# The GreenPoint Rated Climate Calculator

## March 2009 Update

GreenPointRATED
A PROGRAM OF BUILD IT GREEN

Build It GREEN
Smart Solutions from the Ground Up

GREEN BUILDING
in Alameda County

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## Executive Summary

A number of lifestyle-based carbon calculators have been developed to estimate an individual's or household's carbon footprint, but until now, no tool existed to measure the total avoided greenhouse gas emissions from building green homes.[1]

The new **GreenPoint Rated Climate Calculator**, developed by a team led by Green Building in Alameda County, provides this information in a way that's systematic, credible and backed by third-party verification.

The Climate Calculator is likely to be an influential tool for helping California's residential building industry reduce its carbon footprint. The Calculator is an adjunct to the GreenPoint Rated program, which provides a consumer label for green homes.

When a house or multifamily building undergoes the GreenPoint Rating process, the Climate Calculator will generate data on greenhouse gas (GHG) emissions avoided, measured in carbon dioxide equivalents, or $CO_2e$. Other savings are also calculated, including non-$CO_2$ savings like gallons of water, tons of waste, kilowatt-hours of electricity, and therms of natural gas.

### Notable findings

- **Buildings in denser, transit-oriented communities provide the greatest emissions reductions.**
- **In the building's design, the most important $CO_2e$ reduction strategies are building energy efficiency, reduced home size, photovoltaic systems, energy-efficient appliances (including non-HCFC refrigerants), construction waste recycling, and water savings from efficient landscapes and plumbing fixtures.**
- **Construction and demolition waste recycling produces immediate and significant one-time $CO_2e$ savings for the building and community.**
- **Green retrofits or remodeling reduces net $CO_2e$ emissions, while constructing new housing (whether green or conventional) increases net $CO_2e$ emissions. Given that 70% of homes in the state were built before 1980,[2] the opportunity for true emissions reduction is greatest in the existing home sector.**

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[1] See Appendix F for an abbreviated list of carbon calculators.

[2] California Energy Commission household forecast for California Energy Demand 2008–2018, November 2007, report number CEC-200-2007-015-SF2.

## Introducing the GreenPoint Rated Climate Calculator

Green buildings incorporate a suite of environmentally preferable practices during siting, design and construction. Consequently, most green buildings are thought to have lower carbon footprints than traditionally built or remodeled buildings; but how much lower? Which green building strategies are most effective for reducing greenhouse gas (GHG) emissions? While the operational energy-related emissions savings from the building industry are well understood, how do the indirect- and non-energy benefits of green buildings compare? How will the growing inventory of green homes contribute to the state's ambitious GHG reduction goals?

The GreenPoint Rated Climate Calculator helps answer these questions. When a remodeled or newly built residence undergoes the GreenPoint Rating process, a third-party Rater will use the Calculator to generate data on GHG emissions avoided and other savings.[3] The Climate Calculator produces four sets of data:

- $CO_2e$ data derived from the building's green design features, including:
  - building energy efficiency,
  - reduced home size,
  - photovoltaic systems,
  - energy-efficient appliances,
  - advanced refrigerants,
  - water-efficient plumbing fixtures, and
  - water-efficient landscapes;
- $CO_2e$ data related to the recycling of construction and demolition waste;
- $CO_2e$ data related to the project's location, which quantifies the potential reduction in miles driven by residents who live in more compact, transit-oriented, mixed-use developments; and
- Non-$CO_2$ savings, including gallons of water, tons of waste, kilowatt-hours of electricity, and therms of natural gas.

All these results are incorporated into a GreenPoint Rated consumer label for each home (see page 13 for a preview illustration).

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[3] See the Build It Green website at www.builditgreen.org for more information on the GreenPoint Rated program and the Green Building Guidelines for New Homes, Multifamily buildings, and Existing Homes.

## Background & Methodology

The green building measures included in the Calculator are drawn from the *Green Building Guidelines* and GreenPoint Rated checklists published by Build It Green for single-family new construction, multifamily new construction and single-family existing homes.

The underlying standards and methodologies built into the Climate Calculator were developed with help from:

- climate change experts,
- State of California agency staff, and
- energy and green building leaders.[4]

The project team encountered some challenges as they sought to develop a Calculator based on accurate, verifiable data and assumptions. Foremost was the need to make the Calculator truly representative of the numerous co-benefits that green buildings provide, some of which have impacts on GHGs while others do not. Also, to be credible the Calculator had to reference valid standards, research reports, and assumptions.

Lastly, and perhaps most challenging, the Calculator must work for the GreenPoint Raters in the field. A calculator that is too onerous to fill out would drive up the cost of GreenPoint Ratings, while an overly simplified calculator would lack credibility. The GreenPoint Rated Calculator currently meets these objectives, and will continue to be refined as more and better data becomes available and as GreenPoint Raters provide feedback based on their experience with using the Climate Calculator in the field.

For a more detailed discussion of the Calculator's methodology, see Appendix A. Appendix B lists all the measures included in the Calculator at this time. Many *Green Building Guidelines* measures were excluded from the Calculator or deferred to a future version because of the measure's low correlation with climate change or resource benefits (such as light pollution reduction),

***Carbon Footprint and Emissions Avoided***

The Calculator is a carbon footprint analysis tool. A footprint seeks to chronicle the *total emissions* for a particular building (or household, individual or organization). The Climate Calculator quantifies the *emissions avoided* when building a green home or using green remodeling practices by comparing the footprint of a conventional home to that of the GreenPoint Rated home. The difference is the savings. The Calculator results demonstrate that green homes built or remodeled to reduce waste, energy and water have lower emissions than the same home built without green building strategies. For more information on footprints in the Calculator, see Appendix A: Methodology.

[4] The project team and stakeholders are listed on page 19.

insufficient data (for example, no third-party study on the energy savings of a gearless elevator compared to a hydraulic elevator), or difficulty devising a way of measuring its impact (for example, environmentally preferable materials). See Appendix D for a list of measures not yet included in the Calculator and Appendix E for a list of measures excluded from the Calculator.

## Notable Findings

The findings described here are derived from the project team's extensive research and analysis into the correlations between specific green building strategies and their impacts on GHG emissions and consumption of energy, water and other resources. Findings are based on actual projects that were run-through the Calculator.

- **Buildings in denser, transit-oriented communities provide the greatest emissions reductions.** The research and analysis underpinning the development of the Climate Calculator confirmed what many land use experts have long claimed: that a project's location and layout plays a larger role in its climate change impacts than does the building's design. On average, people living in less sprawling, more transit-oriented communities and cities travel by car much less than people living in lower density communities without good access to public transit or local jobs.

  To assign GHG impacts related to a building's location, the Climate Calculator uses average vehicle miles traveled (VMT) data based not just on a project's density, but also on its proximity to public transit, shopping and other services, and on the neighborhood's accessibility for pedestrians and bicyclists.

- **In the building's design, the most important $CO_2e$ reduction strategies are building energy efficiency, reduced home size, photovoltaic systems, energy-efficient appliances (including non-HCFC refrigerants), construction waste recycling, and water savings from efficient landscapes and plumbing fixtures.**
  - *Building energy efficiency.* The GreenPoint Rated Climate Calculator's baseline assumptions include all the building design strategies required to meet Title 24 Energy Efficiency Standards. The Climate Calculator uses the project's Title 24 energy modeling results to assign a $CO_2e$ reduction value based on avoided emissions from energy savings achieved by exceeding Title 24. This means that the Climate Calculator provides an aggregated $CO_2e$ total for most of the building energy efficiency strategies rather than presenting $CO_2e$

***Energy Efficiency Strategies for Exceeding Title 24***

Exceeding California's Building Energy Efficiency Standards (Title 24) results in reduced greenhouse gas emissions, lower utility costs and increased comfort. Although appropriate strategies will differ depending on the local climate, in general the top strategies include:

- Passive solar design with high thermal mass
- Increased building insulation
- High performance windows
- 14+ SEER air conditioners
- 92%+ AFUE furnaces
- Pipe insulation on all hot water lines
- Home Energy Rating System (HERS) inspections on quality of insulation installation, infiltration leakage and duct efficiency

For information on these and other energy efficiency strategies, refer to the *Green Building Guidelines* for Multifamily, New Homes and Home

results for individual strategies. Energy measures that are required in the California Building Energy Code (Title 24) are not included in the energy savings analysis since they do not exceed minimum code requirements. For those energy-related measures above code minimums but not accounted for in Title 24 analysis, the Climate Calculator has separately quantified the energy and GHG savings. GreenPoint Rated requires time-dependent energy us to be 15% better than energy code, however, the Climate Calculator bases savings on kilowatt-hour per year reductions and are thus independent on the time of day energy is consumed or conserved. Analysis for existing homes was calculated based on the improved performance over a typical home of the same vintage (see Appendix B for more information on measures included in the calculations for existing homes).

