Climate Action Team
Green Building Sector Subgroup
Scoping Plan Measure Development and Cost Analysis

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1. Measure: Green Building

2. Agency: State and Consumer Services

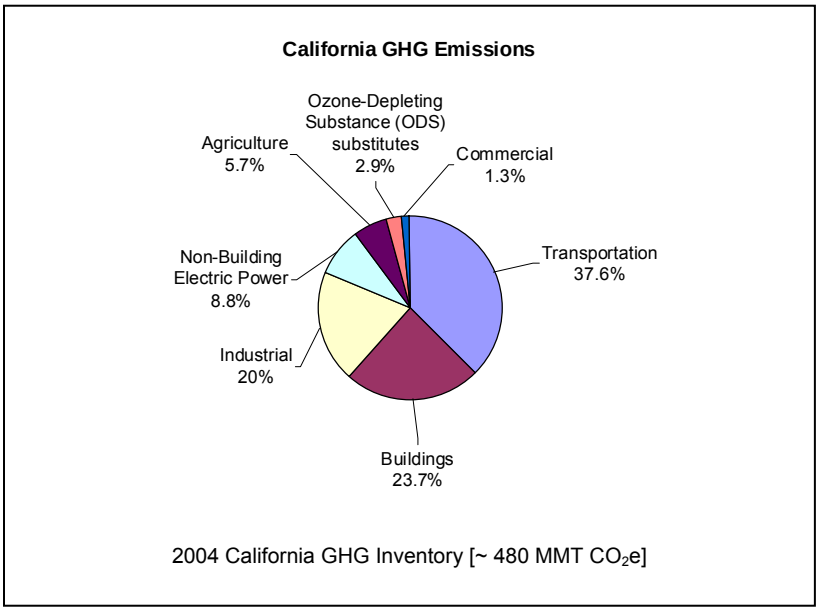
CAT Subgroup: Green Building Climate Action Team (GBCAT)

GBCAT Member Agencies: Department of General Services (DGS), California Environmental Protection Agency (Cal/EPA), California Integrated Waste Management Board (CIWMB), Housing and Community Development (HCD), California Building Standards Commission (CBSC), California Department of Transportation (Caltrans), California Air Resources Board (CARB)

3. Measure Description

Overview

Buildings are the second largest end-use contributor to greenhouse gas (GHG) emissions that cause climate change in California. Energy usage in buildings contributed 23.7% or 114 MMT carbon dioxide equivalent (CO_2e) of the total 480 MMT CO_2e emitted in 2004. (Hunsaker 2008) According to the Pew Center on Global Climate Change, energy usage in buildings contributes 43% to national GHG emissions annually. (Pew 2006) Significant GHG emission reductions can be achieved from the built environment through the design and construction of new green buildings as well as the sustainable operation and renovation of existing buildings.



2004 California GHG Inventory [~ 480 MMT CO_2e]

Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows (Roodman and Lenssen, 1995). Building "green" is an opportunity to use resources efficiently while creating healthier buildings that are protective of human health. Also known as high performance buildings, green buildings result in increased productivity for building occupants, reduced operating costs, and minimized impacts to the environment.

Green buildings reduce GHG emissions directly through energy (electricity and natural gas) efficiency and indirectly through resource conservation and recycling. Green buildings properly sited near public transit can reduce transportation-related GHG emissions and will integrate well with efforts to improve transportation infrastructure and planning.

Moreover, while considerable opportunity exists for capturing GHG reductions during the construction of new buildings, the sheer size and comparatively low energy and environmental performance of existing buildings suggests that improving these buildings be a priority. Recent updates to the California Energy Code (Title 24 CCR) and the increased awareness and adoption of green building standards in new construction reveals in contrast that even buildings

7 to 10 years old can provide significant GHG emission reductions if they are brought up to current standards.

This measure seeks to reduce GHG emissions by increasing the energy and environmental performance of public and private buildings through the use of green building standards. For the purposes of this measure, public buildings include state owned and leased facilities as well as schools; private buildings include commercial and residential buildings. Green building standards referenced as part of this measure include voluntary action by various sectors to design and construct buildings to be certified to meet green building rating systems.

