Lessons Learned From Developing the GreenPoint Rated Climate Calculator

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ABSTRACT

This paper presents results and lessons learned from the development of the GreenPoint Rated (GPR) Climate Calculator for new home and existing home construction. Although green building strategies are often assumed to reduce both energy consumption and greenhouse gas emissions, the GPR Climate Calculator seeks to quantify the climate benefits in a rigorous and comprehensive manner. The Climate Calculator is intended to support public-sector policy initiatives, such as AB 32, stimulate market demand for green homes, and recognize builders for sustainable building methods.

Results of this project illustrate the difficulties of defining the scope of emissions benefits, in terms of lifecycle emissions savings and direct savings, and temporal issues related to one-time emissions savings versus annual savings. The project team categorized the green building measures into six areas of measurable greenhouse gas emissions impact: Title 24 energy-related measures, non-Title 24 energy measures, waste management/recycling measures, outdoor water measures, indoor water measures, , and transportation-related measures.

The paper will describe which measures were ultimately included in the GPR Climate Calculator, data sources for emissions savings estimates, and how the results of the Calculator can be applicable to commonly accepted GHG emissions quantification protocols. GreenPoint Rated is a residential rating program for California, administered by Build It Green. The program is designed to provide a credible yet accessible entry point into green building and guide builders to achieve high levels of performance. The GPR Climate Calculator was developed by StopWaste.Org, Build It Green, KEMA Green Building Services, and ICLEI-Local Governments for Sustainability.

Introduction

Green building strategies have the potential to affect large reductions in energy consumption and greenhouse gas emissions. Globally, the use of energy in human activities related to buildings accounts for about 25-30% of energy-related emissions, and constitutes 19-22% of total anthropogenic CO_2 emissions.[1] In the United States, these numbers are even higher; buildings account for 36% of total energy use, 65% of electricity consumption, and 30% of greenhouse gas emissions.[2] Moreover, buildings consume 30% of U.S. raw materials, account for 30% of the nation's solid waste (136 million tons annually) and consume 12% of available potable water.[3]

[1] Wiel, Stephen, Nathan Martin, Mark Levine, Lynn Price, Jayant Sathaye. "The role of building energy efficiency in managing atmospheric carbon dioxide." *Environmental Science and Policy* 1 (1998): 27-38. Online. p27.
[2] "An Introduction to the U.S. Green Building Council and the LEED Green Building Rating System," PowerPoint Presentation, October 2005, Online. http://www.slideshare.net/jetsongreen/about-usgbc-leed
[3] Ibid.

The US green building industry has a foothold in two sectors with rapidly increasing CO_2 emissions – the commercial and residential sectors. [4] In fact, the value of green building construction increased from $10 billion to $36-$49 billion from 2005-2008, and could triple by 2013, despite the recession.[5] 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? There is a major opportunity to market the capacity of green building strategies to mitigate the effects of future carbon emissions growth. However, to date there has been no universal standard that directly measures the CO_2 emissions of building strategies or building types.

The absence of a greenhouse gas emissions standard for buildings is mostly a consequence of the inherent complexity associated with determining a particular building's impact on climate change. Climate impacts from buildings cannot simply be measured using a utility bill. Many other factors affect a buildings' climate change impact, such as site selection, materials choices, construction debris recycling, and various building systems (including, but not limited to, HVAC, plumbing and electrical systems). In light of these complications, multi-faceted green building rating systems may be the ideal tools to quantify individual buildings' climate change impacts.

Linking Green Building and Climate Change: The GreenPoint Rated System

The GreenPoint Rated System was an ideal platform to experiment with the use of a green building rating system to quantify greenhouse gas emissions reductions. GreenPoint Rated is a green building program developed by the non-profit membership organization Build It Green, located in Berkeley, California, with assistance from the green building group at StopWaste.Org, a joint powers public agency in the California Bay Area. This rating system, launched in 2006, has grown rapidly and is becoming a standard for green residential home construction and major renovation projects throughout the state of California. As of April 2009, there were almost 14,000 housing units either certified or in process under the GreenPoint Rated system.[6]

The GreenPoint Rated system is comprised of five critical green building tenets: energy efficiency, resource conservation, indoor air quality, water conservation, and community. In order to meet the GreenPoint Rated criteria, a home must obtain at least 50 points and meet minimum point thresholds in each of the five point categories.[7] GreenPoint Rated homes must be evaluated by independent, certified raters, ensuring the integrity and value of the system.