- *Home size efficiency*. The size of a house or multifamily housing unit has a large impact on the amount of materials used to construct the home and its energy use once occupied. Larger homes tend to use more heating and cooling energy and produce more construction waste. The Climate Calculator factors in a home's size to show the net energy benefits and reduced waste of building compact spaces.
- *Photovoltaic systems.* If a project has a solar electric system, the Climate Calculator uses the system's estimated kilowatt-hour per year output to assign a $CO_2e$ reduction benefit. The emissions resulting from the project's net electricity use are calculated using the unique power generation mix of the utility that serves that particular location. Solar hot water systems are accounted for in Title 24, so the Climate Calculator uses the Title 24 outputs for calculating the benefits of solar hot water.

***Water Conservation***

Water conservation directly impacts energy use at the state level, since energy is needed to source, purify, convey and heat water in homes. Once used, even more energy is spent to move and then treat wastewater. Altogether, the management of water in California accounts for 19% of the state's electricity and 30% of its natural gas usage.* And water efficiency has benefits beyond just energy, including helping conserve the state's diminishing supplies of potable water.

Measures that slow the flow of stormwater runoff, such as permeable paving, swales and green roofs, aren't included in the GreenPoint Rated Climate Calculator because their $CO_2$ benefits are at present difficult to quantify for individual projects. However, these measures may in fact have significant climate change benefits. A report by the California Energy Commission notes that increased runoff in the Chino Basin results in more than 40,000 acre-feet per year of stormwater going into stormwater treatment facilities instead of recharging groundwater. The lost stormwater's energy value was 2,250 kWh per acre-foot on average, according to the report.**

*"California's Water-Energy Relationship," California Energy Commission. Nov. 2005.

- *Appliances.* Energy- and water-efficient appliances are not accounted for in Title 24 but can represent a significant portion of a project's $CO_2e$ footprint.
- *Central laundry.* For multifamily projects, the largest appliance-related savings on larger projects come from having central laundry facilities. When residents use common laundry facilities they tend to wash and dry larger loads less frequently than when laundry appliances are located inside each individual home.
- *Advanced refrigerants.* Using HCFC (R-22) and a leakage rate of 2% per year as the baseline condition, the Calculator estimates the avoided global warming potential (GWP) of using advanced refrigerants, including HFC-134A and HFC-407A, in air conditioners.
- *Water-efficient plumbing fixtures.* The Calculator includes $CO_2e$ reductions for the efficient use of water indoors. Low-flow showerheads, faucets and toilets provide significant water savings in homes. Depending on where the project is located and where the water supply is coming from, the water impacts on GHGs may be quite small compared to the Calculator's other savings areas. However, water efficiency has other benefits, including helping conserve the state's diminishing supplies of potable water.
- *Water-efficient landscapes.* The Calculator includes water savings from well designed and maintained landscapes that utilize a range of water-efficient elements. The Calculator uses a water budget for outdoor landscapes that is based on the California Department of Water Resource's Model Water Efficiency Landscape Ordinance. Additionally, principles taken from the Bay-Friendly Landscaping Guidelines are included in GreenPoint Rated as a basis for holistic water conservation techniques outdoors.[5] Landscape water conservation starts with creating drought-resistant soils with compost and mulch, selecting low-water using plants, planning for hydrozoned irrigation areas, and installing high

***Resource Conservation***

The GreenPoint Rated Climate Calculator calculates $CO_2e$ savings from construction and demolition (C&D) waste reduction, which can be significant. However, green building provides many other resource conservation benefits that aren't reflected in the Climate Calculator, such as:

- Durable products that require less frequent maintenance and replacement
- Advanced framing techniques, engineered lumber, and Forest Stewardship Council (FSC)-certified framing lumber
- Recycled-content building products, such as decking, ceramic tiles and carpets
- Flooring made from rapidly renewable resources such as cork,

[5] Information about the Bay-Friendly Landscaping program can be found at www.bayfriendly.org. For more details on the landscaping guidelines used in the Calculator, see Appendix B.

efficiency irrigation technologies. These strategies combined together can save large amounts of water.

- **Construction and demolition waste recycling produces immediate and significant one-time $CO_2e$ savings for the building and community.** Construction and demolition (C&D) waste generation on an individual project occurs only at the time of construction and is not ongoing like energy use. However, recycling high levels of C&D waste can avoid significant $CO_2e$ emissions for the first year on some projects as well as provide ongoing community benefits by reducing emissions from landfills over time.

  Waste diversion is a critical consideration given the state's approaching 2020 deadline for reducing GHG emissions.[6] Compared to measures such as energy efficiency that accrue emissions reductions over time, C&D waste recycling provides immediate savings. Further, cities and local governments should consider waste an ongoing source of GHG reductions because construction—and the waste it produces—is an ongoing activity. An estimated 2.6 million new homes will be added to the California housing stock by 2020,[7] and thus the impacts from avoided construction waste are immense. At 5.7 tons of $CO_2e$ saved per home,[8] recycling the construction waste on new homes has the potential to reduce $CO_2e$ emissions by more than 14.5 million tons by 2020!

[6] Assembly Bill 32, the California Global Warming Solutions Act of 2006, establishes regulatory and market mechanisms for reducing greenhouse gas emissions in California to 1990 levels by 2020.

[7] California Energy Commission household forecast for California Energy Demand 2008–2018.

[8] StopWaste.Org study on emissions reductions from an average size new GreenPoint home.

- **Green retrofits or remodeling reduces net $CO_2e$ emissions, while constructing new homes (whether green or conventional) increases net $CO_2e$ emissions. Given that 70% of homes in the state were built before 1980, the opportunity for true emissions reduction is greatest in the existing home sector.** When comparing Climate Calculator results for various projects, it's important to do an apples-to-apples comparison of similar types of projects. Savings are not directly comparable for new and existing buildings. For new homes, the Calculator is intended to show the avoided emissions of building a green home instead of a traditional home. But building a new home creates emissions that wouldn't have existed otherwise. On the other hand, when an existing home is remodeled using green building practices, the Climate Calculator can be expected to show a net reduction in $CO_2e$, assuming the home's demand on energy, water and other resources wasn't increased from its previous footprint due to factors such as greatly expanding the home's size.

For each project, the Climate Calculator shows emissions compared to a baseline, conventional building. The Climate Calculator will typically show larger savings for a new home than for a remodeled home because more green building strategies are available to the new home builder. These strategies include orienting the building to take advantage of passive solar design, daylighting and natural ventilation and using super-efficient building techniques such as structural insulated panels (SIPs). But even though more savings per home are available to the new home sector, total emissions actually increase with each new home. When a new home is built that doesn't replace an existing building, there is inevitably a net increase in GHG emissions because the construction has added another building to the state's building stock.

While about 200,000 new homes are built each year, the existing housing stock makes up over 13 million homes and has the greatest potential for net emissions reductions. The GreenPoint Rated Existing Home rating system has been designed to provide an entry point for rating small green remodels and additions, as well as tackling larger renovation projects.[9]

- **More data is needed on GHG impacts from many green building strategies.** Many of the green building measures in the *Green Building Guidelines* were excluded from the Climate Calculator either because they are not applicable (see Appendix E) or because there is currently little or no information about their GHG reduction potential (Appendix D). A consensus-based life-cycle assessment (LCA) tool, for example, is currently not available to estimate the total carbon footprint and embodied energy of specific green building materials.[10] However, those impacts combined with other excluded green building measures could be significant. Climate change and building science researchers are encouraged to help expand knowledge and data in this area.

***Indoor Environmental Quality***

Although the Climate Calculator doesn't specifically address healthy home issues, better indoor environmental quality is one of the most important benefits of building green. Having a healthier home is also one of the main motivations for people to buy green homes, green products and green remodeling services. Best practices for better indoor environmental quality include:

- Noise and vibration control, especially in multifamily and mixed-use buildings
- Kitchen and bathroom fans that exhaust to the outside
- Track-off systems at entryways to keep dirt and other contaminants from entering the building
- Low- or no-VOC paints, coatings and adhesives
- Pressed-wood products with reduced formaldehyde and flooring with low VOC emissions

For information on these and other green building practices, see the *Green Building Guidelines* for Multifamily, New Homes and Home Remodeling at www.builditgreen.org.

[9] More on the GreenPoint Rated Existing Home program can be found online at www.greenpointrated.org.

[10] At this time, the only measures included in the Calculator that account for embodied energy are the C&D waste recycling measures. The Climate Calculator relies on the EPA WAste Reduction Model (WARM), which includes the upstream benefits (manufacturing, extraction, transportation) and downstream energy savings (transportation, methane capture, cogeneration) from recycling.