Affected Entities

Affected entities would include state agencies, school districts, owners, buyers and sellers of real property, property managers, investor owned and municipal utilities, local building and planning departments, developers and builders. Based on US Census and Department of Finance data, there are approximately 70,000 building contractors operating in California. These contractors might (depending on their specialties) be required to learn new skills and obtain new licenses or equipment.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

ARB staff worked closely with Cal/EPA and DGS to form a Green Building Climate Action Team (GBCAT) subgroup. The initial kick-off meeting of the GBCAT was held on Tuesday, October 9, 2007. The GBCAT was formed as a subgroup of the California Green Action Team (GAT) and Climate Action Team (CAT), tasked with assisting the building sector to meet California's greenhouse gas (GHG) emission reduction targets. The GBCAT is an interagency task force that meets monthly to discuss on-going statewide efforts and develop tools to assist in the assessment and quantification of climate action strategies from green buildings.

The GBCAT formed an Advisory Group to participate in technical discussions of green building strategies the GBCAT subgroup was considering for recommendation to the California Air Resources Board (ARB) for inclusion in the Scoping Plan. The GBCAT held its first Advisory Group meeting on March 4, 2008 where key stakeholders provided comments on the proposed green building measure. Additional Advisory Group meetings were held on April 29, 2008 and August 4, 2008 to provide updates on the latest developments with the green building measure.

Green buildings provide benefits to all communities. Improvements in indoor air quality would likely result in greater positive impacts for economically disadvantaged communities as they currently experience disproportionately higher rates of chronic respiratory and other environmentally related illnesses. Additionally, green buildings contribute to reduced ground level ozone due to localized cooling effects.

Small business owners would benefit from this green building measure by cost savings in operating expenses. Small business owners such as builders, contractors, and developers may not realize this same benefit as they would be responsible for only paying upfront costs.

There is no potential for leakage as a result of this measure.

CEQA documentation is usually prepared for construction projects. As part of the CEQA documentation, sustainably sited green building projects should be able to claim mitigated environmental impacts.

Related Objectives

- *This measure is motivated by a combination of energy and greenhouse gas benefits, and economic stimulation from the reinvestment of energy savings into new green products and services*. The green building initiative (EO S-20-04) was underway nearly two years before the passage of AB 32. This initiative focuses on the design, construction, operations,

maintenance, and leasing of green buildings to achieve a 20% reduction in grid-based electricity usage and high resource efficiency. Increasing the amount of green building in the State will result in resource conservation benefits and positively impact occupant health and comfort. Direct and indirect greenhouse gas emission reductions are usually resulting from reductions in energy consumption, water conservation, reduced use of greenhouse gas emitting products, and sometimes from on-site clean generation of electricity.

Measure Metrics

The primary metric would be the total square footage of buildings by sector that are designed, built, operated, maintained, and renovated to meet green building standards. A secondary metric could include the percentage that buildings in various sectors exceed the Title 24 Energy Code. Additional metrics include the number of public and private buildings that have incorporated other green building features such as reduced potable water usage and minimized construction and demolition waste generated per square foot.

Measure Goals and Potential Implementation Approaches

By 2020, public and private buildings will contribute significantly to California's efforts to reduce GHG emissions. An estimated

I. **Policies, Standards, and Programs:** There are several implementation mechanisms the State is either in the process of adopting or could mandate to achieve GHG emission reductions from the building sector.

Green Building Executive Order S-20-04

Governor Schwarzenegger signed Executive Order (EO) S-20-04 in December 2004, which established California's green building policy for energy and resource-efficient high performance buildings. Also known as the Green Building Initiative, EO S-20-04 requires the state to reduce state building electricity usage 20% by 2015, by retrofitting, building and operating the most energy and resource efficient buildings. It also encourages all cities, counties, schools, government entities not under the Governor's executive authority, and commercial building owners to do the same.

Other provisions of the Green Building Initiative include:

- All new and renovated state-owned facilities must be designed, constructed and operated as Leadership in Energy and Environmental Design for New Construction (LEED-NC) "Silver" or higher certified buildings.
- All large existing state buildings must achieve at least an Energy Star rating of 75 and meet LEED for Existing Buildings (LEED-EB) standards, as well as evaluate the merits of clean on-site generation.
- The California Public Utilities Commission is urged to improve commercial building efficiency programs to achieve a 20% reduction in energy usage.
- The California Energy Commission is directed to undertake all actions within its authority to increase commercial and residential building energy efficiency 20% by 2015, and collaborate with state licensing boards to ensure building and contractor compliance,
- The California Public Employees Retirement System and State Teachers Retirement System are requested to target sustainable investments.

