

Appendix I
Green Buildings Strategy

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Introduction

This appendix provides an overview of the California green building strategy and is comprised of three sections. Section A is structured analogous to the key sectors in Chapter 4 of the 2017 Scoping Plan – providing a framework for the strategy, highlighting the climate-oriented goals for the building sector, discussing cross-sector interaction, and listing the measures that will help achieve the State’s 2030 target and support the high-level goals for green buildings. Section B describes research needs related to green buildings. Section C provides references for the content in the 2017 Scoping Plan related to green buildings.

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A. Framework for Action

On average, we spend 90 percent of our time indoors (Jenkins et al, 1992) (Klepeis et al 2001). The buildings in which we live, work, and play, provide shelter but also affect our environment and health in many ways. California's Green Buildings Strategy offers a cross-sector solution to reducing greenhouse gas (GHG) emissions with broad sustainability goals in mind – accounting for economics, the environment, social equity, and occupant health.

In California, building GHG emissions are second only to transportation, when accounting for energy use, water use, and wastewater treatment. Mining, harvesting, processing and transporting materials used to construct and repair buildings also contribute to GHG emissions when considering life-cycle accounting. GHG emissions are also released during the construction process as a result of building equipment, construction and demolition waste, and land-cover changes. Ongoing GHG emissions are released from landfills during building operations as occupants dispose of waste. Lastly, buildings contribute to transportation-related emissions as people travel to and from home, workplaces, shopping, and recreational events. Thus, there are many opportunities to reduce GHG emissions associated with buildings.

“Green buildings” are designed, constructed, operated, and maintained to maximize energy efficiency, conserve water, reduce waste, provide good indoor environmental quality and can be sited close to services to support lowering VMT. Green buildings sited near walking and biking networks and public transit options make it easier for people to drive less. When buildings incorporate active design features, such as a visible and inviting staircase, they encourage occupants to increase their physical activity levels; locating buildings near existing parks and open space can encourage more physical activity, which can result in a multitude of health benefits. As a result, green buildings present a wide-ranging strategy to support California's climate change goals while protecting the environment, assuring comfort, and promoting public health.

Moreover, green buildings can help make communities more resilient as renewable energy generation is paired with battery storage, flood-proofing precautions are taken, and water conservation measures are installed. Energy efficiency upgrade and weatherization programs can help buildings become more energy efficient and resilient to climate change. These programs can help ensure that residents, particularly low-income households, use less energy. Energy efficient homes stay cool for longer periods of time, which relieves stress on the grid during extreme heat events. When buildings incorporate cool roofs, cool pavements, and shade trees, they contribute to reducing the heat island effect, which has broader implications to help with resiliency and protecting disadvantaged communities and sensitive population groups, such as the elderly.¹

¹ U.S. EPA's publication *Smart Growth Fixes for Climate Adaptation and Resilience* contains measures that can be incorporated to assure resiliency for buildings in California that will be built to resist the threats of climate change. These include adaptation to flooding and extreme precipitation, sea level rise, extreme heat, drought and wildfire to protect buildings and neighborhoods from fire damage.

California has long been a leader in efforts to improve the performance of buildings, both at the time of construction and upon a major remodel or equipment replacement. Many programs and regulations are in place to help achieve GHG emission reductions from buildings. For over forty years, California has been developing codes and standards to ensure buildings and appliances are energy efficient. Additional programs are incentivizing upgrades to existing buildings to reduce energy demand. Since 2000, California State agencies have been leading by example to green the design, construction, maintenance, and operation of government buildings to meet the goals of past and current executive orders, including E.O. B-18-12.

The California Green Building Standards Code, commonly known as the “CALGreen Code,” was a first-in-the-nation state-adopted green building code originally published in 2008. It sets goals for planning and design, energy efficiency, water conservation, resource efficiency, and indoor environmental quality. The CALGreen Code works in harmony with the State’s other mandatory building codes and goes through regular updates to support statewide climate goals. CALGreen applies to the planning, design, operation, construction, use, and occupancy of every newly-constructed building or structure unless otherwise indicated. Additions and alterations to existing buildings meeting specified conditions may also require compliance with CALGreen. CALGreen includes both mandatory and voluntary measures. A tier system – a voluntary portion of the CALGreen Code – allows local enforcing agencies to adopt consistent and streamlined methods for green building construction beyond the mandatory minimum requirements. For example, CALGreen requires 80 percent of floor area with resilient flooring to be certified or to meet thresholds for volatile organic chemicals as specified. However, a local government could voluntarily adopt higher or more restrictive standards of Tier 1 (90 percent floor area compliance) or Tier II (100 percent compliance), which exceed the minimum statewide requirements, as a mandatory standard within its jurisdiction. A reference to the CALGreen Code is included at the end of this appendix.