## What these findings mean for…

### Policymakers & climate action planners

Green building is a cross-cutting strategy that can augment a city's or local government's Climate Action Plan by reducing emissions in all major policy areas, including transportation, energy and waste. The Climate Calculator is intended to support public-sector policy initiatives in California, such as Assembly Bill 32 and other state and local initiatives for reducing greenhouse gas emissions.

Policymakers have enormous influence over the GHG reduction potential of residential buildings. As noted earlier, compact, transit-friendly communities reduce average vehicle miles traveled. The resulting GHG savings dwarfs the savings arising from a building's design. Planning policies that discourage sprawl and support mixed-use neighborhoods that are walkable, bikable and transit-friendly have the potential to play a major role in reducing a community's carbon footprint.

Policymakers and climate action planners can use results from the Climate Calculator to estimate the GHG emissions reduction potential of homes and multifamily projects in their jurisdiction. The Calculator is also useful for highlighting cross-cutting best practices in a Climate Action Plan or for City planning purposes, such as in adopting green building ordinances or construction and demolition waste recycling policies. A further benefit of the Calculator is that emissions are reported by how direct they are to the project; i.e. "Scopes" as defined by the World Resources Institute. By including the scopes of emissions, it is possible to analyze results from the Climate Calculator for whatever need is desired, whether that be for Climate Action Plans, carbon trading markets, or other uses. [11]

### Builders, developers & building designers

The GreenPoint Rated Climate Calculator is not intended as a design tool to help architects or engineers compare the impacts of various design options. Instead, it's intended to allow the builder to demonstrate to the owner or future owners the verified climate benefits of that building. In the future, a stand alone, design version of the tool may be made available for use by project teams.

By providing data for the GreenPoint Rated consumer label, the Climate Calculator will help stimulate market demand for green single-family and multifamily homes as well as green remodeling activities. It also will reward green building professionals by providing

[11] See Appendix A: Methodology for more on emissions Scopes.

them with another tool with which to distinguish their products from competitors who build conventional homes with higher waste, utility bills and GHG emissions.

## How it works

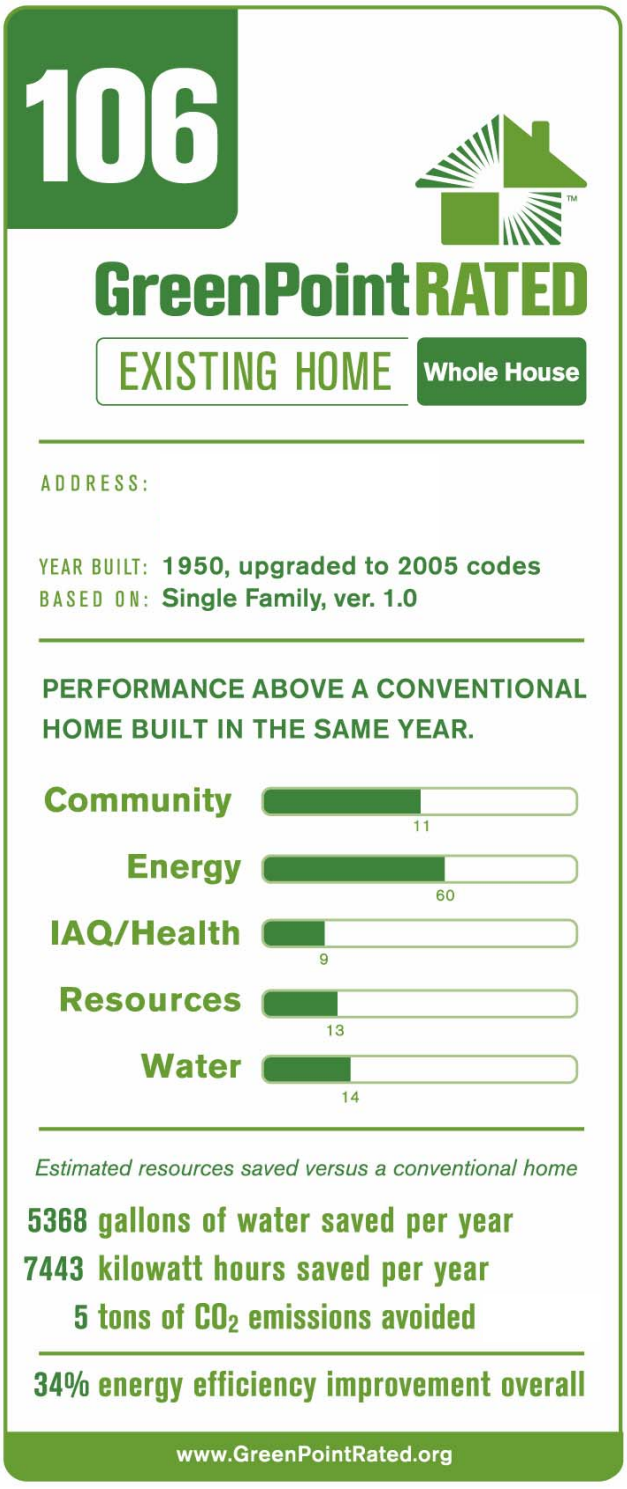
The GreenPoint Rated Climate Calculator is part of the GreenPoint Rating process for single family new homes. The inputs for the Climate Calculator are collected and verified by the GreenPoint Rater through the normal GreenPoint Rating process. The Rater then uploads their verification data and checklist to the forthcoming online Build It Green tracking system. The Build It Green tracking system includes the fully-functioning Climate Calculator along with a revised interface for managing GreenPoint Rated project documentation and verification. Currently the Calculator is housed online within the Tracking System and is not available as a stand-alone tool. Raters upload their GreenPoint Rater verification forms to the Tracking System website and Calculator results are quantified and output in reports available to the Rater and other users of the tracking system.

## Next steps

The GreenPoint Rated Climate Calculator is now incorporated into the GreenPoint Rating process for single family new homes. Over the next few months, the Climate Calculator will be built-in to the Rating process for Existing Homes and Multifamily new homes as well. By the end of 2009 all new GreenPoint Rated projects will receive a new version of the consumer label (see preview next page) that includes both the GreenPoint Rated score and the Climate Calculator results.

The Climate Calculator will continue to be refined and updated as more and better data becomes available and as GreenPoint Raters provide feedback based on their experiences with using the Climate Calculator in the field.

**Sample GreenPoint Rated Consumer Label with Climate Calculator Savings Results**



## Project Background

The GreenPoint Rated Climate Calculator was developed with input from many stakeholders, including climate change experts, State of California staff, and energy and green building leaders.

### Project team

| | |
|---|---|
| Project management and funding: | Green Building in Alameda County |
| GreenPoint Rated coordination: | Build It Green |
| Technical lead: | KEMA Green Building Services |
| Technical support: | ICLEI–Local Governments for Sustainability |
| Stakeholder group: | Representatives from the following agencies: California Energy Commission, California Air Resources Board, California Integrated Waste Management Board, California Department of Public Health, California Urban Water Conservation Council, Center for Clean Products, City of Berkeley, City of Emeryville, City of Rohnert Park, City of San Jose, City of Sacramento, Collaborative for High Performance Schools, CTG Energetics, Environmental Defense, Healthy Buildings Network, Natural Resources Defense Council, San Francisco Department of the Environment, Scientific Certification Systems, SolData, Sustainable Capital, What's Working, US EPA Region 9. |

#### About Green Building in Alameda County

The Green Building in Alameda County program works with building professionals and local governments in Alameda County to increase the supply and capacity for green building, and engages in consumer outreach and policy development to increase the demand for green building. Green Building in Alameda County is a program of StopWaste.Org, which is the Alameda County Waste Management Authority and Source Reduction and Recycling Board operating as one public agency.

For more information: Green Building in Alameda County
1537 Webster Street, Oakland, CA 94612
510.891.6500 www.buildgreennow.org
Contact: Wes Sullens, Karen Kho

#### About Build It Green

Build It Green is a non-profit membership organization whose mission is to promote healthy, energy- and resource-efficient building practices in California.

For more information: Build It Green

1434 University Avenue, Berkeley, CA 94702
510.845.0472 www.builditgreen.org
Contact: Tenaya Asan

# Appendices

A. Methodology

B. Measures Included in the Calculator

C. Emissions Factors & Coefficients

D. Measures Not Yet Included in the Calculator

E. Measures Not Applicable to the Calculator

F. Other Emissions Calculators

# Appendix A: Methodology

The Climate Calculator quantifies the climate change benefits of building a specific GreenPoint Rated home. The data inputs for the Climate Calculator are incorporated into the Rater verification process for GreenPoint Rated so that all participating homes will be assigned greenhouse gas and resource reduction benefits. GreenPoint Raters have provided input on the feasibility of obtaining various data in the field. California Climate change experts, State of California agency staff, and energy & green building leaders also consulted on the assumptions behind the calculator.[1]

The green building measures in the Climate Calculator are drawn from the GreenPoint Rated program, which includes single-family new construction, multifamily new construction and single-family existing homes. The measures are broadly grouped into the following seven impact categories for the Climate Calculator with corresponding metrics and methodologies:

1) Energy efficiency and energy reduction measures included in Title 24 performance modeling
2) Energy issues not accounted for in Title 24 performance modeling (prescriptive energy requirements, appliances, renewable energy, refrigerants etc.)
3) Outdoor water use
4) Indoor water use
5) Land use and siting effects on occupant vehicle use
6) Materials and recycling
7) Advanced refrigerants and refrigerant leakage.