California Green Building Standards Code

At its July 19, 2007, meeting, the California Building Standards Commission (CBSC) formally directed CBSC staff to develop green building standards for new construction of

buildings. CBSC and HCD have the authority to adopt building standards and regulations as defined in Health and Safety Code (HSC) Sections 18909 and 18919 pursuant to the California Building Standards Law. In the meeting, CBSC requested and encouraged HCD to develop green building standards for new construction of residential buildings and submit these standards for adoption during the 2007 annual code adoption cycle.

The CBSC and the Department of Housing and Community Development (HCD) collaborated with stakeholder groups and other state agencies to develop the California Green Building Standards Code. In addition to public input, CBSC and HCD reviewed existing green building standards, best practices, guidelines, and other published material to develop the draft green building standards. The initial proposed California Green Building Standards Code submittals were transmitted to the CBSC for adoption in November, 2007. These proposals were reviewed by the Commission's Code Advisory Committee in February 2008.

In July 2008, the California Building Standards Commission (CBSC) adopted the Green Building Standards Code (GBSC). This initial code provides a first step in ongoing development of statewide green building standards. It is scheduled to become effective in July of 2009, at which time local jurisdictions may adopt the standards as mandatory if they chose. The code will establish mandatory minimum standards for residential buildings in the 2010 edition of the California Building Standards Code, anticipated to become effective around January 1, 2011. The green building construction standards will be placed in Title 24, Part 11 of the California Code of Regulations.

The mandatory measures for low-rise residential buildings include a cross-reference to the energy efficiency building standards contained in the Title 24 Energy Code, 20% reduction of indoor potable water consumption, 50% C&D recycling rate, and low emitting materials to protect indoor air quality. The code also includes voluntary standards for commercial buildings, hospitals, and includes a placeholder for schools. In the future, these standards will be modified, enhanced, and expanded to cover additional building types.

Third-Party Green Building Rating Systems

There are many green building programs designed to evaluate and rate energy efficiency and environmental performance of buildings. Please see below for several of the more well-recognized green building rating systems. GHG emission reductions can be achieved as these programs continue to develop and transform the market.

a. The US Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) certification program is a nationally accepted rating system that provides a whole building approach to sustainability by recognizing performance in five areas including: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. LEED has certifications for new and existing buildings that cover design, construction and operations.

b. The Collaborative for High Performance Schools (CHPS) offers a green building certification program geared towards California schools.

c. Build It Green (BIG) administers the GreenPoint Rated residential green building rating program with a California focus.

d. Green Globes is an environmental assessment, education and rating system that is promoted in the US by the Portland OR based Green Building Initiative. Green Globes addresses both new construction of commercial buildings and the maintenance and improvement of existing buildings. A study by the University of Minnesota stated that

while Green Globes and LEED are very similar, Green Globes has a slightly greater emphasis on saving energy while LEED has a slightly greater emphasis on materials choices.

Environmental Performance Audits and Efficiency Upgrades

The State could establish requirements for disclosure of energy consumption for potential buyers and lessees of real property.

a. This would include a requirement to complete an energy audit prior to transfer of ownership of real property.

b. Owners could additionally be required to complete energy efficiency upgrades at time of transfer of ownership. Alternatively, owners could be required to complete energy upgrades any time they pull a permit for a major remodel.

The long-term goal for this measure would be to have all existing real property in the State of California to incorporate green building features and be operated in a sustainable manner. Given that the best option for insuring the incorporation of green building standards into existing buildings would be at the time of sale or lease, conversion of existing building stock would be an incremental process.

II. **Implement Incentive Programs:** Various incentive programs could be established to offset some or all of the costs of energy and sustainability retrofits, or to provide monetary and non-monetary incentives to encourage owners to implement improvements.

a. Grant programs could be established to outright fund energy and green building retrofits that result in a GHG reduction.

b. Bond programs could be established to fund up front investments in projects that need start-up funding or to provide cash for implementing GHG reduction measures that cannot be directly monetized, or to buy down the costs of financing so that more measures could be cost-effectively implemented.

c. Utility programs could be expanded to include all utilities (Investor owned and municipal) as well as all types (electric, gas, water), and funding levels could be increased and/or funding programs expanded to provide incentive moneys for a wider range of measures (ie. GHG reductions)

d. Non-monetary incentives such as expedited permitting could also be developed to assist with the implementation of increased green building standards.

e. Incentive awards programs could be established to recognize building owners who have invested in energy and sustainability improvements and/or to award a label (such as “California Gold Building”) to buildings that achieve a high level of energy and environmental performance.

