Berkeley
DEEP GREEN
Building

Promoting Sustainable Building Practices
to advance
Berkeley's Climate Action and Resiliency Goals

This proposal was conceived and prepared by the

Berkeley Zero Net Energy++ Working Group

A group of citizens and building professionals dedicated to making Berkeley's Building Code a model of green, non-toxic, sustainable building practices and achieving Berkeley's Climate Action Plan and Resilience Strategy goals by inspiring, educating and supporting the community

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Executive Summary

Many new residential developments have been approved in the City of Berkeley in recent years, and even more are in the pipeline. At the same time, existing buildings comprise the vast majority of Berkeley's building stock. Most of these buildings, existing and new, consume excessive energy and water.

While many new projects have the benefit of being sited on transit corridors, they often fall short of their full potential to reduce environmental impacts because they do not incorporate best practices for Green Building. Berkeley's recently adopted Building Energy Savings Ordinance (BESO) helps identify potential energy conservation measures, but does not provide incentives and specific guidance to support homeowners, builders and developers in meeting Environmental and Greenhouse Gas (GHG) reduction goals.

Berkeley Deep Green Building proposes an incentive-based path towards buildings that meet Berkeley's environmental and GHG reduction goals, protect the health and safety of Berkeley workers and residents, and support the health and sustainability of communities across the globe. The program is intended to be voluntary and incentive-based in the beginning, leading to the adoption of mandatory measures in later stages. In line with the vision of California's Long Term Energy Efficiency Goals, the program would initially focus on the residential sector, to help achieve the State's 2020 residential sector energy goals. Over time, Berkeley Deep Green Building would incorporate measures for the non-residential sector, aligning with the State's 2030 targets for non-residential structures.

Berkeley Deep Green Building ties into Berkeley's Climate Action Plan and BESO, and into State codes and other programs such as Title 24, Energy Upgrade California and the California Advanced Home Program. In addition to new incentives to be provided by the City of Berkeley, homeowners, builders and developers participating in Berkeley Deep Green Building would be eligible for a number of incentives already offered by the State and PG&E.

Berkeley Deep Green participation would be offered in two Levels. Level 1 includes high impact sustainability measures that address energy efficiency, toxicity, responsible sourcing and water use. These measures are the easiest to achieve and tie into Title 24 and other State-level efforts to arrive at Net Zero Energy. Level 2 measures are more stringent and offer greater impact in achieving environmental and GHG reduction goals. Berkeley Deep Green is intended to encourage/incentivize most projects to comply with Level 1, while further incentivizing/rewarding Level 2 projects to take on the highest levels of environmental stewardship.

Berkeley Deep Green Building would not only help to achieve Berkeley's environmental and GHG reduction goals but can also be a model for other cities to follow, helping to achieve long term sustainability goals in communities across the United States, and around the globe.

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Introduction

Berkeley is building again. Over 2000 new units have been approved in the past 3 years, and many are under construction. Another thousand are in the pipeline—with more sure to come. Many of these new developments are on or near major transit corridors, qualifying them as 'transit-oriented development', which is environmentally preferable to development that is dependent on automobiles.

But while reducing dependence on automobiles is an important goal, transit-oriented development falls short of its potential when buildings themselves use excessive energy and water over their lifetimes or are built with energy intensive, toxic and/or unsustainably produced materials.

At the same time, existing structures form a sizeable percentage of Berkeley's building stock. Berkeley's recently enacted Building Energy Savings Ordinance (BESO) requires all home owners to audit their home performance and will help—over time—to identify energy efficiency improvements for existing buildings. However, there are few incentives to implement improvements and little guidance on how to prioritize work to best support climate change goals.

Berkeley Deep Green Building is a proposal for an incentive-based path toward buildings that meet Berkeley's environmental and greenhouse gas (GHG) reduction goals, protect the health and safety of Berkeley workers and residents, and support the health and sustainability of communities across the globe.