The sources of greenhouse gas emissions addressed by the calculator include:

- **Electricity generated by power plants**: For example, 0.49 lbs of CO2e are created for every kilowatt hour (kWh) used in PG&E service territory.[2] Each investor owned utility in California has a corresponding emissions factor of CO2e depending on their mix of power sources.
- **Electricity demand from water use:** On average, the consumption of one million gallons of water in California requires 3950 kWh of electricity for conveyance and treatment.[3] Thus, water savings can be equated to GHG emissions. For the Calculator, the actual location of the project (zip code) will be used to determine the amount of energy embedded in water. See Appendix C: Emissions Factors for list of California utility coefficients used in the Calculator.
- **Heating with natural gas:** In California, 11.6 lbs $CO_2e$ are generated per Therm of natural gas used.[4]
- **Transportation as a function of density**: Emissions from mobile sources are calculated using vehicle miles traveled (VMT), engine data (e.g. engine type and fuel efficiency),

[1] See the project team and stakeholders on page 19
[2] California Climate Action Registry, http://www.climateregistry.org/CARROT/public/reports.aspx, Clean Air and Climate Protection (CACP), ICLEI and National Association of Clean Air Agencies (NACAA), www.cacpsoftware.org. See Appendix C: Emissions Factors for full citation.
[3] CEC Staff Report: California's Water-Energy Balance (Report CEC-700-2005-11-SF).
[4] California Climate Action Registry General Reporting Protocol, Version 2.2, March 2007.

and GHG emissions per mile traveled. Research has shown that the average number of housing units per residential acre (which excludes other land uses) correlates well with the average vehicle miles traveled (VMT); the higher the density the lower the VMT.[5] As such, it is possible to predict VMT reduction based on change in density at the project level. But density must be done correctly; the Calculator only shows savings if alternative transportation options and pedestrian-friendly design are included as well.

- **Waste materials going to the landfill:** Construction waste typically includes wood, wallboard, corrugated (cardboard), concrete, metal, green waste and other debris. Each has a corresponding GHG emissions factor that is a function of embodied energy in production, transportation, and landfilling.[6] Material waste streams analyzed in the Calculator include wood, cardboard, concrete, green waste, metal, and mixed materials sent to recycling centers (if the average facility recycling rate is known).
- **Leakage of refrigerants**: Gases used in refrigeration escape at a rate of 2% a year, or 1 lb per year for a typical home application.[7] Each refrigerant has an associated global warming potential (GWP) related to this amount and interval that can be compared to the same mass of $CO_2$ (with a GWP of 1).

Many measures were excluded from the calculator because of either a low correlation with climate change or resource benefits (e.g. light pollution reduction), insufficient data available (e.g. no third party study on the energy savings of a gearless elevator over a hydraulic elevator), or difficulty devising a solid metric by which to measure its impact (e.g. environmentally preferable materials). See Appendix D for a list of measures not yet included in the calculator and Appendix E for a list of measures excluded from the Calculator.

For new homes, energy measures that are required in the 2005 California Building Energy Code (Title 24 part 6) are not included in energy savings estimates since they do not exceed minimum code requirements. The building measures taken to achieve energy performance beyond code are detailed as part of the whole building energy modeling, and thus are not quantified individually. Energy savings from good design and high performance building technologies are included as part of the modeled home's performance.

For existing homes, there are two types of GreenPoint Rated categories: whole house and partial house (called "Elements").

- **Whole House:** The project must meet the minimum requirements of the Green Point Rated checklist, which includes Title 24 performance modeling.
- **Elements:** For partial retrofits (or any other project not requiring Title 24 performance modeling), the checklist identifies specific measures a project may claim prescriptively. Savings for energy-related measures are calculated based on the improved performance over a typical home of the same size and vintage. The Elements program uses four vintage categories: a) pre-1980 (i.e. pre-Title 24); b) 1980-2001; c) 2002-2005; and d) 2006-present. The four vintages correspond with significant changes in building energy efficiency practices coinciding with major Title 24 updates. Historic information, like SEER of air conditioning or insulation levels in the walls, can be estimated based on

[5] Holtzclaw, John, *Smart Growth As Seen From the Air, Convenient Neighborhood, Skip the Car*, June 2000, www.sierraclub.org/sprawl/transportation/holtzclaw-awma.pdf
[6] Waste Reduction Model (WARM) calculator, US EPA, 2008 update, www.epa.gov
[7] LEED NC Reference Guide Version 2.2, US Green Building Council, October 2005

vintage and energy savings over the assumed basecase. These measures are listed in Appendix B.

## A note on CO2 emissions types

While the data on emissions generated by the Climate Calculator are informative, not all emissions are equally attributable to the building's design or construction. In particular, some of the emissions data quantified in the Calculator are based on factors outside the control of the building owner or contractor, such as the carbon footprint in each kilo-watt of energy delivered to the site. Because of the different nature of emissions in terms of who owns or creates them, a set of emissions "scopes" are used to classify each type of emission as direct or indirect. See Table A for an overview of the World Resources Institute's definition of emission scopes and how they relate to measures in the GreenPoint Rated Climate Calculator. [8] Each of the measures included in the Climate Calculator are assigned scope 1, 2, or 3.

**TABLE A: Emissions Scopes Used in Footprinting**

| | SCOPE 1 | SCOPE 2 | SCOPE 3 |
|---|---|---|---|
| Definition of Scope | Direct emissions:<br><br>*Emissions occur on-site and are owned or controlled by the homeowner/builder.* | Indirect emissions from the consumption of purchased electricity:<br><br>*Emissions occur off-site but are directly attributable to the owner/builder. Scope 2 emissions physically occur at the facility where electricity is generated.* | All other indirect emissions:<br><br>*Emissions that occur off-site and are a consequence of the activities of the owner/builder, but occur from sources not owned or controlled by the homeowner/builder.* |
| Measures in the GreenPoint Rated Climate Calculator | Natural gas or propane savings due to energy efficiency, solar water heating, high efficiency appliances. | Electric energy savings due to energy efficiency and/or electricity generated on-site via PVs/wind. Compared against the emissions factor for the utility that serves the site. | Measures with upstream and downstream impacts: waste diversion, recycling, water conservation, embodied energy in materials production, lifecycle analysis. |

## Footprints

The Climate Calculator defines emissions and resource savings as the difference between a basecase conventional home's profile and the green home. To do this, the Calculator develops two footprints: one based on a conventional home, and the second is the GreenPoint Rated home.

[8] Definitions for Scopes come from the World Resources Institute's *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (rev. ed.),* 2004 (www.ghgprotocol.org).

The basecase conventional home serves as a starting point for comparing the two footprints. The basecase is hypothetically the home that would have been built had it been designed and built to conventional code-compliant standards and practices. The conventional home is developed in the Calculator by estimating average home size, occupancy, energy use, appliance selection, refrigerant type, construction waste profile, development density, and more. Each of the conventional home assumptions have been vetted with leaders in the respective industries and are documented in Appendix B.

The GreenPoint Rated home then becomes the “green” case whereby the green home’s profile is compared against the basecase, conventional home. The difference between the two footprints is the assumed savings. For existing buildings, the methodology is slightly different because the basecase home is based on the vintage of construction, instead of current standard practice, but otherwise the methodology is the same as for new homes.