III. **Expand Information Programs:** Various information/education programs could be expanded to increase awareness of the importance of implementing building improvements, and to acquaint building owners with implementation methods or provide technical assistance and resources that are available to assist them.

a. Green Building principles could be integrated into higher education and training programs such as architectural, engineering, construction management, property management, landscape design and trade schools.

b. Existing outreach programs could be expanded or new ones established to inform local government decision makers, small businesses, and building owners about how green

building provides benefits to their communities— (for instance, decreasing air pollution, and reducing demand on municipal water and waste water treatment infrastructures, relieving traffic congestion.)

c. Outreach programs could be expanded or new ones established to inform building owners about the economic benefits of improving the energy and environmental performance of their buildings.

IV. Develop Resources to Track GHG Emission Reductions: Actual GHG emission reductions from green buildings will vary depending on the success of implementing the measure. Periodic program evaluation, including development of case studies, protocols, carbon calculators, and decision-support tools is needed to support the GHG estimates and monitor GHG emission reductions from green buildings over time. This periodic program evaluation is necessary to measure and verify GHG emission reductions from green buildings are achieved in the year 2020.

4. Technology

Implementing a green building measure will rely on a broad range of technologies, including improved building design, construction, maintenance and operation. Many of these technologies are currently available "off the shelf" and will require little development. Other technologies are emerging and can be implemented as they become commercially available. Statewide commitment to a green building measure will stimulate more technological innovation and lead to new green products and services that can provide additional GHG reductions while providing an economic stimulus for the state.

5. Statutory Status

Statutory changes may be needed to require energy use disclosure and environmental performance upgrades. Educational efforts could proceed without statutory authority.

6. Implementation Steps and Timeline

Completion of a green building measure will require a phased-in approach between 2010 and 2020. Improvements to existing state and commercial facilities, public schools, and residences will likely need to happen over time and as the required up front investments can be funded. Similarly, increasing the energy and environmental performance for new construction of state, commercial, and residential units is expected to occur at different intervals over the years. This measure analysis includes target years for achieving varying levels of GHG emission reductions. Please see Tables 1-16 for estimated annual environmental savings, emission factors, and GHG emission reduction potential for State buildings, public schools, residential, and commercial buildings.

7. Greenhouse Gas Emission Reductions

Assumptions for Annual Savings

Green Building Standards Code: This green building measure analysis assumes that the California Green Building Code will include mandatory environmental performance standards for residential and non-residential buildings beginning in the year 2011. Three main criteria were used to quantify GHG emission reductions for new construction. GHG estimates assume a 15% increase in energy efficiency will occur between the 2008 Title 24 Energy Code and the 2011 Title 24 Energy Code, which will be updated concurrently with the California Green Building Code. GHG estimates also assume that the California Green Building Code will include

mandatory measures for 20% reduction of potable water consumption and a 50% C&D recycling rate would be applicable to all new construction.

Average energy usage for commercial buildings was based on CEC data from all 16 climate zones. Similarly, average energy usage for residential buildings from all 16 climate zones was averaged between a 1761, 2100, and 2700 s.f. single family home. It is based on HVAC and water heating energy usage as modeled in the Title 24 Energy Code.

Performance Measure	Description	Average Usage (per square foot)		Annual Savings (per square foot)
Improved Energy Performance	15% Beyond 2008 Title 24 Energy Code	Natural Gas	0.23 Btu	0.03 Btu
		Electricity	17.56 kWh	2.634 kWh
Reduced Potable Water Consumption	20% Savings	Water	202.95 gallons	40.59 gallons
C&D Waste Reduction	50% Recycling Rate	C&D Waste	0.002 tonnes	0.001 tonnes

Table 1. Green Building Code Estimates for Non-Residential Construction

Performance Measure	Description	Average Usage (per home/year)		Annual Savings (per home)
Improved Energy Performance	15% Beyond 2008 Title 24 Energy Code	Natural Gas	46.06 MBtu	6.9 MBtu
		Electricity	1.67 MWh	0.25 MWh
Reduced Potable Water Consumption	20% Savings	Water	141,839 gallons	28,368 gallons
C&D Waste Reduction	50% Recycling Rate	C&D Waste	8.43 tonnes	4.22 tonnes

Table 2. Green Building Code Estimates for Residential Construction

Beyond Code: Green building new construction efforts "Beyond Code" can help to achieve additional GHG emission reductions. This measure analysis anticipates that local governments will pass green building ordinances with targets to exceed minimum state standards or mandates to achieve certification in compliance with third-party green building rating systems. GHG emission reductions may also be achieved as non-profit organizations such as the USGBC, CHPS, BIG, and Green Globes continue to expand criteria within their green building rating systems. Environmental performance criteria within the rating systems may eventually make their way into the California Green Building Code as future voluntary "reach" standards.