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[4] Energy Information Administration. "U.S. Carbon Dioxide Emissions from Energy Sources 2005 Flash Estimate." June 2006. Online. http://www.eia.doe.gov/oiaf/1605/flash/flash.html

[5] McGraw Hill Construction, "Green Building Could Triple by 2013, Says McGraw-Hill Construction: Green Outlook Report tracks dramatic growth, forecasts green building over next five years." November 2008, Online. http://www.mcgraw-hill.com/releases/construction/20081118.shtml

[6] Build It Green. For current numbers, please contact GreenPoint Rated staff at greenpointrated@builditgreen.org

[7] "GreenPoint Rated – The Program, Introducing GreenPoint Rated." Build It Green, Berkeley, CA. Online: www.greenpointrated.org

Once a home is verified to meet the criteria for a GreenPoint home, Build it Green issues a certificate to the builder which can be used in marketing of the new homes. The GreenPoint Rated system has evolved to include four distinct ratings: Single Family New Home, Multifamily New Construction, Single Family Existing Home, and Multifamily Existing Building. These four systems overlap but are not equivalent; therefore, the Climate Calculator has been adapted to address specific credits in each of these systems.

Calculator Development Process

To assess the climate change impacts related to each GreenPoint Rated system, StopWaste.Org teamed with ICLEI and KEMA Inc. Others consulted on the Climate Calculator included state climate change experts, State of California agency staff, and energy and green building leaders. Table 1 illustrates the structure of the Calculator development team.

Existing Climate Calculators in the Market

The first step in the Climate Calculator development process was to research the "Climate Calculators" already in the market. Most existing tools, such as the US EPA Personal Emissions Calculator, calculate a person's annual emissions impact based on vehicle usage and food intake, amongst other factors. Other tools, like the Lawrence Berkeley Lab Home Energy Saver, calculate a whole-building carbon footprint based on energy and/or water and other factors. However, none of these calculators has attempted to tie carbon emissions directly to a third party verified green building certification system.

Table 1. GreenPoint Rated Climate Calculator Development Team and Stakeholders

Project management and funding:	StopWaste.Org
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.

Establishing Baselines to Calculate Emissions Reductions

For each GreenPoint Rating system (single family, multifamily; new & existing), the development team sought to compare the greenhouse gas emissions generated by an "average" GreenPoint Rated home or multifamily unit with the emissions generated by a conventionally

built "average" home, adjusted for climate zone and utility territory.[8] 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 first challenge in developing the Climate Calculator was establishing a baseline level of household emissions from which to calculate reduced emissions from green building measures. The technical development team extensively reviewed existing data and research studies to find the best sources for baseline emissions information related to six areas of measurable greenhouse gas emissions impact: Title 24 energy-related measures, non-Title 24 energy measures, outdoor water measures, indoor water measures, waste management/recycling measures, and transportation-related measures. Baseline data for the Calculator has been developed from sources including the EPA's ENERGY STAR and WaterSense programs, the EPA's WAste Reduction Model (WARM) for recycling-related emissions, the Alliance for Water Efficiency, the Public Policy Institute of California, Association of Home Appliance Manufacturers, Natural Resources Canada, the California Energy Commission's Database for Energy Efficient Resources (DEER) database, Pacific Gas & Electric workpapers, and Lawrence Berkeley National Lab, among many others.

Example baseline emissions calculation. One of the first baselines calculated was that of energy use in single family homes. The 2004 Residential Appliance Saturation Study estimates the average energy use for single and multifamily California homes. From 2002-2003, 21,920 residential customers were surveyed on their energy equipment and energy-use behaviors. Results of this project were organized by type of home, climate zone, and utility service area, and served as the basis for our calculation of the carbon average non-green home in the Existing Homes rating system.[9] For new homes, baseline energy use is assumed to be the modeled Title 24 basecase home.

Most of the large electric utilities in California have been publicly reporting the GHG emissions associated with their delivered electricity under the California Climate Action Registry. These public emissions reports are conducted according to commonly accepted GHG reporting standards. Moreover, the fuel mixes for the California utilities are known, as well as the pounds of CO_2 generated per kWh for non-renewable fuels in this fuel mix. By multiplying the average number of kilowatt hours consumed by a typical home by the appropriate utility emissions factor (MT CO_2/kWh), it is possible to estimate the average pounds of CO_2 generated annually by a typical home in that utility's service territory.