## Appendix B: Measures Included in the Calculator

The information included in this table was used in the design and creation of the calculator. Measures are organized by categories outlined in Build It Green's Single Family and Multifamily Green Building guidelines. Regional emissions factors used in calculations are summarized in Appendix C.

| Measure | Description impact | Data input | Savings | Baseline | Calculation |
|---|---|---|---|---|---|
| **Community Planning and Design** | | | | | |
| **Conserve Resources by Increasing Density (10 Units per Acre or Greater)** | Increased density is shown to correlate to higher use of transit, and less driving. | Average home density | Calculator developed by ICLEI | Typical density of single family dwellings in sprawl. Adapted from John Holtzclaw study "Smart Growth As Seen From the Air". This calculation includes EMFAC On Road Emission Factors from ARB/BAAQMD. | VMT emissions data are correlated with avg housing units per residential acre and proximity to services/transit. Must include this measure (density) along with the next 3 measures in this table to take credit for VMT savings. |
| **Design for Walking & Bicycling** | Pedestrian and bicycle-friendly design correlates with less driving | Same as above | Same as above | Same as above | Included in ICLEI density/VMT calculation above |
| **Pedestrian Access to Community Services within ½ Mile** | Mixed-use developments with pedestrian access correlate with less driving | Same as above | Same as above | Same as above | Included in ICLEI density/VMT calculation above |
| **Transit Options** | Increased public transit options correlate with less driving | Same as above | Same as above | Same as above | Included in ICLEI density/VMT calculation above |
| **Home Size Efficiency (for new single family homes only)** | Smaller homes reduce heating and cooling loads and result in less waste to construct. | house sf | kWh and tons of waste | Assume baseline home size per BIG single family Rater Manual (version 3.4, January 2008, page 65), based on ANSI Z765-2003.<br>Energy: kWh/sf from Title 24 model.<br>Waste: from StopWaste.Org study on average waste generation for new homes. | Energy: Multiply kWh/sf x difference in sf from basecase sf x adjustment factor.<br>Waste: multiply lbs/generated per sf by difference in sq ft from basecase sf. |
| **Site** | | | | | |
| **Recycle Job Site Construction Waste (Including Green Waste)** | Recycling construction waste results in upstream benefits (manufacturing, extraction, transportation) and downstream energy savings (transportation, methane capture, cogeneration) . | lbs waste diverted by material | Crushed concrete, mixed metals, green waste, cardboard & wood tons | No recycling of materials. | Savings based on EPA WAste Reduction Model (WARM) 2008 update. |

| Measure | Description impact | Data input | Savings | Baseline | Calculation |
|---|---|---|---|---|---|
| **Landscaping** | | | | | |
| **Minimize Turf Areas in Landscape Installed by Builder** | Electricity used to source, convey and treat water in the state has associated GHG emissions. Following Bay-Friendly Landscaping techniques can significantly reduce water demands from landscapes.[9] | Reference ET, square feet of landscape, and GPR checklist | kWh/gallon of $H_2O$ coefficient adapted from CEC study on Water-Energy relationship | Assume 50% of landscaping consists of regularly watered plants (turf), remaining 50% consists of occasional watering plants. No weather-based controllers. | Must include Hydrozoning, High-Efficiency Irrigation Systems, and must use compost and mulch to get savings. Water budget based on Bay Friendly Landscaping prerequisites and utilizing data from Public Policy Institute of California, and CA WELO. |
| **Implement Hydrozoning: Group Plants by Water Needs** | Same as above | Same as above | Same as above | Same as above | Same as above |
| **Install High-Efficiency Irrigation Systems** | Same as above | Same as above | Same as above | Same as above | Same as above |
| **Apply 2 inches Compost into the Top 6-12 inches of Soil** | Same as above | Same as above | Same as above | Same as above | Same as above |
| **Mulch All Planting Beds to greater of 2" or Local Water Ordinance** | Same as above | Same as above | Same as above | Same as above | Same as above |
| **75% of Plants Are California Natives or Mediterranean Species** | Same as above | Same as above | Same as above | Same as above | If this measure checked off on checklist, then design case is assumed to have no areas of high water use. |
| **Plant Shade trees** | Trees sequester carbon when growing and also cool surrounding air, resulting in reduced air conditioner use in hot climates. | Shade trees or not? Include climate zone | A 25 foot tree reduces annual cooling costs of a typical residence by about 8-12 percent. Assumed 8% cooling savings per home. | No 25' shade trees. | A/C electricity use estimated based on climate zone using RASS study. A/C savings estimates (8-12%) come from Energy-Efficient Landscapes McPherson, Rowntree and Wagar (1995) page 150, and, Urban Forest Landscapes, Integrating Multidisciplinary Perspectives (Edited by Gordon A. Bradley) |
| **Meets California-Friendly Landscape requirements** | Reduced water use in landscapes. | Water budget calculation | kWh/gallon of $H_2O$ conserved | Conventional landscaping | kWh/gallon of $H_2O$ conserved |
| **Plumbing** | | | | | |
| **Install Only High Efficiency Toilets (Dual-Flush or ≤1.3 gpf)** | Water is saved by installing toilets that use less water per flush. | # fixtures | gallons per fixture over baseline; apply kWh/gallon of water savings | Assume average flush rate of 1.6 gpf, | CA Building Standards Commission Green Building Code modified with input from CUWCC |
| **Rain Water Collection System** | Rain water collection reduces the need for utility water | gallons collected | kWh/gallon of $H_2O$ conserved | No rain water collection | Amount of water collected annually = gallons of water saved |

[9] Prerequisite requirements for the Bay-Friendly Landscaping principles are included in the GreenPoint Rated Guidelines. See www.bayfriendly.org for more information on the program.

| Measure | Description impact | Data input | Savings | Baseline | Calculation |
|---|---|---|---|---|---|
| **Composting or waterless toilet** | Waterless toilets reduce the need for water. | # fixtures | kWh/gallon of $H_2O$ conserved | conventional toilet of 1.6 gpf | CA Building Standards Commission Green Building Code modified with input from CUWCC |
| **Greywater system operational (includes washing machine at minimum)** | Use of greywater reduces the need for utility water supply and for wastewater treatment | gallons collected | kWh/gallon of $H_2O$ conserved | No greywater system | Quantity of greywater = gallons of water saved |
| **Plumbing fixtures with below standard flow rates (faucets <1.5 & showers <2.0 gal/min)** | Reduces water use, which saves electricity in pumping water from the reservoirs. | # fixtures | savings (gal) per fixture | Conventional plumbing fixtures based on Federal maximum flow rates (EPAct); kitchen faucets exempt | CA Building Standards Commission Green Building Code modified with input from CUWCC. No hot water savings calculated at this time. |
| **Water savings for waterless urinals** | Waterless urinals save water, | # of urinals | savings (gal) per fixture | Federal law requires 1gpf max for urinals.<br>1 gpf x flushes/yr | CA Building Standards Commission Green Building Code modified with input from CUWCC |
| **Water savings for flow restrictors/ control valves, pre-rinse spray valves** | Reduces water and energy use. | # fixtures with flow restrictors installed and flow rates | savings (gal) per fixture | Standard water fixture efficiency | CA Building Standards Commission Green Building Code modified with input from CUWCC. No hot water savings calculated at this time. |
| **Appliances** | | | | | |
| **Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants** | High efficiency air conditioning lowers energy use (accounted in T24). Some refrigerants have high Global Warming Potential (GWP). | amt of refrigerant /ton of cooling | Compared against GWP of HCFC-22 (also known as R-22) | Standard refrigerant (HCFC-22) | Refrigerant GWPs delta as calculated. 'LEED NC Reference Guide Version 2.2 and EPA website. Assumes 2% leakage per year. |
| **Install Water and Energy Efficient Dishwasher** | Water-efficient dishwashers reduce water and energy use | # of dishwash-ers and ENERGY STAR ratings | Use ENERGY STAR calculator for kWh and therm savings. | DOE Standard Dishwasher energy factor and annual water consumption. Differs based on water heater energy source (electric or gas). | Based on ENERGY STAR calculator or actual appliance data. |
| **Install ENERGY STAR Clothes Washing Machine with Water Factor of 6 or Less** | Water-efficient clotheswashers reduce water and energy use. | # washing machines and ENERGY STAR ratings | ENERGY STAR clotheswasher calculator for energy (kWh and therm) & water savings | Standard full-size washer water and energy use per year. Differs based on water heater energy source (electric or gas). | Based on ENERGY STAR calculator or actual appliance data. |
| **Install ENERGY STAR Refrigerator** | ENERGY STAR refrigerators can reduce electricity bills. | # refriger-ators and ENERGY STAR ratings | kWh savings from ENERGY STAR calculator | DOE standard efficiencies for refrigerator configuration and size | Based on ENERGY STAR calculator or actual appliance data. |
| **Central laundry (multifamily only)** | Residents tend to wash larger loads, and less frequently when using a centralized laundry room. This saves on water and energy. | number of units in project | 70% water savings, 80% kWh savings, and 81% natural gas savings per year per unit over conventional washers | Central laundry savings use baseline of conventional clothes washers installed in every unit (not ENERGY STAR) | Savings = Conventional clothes washer resource use x (70%, 80%, 81%) = Water savings, kWh savings and natural gas savings. |

