLEI, 2008). Future waste commitment emissions are indirect emissions associated with waste generated within the jurisdiction of Butte County, regardless of where that waste is disposed. Waste collected by the Butte County Regional Waste Management Authority is produced by Butte County businesses and residents but may be deposited at solid waste disposal facilities outside of Butte County's jurisdiction.

GHG emission estimates based on population (future waste commitment of the community's single year waste) are reported for informational purposes only, but are not included in the inventory. Including both the waste in place emissions and a single year snapshot of a population's emissions would be 'double counting' for the inventory year 2008. Landfill emissions may not offer much mitigation potential, particularly for landfills with landfill gas to energy (LFGTE) systems already in place, as is the case at the Neal Road Facility. Indirect, population-based emissions however, may provide opportunities

¹⁸ Lusk, David pers. Comm. Senior Air Quality Engineer, Butte County Air Quality Management District, Butte, CA. September 29, 2009—data received on CD by Margaret Williams, ICF Jones & Stokes.

for cost-effective mitigation options aimed at reducing the waste generated in residences and businesses. Specific methodologies for GHG estimates from both sources are described in the following paragraphs.

Waste (landfills, waste in place) - Specific site information about the Neal Road Facility was collected through the California Integrated Waste Management Board¹⁹ web site and through consultation with Bill Mannel with the Butte County Public Works Department.²⁰ Butte County owns and operates the Neal Road Recycling and Waste Facility. Opened in 1965 and scheduled to close in 2033, this facility contains two depositional sites. The first, closed in 2004, has a gas flaring system installed. The second, opened in 2005, is scheduled to have a gas to energy system operating by 2011. According to the CIWMB, the Neal Road Facility contained 3,555,429 cubic yards of waste in 2000. Assuming that annual waste deposition for 2006-2008 (tons) was representative of the period 2000-2008, the facility was estimated to contain 2,546,010 tons of waste in 2008. Methane emissions from waste in place were calculated using the IPCC FOD²¹ method with historical California waste stream data applied.²² This method treats the landfill as a stationary source emitting for the current inventory year, although the emissions are due to waste placed in the landfill over many years. It was assumed that current and future gas capture systems have an efficiency of 75%.²³ For the 2020 and 2030 scenarios, total tons of waste in place was estimated based on 2008 per capita waste generation and population growth rates as provided in the General Plan and by the State Department of Finance. The FOD model assumes a percentage of the waste is biodegradable (ANDOC) and this percentage changes as the waste stream profile changes over time. 2009 ANDOC percentage were assumed for all future years.

Waste (Single-year, future waste commitment) – Community waste generation information (tons solid waste/year) for 2008 was obtained through CIWMB. 2006 data was not available. The methane generation potential of a single year's waste, or the future waste commitment, was estimated using the following: the single year waste (tons) generated in Butte County the breakdown of waste types (waste stream profile, emissions factors based on the EPA's WARM model²⁴⁻²⁵). The CIWMB conducted a comprehensive study in 2004 of waste and waste operations

¹⁹ California Integrated Waste Management Board. 2009. California Waste Stream Profiles Homepages. Last revised: 2008 year data. Available: < <http://www.ciwmb.ca.gov/Profiles/> > . Accessed: September 15, 2009.

²⁰ Mannel, Bill, pers. Comm. Manager, Waste Management Division. Butte County Public Works, Butte, CA. September 16, 2009—phone conversation with Margaret Williams, ICF Jones & Stokes.

²¹ Intergovernmental Panel on Climate Change. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5- Waste. IPCC National Greenhouse Gas Inventories Programme. Hayama, Japan.

²² California Air Resources Board. 2009. Landfill Emissions Tool. Last update May 27, 2009. Available at < <http://www.arb.ca.gov/cc/protocols/localgov/pubs/pubs.htm> > . Accessed September 17, 2009.

²³ ICLEI-Local Governments for Sustainability. 2008. Local Governments Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions. August 2008 version.. Adopted by California Air Resources Board August 12, 2008. Sacramento, CA.

