FOR INFORMATIONAL PURPOSES ONLY

Greenhouse Gas Emission Factors Info Sheet

Are you putting together a greenhouse gas (GHG) inventory or climate action plan for a business, city, or county? Do you want to estimate the GHG savings associated with a lighting retrofit? Are you reducing your "carbon footprint" through the ClimateSmart™ program[1] and want to estimate the emissions you balanced out? This document is intended to help customers understand the various emission factors available to estimate GHG emissions for purposes such as voluntary GHG emissions reporting and climate action planning. It should not, however, be used for mandatory GHG reporting, financial analysis, or regulatory compliance, and does not necessarily reflect the approaches taken by PG&E for regulatory compliance purposes.

What Is A GHG Emission Factor?

With regard to the energy provided by PG&E, a GHG emission factor[2] is a measure of the amount of carbon dioxide (CO_2) emitted per kilowatt-hour of electricity or per therm of natural gas.[3]

- Electricity generated from fossil fuels such as natural gas and coal produces CO_2 emissions, while some other sources of electricity (such as hydropower, wind, and nuclear power) do not generate CO_2 emissions. The electricity that PG&E delivers to customers comes from a variety of generation sources in any given year. Since PG&E's electricity sources vary, the GHG emission factor for its electricity varies too.[4]
- For natural gas, there is only one factor needed to estimate the GHG emissions from the use or avoided use of PG&E's natural gas, since the composition of PG&E's natural gas does not change significantly over time.

Electricity Emission Factors

If you are estimating the GHG emissions generated by the use of electricity by a business, city, county, etc. over the course of a year, you can use the average emission factor for the PG&E electricity delivered during that specific year.

[1] The ClimateSmart program helps PG&E customers balance out their GHG emissions through investments in environmental conservation, restoration and protection projects that reduce or prevent GHG emissions. By adding a voluntary, tax-deductible donation to customers' monthly PG&E bill, customers can reduce their carbon footprint and join the fight against climate change.

[2] An emission factor is also known as an emission rate or emission coefficient.

[3] There are also many other types of GHG emission factors. For example, there are emission factors for diesel, coal, and other fuels, as well as estimated emission factors for vehicles, landfills, and other products and processes. See the ICLEI Local Government Operations Protocol for some examples.

[4] PG&E and other utilities purchase some of their electricity from a power pool for re-sale to customers. It is not possible to trace that electricity back to a specific generator, for the same reason that a share of stock purchased through a stock exchange cannot be traced back to a specific seller. An emission factor for such purchases is therefore estimated.

Historical emission factors: Historical average emission factors take into account all of the sources of electricity that PG&E delivered to customers during a specific year. As a founding member of the California Climate Action Registry (CCAR), PG&E has calculated emission factors for each year starting in 2003, which have been third-party verified. For factors prior to 2003, please see FAQ #2.

Current emission factors: Because of the rigorous process PG&E follows to calculate and have its emission factors independently verified by a third party, the most recent year's GHG emission factor is not available until late in the following year. For example, the 2010 emission factor will not complete third-party verification until December 2011. If you want to estimate GHG emissions in a recent year for which an emission factor is not yet available, we advise you to use the average of the emission factors for the PG&E electricity delivered to customers based on the preceding five years of available data, because PG&E's electricity mix varies from year to year.

Future emission factors: If you want to estimate your GHG emissions in the future, you can use the emission factors that are forecast for PG&E's electricity in the CPUC GHG Calculator, which is a publicly-available document that provides emission factor forecasts from 2012–2020.[5]

ClimateSmart: If you are a ClimateSmart customer and want to estimate the GHG emissions you balanced out through the program, you should use the CPUC-approved emission factor for the emission reductions achieved through the program. This factor is an estimated average emission factor for PG&E electricity delivered to customers over several years, and was developed in 2005, prior to the program's approval in late 2006. As such, it includes some of the emissions associated with the delivery of electricity, as that was the methodology developed for the program at that time. Emission factor methodologies have since been standardized and do not include emissions associated with delivery.