| Measure | Description impact | Data input | Savings | Baseline | Calculation |
|---|---|---|---|---|---|
| **Heating, Ventilation, and Air Condition (HVAC)** | | | | | |
| **Don't Install Fireplaces or Install Sealed Gas Fireplaces** | Efficient gas fireplaces consume less gas and reduce winter heating costs. | # fixtures | 9 therms/yr per fixture | Assume no fireplace | Calculation based on study from the Natural Resources Canada Office of Energy Efficiency www.oee.nrcan.gc.ca/equipment |
| **Building Performance** | | | | | |
| **Design and Build High Performance Homes - 15% above Title 24 -** | High performance homes use less energy | Title 24 report kWh & therms | % above code (Minimum requirement: 15% above code TDV energy budget on CF-1R) | Baseline house that is Title 24 compliant | Title 24 performance model output. Non- TDV kWh and therm usage below baseline code. |
| **Building Diagnostics (Multifamily only)** | Commissioning ensures that the building operates according to design intent. | Are diagnostics included or not? | 2-20% savings typical. Assume 3% conservative estimate (LBNL study) | Assume no commissioning done - current average energy consumption, or T24 performance model results | 3% energy savings relative to performance model for Title 24 home (design case). |
| **Renewable Energy** | | | | | |
| **Install Photovoltaic (PV) Panels** | PV installations displace the need for fossil-fuel based grid electricity | Estimated annual output | kWh offset | Assume no PV panels. | (Annual kWh solar output x tons CO2/utility kWh) = tons of CO2 displaced |
| **Energy Upgrades for Existing Homes (whole house)** | Retrofitting existing homes increases energy perfomance | Estimated kWh savings of whole house | % above code or basecase | No actions – modeled average current energy consumption | Calculate using performance software. |

| Measure | Description impact | Data input | Savings | Baseline | Calculation |
|---|---|---|---|---|---|
| **Existing Home GPR prescriptive energy measures (Elements - when no T24 modeling required)** [10] | | | | | |
| **Energy Upgrades, Tier 1** | | | | | |
| **Attic, crawl space, and wall insulation** | A well insulated building has better energy performance. | Climate zone, insulation thickness | Better than basecase | Based on typical house within vintage category | Annual kWh and Btu savings over baseline |
| **High Efficiency Furnace (+90% AFUE)** | Higher efficiency furnaces consume less energy | Climate zone, equip specificatio ns | Better than basecase | Based on typical house within vintage category | Rater verification of AFUE |
| **Minimal Duct Leakage < 15% lost** | Less leakage = higher efficiency | From test protocol | Better than basecase | Based on typical house within vintage category | Annual kWh and Btu savings over baseline |
| **High Efficiency Air Conditioning Unit (zones 2,4,8-16)** | Higher efficiency AC units use less energy to cool the home | Climate zone, equip specificatio ns | Better than basecase | Based on typical house within vintage category | Annual kWh and Btu savings over baseline |
| **Blower Door Test 0.5 ACH or 50% improvement** | sealing air leaks can reduce heating and cooling loads | From test protocol | Better than basecase | Based on typical house within vintage category | Rater verification in the field (Based on KEMA study) |
| **Energy Upgrades, Tier 2** | | | | | |
| **High Efficiency Water Heater** | Higher efficiency water heaters consume less energy | Climate zone, equip specifica- tions | Better than basecase | Based on typical house within vintage category | Annual kWh and Btu savings over baseline |
| **Radiant Barrier** | Reduces penetration of roof heat into attic | Installed or not | Better than basecase | Based on typical house within vintage category | Rater verification in the field (Based on KEMA study) |
| **Window Upgrades** | Improves the loss/gain of heat through windows | Climate zone, equip specifica- tions | Better than basecase | Based on typical house within vintage category | Annual kWh savings over baseline |
| **Duct Insulation** | Minimize losses in ducts | Climate zone, insulation R-value | Better than basecase | Based on typical house within vintage category | Annual kWh savings over baseline |
| **Programmable Thermostat** | Allows for more control of HVAC use, helpful in reducing energy | Climate zone | Better than basecase | Based on typical house within vintage category | Rater verification in the field (Based on KEMA study) |
| **High Efficiency Air Conditioning Unit (zones 1,3,5,6,7)** | Higher efficiency AC units use less energy to cool the home | Climate zone, equip specificat- ions | Better than basecase | Based on typical house within vintage category | Annual kWh and Btu savings over baseline |
| **Water and Energy Efficient Dishwasher Installed** | Water-efficient dishwashers reduce water and energy use | # machines and ENERGY STAR ratings | Use ENERGY STAR calculator for kWh savings. | Based on typical house within vintage category | Project use = Gallons/cycle x 0.1 cycles/day x 365 days |
| **ENERGY STAR Refrigerator Installed** | ENERGY STAR refrigerators can reduce electricity bills. | # machines & ENERGY STAR ratings | kWh savings from ENERGY STAR calculator | Based on typical house within vintage category | Based on ENERGY STAR calculator |
| **Energy Efficient Lighting (at least 10% of total)** | Energy efficient lighting saves energy | Lighting survey | Better than code basecase | Based on typical house within vintage category | kWh savings |

[10] Savings are based on the CEC Database for Energy Efficiency Resources (DEER) study, www.energy.ca.gov/deer except where noted as savings estimates from the KEMA Measure Quantification Study of Savings for NCPA/SCPPA, 2006 (referenced herein as "KEMA Study").

## Appendix C: Emissions Factors & Coefficients

| EMISSIONS SOURCE | EMISSIONS FACTOR | | YEAR | DATA SOURCES |
|---|---|---|---|---|
| Electricity | | | | |
| California grid-wide average | 878.7 | lbs $CO_2$/MWh | 2005 | [1] |
| Austin Energy | 1078.0 | lbs $CO_2$/MWh | 2005 | [2] |
| City of Anaheim Public Utilities | 1416.7 | lbs $CO_2$/MWh | 2005 | [2] |
| City of Palo Alto Public Utilities | 39.0 | lbs $CO_2$/MWh | 2005 | [2] |
| Los Angeles Department of Water and Power | 1238.5 | lbs $CO_2$/MWh | 2005 | [2] |
| PacificCorp | 1747.3 | lbs $CO_2$/MWh | 2005 | [2] |
| PG&E | 455.8 | lbs $CO_2$/MWh | 2005 | [2] |
| Platte River Power Authority | 1955.7 | lbs $CO_2$/MWh | 2005 | [2] |
| Riverside Public Utilities | 1346.2 | lbs $CO_2$/MWh | 2005 | [2] |
| Roseville Electric | 565.5 | lbs $CO_2$/MWh | 2005 | [2] |
| Southern California Edison | 641.3 | lbs $CO_2$/MWh | 2005 | [2] |
| San Diego Gas & Electric | 780.8 | lbs $CO_2$/MWh | 2005 | [2] |
| Sacramento Municipal Utility District | 555.3 | lbs $CO_2$/MWh | 2005 | [2] |
| Turlock Irrigation District | 628.5 | lbs $CO_2$/MWh | 2005 | [2] |
| Natural Gas | | | | |
| Natural Gas | 11.616 | lbs $CO_2$e/therm | 2007 | [2] |
| Propane | 0.00567 | MTCO2/gallon propane | | |
| Water | | | | |
| Northern California: | | | | |
| Indoor water | 3,950 | | | |
| Outdoor water | 1,450 | | | |
| Rainwater system - used indoors | 1,450 | | | |
| Rainwater system - used outdoors | 1,450 | | | |
| Greywater system - used indoors | 3,950 | | | |
| Greywater system - used outdoors | 3,950 | kWh/million gal. | 2005 | [3] |
| Southern California | | | | |
| Indoor water | 12,700 | | | |
| Outdoor water | 10,200 | | | |
| Rainwater system - used indoors | 10,200 | | | |
| Rainwater system - used outdoors | 10,200 | | | |
| Greywater system - used indoors | 12,700 | | | |
| Greywater system - used outdoors | 12,700 | kWh/million gal. | 205 | [3] |
| Waste | | | | |
| Concrete | -0.01 | MTCO2E per ton recycled | 2008 | [4] |
| Wood | -0.79 | MTCO2E per ton combusted | 2008 | [4] |
| Cardboard | -3.11 | MTCO2E per ton recycled | 2008 | [4] |
| Mixed metals | -5.26 | MTCO2E per ton recycled | 2008 | [4] |
| Green waste | -0.20 | MTCO2E per ton composted | 2008 | [4] |

| EMISSIONS SOURCE | EMISSIONS FACTOR | | YEAR | DATA SOURCES |
|---|---|---|---|---|
| Refrigerants | | | | |
| Baseline: R-22 refrigerant | 1780 | lbs CO2/lb of refrigerant | 2005 | [5] |
| Ammonia | 0 | lbs CO2/lb of refrigerant | 2007 | [6] |
| HFC-134A refrigerant | 1320 | lbs CO2/lb of refrigerant | 2005 | [5] |
| HFC-407C refrigerant | 1700 | lbs CO2/lb of refrigerant | 2005 | [5] |
| HFC-410A refrigerant | 1780 | lbs CO2/lb of refrigerant | 2005 | [5] |
| Vehicle Miles Traveled | | | | |
| VMT reduction based on density | Varies | VMTs reduced | 2005 | [7] |