"Beyond Code" annual savings estimates use the same data for average usage of electricity, natural gas, water, and C&D waste generated. However, "Beyond Code" GHG estimates assume varying levels of improved energy performance between 2010 and 2020. "Beyond Code" assumptions for improved energy performance are based on the California Public Utility Commission (CPUC 2008) goals. Meeting these goals will help to achieve the CPUC target that by 2020, all new homes will be "Zero Net Energy" and by 2030, all new commercial buildings will be "Zero Net Energy." An estimated 25% of new construction will go an additional 25% beyond code for reduced potable water consumption and C&D waste recycling.

Year	Percent of New Construction	Performance Measure	Description	Annual Savings (per square foot)
2010	50%	Improved Energy Performance	35% Beyond 2008 Title 24 Energy Code	0.08 Btu 6.15 kWh
	10%		55% Beyond 2008 Title 24 Energy Code	0.13 Btu 9.66 kWh
2015	90%		35% Beyond 2008 Title 24 Energy Code	0.08 Btu 6.15 kWh
2011	25%	Reduced Potable Water Consumption	50% Savings	101.475 gallons
2011	25%	C&D Waste Reduction	75% Recycling Rate	0.0015 tonnes

Table 3. Beyond Code Estimates for Non-Residential Construction

Year	Percent of New Construction	Performance Measure	Description	Annual Savings (per home)
2010	50%	Improved Energy Performance	35% Beyond 2008 Title 24 Energy Code	16.12 Mbtu 0.58 MWh
	10%		55% Beyond 2008 Title 24 Energy Code	25.33 Mbtu 0.92 Mbtu
2015	90%		35% Beyond 2008 Title 24 Energy Code	16.12 Mbtu 0.58 MWh
2011	25%	Reduced Potable Water Consumption	50% Savings	70,920 gallons
2011	25%	C&D Waste Reduction	75% Recycling Rate	6.32 tonnes

Table 4. Beyond Code Estimates for Residential Construction

Environmental Performance Upgrades for Existing Buildings: The GHG emission reduction potential estimates for existing buildings are based on voluntary upgrades to non-residential and residential buildings. The environmental performance upgrades and annual savings per square foot of non-residential buildings are based on ICLEI, Local Governments for Sustainability estimates. (ICLEI 2007) Upgrades to existing residential are based on 25% improvement to average energy and water usage.

Performance Measure	Description	Annual Savings	
		8,500 ft^2 Bldg.	per ft^2
Building Commissioning	Energy Savings	7,400 kWh electricity savings	0.87 kWh/ft2
Energy Efficient Design & Equipment	Optimized design and equipment selection	32,000 kWh electricity savings	3.76 kWh/ft2
Renewable Energy Generation	On-site renewable energy generation	16,070 kWh electricity savings	1.89 kWh/ft2
Water Conservation	Select appropriate plants, reduce lawn size, keep plant debris onsite	345,000 gallons outdoor water savings	40.59 gallons/ft2
Solid Waste Management (one-time)	Recycled 50% of C&D Waste	43.7 tons recycled	0.0052 tons/ft2

Table 5. Environmental Performance Upgrades to Existing Non-Residential Buildings

Performance Measure	Description	Average Usage (per home/year)		Annual Savings (per home/year)
Improved Energy Performance	25% Improved Energy Performance	Natural Gas	440 Therms	110 Therms
		Electricity	6,300 kWh	1,575 kWh
Reduced Potable Water Consumption	25% Savings	Water	141,839 gallons	35,460 gallons

Table 6. Environmental Performance Upgrades to Existing Homes

GHG Emission Factors

Water to GHG Calculator	
Metric Ton CO_2/million gal	3.85E+00
C&D Waste to GHG Calculator (ICLEI 2007)	
Metric Ton CO_2/Ton for res	7.05E-01
Metric Ton CO_2/Ton for com	2.48E-01
Energy to GHG Calculator	
Metric Ton CO_2/Therm	5.21E-03
Metric Ton CO_2/MWh	4.42E-01

Table 7. GHG Emission Factors (Hunsaker 2008)