Introducing the Climate Calculator

The sources of greenhouse gas emissions that the team was ultimately able to address within the Climate Calculator include:

[8] "The GreenPoint Rated Climate Calculator: March 2009 Update," Green Building in Alameda County. Online. http://www.stopwaste.org/docs/calculator_report-spring_09_update.pdf

[9] "California Statewide Residential Appliance Saturation Study: Final Report." Prepared for the California Energy Commission by KEMA-XENERGY, Itron, and RoperASW. June 2004.

- **Electricity generated by power plants**: For example, the equivalent of 0.49 lbs of CO_2 (CO_2e) are created for every kilowatt hour (kWh) used in PG&E service territory.[10] Each investor owned utility in California has a corresponding emissions factor of CO_2 e 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.[11] Thus, water savings can be equated to GHG emissions. For the Calculator, the actual location of the project (zip code) is 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.[12]
- **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), 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.[13] 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.[14] 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.[15] 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).

Determining Appropriate Emissions Scopes for Each Green Building Measure

The Climate Calculator is directly tied to the measures within the GreenPoint Rated system. Table 2 describes measures from the GreenPoint Checklist that were included in the Climate Calculator, along with the associated scope of each measure. The Climate Registry

[10] 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.
[11] CEC Staff Report: California's Water-Energy Balance (Report CEC-700-2005-11-SF). Online. http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF
[12] California Climate Action Registry General Reporting Protocol, Version 2.2, March 2007. Online. www.climateregistry.org/tools/protocols/general-reporting-protocol.html
[13] Holtzclaw, John, *Smart Growth As Seen From the Air, Convenient Neighborhood, Skip the Car*, June 2000, www.sierraclub.org/sprawl/transportation/holtzclaw-awma.pdf
[14] Waste Reduction Model (WARM) calculator, US EPA, 2008 update, www.epa.gov
[15] LEED NC Reference Guide Version 2.2, US Green Building Council, October 2005

requires that reported emissions be divided into "Scope 1," "Scope 2," and "Scope 3" emissions categories, so the Climate Calculator organizes emissions results by scope in order to conform to these requirements. Direct emissions are Scope 1, indirect emissions are Scope 2, and optional emissions are Scope 3. Some measures have different associated scopes depending on the fuel type (gas and propane are considered Scope 1 emissions, while electricity is Scope 2).

Table 2. Measures Included in the Climate Calculator

Category	Measure	GHG Scope
Community	Conserve Resources by Increasing Density (10 Units per Acre or Greater)	3
	Design for Walking & Bicycling	3
	Pedestrian Access to Community Services within ½ Mile	3
	Transit Options	3
	Home Size Efficiency	1,2,3
Site	Recycle Job Site Construction Waste (Including Green Waste)	3
Landscaping	Minimize Turf Areas in Landscape Installed by Builder	3
	Install High-Efficiency Irrigation Systems	3
	Plant Shade Trees	2
	Meets Bay-Friendly Landscape requirements	3
Plumbing	Install Only High Efficiency Toilets (Dual-Flush or ≤1.28 gpf)	3
	Rain Water Collection System (small is <300 gallons, and large is > 300 gallons)	3
	Composting or waterless toilet	3
	Greywater system operational (includes washing machine at minimum)	3
	Plumbing fixtures with below standard flow rates (faucets <1.5 & showers <2.0 gal/min)	3
	Water savings for waterless urinals	3
	Water savings for flow restrictors/ control valves, pre-rinse spray valves	3
Appliances	Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants	1
	Install Water and Energy Efficient Dishwasher (all measures)	1,2,3
	Install ENERGY STAR Clothes Washing Machine with Water Factor of 6 or Less	1,2,3
	Install ENERGY STAR Refrigerator	2,3
	Don't Install Fireplaces or Install Sealed Gas Fireplaces	1
Building Performance	Design and Build High Performance Homes - 15% above Title 24	1,2
	Building Diagnostic Testing	2
	Energy Upgrades for Existing Homes	1,2
Renewable Energy	Install Photovoltaic (PV) Panels and/or Solar Hot Water	1,2

Additionally, some measures have both indirect and optional associated emissions. For instance, an electric dishwasher has scope 2 emissions associated with its energy use and scope 3 emissions associated with its water use. Finally, the Calculator calculates emissions as "annual," or continuing, except for emissions associated with construction waste, which are "one-time" emissions.