[1] California grid-wide average is from EPA e-RID2006V2_1_year04_aggregation file (Sheet "EGRDSRL04")
[2] Certified $CO_2$ emission factor for delivered electricity: www.climateregistry.org/tools/members-only/reporting-tips.html
[3] CEC Staff report: California's Water-Energy Balance (Report CEC-700-2005-11-SF)
[4] Savings factors based on EPA WAste Reduction Model (WARM) calculator, www.epa.gov, 2008 update with modifications on assumptions for sequestration by StopWaste.Org and ICLEI.
[5] Based on LEED-NC Reference Guide Version 2.2 (October 2005)
[6] EPA listed refrigerant. http://www.sznorinco.com/chemicals/dy/proe23.html.
[7] EMFAC 2007 data in conjunction with formulas and assumptions for this calculation is adapted from John Holtzclaw's work: "Smart Growth As Seen From the Air, Convenient Neighborhood, Skip the Car." http://www.sierraclub.org/sprawl/transportation/holtzclaw-awma.pdf

## Appendix D: Measures Not Yet Included in the Calculator

The following list of measures are not included in the Calculator but will likely be included when new research becomes available.

| MEASURE | COMMENTS |
|---|---|
| **COMMUNITY DESIGN & PLANNING** | |
| **Subdivision Layout & Orientation to Improve Natural Cooling and Passive Solar Attributes** | Not adequately addressed in T24 (base = proposed home orientation), but there are too many variables to include this analysis at this time. Perhaps the California Energy Commission or other entity will develop tools for this analysis in the future. |
| **Redevelopment of an existing building** | Too many variables and unknowns. Can take credit for source reduction/recycling of construction materials. |
| **SITE** | |
| **Reduce Heat-Island Effect - Install light-colored, high albedo materials (solar reflectance index >= 0.3) for at least 50% of site's non-roof impervious surfaces** | Not included in T24 modeling. Difficult for GPR raters to verify without significant efforts in documentation. Studies on reducing the urban heat island effect through high albedo materials and correlating those benefits to building sites are not conclusive at this time. |
| **FOUNDATION** | |
| **Replace Portland Cement in Concrete with Recycled Flyash or Slag** | Concerns over the availability of flyash/slag in the west make this measure questionable for emissions savings due to the amount of transportation energy associated with the use of flyash. Therefore, while we acknowledge flyash as a good practice due to its use of a waste by-product (recycling), and as a less energy intensive material than Portland cement, we are hesitant to claim any benefits in CO2 emissions due to its use. Flyash is difficult to document for Raters as well. WARM does include a flyash coefficient so in the future this measure may be possible to add. |
| **LANDSCAPING** | |
| **Construct Resource-Efficient Landscapes** | |
| **No Plant Species Will Require Hedging or Shearing** | There are benefits in reduced gasoline use (or in some cases electric) from the avoidance of motorized maintenance equipment to shear hedges and mow lawns. This measure also reduces the amount of green waste produced on site that is either then landfilled or composted. In order to take credit for reduced green waste, we would need average green waste generation rates for hedges, which is not available at this time. This issue will be revisited in next version. |
| **Use 50% Salvaged or Recycled-Content Materials for 50% of Non-Plant Landscape Elements** | Difficulty in accurately compiling and understanding life cycle impacts (e.g. raw materials, manufacturing and distribution streams, transportation) make it nearly impossible to accurately estimate CO2 impacts. Developing baseline emissions estimates for the manufacturing industry would be necessary to truly quantify emissions reductions beyond “standard” practice. Look to tools like Pharos to help with this issue in the future. |

| MEASURE | COMMENTS |
|---|---|
| **STRUCTURAL FRAME & BUILDING ENVELOPE** | |
| **Apply Optimal Value Engineering** | Energy savings from this strategy are included in Title 24 as part of the wall framing factor. Documenting a reduction in the quantity of wood was seen as too difficult for Raters to collect economically, so this measure is not included at this time. |
| **Use FSC-Certified Wood** | The impact of sustainably harvested forests as opposed to conventional forestry practices on greenhouse gas emissions may be correlated but specific data about it is not currently available. The FSC Board of Directors, with support from FSC staff, is currently debating the role FSC will play in relation to the global climate debate including the possible role of forests in carbon sequestration." April 7th, 2008 at Mongabay.com: news.mongabay.com/2008/0407-hance_fsc_interview.html |
| **Use Recycled-Content Steel Studs for 90% of Interior Wall Framing** | May or may not have energy benefit. Recycled steel is better than virgin steel, but probably more intensive than wood framing and may not make up for that in energy savings over life of home. Lifecycle analysis tools are not conclusive at this time. Look to tools like Pharos, Athena Institute, or BuildCarbonNeutral.org in the future. |
| **Green Roofs (25% of roof area minimum)** | Has some insulation value, but that benefit can be modeled in Title 24. Stormwater and water savings are dependent on rainfall data, roof design, and other elements which are difficult to quantify. Can include green roofs under the landscape water savings. |
| **Construction materials efficiencies** | Difficult to quantify. Even if baseline amount of material could be determined for any specific building or modular building components, transportation/landfilling diversion from this amount would be difficult to calculate. |
| **EXTERIOR FINISH** | |
| **Use Recycled-Content (No Virgin Plastic)** | Difficulty in accurately compiling and understanding life cycle impacts (e.g. raw materials, manufacturing and distribution streams, transportation) make it nearly impossible to accurately estimate CO2 impacts. Developing baseline emissions estimates for the manufacturing industry would be necessary to truly quantify emissions reductions beyond "standard" practice. Look to tools like Pharos to help with this issue in the future. |
| **INSULATION** | |
| **Inspect Quality of Insulation Installation before Applying Drywall** | Inspection of insulation installation is critical but difficult to quantify. Title 24 accounts for this in part. |
| **PLUMBING** | |
| **Water Submetering** | Lack of data related to baseline whole building water usage. One realty company that owns over 75,000 apartment units throughout the country reported average water savings between 20 and 30 percent of total use when submetering was in place. A submetering study in Seattle did not record any savings. Savings are excluded for now because of inconclusive study results. |

| MEASURE | COMMENTS |
|---|---|
| **HVAC** | |
| **Innovative wastewater technology (constructed wetland, sand filter, aerobic system)** | Removed from the list because not possible to calculate energy use for a single septic system compared with an innovative wastewater technology. Could possibly assign water-energy benefit based on the CEC study, but savings were deemed too low to justify inclusion at this point. Water savings from reduced sewage are accounted for. |
| **Install drain water heat-recovery system** | Not accounted for in Title 24. Savings related to this measure are expected to be quite small, but no peer-reviewed literature was found to quantify expected energy savings. |
| **Install Effective Exhaust Systems in Bathrooms and Kitchens** | Specific energy savings data for bathroom fans not available at this time. |
| **Install ENERGY STAR Ceiling Fans & Light Kits in Living Areas & Bedrooms** | Ceiling fans can reduce the need for air conditioning. Estimated 151 kWh/yr saved per fan based on ENERGY STAR data. However, baseline data for average fan use was not available at time of development. Revise in next version. |
| **Automatically Controlled Integrated System (including variable speed control)** | Integrated systems heat and cool more efficienctly. Night Breeze system is typical of this type of system. Saving data available from Davis Energy Group, but more studies desired before adding to Calculator. Further, some energy benefit may already be accounted for in Title 24. Risk of double-counting. |
| **RENEWABLE ENERGY** | |
| **BUILDING PERFORMANCE** | |
| **House Obtains ENERGY STAR with Indoor Air Package Certification** | Mostly concerned with IAQ, not energy savings. This measure overlaps with many of the above measures and is thus accounted for elsewhere. |
| **Renewable Energy: Extraordinary Passive Solar or other Energy Design (> 50% of load) that is proven to not already be reflected in T-24 modeling** | The Rater must establish proof of over and above energy savings not reflected in T24. |
| **FINISHES** | |
| **Use Environmentally Preferable Materials for Interior Finish** | This measure gives Points for five different kinds of materials. In none of the five cases have we found a credible source for calculating an emissions benefit relative to a baseline scenario. Overall, this is too general and difficult to compare to a baseline scenario at present. Look to tools like Pharos to help with this issue in the future. |
| **Gearless Elevators** | No third party study. Without independently verified data on gearless elevators, energy savings cannot be accurately verified. |
| **FLOORING** | |
| **Use Environmentally Preferable Flooring** | No credible source for calculating an emissions benefit relative to a baseline scenario have been found. Overall, this is too general and difficult to compare to a baseline scenario at present. Look to tools like Pharos to help with this issue in the future. |