Some local governments are also adopting requirements for all new construction and major renovations to be certified to third party certified green building rating systems such as LEED, GreenPoint Rated, and/or the Living Building Challenge. Each of these methods will assist local jurisdictions to further reduce GHG emissions and promote even more sustainable construction practices. Some third party green building rating systems are now also beginning to address social equity as a key component to certification. A summary of local government actions that focus on green buildings is included in Appendix B.

Legislation and/or regulatory action taken since the last Scoping Plan update (May 2014) support green building strategies in the areas of doubling energy savings, commercial building energy use disclosure, recycled water use, mandatory recycling of solid and organic waste, landscape water use, electric vehicle charging infrastructure, and consideration of climate change in State infrastructure planning. These existing policies, programs, measures, regulations and initiatives for reducing building-related emissions are described in more detail in Appendix H7.

1. Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

- Ensure that new buildings are designed, built, and operated as green buildings to achieve GHG emission reductions.
- Promote cost-effective retrofitting and inclusion of green building features in existing buildings to achieve greater energy efficiency, water savings, waste reduction, and minimize transportation impacts to assist with achieving climate change goals.
- Support advancement of efforts to maintain and operate existing buildings to third-party certified green building rating systems and tools to measure and track GHG emission reductions associated with green buildings.
- Ensure that proposed voluntary measures and regulatory actions support achieving short-, mid- and long-term climate goals.
- Ensure that measures support the development of zero carbon buildings² throughout California.
- Ensure that proposed regulatory actions and incentives are cost-effective and target programs and investments to enhance benefits in disadvantaged communities where appropriate.
- Ensure that measures meet the needs of the building industry while also encouraging actions that reduce environmental impacts, protect occupant health, assure comfort, and maximize productivity.
- Prioritize strategies that promote health and equity co-benefits while meeting comprehensive green building and GHG emission reduction goals.

2. Cross-Sector Interactions

Buildings have tremendous cross-sector interactions that influence our health and well-being and affect land use and transportation patterns, energy use, water use, communities, and the indoor and outdoor environment. The future of green buildings is not only about energy-efficiency and transitioning to zero carbon performance, but about creating healthy and sustainable buildings sited in smart locations. A lower-carbon future will require higher-performing and healthier buildings, which translates into higher-performing and healthier communities.

The Governor's Executive Order B-30-15 directed that State agencies' planning and investment will be guided by the following principles:

- *Priority should be given to actions that build climate preparedness and reduce greenhouse gas emissions;*

² A zero carbon building generates zero or near zero GHG emissions over the course of a year from all GHG emission sources associated, directly and indirectly, with the use and occupancy of the building (initial definition included in the May 2014 *First Update to the Climate Change Scoping Plan*).

- *Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;*
- *Actions should protect the state's most vulnerable populations; and*
- *Natural infrastructure solutions should be prioritized.*

In light of that direction, building policies must take the current and future effects of climate change into account by planning to be resilient to more extreme heat, storms, floods, and sea level rise. Moreover, California must adopt policies and mechanisms to assure that healthy, attractive, and energy-efficient buildings are equally available to vulnerable and low-income populations, who tend to have poorer health, and suffer the effects of climate change first and worst. California should also assure that grants, loans, and incentive programs for green buildings are accessible to disadvantaged communities, that these communities are prioritized for employment in green building and renewable energy projects, and that these communities participate in development of rules and regulations.

Using sustainable principles in buildings can increase energy, water, and material efficiency, properly manage stormwater runoff through green infrastructure, and reduce operating costs. Sustainable buildings can be showcases to educate people about environmental issues, possible solutions, partnerships, creativity, and opportunities for reducing environmental impacts in our everyday lives and as part of larger systems. Green buildings can serve as catalysts for improved resource management away from the building site, through thoughtful materials sourcing. When properly constructed and maintained, green walls and indoor vegetation and greenery can provide exposure to natural elements.

Green buildings can promote health, well-being, and productivity through the provision of healthy indoor environments with good indoor air quality, natural lighting, proper ventilation, the use of non-toxic and non-harmful building materials and finishes.