Avoided emissions: When you implement an energy efficiency project or install a zero-emissions generator (e.g. a solar photovoltaic system), you are avoiding the use of PG&E electricity, and therefore reducing GHG emissions. Determining the emissions avoided by such projects is complicated. In particular, it depends on the season and time of day that electric generation was reduced. For simplicity, you can use the relevant historical, current, or future emission factor to estimate the GHGs avoided from these projects. See FAQ #5 for more information.

[5] E3, GHG Calculator version 3c, worksheet tab "CO_2 Allocations," cells AH35 - AH44.

Emission Type	Emission Factor			Source
	Year	*Lbs CO_2 /MWh*	*Metric tons CO_2/MWh*	
Historical Emissions	2003	620	0.281	PG&E's third-party-verified GHG inventory submitted to the California Climate Action Registry (CCAR)[6] (2003-2008) or The Climate Registry (TCR) (2009)
	2004	566	0.257	
	2005	489	0.222	
	2006	456	0.207	
	2007	636	0.288	
	2008	641	0.291	
	2009	575	0.261	
Current Emissions	2010, 2011[7]	559	0.254	Average of PG&E's 2005 to 2009 GHG emission factors
Future Emissions (estimated)	2012	453	0.205	CPUC GHG Calculator, which provides an independent forecast of PG&E's emission factors as part of a model on how the electricity sector would reduce emissions under AB 32[8]
	2013	431	0.196	
	2014	412	0.187	
	2015	391	0.177	
	2016	370	0.168	
	2017	349	0.158	
	2018	328	0.149	
	2019	307	0.139	
	2020	290	0.131	
ClimateSmart Program Emission Reductions[9]	2007-2011	-524	-0.238	CPUC ClimateSmart Decision (06-12-032)
Note: The ClimateSmart program reduces emissions. Therefore, for net GHG reporting, emissions reductions from accounts participating in the program can be subtracted from an entity's total emissions.				

[6] The 2003-2008 factors are in the Power/Utility Protocol (PUP) spreadsheet of PG&E's CCAR reports. The 2009 factor is in the Additional Optional Information tab of the Electric Power Sector (EPS) Report spreadsheet of PG&E's TCR report.

[7] PG&E's 2010 emission factor will be available in late December 2011. As the CPUC GHG Calculator does not include a 2011 emission factor, we recommend using the "current" emission factor for 2011. These factors will be reviewed and updated annually.

[8] E3, GHG Calculator version 3c, worksheet tab "CO_2 Allocations," cells AH35 - AH44.

[9] The ClimateSmart program electricity emission factor is in lbs CO_2e. CO_2e (or CO_2 equivalent) is a measure used to compare the emissions from various GHGs based upon their global warming potential (GWP). The CO_2e for a GHG is derived by multiplying the amount of the GHG by the GWP of the GHG. The ClimateSmart program electricity emission factor is in lbs CO_2e because it includes both the emissions from customers' use of PG&E electricity as well as an estimate of some of the emissions associated with electricity delivery. This factor was put forth by PG&E in CPUC Application 06-01-012 on 1/26/2006, approved in Decision 06-12-032, and extended through 2011 in Decision 10-10-025.

ClimateSmart emission factor for customer use of electricity	520 lbs CO_2/MWh
ClimateSmart emission factor for delivery of electricity	4 lbs CO_2e/MWh
Total ClimateSmart emission factor for electricity	524 lbs CO_2e/MWh

Natural Gas Emission Factors

Historical, Current, or Future: Natural gas combustion (such as in a stove, a furnace, or a natural gas-fueled power plant) releases CO_2. Therefore, you can use the emission factor for natural gas that expresses the amount of GHGs emitted per therm of natural gas combusted. Since the composition of PG&E natural gas does not change significantly over time, this factor does not change from year to year.