| MEASURE | COMMENTS |
|---|---|
| **APPLIANCES & LIGHTING** | |
| **Install Built-In Recycling Center** | While recycling and composting at home have benefits, this measure was dropped because it is a behavioral issue. An investigation into the ways to estimate the amount of recycling is being conducted now and this measure will likely be used in the next update of the Calculator. |
| **OTHER** | |
| **Materials sourced and manufactured within a 500 mile radius of the home (per LEED for Homes)** | Difficulty in accurately compiling and understanding life cycle impacts (e.g. raw materials, manufacturing and distribution streams, transportation) make it nearly impossible to accurately estimate CO2 impacts. Developing baseline emissions estimates for the manufacturing industry would be necessary to truly quantify emissions reductions beyond "standard" practice. Look to tools like Pharos to help with this issue in the future. |
| **Reduced Parking Capacity** | Difficult to define a baseline value because jurisdictions vary in their parking requirement. Parking is somewhat accounted for in the density/VMT calculator developed by ICLEI. |
| **Affordability** | According to the NPH study "Planning for Residential Parking: A Guide For Housing Developers and Planners" affordable housing requires less parking and therefore less VMT can be expected by residents. However, if reduced parking capacity does in fact drive GHG reductions, then a parking measure should get credit, not affordability. Found online at: www.nonprofithousing.org/actioncenter/toolbox/parking. |
| **E-Meters** | Measure not included in calculator due to behavioral aspect of this measure and any associated savings potentially counted in other measures (e.g. installation of energy efficient dishwasher). Also, excluded due to uncertain baseline energy use (i.e. T24 performance estimate not necessarily appropriate).<br>NYSERDA states 10-26% savings on electric consumption from first year. http://www.nyserda.org/publications/SubmeterManual.pdf (PDF page 10) |

## Appendix E: Measures Not Applicable to the Calculator

These measures from the Guidelines were considered not applicable to the Calculator.

Reasoning for not including them:
A: Very small or no quantifiable climate change or resource benefit(s) expected
B: Difficult for Raters to acquire data
C: Difficult to define basecase and savings above basecase

| MEASURE | Reason for Exclusion | | |
|---|---|---|---|
| | A | B | C |
| **COMMUNITY DESIGN AND PLANNING** | | | |
| Develop Infill Sites | | | o |
| Design for Safety & Social Gathering | o | | o |
| Design for Diverse Households | o | | o |
| **SITE** | | | |
| Protect Native Soil and Minimize Disruption of Existing Plants & Trees | o | | o |
| Deconstruct Instead of Demolishing Existing Buildings On Site | | | o |
| Install a Foundation Drainage System | o | | |
| Sealed and Moisture Controlled Crawlspace | o | | |
| **FOUNDATION** | | | |
| Use Frost-Protected Shallow Foundation in Cold Areas (C.E.C. Climate Zone 16) | o | | |
| Use Radon Resistant Construction (In At-Risk Locations Only) | o | | |
| **LANDSCAPING** | | | |
| Use Fire-Safe Landscaping Techniques | o | | |
| Reduce Light Pollution by Shielding Fixtures and/or Directing Light Downward | | o | o |
| **STRUCTURAL FRAME & BUILDING ENVELOPE** | | | |
| Use Engineered Lumber | | o | o |
| Design, Build and Maintain Structural Pest and Rot Controls | o | | |
| Reduce Pollution Entering From the Garage | o | | |
| **EXTERIOR FINISH** | | | |
| Install a Rain Screen Wall System | o | | o |
| Use Durable and Non-Combustible Siding Materials | | | o |
| Select Durable and Non-Combustible Roofing Materials | | | o |
| Window flashing installation techniques specified | | | o |
| **INSULATION** | | | |
| Install Insulation that is Low-Emitting (Certified Section 01350) | o | | |
| **PLUMBING** | | | |
| Greywater pre-plumbing (includes washing machine at minimum) | o | | |
| Install drain pans or leak detection devices under plumbed appliances | | | o |

| MEASURE | Reason for Exclusion | | |
|---|---|---|---|
| | A | B | C |
| **HVAC** | | | |
| Install Carbon Monoxide Alarm(s) | o | | |
| Humidity control systems (only in humid/marine climate zones 1,3,5,6,7) | | | o |
| Install Sealed Combustion Unit | o | | |
| Install High Efficiecny HVAC Filter (MERV 6+) | o | | |
| **RENEWABLE ENERGY** | | | |
| Pre-Plumb for Solar Hot Water Heating | o | | |
| Install Wiring Conduit for Future Photovoltaic Installation & Provide 200 $ft^2$ of South-Facing Roof | o | | |
| **BUILDING PERFORMANCE** | | | |
| **FINISHES** | | | |
| Design Entryways to Reduce Tracked in Contaminants | o | | |
| Use Low-VOC or Zero-VOC Paint | o | | |
| Use Low VOC, Water-Based Wood Finishes (<250 gpl VOCs) | o | | |
| Use Low-VOC Caulk and Construction Adhesives (<70 gpl VOCs) for All Adhesives | o | | |
| Use Recycled-Content Paint | | | o |
| Reduce Formaldehyde in Interior Finish (CA Section 01350) | o | | |
| After Installation of Finishes, Test of Indoor Air Shows Formaldehyde Level <27ppb | o | | |
| Reduce Formaldehyde in Interior Finish (Section 01350) | o | | |
| **FLOORING** | | | |
| Flooring Meets Section 01350 or CRI Green Label Plus Requirements | o | | |
| **APPLIANCES & LIGHTING** | | | |
| **OTHER** | | | |
| Incorporate GreenPoint Rated Checklist in Blueprints | o | | |
| Develop Homeowner Manual of Green Features/Benefits | | | o |
| Homebuilder is ISO 14001 certified | o | | o |
| Majority of Homebuilder's management/staff are Certified Green Building Professionals | o | | o |
| Detailed Durability Plan (per LEED for Homes specifications) | | | o |
| 3rd Verification of Implementation of Durability Plan (per LEED for Homes specifications) | | | o |
| Comprehensive Owner's Manual and Homeowner Educational Walkthroughs | o | | o |

# Appendix F: Other Emissions Calculators

Unlike some calculators, the GreenPoint Rated Climate Calculator isn't a do-it-yourself rating tool that estimates the impacts of individual's behaviors, although it may be complementary to those behavior-based calculators. The GreenPoint Rated score and the Climate Calculator results are independent of the occupants' behavior in most cases. The assumptions used in the Calculator remain valid for that building regardless of ownership or occupancy, unless significant changes are made to the building's structure or systems. For this reason, the Climate Calculator is different from other calculators used for estimating $CO_2e$ attributed to homes.

Methodologies, such as the World Resources Institute methodology, measure impacts on climate change at a macro level, either by assessing the emissions of a business, an entire industry sector, or a local or regional government's jurisdiction. Home carbon footprinting tools, like those that allow users to offset their air travel or purchasing habits, are specific to the behavior of the occupants. The GreenPoint Rated Climate Calculator bridges the gap between those calculators that estimate the carbon footprint of individuals; and the large, industry-wide emissions reporting protocols.

The following is a list of emissions calculators available to help estimate carbon footprints and/or avoided emissions from green building.

**US EPA Personal Emissions Calculator**
www.epa.gov/climatechange/emissions/ind_calculator.html
For individuals and households, focuses on emissions from household energy use, transportation fuels, and waste disposal. Mostly national averages except for electricity; electricity emissions factors are categorized by geographic subregion. Relies on individual to enter data.

**Cool California**
www.coolcalifornia.org
Calculates the carbon footprint for home or business energy use, as well as car and air travel, food, and goods and services. Data sources are all based on California metrics.

**US EPA Waste Reduction Model (WARM)**
www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html
Calculates emissions from landfilling and savings from recycling and composting.

**US EPA Recycled Content (ReCon) Tool**
www.epa.gov/climatechange/wycd/waste/calculators/ReCon_home.html
Calculates emission savings from using recycled content materials.

**Lawrence Berkeley Labs Home Energy Saver**
http://hes.lbl.gov
Using inputs from homeowners about their house and energy bills, the program calculates the home's carbon footprint and suggests strategies for efficiency improvements.

**ENERGY STAR Portfolio Manager**
www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
Tracks and assesses energy and water consumption across entire portfolio of buildings.

**ENERGYguide**
www.energyguide.com
Prepares a home energy analysis report designed to help save energy and money.

**Home Energy Checkup**
www.ase.org/section/homeenergycheckup
A guide to identifying options for reducing energy costs through energy efficiency improvements.

**Travel Matters**
www.travelmatters.org
Calculates emissions from your travel.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