Program overview

Berkeley Deep Green Building incorporates best practices to:

1. **Support zero net energy** at the individual building and community scale
2. **Reduce embodied energy** in building materials and practices
3. **Reduce toxicity** in building materials
4. **Source sustainably produced materials** from fair trade, fair wage and culturally and environmentally sustainable suppliers; and
5. **Conserve water**.

Some of the components are similar to those in the US Green Building Council's LEED, Build It Green's Green Point Rated, and the International Living Future Institute's Living Building Challenge. However, Berkeley Deep Green while tied into California Codes and mandates for energy and water efficiency, is tailored to Berkeley with its limited rainfall and high urban

density. In addition, it acknowledges the latest science in environmental health and it looks holistically at a building's global warming impacts.

The program is intended to be voluntary and incentive-based at first, leading eventually to the adoption of new mandatory requirements, as appropriate.

The program's methods are to:

INSPIRE↦EDUCATE↦INCENTIVIZE↦EVALUATE & INCORPORATE

In addition to incentivized measures and eventual rules, Berkeley Deep Green Building includes a robust educational component, with outreach and programs for homeowners, contractors, architects, engineers, landlords, developers, lenders, appraisers, and members of the public.

Initially, Berkeley Deep Green Building applies only to residential buildings, including new buildings and remodeling projects over a specific size. This tracks the State's emphasis on residential buildings and reflects the complexities of devising regulations applicable to nonresidential enterprises with vastly different needs and uses, from offices full of computers to hospitals, grocery stores, factories and labs with equipment, heat, lighting, refrigeration and other specific needs that vary widely. In a later phase, the program will be extended to commercial, manufacturing and office buildings of all types.

Alignment with Berkeley and Statewide goals

Berkeley Deep Green Building helps implement Berkeley's 2009 Climate Action Plan, Berkeley's 2016 Resilience Strategy, the California Energy Commission's Title 24, and California's Zero Net Energy goals, and reflects the community's commitment to health, sustainability, and equity.

According to Berkeley's Climate Action Plan, commercial and residential buildings account for 53% of the city's GHG emissions. The first goal of the Plan is for "*new and existing Berkeley buildings [to] achieve zero net energy consumption through increased energy efficiency and a shift to renewable energy sources.*" Clean and reduced energy use in buildings is also a key goal of Berkeley's Resilience Strategy.

The State of California, through Title 24, is continually increasing energy efficiency standards for buildings and is now preparing regulations for all new residential construction to be 'zero net energy' by 2020. Berkeley Deep Green Building supports achievement of the state's Title 24 and zero net energy goals.

The usage of natural gas represents 65% of Berkeley buildings' GHG emissions. Incentives to improve energy efficiency and shift from natural gas to electricity make the city's GHG reduction goals more attainable, especially if the proposed Alameda County East Bay Community Energy project comes online, offering even cleaner electricity to Berkeley residents.

Technologies exist to support zero net energy in new construction and remodels, but not all building professionals are aware of these opportunities. In California, with its increasingly low carbon power supply, highly-efficient heat pumps for space and water heating produce far fewer greenhouse gas emissions over their lifetimes than natural gas-powered equipment. New materials for reducing air infiltration and requirements for increased insulation levels reduce the amount of space heating required. These measures, coupled with reduced plug loads, high-efficacy lighting, and solar hot water help to minimize electricity demand. Berkeley Deep Green Building incentivizes all of these, and more.

Program components

The Berkeley Deep Green Building program is offered in two Levels, providing a roadmap to achieve its goals. Initially, the program is envisioned as voluntary, with valuable incentives tied to compliance. Over time, voluntary components will be incorporated into the code, either at the state level or by the City of Berkeley. Since program goals are tied to California's long term energy goals, projects will be eligible for a number of energy efficiency incentives offered by the State as well as for incentives that the City of Berkeley may choose to offer.