ClimateSmart: If you are a ClimateSmart customer and want to estimate the GHG emissions you balanced out through the program, you should use the CPUC-approved emission factor for the emission reductions achieved through the program. Because this emission factor was created specifically for the program when it was developed, it includes both the emissions associated with the combustion of gas as well as an estimate of some of the emissions associated with the delivery of gas. Emission factor methodologies have since been standardized and do not include emissions associated with delivery.

Emission Type		Emission Factor		Source
	Year	*Lbs CO_2 /therm*	*Metric tons CO_2/therm*	
Historical, Current, or Future	All years	11.7	0.00531	US Energy Information Administration[10]
ClimateSmart™ program[11]	2007-2011	13.446	0.00610	CPUC ClimateSmart™ Decision (06-12-032)

UPDATES: This guidance will be updated annually, so please check the PG&E web page on Resources for Local Governments and Sustainable Communities for the most recent version.

[10] US Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program.

[11] The ClimateSmart program gas emission factor is in lbs CO_2e. CO_2e (or CO_2 equivalent) is a measure used to compare the emissions from various GHGs based upon their global warming potential (GWP). The CO_2e for a GHG is derived by multiplying the amount of the GHG by the GWP of the GHG. The ClimateSmart program gas emission factor is in lbs CO_2e because it includes both the emissions from customers' use of PG&E gas as well as an estimate of some of the emissions associated with gas delivery. The inclusion of these emissions is also why it is higher than the US EIA emission factor. This factor was put forth by PG&E in CPUC Application 06-01-012 on 1/26/2006, approved in Decision 06-12-032, and extended through 2011 in Decision 10-10-025.

ClimateSmart emission factor for customer use of natural gas	11.7 lbs CO_2/therm
ClimateSmart emission factor for delivery of natural gas	1.746 lbs CO_2e/therm
Total ClimateSmart emission factor for electricity	13.446 lbs CO_2e/therm

Frequently Asked Questions:

1. Q: Why do the emission factors for PG&E electricity vary from year to year?
   A: PG&E's electricity emission factors vary primarily because the amount of available hydroelectricity varies from year to year. During drought years, less hydroelectricity is available. Therefore, other electric generation (usually natural gas generation) is used instead. PG&E's electricity emissions factors will generally trend downward as PG&E increases the amount of zero-emission renewable generation in its electricity portfolio. Emission factors also change, but less significantly, based on variables such as change in demand due to weather (hot summers mean more AC demand). Increased demand is generally met by fossil fuel generation (which raises the average emission factor). PG&E works to mitigate demand by following California's "loading order," which involves decreasing electricity demand by increasing energy efficiency and demand response, and meeting new generation needs first with renewable and distributed generation resources, and second with clean fossil-fueled generation. The loading order was adopted in the *2003 Energy Action Plan* prepared by the California energy agencies.

2. Q: Does PG&E have emission factors for years prior to 2003?
   A: PG&E was among the earliest companies to voluntarily quantify and report its GHG emissions using rigorous, publicly-vetted GHG reporting standards. As a charter member of CCAR and TCR, PG&E has voluntarily registered and publicly reported its third-party verified GHG inventory every year since 2003. Prior to 2003, there were no commonly-accepted guidelines to report the GHG emission factors from a utility. If you would like to calculate emissions prior to 2003, you can use the 1990 emission factor in FAQ #3 below.