GHG Emission Reduction Potential for Public Buildings

Planned State Construction: LEED-NC Gold Certified Buildings

Since the Governor's Executive Order mandates that all State construction projects be certified as "LEED-NC Silver" buildings, this measure proposes that State buildings go beyond business as usual to be certified as "LEED-NC Gold" facilities. DGS, California Department of Corrections and Rehabilitation (CDCR), and the Department of Transportation (Caltrans) are the three main state agencies responsible for their own new construction programs. DGS estimates that 6.4 million ft^2 total is budgeted to be newly constructed as LEED-NC certified buildings. CDCR plans to build 10 million ft^2 of new buildings to meet LEED-NC Silver. Caltrans adopted a policy for all building projects programmed beginning January 1, 2008 to meet LEED green buildings standards. Caltrans plans to build about 20 projects with an average of 5,000 ft^2 per year. All new buildings less than 10,000 ft^2 will meet LEED-NC standards. All facilities over 10,000 ft^2 will be certified as LEED-NC Silver green buildings. Between these three state agencies, the total planned state construction with approved funding through capital outlay BCP is equal to 17.5 million ft^2. Planned state construction is anticipated for completion in a 3-7 year timeframe. Using a phased-in approach, planned state construction will provide a GHG emission reduction potential of approximately 121,025 tonnes CO_2 in 2020.

Target Year	% of Planned State Construction	Occupied Space (ft^2)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	5%	875,000	4,986
2015	50%	8.75 million	40,250
2020	100%	17.5 million	121,025

Table 8. GHG Emission Reduction Potential for Planned State Construction

Existing State Facilities: Environmental Performance Upgrades

According to the Department of General Services (DGS), University of California (UC), California State University (CSU), California Community Colleges (CCC), and Administrative Office of the Courts the State owns and operates over 290 million ft^2 of occupied space representing a total of 13,429 buildings. Existing state facilities include occupied space in the form of office buildings, courthouses, prisons, mental hospitals, developmental centers, universities, and colleges. Assuming a phased-in approach to upgrade existing state facilities, an estimated 883,051 tonnes CO_2e could be avoided in the year 2020. Beginning in 2010, 10% of existing state facilities would be upgraded and by 2020, 100% or 290 million ft^2 of existing occupied space would incorporate environmental performance upgrades.

Target Year	% of Existing Floorspace Upgraded	Floorspace Upgraded (ft^2)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	10%	29 million	125,430
2020	100%	290 million	883,051

Table 9. GHG Emission Reduction Potential for Upgrading Existing State Facilities

New Construction of High Performance Schools

The California Department of Education (CDE) estimates that 5,843 new classrooms per year are needed to accommodate the rising student population. If the average K-12 school size includes 31 classrooms per school, an estimated 188 new schools will be constructed annually. Assuming the average school size is approximately 30,000 ft^2, a total of 5.64 million ft^2 would be constructed in 2010. An estimated 8,845 tonnes CO_2 would be avoided in 2010 by schools that meet the Green Building Code. An additional 10,775 tonnes of CO_2 would be avoided in 2010 if all schools are also certified to the CHPS Criteria. An estimated 107,233 tonnes of CO_2 would be avoided in 2015. By 2020, an estimated 194,846 tonnes CO_2 would be avoided if all schools are certified as high performance schools.

Target Year	Total # of CHPS Schools	New Construction and Major Modernization (ft^2)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	188	5.64 million	19,620
2015	1,128	33.8 million	107,233
2020	2,068	62.04 million	194,846

Table 10. GHG Emission Reduction Potential for High Performance Schools

Existing Public Schools

According to the California Department of Education, there are a total of 9,674 public schools in California. If the average school size is approximately 30,000 ft^2, total floorspace of existing public schools equals 290,220,000 ft^2. Most existing public schools do not apply for modernization funding until they are 20, 30, or 40 years old. In order to qualify for funding, the School Facilities Program requires portable classrooms to be at least 20 years old and permanent classrooms must be at least 25 years old. In order to increase the number of existing schools that go through the modernization process, a future bond could include funding for modernization of existing schools as a stand alone program. Assuming a phased-in approach to upgrade 10% of existing schools annually, an estimated 125,235 tonnes CO_2 could be avoided in 2010. Approximately 751,408 tonnes CO_2 could be avoided in 2015. If all existing schools are upgraded to meet CHPS standards, an estimated 1,252,346 tonnes CO_2 could be avoided in the year 2020.

Target Year	% of Existing Schools	Floorspace Upgraded (ft^2)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	10%	29 million	125,235
2015	60%	174.1 million	751,408
2020	100%	290.2 million	1,252,346

Table 11. GHG Emission Reduction Potential for Existing Schools

GHG Emission Reduction Potential for Private Buildings

New Residential Construction: Green Building Code and Beyond

California projects significant population growth in the coming decades. Based on the last two decades, an average of 169,000 residential units is built each year. (CDHCD 2006) The CEC Energy Demand Forecast estimates that 186,509 homes will be built annually between 2010 and 2020. An estimated 1,534,352 tonnes CO_2e would be avoided in 2020 through the mandatory Green Building Code and "Beyond Code" residential green building construction efforts.