Level 1 includes high-impact energy efficiency measures that generally are relatively easy to achieve, and addresses toxicity, responsible sourcing, and water use. Many of these measures dovetail with Title 24 and with state-level efforts to arrive at zero net energy. Incentives to achieve Level 1 standards should be substantial enough to induce most or all projects to comply. Level 2 standards reach further and are tied to additional incentives. In addition, not all components must be adopted to obtain incentives, though more comprehensive adoption will be more highly rewarded.

Each of the components listed below is discussed in more detail in **Appendix A.**

Berkeley Deep Green Building: Level 1

1. Above-code energy efficiency performance standard
2. Prescriptive energy efficiency measures
    a. 100% electric—no gas
    b. 100% high-efficacy lighting
    c. Best-in-class major appliances and equipment
    d. Switched outlets
3. State-defined 'solar ready' plus additional measures, where sufficient solar access exists
4. Cleaner insulation
    a. Insulation free of organohalogen flame retardants
    b. Low global-warming-potential insulation

5. Pre-remodel BESO assessment of home energy efficiency
6. Post-remodel energy, comfort, and air quality monitoring
7. Use of 100% Forest Stewardship Council (FSC)–certified sustainably harvested wood
8. Water conservation measures
    a. 100% extra-low-flow fixtures and appliances
    b. Water-permeable paving
    c. Water-conserving landscape (edible landscaping exempt)
    d. Laundry-to-landscape greywater and greywater-ready tub and shower plumbing

Berkeley Deep Green Building: Level 2

1. Energy efficiency performance standard higher than in Level 1
2. Reduced carbon footprint (embodied energy) of building
    a. Reduced concrete use (for hardscape and other nonstructural applications)
    b. Low-carbon-footprint concrete
    c. Wood in lieu of steel/concrete.
    d. Alternative and creative measures to reduce carbon footprint and to support responsible sourcing in a special, flexible category:
        i. Salvaged siding
        ii. Earth finishes
        iii. Fair trade/sustainably produced/green and fair labor–certified materials
        iv. Other high recycled content, locally sourced/produced and rapidly renewable materials
3. Installed solar photovoltaic (PV) system and/or solar thermal system sufficient to achieve zero net energy for the building, where sufficient solar access exists
4. Reduced toxicity through avoidance of Living Building Challenge Red List chemicals
5. Advanced water conservation measures
    a. Operational tub and shower greywater system
    b. Operational rainwater collection for non-potable domestic use

To learn more about each of the Level 1 and Level 2 measures, refer to **Appendix A**, which is organized in the same manner as the above lists.

Incentives

Over time, some or all of the incentive-based measures in Berkeley Deep Green Building may be incorporated into the building code, while new measures (which become available through industry innovations) can be included in the incentive-based program. For the program to be successful, incentives must be meaningful, motivating and easily understood. Specific incentives will be developed in collaboration with city staff.

Tools and motivators might include assistance with financing (permit fee rebates, low interest loans), relaxation of zoning requirements, bonuses, acceleration of permitting and inspection process, and/or public recognition through competitions, awards and PR events.

In addition, there are a number of local, state and federally sponsored incentives that may apply to projects. These include the following incentives and programs**.**

1. **Property Assessed Clean Energy (PACE)**

   Up to 100% financing of energy efficiency, water efficiency and renewable energy projects with little or no upfront costs, and payment through existing property tax bill. http://energycenter.org/policy/property-assessed-clean-energy-pace

2. **Bay Area Multi-Family Building Enhancements (BAMBE)**

   Cash rebates and free energy consulting for multifamily properties that undertake energy efficiency enhancements. http://bayareamultifamily.org

3. **Property tax exclusion for solar energy systems**

   Customers who install active solar systems such as solar water heaters and solar space heaters will not have their property tax re-assessed. (http://programs.dsireusa.org/system/program/detail/558).http://www.pv-tech.org/news/california_property_tax_exemptions_for_pv_systems_extended_to_2025

4. **Zero net energy pilot program by PG&E**

   Supports research, conducts workshops and outreach activities, and provides design and technical consultations to customers.