3. Q: What emission factor should I use to calculate the emissions from electricity use in 1990?
   A: You can use the factor from a study published by Lawrence Berkeley National Laboratory, which cites an emission factor of 0.070 kg C/kWh for PG&E in 1990.[12] This figure translates to approximately 0.257 metric tons CO_2/MWh or 566 lbs CO_2/MWh.[13]

4. Q: How should I estimate the change in emissions from electricity use over time, for example, from 2005 to 2008?
   A: The Climate Registry's Local Government Operations Protocol, Version 1.1, May 2010 provides guidance to entities on tracking emissions against a base year. In the case of PG&E customers, it recommends using the PG&E-specific emission factors relevant to the years of electricity use. Using the PG&E- and year-specific factors allow you to more accurately track the change in emissions from electricity use. Using a single emission factor, such as the 2005 factor for both 2005 and 2008, would only identify the change in emissions reflective of the change in electricity use over time, and would not take into account the change in the emissions intensity (i.e. the amount of emissions per unit of electricity) of the electricity used. Therefore, tracking GHG emissions using PG&E's year-specific emission factor multiplied by the kWh change in your electricity use would give you a more complete picture of how and why GHG emissions from your electricity use changed over time.

5. Q: Why do you use an average emission factor to estimate avoided emissions and not a marginal[14] or project-specific emission factor?
   A: For the purposes of climate action planning, using an average emission factor (the relevant historical, current, or future emission factor, depending on the

[12] LBNL-49945, Marnay *et al*, Estimating the CO_2 emissions factors for the California Electric Power Sector, August 2002.

[13] 0.070 kg C/kWh * (44.0g CO_2 / 12.0g C) = 0.257 kg CO2/kWh = 0.257 metric tons CO_2/MWh.
0.257 metric tons CO_2/MWh * 2204.6 lbs/metric ton = 566 lbs CO2/MWh.

[14] A marginal emission factor represents the emissions from electricity generated "at the margin", i.e., electricity generated in response to an additional unit of electricity demand. In California, this factor is typically that of a natural gas power plant, because this type of plant is most frequently deployed when electricity demand increases in the state. The California Air Resources Board's (ARB's) Scoping Plan uses a marginal emission factor for California of 963 lbs CO_2e/MWh. *See*: ARB, Climate Change Proposed Scoping Plan, Appendices, Volume II: Analysis and Documentation, October 2008, page I-23.

time period for which you are estimating emissions) simplifies the emissions calculation process. Using the average factor is a simplification and may not reflect the approach taken by larger customers or PG&E for regulatory compliance purposes. For example, PG&E may be required to estimate the amount of GHGs avoided through its energy efficiency programs by using emission factors specific to the hours of the day, the days of the year, or the seasons in which the energy use was avoided. This approach is more complex than using an average emission factor, which represents the electricity used over the course of an entire year. For the purposes of climate action planning, however, the use of an average emission factor is sufficient.

6. Q: What emission factor should I use if I want to estimate the emissions avoided through participation in PG&E's demand response programs[15]?
   A: For the purposes of climate action planning, you can use an average emission factor (the relevant historical, current, or future emission factor, depending on the time period for which you are estimating emissions), in order to simplify the emissions calculation process. Using the average factor is a simplification and may not reflect the approach taken by large customers or PG&E for regulatory compliance purposes. For example, if you use a back-up generator to qualify for a demand response program, you should adjust your emissions calculations accordingly.

7. Q: If I am a Direct Access (DA) or Customer Choice Aggregation (CCA) electricity customer, what emission factor should I use?
   A: If you are a DA or CCA customer, you should contact your DA or CCA electricity provider to get the appropriate emission factor for the electricity you are purchasing. If the emission factor is unavailable, The Climate Registry's Local Government Operations Protocol and the World Resources Institute's GHG Protocol recommend using the EPA Emissions & Generation Resource Integrated Database (eGRID) annual output emission factors for the WECC California (CAMX) sub-region.

8. Q: Can PG&E customers use the U.S. EPA carbon calculator to calculate the emissions from PG&E electricity?
   A: PG&E does not recommend its customers use this calculator. The EPA calculator uses an average emission factor for electricity generated nationwide. PG&E's emission factor is independently verified and based on the PG&E-specific mix of electricity delivered to PG&E customers. Because of PG&E's higher use of lower- and zero-emission generation sources, PG&E's emission factor is approximately half the national average.[16] Therefore, using the EPA calculator would dramatically overstate PG&E customers' emissions.