Target Year	Total # of New Green Code Homes	Total # of New Beyond Code Homes	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	186,509	93,254	691,222
2015	1,193,508	1,074,157	1,121,253
2020	2,263,625	2,263,625	1,534,352

Table 12. GHG Emission Reduction Potential for New Home Construction

Existing Homes: Environmental Performance Audits and Efficiency Upgrades

According to the 2004 California GHG inventory, the residential sector contributed 13.8% or 66.24 MMT CO_2e total to statewide emissions in 2004. (Hunsaker 2008) One of the proposed strategies for reducing GHG emissions from the residential sector includes environmental audits and efficiency upgrades. Homeowners could voluntarily participate in an environmental performance testing program to benchmark energy and water usage and determine their carbon footprint. Homeowners can participate in programs such as the CEC's Home Energy Rating System and Build It Green's GreenPoint Rated for Existing Homes to prioritize green building upgrades. If 6% of existing homes per year undergo efficiency upgrades, nearly 7.5 million homes or approximately 50% of the existing housing stock in the State of California could be retrofit by 2020. An emission reduction potential of 10.4 MMT CO_2e would be achieved in 2020 if half of existing homes reduce their carbon footprint by 25%.

Target Year	Total % of Homes Renovated	Total # of Homes Renovated	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	6%	263,488	1,064,659
2015	32%	4,280,773	6,016,373
2020	56%	7,420,308	10,428,803

Table 13. GHG Emission Reduction Potential for Voluntary Residential Efficiency Upgrades

New Commercial Construction

The CEC estimates that over 111.6 million ft^2 of new commercial floorspace will be built in 2010. An estimated 121.5 million ft^2 is projected to be built in 2020. If 100% of new commercial construction meets several minimum mandatory environmental performance standards as part of a Green Building Code, the GHG emission reduction potential would total 1,715,658 tonnes of CO_2 in 2020. An additional 3,000,799 tonnes of CO_2 could be avoided in 2020 if commercial buildings go "Beyond Code," and are certified to LEED-NC or other green building rating system standards. An estimated 4,716,457 tonnes CO_2e would be avoided in 2020 through new commercial green building construction efforts.

Target Year	Total Commercial Floorspace Forecast (ft^2)	Green Building Code (tonnes CO_2e)	Beyond Code (tonnes CO_2e)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	111.6 million	175,090	331,527	506,617
2015	115.25 million	935,771	1,686,293	2,622,064
2020	121.5 million	1,715,658	3,000,799	4,716,457

Table 14. GHG Emission Reduction Potential for New Commercial Construction

Existing Commercial Buildings

According to the 2004 California GHG inventory, the commercial sector contributed 7.6% or 36.48 MMT CO_2e total to statewide emissions in 2004. (Hunsaker 2008) One of the proposed strategies for reducing GHG emissions from the commercial sector includes environmental audits and efficiency upgrades. Business owners could voluntarily participate in an environmental performance testing program to benchmark energy and water usage and determine their carbon footprint. Commercial building owners can utilize resources such as EnergyIQ to prioritize green building upgrades.

According to a commercial floorspace forecast from the California Energy Commission (CEC), over 7.05 billion ft^2 of total floorspace will be in place by 2020. If just 3% of commercial buildings per year undergo efficiency upgrades, nearly 2.3 billion ft^2 or approximately 33% of total floorspace could be upgraded by 2020. An emission reduction potential of 7.4 MMT CO_2e would be achieved in 2020 if one-third of existing commercial buildings reduce their carbon footprint by 25%.

Target Year	% of Floorspace Upgraded	Cumulative Floorspace Upgraded (ft^2)	Annual GHG Emission Reduction Potential (tonnes CO_2e)
2010	3%	211,711,797	932,603
2015	18%	1,270,270,782	4,215,462
2020	33%	2,328,829,767	7,498,321

Table 15. GHG Emission Reduction Potential for Existing Commercial

Summary of GHG Emission Reduction Potential: ARB staff estimates that public and private green buildings have the potential to reduce GHG emissions by about 26 MMT CO_2e in the year 2020. See Table 16 for a summary of these GHG emission reduction estimates.