5. **Energy efficient mortgages (EEM)**

   The Federal Housing Agency's Energy Efficient Mortgages program helps families save money on their utility bills by enabling them to finance energy efficient improvements with their FHA-insured mortgage. The energy package is the set of improvements that the Borrower chooses to make based on the recommendations and analysis performed by a qualified home energy assessor. (http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/eem/energy-r)

6. **PG&E residential energy efficiency rebate program**

   a. PG&E offers rebates to eligible residential customers who install energy efficient space conditioning systems and appliances. (http://programs.dsireusa.org/system/program/detail/1428)

   b. A similar program is extended to multifamily residential buildings.

7. **PG&E California Advanced Homes (CAHP) incentives**
   For builders of new homes, incentives are applicable to homes that display a 15% to 45% improvement over Title 24 2008 codes. Additional incentives are available when onsite solar PV systems are installed or to homes that display more than 40% improvement over Title 24 2013. http://cahp-pge.com/

Education and outreach

Education and outreach are key to the success of the Berkeley Deep Green Building program, ensuring that property owners as well as building, finance and regulatory professionals understand deep green building practices in general and their value to both the environment, and to the bottom line. Outreach is intended to inspire stakeholders to participate in the Berkeley Deep Green Building program, and can appeal to long term financial advantages (lower operating costs and increased desirability/rents/prices for super green and non-toxic buildings), concern for global warming and the welfare of future generations, and civic pride.

Targets for education and outreach will include homeowners, contractors, architects, engineers, landlords, developers, lenders, appraisers, property managers, city planners and staff, building inspectors, press and members of the public.

The education and outreach program might include:

1. Classes covering all measures included in the Berkeley Deep Green Building programs program, organized in collaboration with PG&E, Build It Green, Realtor Associations, the Berkeley Permit Service Center and/or Berkeley's Adult School
2. A citywide design competition for energy efficient building retrofits
   - Winners displayed at Permit Service Center or other locations
   - PR/media attention
   - Awards ceremony or recognition at a City Council meeting
3. Permit Service Center displays and brochures
4. Promotional items such as high-performing Smart Strips, low-flow WaterSense showerheads, etc.

Timeline for review

Energy efficiency measures, renewable energy production technologies and green, certified and non-toxic building materials are evolving rapidly. Berkeley Deep Green Building anticipates periodic review of program components by planning staff and stakeholders, every 2-3 years. Some program components may be incorporated into the building code as mandatory, while others can be modified, moved to a different Level or updated, and new components can be added. Mandatory periodic review builds in a mechanism for timely adoption of new materials, metrics and methods, as they become available and feasible. State-level changes can

be incorporated as well, such as Title 24 updates. Finally, regular review will allow staff to evaluate the success of individual measures and to modify the program as appropriate.

Residential versus commercial

Berkeley Deep Green Building initially focuses on residential projects for several reasons. Commercial buildings are much more varied in their construction and use, requiring a more flexible set of goals. A manufacturing plant requiring 24/7 refrigeration or heat will have very different energy requirements from an office. An initial focus on residential energy efficiency is also consistent with the state's Long Term Energy Efficiency Strategic Plan, which targets zero net energy for all new residential construction by 2020 and for new commercial construction by 2030.

In the residential sector, recent technological changes enable dramatic improvements in energy performance and a shift to all-electric energy. Electric heat pump hot water heaters and new materials for reducing air infiltration have recently become commercially available, and PV prices have dropped significantly in the last 5 years. Commercial projects are addressed to some degree already under other City of Berkeley green building programs. Over time, commercial buildings can and should be incorporated in the program.

New construction and remodeling

Berkeley Deep Green Building components and incentives need to be tailored to new construction and remodels and various building types, i.e. single family, small multifamily and large multifamily. For remodels, thresholds will have to be established to determine when it would be appropriate for Deep Green features to be incorporated. City Staff are in the best position to consider what thresholds are feasible, and dovetail with other phased in requirements.