[15] PG&E's demand response programs offer incentives to customers that volunteer and participate by temporarily reducing their electricity use when demand could outpace supply.
[16] PG&E website: http://www.pge.com/myhome/environment/pge/cleanenergy/index.shtml

9. Q: What is the difference between the emission factors used in the U.S. EPA's Portfolio Manager benchmarking tool and PG&E's emission factors?
   A: The EPA tool uses emission factors from the EPA Emissions & Generation Resource Integrated Database (eGRID), which are derived from utility data for each of the 26 sub-regions of the U.S. power grid. Users are not able to enter a PG&E-specific emission factor into the tool. Instead, based on the zip code of each building entered, Portfolio Manager identifies the appropriate sub-region and emission factor, and provides a graphic comparison of the sub-region's emission factor and electric generation fuel mix to the national factor. PG&E customers are in the WECC[17] California (CAMX) sub-region, which also encompasses utilities that draw on high-CO_2-emitting coal-fired power plants. Because eGRID's WECC California emission factor has consistently been higher than PG&E's historical emission factors, and because the national emission factor has been approximately double PG&E's historical emission factors for the past several years, customers should note that this tool overestimates emissions from buildings that use PG&E electricity.
   The tool also gives users the choice of selecting a specific power generation facility, which is not appropriate for the purposes of climate action planning since the electricity delivered by PG&E to customers comes from a variety of sources. The WECC California emission factor would be more appropriate.

10. Q: Does PG&E have emission factors for smaller geographic areas like cities or counties within its service territory?
   A: No, PG&E's emission factors are based on the electricity delivered to all of its customers. Because electricity enters PG&E's electrical transmission and distribution system from multiple sources and gets distributed throughout the system to customers, it is not possible to calculate emission factors for specific geographic areas.

11. Q: To what can I compare my GHG emissions?
   A: Reducing one metric ton (2204.6 lbs) of CO_2 emissions is approximately equivalent to:
   - Taking one average passenger car in California off the road for two months;[18]
   - Avoiding the use of 112 gallons of gasoline;[19]
   - Eliminating the GHGs associated with the natural gas use of almost 6 average homes in PG&E's service territory for a month;[20] or

[17] The Western Energy Coordinating Council (WECC) is a regional organization that promotes reliable electric service by establishing operating criteria and facilitating electric system support between utilities.
[18] California Air Resources Board's EMFAC model indicates an average passenger car in California emits 5.96 metric tons of CO_2 per car per year in scenario year 2010, based on 12,000 miles per year per car.
[19] U.S. EPA website: http://www.epa.gov/cleanenergy/energy-resources/refs.html#gasoline
[20] 11.7 lbs CO_2/therm = emission factor for natural gas. 2204.6 lbs = number of lbs/metric ton. 2204.6 / 11.7 = 188.43 therms/metric ton of CO_2. Average annual residential customer natural gas use in PG&E service territory in 2009 was approximately 405 therms according to the 2009 Residential Appliance Saturation Survey (RASS). Therefore, average monthly residential customer gas use = 405 therms / 12 months =

- Eliminating the GHGs associated with the electricity use of more than 7 average homes in PG&E's service territory for a month.[21]

12. Q: Why are PG&E's emission factors in CO_2 and not CO_2e (i.e. CO_2 equivalent)?[22]
    A: The electricity emission factors reported via CCAR and TCR are in pounds of CO_2 and not CO_2e because their methodology for calculating emission factors only includes CO_2 and not CH_4 or N_2O from electricity generation. CCAR and TCR do not include CH_4 or N_2O because these emissions are relatively insignificant. PG&E's emission factors for the ClimateSmart program are in pounds of CO_2e because they include some of the emissions associated with delivery of the gas and electricity. These factors were created specifically for the ClimateSmart program when the program was being developed in 2005. Emission factor methodologies have since been standardized and do not include emissions associated with delivery.