3. Efforts to Reduce Greenhouse Gases

The suggested measures below include continuation, expansion, and refinement of existing efforts, as well as a potential new measure to help achieve the State's 2030 target and to support the high-level goals for green buildings.

- During regular updates to the CALGreen Code:
 - Promote voluntary efforts of local governments to adopt Tier I and Tier II standards, which are higher than the mandatory minimum building code standards, when cost effective.
 - Continue ongoing work to develop voluntary provisions in the CALGreen Code that offer progressive environmental and health-based performance standards to achieve climate change and air quality goals.
 - Consider advancing voluntary provisions forward to mandatory standards when proven cost-effective and supportive of statewide climate goals. In

- doing so, consider experience with provisions of third-party certified green building rating systems when appropriate.³
- Consider further advancing electric vehicle charging infrastructure in the CALGreen Code to assist with electrification of the transportation sector.
 - Consider adopting new building standards to reduce the amount of gases with high Global Warming Potential (GWP) used in building materials and equipment to reduce emissions of short-lived climate pollutants.
 - Consider adopting new building standards to reduce the lifecycle GHG emissions of building materials and construction.
 - Consider adopting more advanced mandatory building standards for environmental quality to provide good indoor air quality to protect occupant health.
- Propose measures and funding mechanisms to incentivize existing building retrofits that focus more broadly on providing incentives for more holistic green building retrofits that would include energy and water efficiency as well as measures to minimize waste and transportation impacts to reduce the carbon footprint of existing buildings.
 - To help with existing building retrofits, consider additional incentive measures and/or the use of Greenhouse Gas Reduction Fund (GGRF) monies to incentivize green building retrofits.
 - Establish target dates and pathways for a zero carbon building State policy.
 - Form a multi-agency and stakeholder working group to:
 - Compile literature review and evaluate research on zero carbon buildings;
 - Propose a definition for zero carbon buildings; and
 - Recommend target dates and pathways to implement policy.

B. Research Needs

Green Building Research Needs

Green building measures overlap with the energy, water, waste, and transportation sectors. In the initial AB 32 Climate Change Scoping Plan, the Green Building strategy stated that further research was needed to better quantify the non-energy GHG co-benefits of green buildings (California Air Resources Board, 2008). Recently completed research quantifies, for the first time, the GHG emission reductions co-benefits of green office buildings (Mozingo & Arens, 2014). However, additional research should continue to be conducted to fully understand the GHG reduction potential of green buildings (Climate Action Team, 2015). Research across all sectors of energy, water, waste, and transportation will be needed to offer technical support for the pursuit of low-carbon building in California as part of the State's long-term climate program (Climate Action Team, 2015). CARB funded a research project to evaluate the technical feasibility of zero carbon buildings, which should be completed by the fall of 2018. A

³ Green building rating systems can continue to push the boundaries in reducing energy, water, and materials use (e.g., Living Building Challenge), promoting human and ecological health concurrently (i.e., WELL Building Standard and Fitwel), greening the residential and affordable housing sector (e.g., GreenPoint rated), and looking beyond the building at how green buildings are integrated with the neighborhood and community (i.e., Living Building Challenge and LEED for Neighborhood Development).

literature review of green building research found the following additional research gaps.

- Quantify the cost premium of green building (Dwaikat & Ali, 2016)
- Life cycle GHG emission reductions should be taken into account in the evaluation of green buildings (Wang, Seo, Liao, & Fang, 2016)
- Evaluate the effectiveness of incentives in non-US countries where green building practices are well advanced (Olubunmi, Xia, & Skitmore, 2016)
- Use a behavioral change research study method to examine how to improve green building incentives (Olubunmi, Xia, & Skitmore, 2016)

Urban Heat Island Focused Research Needs

Green buildings that incorporate shade trees, cool roofs, and cool pavements as well as urban greening programs can help to reduce the urban heat island effect and help cool buildings. Recently completed research evaluated the various urban heat island mitigation strategies and their ability to reduce temperatures in outdoor and indoor environments. While all urban heat island countermeasures can be effective with reducing outdoor air temperatures, only a few strategies are most effective with reducing indoor temperatures and associated heat-related health risks; cool roofs and shading countermeasures perform best, along with passive cooling to help keep temperatures below critical thresholds indoors (Buchin, Hoelscher, Meier, Nehls, & Ziegler, 2016). Additional research is needed to better understand when to use which urban heat island countermeasure and under what circumstances.