Berkeley Deep Green Building and other City, Regional and State programs

Berkeley Deep Green Building ties into other ambitious energy efficiency goals. These include:

1. **Building Energy Savings Ordinance (BESO)**

   BESO requires all building owners in Berkeley to complete an energy efficiency audit, helping them save energy and encouraging them to participate in various State-sponsored whole building programs. The assessment is carried out by qualified energy assessors who inform the building owners of incentives and rebates specific to the energy efficiency opportunities of the building.

2. **Title 24**

Title 24 is a stringent, energy efficient, compulsory State building code. It is subject to triennial review and the requirements are revised based on available techniques and technologies. It is anticipated that Berkeley Deep Green Building will use the same metrics as those in force under Title 24, and that measures outlined in the Deep Green program will treat Title 24 as a baseline upon which Berkeley Deep Green Building will improve.

3. **Energy Upgrade California**

   Energy Upgrade California is a state program supported by CPUC, CEC, utility companies, non-profit organizations, small businesses, and various state agencies to help realize California's climate action and energy efficiency goals. It has a partnership with Energy Star to promote the use of energy efficient products and practices.

   This platform also informs home owners of the availability of incentives and rebates. Since it is anticipated that Berkeley Deep Green Building structures would be eligible for a number of incentives and rebates from the state and utility companies, Energy Upgrade California has the potential to encourage home owners to adopt Berkeley Deep Green Building and help realize California's climate action goals.

4. **California Long Term Energy Efficiency Strategic Plan**

   This plan was formulated in 2008 and adopted by CPUC as a single roadmap to achieve maximum energy efficiency in California. The goal of the plan is that all new homes will be zero net energy or zero net energy–ready by 2020. Similarly, Berkeley Deep Green Building encourages all new and existing homes in the City of Berkeley to rapidly become zero net energy.

5. **California Advanced Home Program (CAHP)**

   CAHP is a pay-for-performance whole building approach that aims to improve market demand for energy efficient single family and multi-family homes. It encourages builders of new homes to exceed Title 24 Part 6 by 15 to 45%. (New Residential Zero Net Energy Action Plan – pg. 14).

Appendix A

Level 1 and Level 2 components are explained in more detail below.

Berkeley Deep Green Building: Level 1

1) Above-code energy efficiency (performance component)

Establish robust site energy use intensity (EUI) maximums for various building types for new construction and remodels above a certain threshold size.

Rationale: Studies consistently show that energy efficiency is the most cost effective and generally the most environmentally benign method of reducing GHG emissions. Mainstream technologies available now and common building techniques can easily and significantly reduce building energy usage. In many cases, the upfront costs of improving energy efficiency are recouped with energy cost savings in under 15 years.

A performance target allows for flexibility in reducing energy demand, through a combination of design strategies depending on the specifics of the project. The current average EUI of residential buildings in the Western states is about 40 KBtu/sq. ft. /yr site energy. Analysis performed by Arup and Davis Energy Group on how to achieve State energy use reduction goals shows that close to half of the average energy use can be eliminated through the standard palette of energy efficiency measures:

- Greater insulation.
- Considered placement of windows and addition of thermal mass to optimize passive solar gain and daylighting.
- High efficacy lighting and vacancy controls.
- Reduced plug loads.
- High efficiency appliances and heating equipment.
- Better air sealing.
- Energy efficient windows.

As an example, the current 2030 Challenge target EUIs for residential buildings in western states are 15.4 to 19.1 kBtu/sq. ft. /yr site energy. The 2030 Challenge EUI maximums are set at increasingly lower levels each 5 years with a goal of zero for 2030. The 2030 Challenge allows for the inclusion of onsite generation of energy through solar hot water and PV in meeting the targets. For reference, the Passive House EUI maximum is 38 kBtu/sq. ft. /yr source energy. (This would be about 14.2 kBtu/sq. ft./yr if translated to site energy. In addition, the EUI target does include onsite PV offsets but only after a certain efficiency threshold has been met for the building envelope and solar hot water is included though as it is not related to envelope measures.) Finally, several cities and Architecture 2030, under the umbrella of the Carbon Neutral Cities Alliance, are developing a metric for setting EUI targets that in the future may be appropriate for Berkeley.