²⁴ Environmental Protection Agency, 2008. Waste Reduction Model. Last updated August 2008. Available at < http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html > , accessed September 15, 2009.

in the state of California. Table F-3 shows the waste stream profile used in this analysis for residential and commercial waste in Butte County. .

Table F-3: California Residential Waste Stream (2004)

Waste type	Percent of Waste
Paper Products	31%
Food Waste	25%
Plant Debris	9%
Wood/Textiles	8%
All Other	27%

This method estimates the methane generation potential of a single year’s solid waste generation, regardless of the solid waste disposal facility where it is deposited. This method is included for informational purposes only and is not included in the inventory total, but provides more detail about the sources and patterns of waste within a jurisdiction. For the 2020 and 2030 scenarios, projected 2030 population buildout of the General Plan 2030 and Zoning Ordinance was used. 2008 per capita waste generation rates and current waste profiles were applied. It was assumed that all waste in current and future years was buried in facilities with methane flaring or gas to energy systems installed and that these systems have 75% methane destruction efficiency. Many systems currently achieve greater efficiencies. Specific destruction efficiency data at facilities receiving Butte County waste was not available and potential future improvements to these systems were not accounted for.

Agricultural –GHG emissions from agriculture are related to fuel use for equipment and vehicles, fertilizer use, methane emissions from livestock, rice cultivation, agricultural practices and embodied emissions associated with water usage. GHG emissions from agricultural equipment and vehicles were estimated using the OFFROAD model and were not scaled based on population differences between the incorporated and unincorporated areas. It was assumed that the bulk of agricultural lands are in the unincorporated portion and relatively few acres are in the more densely populated incorporated municipalities. This method likely results in a slight overestimate of emissions from agricultural equipment and vehicles. Only emissions from vehicles and equipment for agriculture were quantified in this inventory.

Quantitative estimates of emissions associated with rice cultivation, fertilizer usage, livestock and other agriculture practices were not included in this inventory due to analytical limitations. Quantitative estimates of emissions from fertilizer, livestock, rice cultivation and water usage must be based on detailed information regarding fertilizer type and usage, as well as day to day practices that vary substantially from farm to farm depending on size, location and primary crops or livestock. These emissions are not included in the inventory presented here but should be considered in future

²⁵ California Integrated Waste Management Board. 2009. California Waste Stream Profiles Homepages. Last revised: 2008 year data. Available: < <http://www.ciwmb.ca.gov/Profiles/> > . Accessed: September 15, 2009.

inventories as methodology for assessing these emissions improves and site specific agricultural data availability increases.

Other Sources Not Quantified - GHG emissions occur from other sources in Butte County in addition to those quantified in Tables F-1 and F-2 above. Additional sources of GHG emissions include: emissions associated with land use change, embodied emissions associated with water usage, embodied emissions associated with materials, rice cultivation and agricultural practices. The latter two were discussed previously in a qualitative sense in the Agriculture sub-section above. Emissions associated with land-use change result when land changes from timber, grass or other agricultural uses to a more urban use and the amount of stored carbon in biomass is diminished. The opposite is true for transformation of urban lands to natural lands. Currently, analytical methods to estimate the GHG emissions associated with this source at the project or County level are developing. The amount of carbon stored as biomass depends on numerous factors, including plant species, age of vegetation, water availability, nutrient availability and climate/weather conditions. Quantification for emissions associated with land use change in Butte County would require detailed land use maps and species inventories. The resulting estimate of carbon stocks or sequestration rates would be somewhat speculative, as it would be based on average growth and sequestration rates obtained from the literature - not data specific to Butte County. The CCAR Forestry Protocol for assessing carbon stocks for voluntary carbon credits requires site-specific measurements which were beyond the scope of this GHG inventory effort. Nevertheless, this source should be considered in future efforts as data availability improves and inventory protocols become formalized.

ⁱ U.S. Environmental Protection Agency, 2009, *2009 U.S. Greenhouse Gas Inventory Report – Inventory of U.S. Greenhouse Gas emissions and sinks 1990-2007*. Available at <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>. Accessed December 20, 2009.