Green Building Strategy	GHG Emission Reduction Potential in 2020 (tonnes CO_2E)			
	New Construction		Existing Buildings	Total
	Green Building Code	Beyond Code	Green Building Operation & Upgrades	
State	23,540	97,485	883,051	1,004,077
Public Schools	83,313	111,533	1,252,346	1,447,193
Residential	1,143,439	390,913	10,428,803	11,963,155
Commercial	1,715,658	3,000,799	7,498,321	12,214,779
Total	**2,965,951**	**3,600,730**	**20,062,522**	**26,629,203**

Table 16. GHG Emission Reduction Potential for Green Buildings in 2020

8. Costs and Cost Savings

Green buildings provide a cost-effective strategy to reduce greenhouse gas emissions. According to a 2007 cost analysis study, "there is no significant difference in average cost for green buildings as compared to non-green buildings." (Matthiessen (2007) Green buildings reduce operating costs and save money over time.

Energy and water conservation retrofits for residential buildings can vary widely in cost depending on the aggressiveness of the options pursued. Insulation and weather stripping is quite inexpensive. Photovoltaic installations are typically more cost prohibitive. If intelligently applied, energy and water efficiency retrofits for residential and commercial buildings are generally quite modest in cost with fairly rapid payback from energy savings.

If 56 percent of California's residential property or 7,420,308 homes are upgraded by 2020, at a one-time cost of $5,000/unit, approximately $37 billion dollars total or $3.7 billion dollars annually would be spent over this period. At a cost of 15-cents per KWh, energy savings could result in cost savings of $178 million dollars in 2010 to $10.9 billion dollars annually by 2020. The annual cost savings would be about $1,400/unit.

Impacts resulting from this strategy that would negatively affect Californians could include up-front costs related to environmental performance upgrades. These retrofit costs would be expected to be more than offset by reductions in the operational costs of the building (commercial or residential).

9. Other Benefits

The discussions in this analysis have focused on energy conservation by building owners and operators. Other significant benefits to implementation of green building standards include the reduction of potable water consumption and waste water generation. Both of these pose significant infrastructure costs to local municipal water districts and their rate payers.

10. References

California Energy Commission September 2007 California's Residential Electricity Consumption, Prices, and Bills, 1980-2005 http://www.energy.ca.gov/2007publications/CEC-200-2007-018/CEC-200-2007-018.PDF

CDHCD (2006), *California's Housing Needs Presentation*, California Department of Housing and Community Development, Figure 7, June 2006. www.hcd.ca.gov/housing-needs.pdf (accessed 3/14/08)

CAT (2006), Climate Action Team Report to Governor Schwarzenegger and the California Legislature, California Environmental Protection Agency, March 2006. www.climatechange.ca.gov/climate_action_team/reports/2006-04-03_FINAL_CAT_REPORT_EXECSUMMARY.PDF (accessed 3/14/08)

CPUC (2008), California Public Utilities Commission, "California Long Term Energy Efficiency Strategic Plan – Achieving Maximum Energy Savings in California for 2009 and Beyond," July 2008.

Department of Finance California Statistical Abstract, January 2007 http://www.dof.ca.gov/HTML/FS_DATA/STAT-ABS/Toc_xls.htm

HCD (2008), personal communication with Doug Hensel, Housing and Community Development.

Hunsaker (2008), personal communication with Larry Hunsaker.

ICLEI (2007), *Climate Action Plan Template 2007, Prepared for StopWaste.Org by* ICLEI − Local Governments for Sustainability, 2007, pgs. 42-43. www.stopwaste.org/home/index.asp?page=516#ACCPA (accessed 3/14/08)

Matthiessen (2007), "The Cost of Green Revisited," Davis Langdon, July 2007. www.davislangdon.com/USA/Research/ResearchFinder/2007-The-Cost-of-Green-Revisited/

McKinsey & Company (2007), "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?" U.S. Greenhouse Gas Abatement Mapping Initiative, December 2007. http://mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf (accessed 3/13/08)

Pew (2006), "Building Solutions to Climate Change," Pew Center on Global Climate Change, November 2006.

Roodman and Lenssen (1995), "A building revolution: how ecology and health concerns are transforming construction", Worldwatch Paper 124, Worldwatch Institute, Washington, DC, March.

U.S. Census Data (2000), *Housing Statistics California*, U.S. Census Bureau, Census 2000. www.infoplease.com/us/census/data/california/housing.html (accessed 2/28/08)

USGBC (2006), *USGBC Certified Project List*, United States Green Building Council, March 2006. www.usgbc.org