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2) Prescriptive energy efficiency measures on top of performance component

a) **All-electric.** Establish program to shift gas end uses in existing buildings to electricity. New buildings to be all electric.
b) **100% high-efficacy lighting.** All lighting, both interior and exterior to be high efficacy, such as fluorescent or LED as per Title 24 2016 definitions.
c) **Best-in-class major appliances/equipment.** All new refrigerators, freezers, stoves, cooktops, dishwashers, washing machines, water heaters, and HVAC appliances must meet one of the following criteria:
   i) Energy Star Most Efficient, OR
   ii) CEE Tier 3, OR
   iii) Enervee 90+ (or whatever benchmark seems most comparable to the two above)
d) **Switched outlets.** At least one outlet in each room will be switched.

Rationale: The prescriptive energy efficiency measures are designed to both shift energy demand from fossil fuels to renewables and to reduce demand that is not easily addressed by the performance standards in component 1.

Shifting homes to all-electric power allows for energy demand to be met with 100% renewables, either onsite or off. In the past, because of line losses and the inefficiency of turning fossil fuel energy into electricity, electricity delivered to the home represented 3 times as much embodied energy as fossil fuel. This is now changing as more and more PV and wind power generation comes online. Both the State's commitment to increasing the Renewable Portfolio Standard, and Berkeley's intention to migrate to cleaner energy sources through the Alameda County Community Choice Energy program are quickly shifting the power sources for electricity to clean renewables.

In addition, recent developments in heating and lighting technologies have dramatically improved the performance of many sources of electrical demand. Heat pumps are more than twice as efficient as the resistance heaters they are replacing. LEDs and fluorescent lights are as

much as 10 times more efficient than incandescent and last over 5 times as long. By requiring use of these new technologies, electrical demand can be dramatically reduced.

In addition, tank (heat pump) electric water heaters can be used for energy storage, helping to smooth the energy production/demand ("duck") curve.

Further reductions can be achieved by requiring best-of-class major appliances and switched outlets. Energy Star, administered by DOE, is the main program that evaluates and rates appliance energy efficiency. Appliance efficiency is determined based on specific parameters for each category:

- Television: Power consumption under various modes, display screen size
- Computer monitor: Power consumption under various modes, display screen size
- Clothes washer: Energy efficiency, water efficiency, capacity
- Dishwasher: Energy efficiency, water efficiency, size
- Refrigerator and freezer: Energy efficiency, volume
- Ventilation fans (Range hoods, bathroom and utility room fans): Efficacy, noise
- Ventilation fans (Inline fans): Efficacy

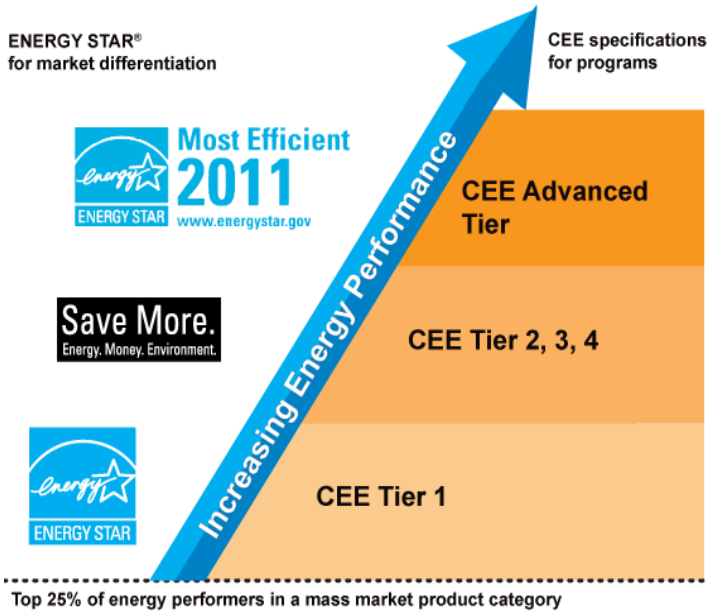
Energy Star Most Efficient is a program that identifies the most efficient Energy Star products in each category.