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

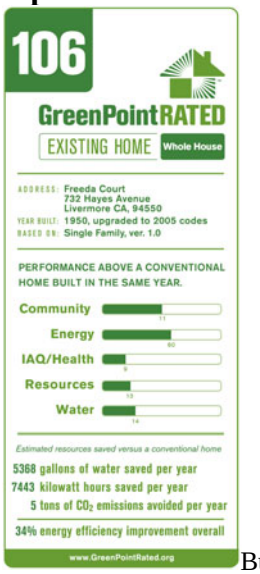
Existing home energy calculations are based on performance beyond code or the basecase for a particular vintage (for pre-2001 homes).

Many measures were excluded from the Calculator because of either a low correlation with climate change or resource benefits (e.g. light pollution reduction, low-emitting materials), 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).

Functionality of the Calculator

The GreenPoint Rated Climate Calculator is entirely integrated into the GreenPoint Rating process. The inputs for the Climate Calculator are collected and verified by the GreenPoint Rater through the normal GreenPoint Rating process, which includes documentation review and field verification. The Rater then uploads their verification data and checklist to the online GreenPoint Rated tracking system. Climate Calculator results are quantified and output reports are available to the Rater and other users of the tracking system. Figure 1 is an example of a GreenPoint Rated home certificate that includes Climate Calculator outputs.

Figure 1. Sample GreenPoint Rated Home Certificate



Build it Green.

It was critical in the development of this tool that 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.

Lessons Learned and Recommendations Related to Calculator Development

Initial project run-throughs using the Climate Calculator are finding emissions reductions of about 20% over conventional new construction built to code. As GreenPoint Raters begin entering Climate Calculator information into the Build it Green web tracking tool, more data will become available. Significant supplemental findings have been derived from the project team's extensive research and analysis into the correlations between specific green building strategies and their impacts on CO_2 emissions and consumption of energy, water and other resources:

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 California Energy Code (Title 24) Energy Efficiency Standards. The Climate Calculator provides an aggregated CO_2e total for most of the building energy efficiency strategies rather than presenting CO_2e results for individual strategies. 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. Analysis for existing homes was calculated based on the improved performance over a typical home of the same vintage.

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.

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. 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 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.[16] 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,[17] and thus the impacts from avoided construction waste are immense. At 5.6 tons of CO_2e saved per home,[18] recycling half the construction waste on new homes has the potential to reduce CO_2e emissions by more than 14.5 million tons by 2020!

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 or plug loads.

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.

More Data Is Needed on GHG Impacts from Many Green Building Strategies

Many of the green building measures in Build It Green's *Green Building Guidelines* and *checklist* were excluded from the Climate Calculator either because they are not applicable or because there is currently little or no information about their GHG reduction potential. A consensus-based life-cycle assessment (LCA) tool, for example, is currently not available to

[16] 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.
[17] California Energy Commission household forecast for California Energy Demand 2008–2018.
[18] "The GreenPoint Rated Climate Calculator: March 2009 Update."

estimate the total carbon footprint and embodied energy of specific green building materials. [19] However, those impacts combined with other excluded green building measures could be significant. Ongoing research efforts aim to include new metrics like indoor air quality and the non-energy benefits of water conservation.

Conclusions

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, water and waste. The GreenPoint Rated score and the Climate Calculator results are based on the building design and construction and are thus independent of the occupants' behavior. The assumptions used in the Calculator remain valid for that building regardless of ownership or occupancy, unless significant changes are made to the building structure or systems. In this way, 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 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 CO_2 reduction potential of residential buildings and as such need feedback mechanisms like the GreenPoint Rated Climate Calculator in order to ensure policy measures are connected with tangible results.

The GreenPoint Rated Climate Calculator places the impact of buildings at the ground level—in the hands of the developers, builders and homeowners. 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 them with another tool with which to distinguish their products from competitors who build conventional homes with higher waste, utility bills and GHG emissions.

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[19] 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.

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