13. Q: Does PG&E have specific CH_4 and N_2O emission factors for its electricity and natural gas?
    A: No, however, PG&E customers can still estimate the CH_4 and N_2O emissions associated with their electricity use by using the California-specific emission factors provided on Page 209 of The Climate Registry's Local Government Operations Protocol, Version 1.1, May 2010, in Table G.7: California Grid Average Electricity Emission Factors (1990-2007).
    For natural gas, customers can use the relevant default emission factors for natural gas provided on Page 205 of the Local Government Operations Protocol, Version 1.1, May 2010, in Table G.3: Default Methane and Nitrous Oxide Emission Factors by Fuel Type and Sector.

14. Q: Why don't PG&E's emission factors include the emissions associated with the delivery of electricity or natural gas?
    A: The emissions associated with the delivery of electricity or natural gas are not included in the PG&E's emission factors for delivered electricity or natural gas because those emissions are reported separately by PG&E in its third-party verified GHG inventory. Standard voluntary reporting practice is to report such emissions, like the emissions associated with transmission and distribution line losses, natural gas compressor stations, and vehicles used to service electricity

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approximately 33.75 therms/month. Therefore, 188.43 therms per metric ton CO_2 / 33.75 therms per home per month = gas use by 5.58 homes per month.

[21] 0.559 lbs CO_2/kWh = average of the PG&E emission factors for the 5 most recent years of reported emission factor data (2005-2009). 2204.6 lbs = number of lbs/metric ton. 2204.6 / 0.559 = 3943.8 kWh/metric ton of CO_2. Average annual residential customer electricity use in PG&E service territory in 2009 was approximately 6,458 kWh according to the 2009 Residential Appliance Saturation Survey (RASS). Therefore, average monthly residential customer electricity use = 6,458 kWh / 12 months = approximately 538 kWh. Therefore, 3943.8 kWh per metric ton CO_2 / 538 kWh per home per month = electricity use by 7.33 homes per month.

[22] CO_2e or CO_2 equivalent is a measure used to compare the emissions from various GHGs based upon their global warming potential (GWP). The CO_2e for a gas is derived by multiplying the amount of the gas by the GWP of the gas.

and natural gas delivery systems, separately from the emissions generated by the generation or use of the energy itself.

15. Q: How can I estimate the emissions avoided from using electric or natural gas vehicles instead of conventionally-fueled vehicles?
    A: The California Energy Commission (CEC) has modeled full well-to-wheel (WTW) carbon intensities for transportation fuel pathways using Argonne National Labs' GREET model, modified to California inputs.[23] The California Air Resources Board (CARB) has continued to refine and expand fuel pathways defined by this approach in the Low Carbon Fuel Standard (LCFS) regulation.[24] In transportation, a full WTW approach becomes necessary, otherwise full battery electric vehicles, lacking a tailpipe, will have zero emissions. Both natural gas and electric vehicles provide CO_2 and criteria emission benefits over conventional gasoline- and diesel-fueled vehicles. The documents and links footnoted above provide access to the most up-to-date information about this topic.

16. Q: Who can I contact at PG&E to ask questions about emission factors?
    A: Email GHGEmissionFactors@pge.com and a PG&E employee will get back to you shortly.

[23] CEC. Full Fuel Cycle Assessment: Tank To Wheels Emissions And Energy Consumption. Consultant Report (Draft). CEC-600-2007-003-D, February 2007.

[24] ARB LCFS website: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm. For specific fuel pathway carbon intensities including indirect land use impacts and energy economy ratios (drivetrain efficiency adjustments for electricity and fuel cells), see the LCFS Initial Statement of Reasons (ISOR), page ES-19 - ES-21: http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor1.pdf. Other resources include specific fuel pathway studies for electricity at http://www.arb.ca.gov/fuels/lcfs/022709lcfs_elec.pdf and for natural gas at http://www.arb.ca.gov/fuels/lcfs/022709lcfs_cng.pdf.