- Which urban heat island countermeasures perform best for the various building types? For example, are cool roofs the most effective technique for multi-family residential buildings to keep indoor temperatures cool?
- Are green roofs as effective as cool (light-colored/high albedo) roofs in cooling indoor environments?
- Do green roofs negatively affect indoor air quality and cause mold, insect humidity or other problems indoors?
- How do home- and business-owners, local governments, and others prioritize which urban heat island countermeasures to use?⁴

Energy Efficiency Research Needs

Energy efficiency is a primary strategy for reducing the state's energy use, costs, and GHG emissions. The commercial and residential sectors combined used 70 percent of electricity consumed in California investor-owned utility (IOU) service territories in

⁴ A recent CARB-funded study conducted life-cycle assessments of conventional and cool pavements and developed a decision-support tool for local governments to use when considering different pavement materials. The study found that in many communities, cool pavements help to mitigate the urban heat island effect, but the energy and emissions embodied in cool pavement materials can exceed the expected energy and emissions savings from reduced cooling and heating in buildings. However, reflective pavements offer a one-time global cooling benefit that exceeds the 50-year lifecycle carbon penalty.

2011⁵. Most building electricity use is for lighting, air conditioning, refrigerators, and consumer electronics. Energy use for plug loads in the residential and commercial sectors is one of the fastest growing energy loads in California. Current estimates indicate that plug loads are contributing about 15 to 20 percent of residential and 10 to 15 percent of commercial electrical use, and could nearly double by 2030⁶.

Significant improvements in energy efficiency have been made, but innovation is needed to increase the efficiency of lighting sources and their controls, cooling, ventilation, refrigeration systems, and office electronics. This also includes the integration of multiple technologies in whole buildings, due to the interactive effects that one technology can have on the other⁷. For instance, reducing lighting load and improving the building envelope can affect air-conditioning and ventilation requirements. This comprehensive approach will be needed to achieve the state's goal of zero net energy for new residential buildings by 2020 and for new commercial buildings by 2030 and to achieve zero net energy or near zero net energy (with deep retrofits) for at least half of existing commercial buildings by 2030. Achieving these goals cost-effectively will require development and adoption of advanced building energy efficiency technologies and strategies beyond what is currently commercially available.

To achieve zero net energy or high efficiency buildings, past and current research has focused on increasing the efficiency and performance of the main energy using systems in buildings (e.g., lighting, heating, ventilation and air conditioning systems (HVAC), plug loads) along with testing and demonstrating technologies and strategies. Additional research is needed to assess the potential of integrating and optimizing multiple energy efficiency technologies with demand response, electric generation and energy storage system. Standardizing the integration of these technologies and validating their benefits to customers and the electric system also requires additional research. The 2015-2017 Triennial Investment Plan⁸ identifies the following research needs:

1. Advance efficiency solutions that lower energy consumption in buildings.
2. Develop model designs and strategies for cost-effective zero net energy residential and commercial buildings.
3. Apply advanced social science research methods to improve the adoption of next generation energy efficiency solutions.
4. Develop and evaluate strategies that improve indoor air quality in energy efficient buildings.
5. Advance strategies that reduce the energy and water impact of buildings
6. Identify and demonstrate promising energy efficiency and demand response technologies that are suitable for commercialization and utility rebate programs.

⁵ California Energy Commission. 2014. The Electric Program Investment Charge: Proposed 2015-2017 Triennial Investment Plan. California Energy Commission. Publication Number: CEC-500-2014-038 CMF.

⁶ California Energy Commission. 2014. The Electric Program Investment Charge: Proposed 2015-2017 Triennial Investment Plan. California Energy Commission. Publication Number: CEC-500-2014-038 CMF.

⁷ California Energy Commission. 2014. The Electric Program Investment Charge: Proposed 2015-2017 Triennial Investment Plan. California Energy Commission. Publication Number: CEC-500-2014-038 CMF.

⁸ California Energy Commission. 2014. The Electric Program Investment Charge: Proposed 2015-2017 Triennial Investment Plan. California Energy Commission. Publication Number: CEC-500-2014-038 CMF.

7. Demonstrate the large scale deployment of integrated building demand side management and demand response programs.

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⁹ California Health and Safety Code Section 17928(b) requires the California Department of Housing and Community Development to submit a report to the Legislature each year on green building measures proposed as building standards during the prior fiscal year and green building guidelines or resources reviewed during the development of green building measures proposed as building standards during the prior fiscal year. The most recent report can be accessed at: <http://www.hcd.ca.gov/building-standards/calgreen/index.shtml>

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