CEE (Consortium of Energy Efficiency) uses the Energy Star as a benchmark for various tiers:

- CEE Tier 1 is aligned with Energy Star program. Top 25% of models.
- CEE Tier 2, 3 and 4: Tiers above Energy Star minimum to be eligible for incentives. If incentives are offered, this is tied with Save More. Cost effective for customers with incentives.
- CEE Advanced Tier: Stretch targets. Attracts innovations. Top performance. Cost effective in future.

Enervee collects performance data for various appliances, and gives a score from 0 to 100 (the higher the score, the more efficient the product), for each product based on energy efficiency, other product-specific features, and cost. Enervee claims that the data and the scores are updated on a regular basis and presents the most accurate information based on market transformations.

Switched outlets will also enhance energy efficiency by allowing electronic equipment to be easily shut off completely. Many electronic devices draw a small current of electricity all of the time, even when they are not in use. These loads can be significant and while state and federal regulations should be promulgated that eliminate these ghost loads, providing users with a simple switch to turn them off will help in the meantime.



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3) State-defined 'solar ready' plus additional measures, where sufficient solar access exists

Where sufficient solar access exists, provide the necessary components to make building solar ready as per Section 110.10 of the 2013 Building Energy Efficiency Standards (BEES), with the following additions, deletions and exceptions:

Photovoltaic (PV):

a) Main Service panel: if a 200A service, busbar must be 225A minimum with a 200A maximum main breaker; if 100A service, busbar must be 125A minimum with a 100A maximum main breaker. There must be a reserved space in the panel for a double pole circuit breaker located at the opposite (load) end from the input feeder of the busbar.
b) No center-fed main service panels will be used.

c) Inverter location: minimum 3’ wide unobstructed space (from ground to eave above) adjacent to the main service panel; include NEC required working clearance.
d) Module sizing and location: sufficient area for PV modules must be reserved which allows for the anticipated power needs to achieve a zero net energy home, plus the anticipated power needs for Electric Vehicle charging, where parking is provided or required. For a typical zero net energy home there should be space allocated for 10 kW of PV, and if there are additional power needs (such as an electric spa) that power need must also be taken into account. The reserved PV roof area shall be unobstructed and unshaded and facing between 110° to 270° from North: Minimum dimension of the reserved area to be 11’ in the ridge-to-eave dimension, and assuming a power density of 15W/sf; allow for current fire code ridge and side clearances beyond the designated module areas (currently 3’ to ridge and 3’ clear on one side)
e) Clear and unobstructed pathway from the identified inverter location (preferably next to the main service panel) to the identified roof area.
f) OSHA approved fall arrest anchors installed at or near ridges; 5000 lb. capacity each, 8’ maximum on center covering the designated module area.

Solar Thermal:

a) Solar water heater collector location: provide adequate unobstructed and unshaded roof area for an appropriate designated collector square footage on roof(s) facing between 110° (E) to 270° (W). Appropriate designated square footage shall be defined as 0.75 square feet per expected gallon-per-day (gpd) consumption for south facing pitched roofs or 1.5 square foot per expected gpd consumption for flat roofs. Area to be sized such that typical solar collector sizes can fit (no less than 4’x8’ dimensions).
b) Designated location for solar storage tank. Size of storage capacity to be one gallon per gpd of expected daily use (i.e.: A single family home with an expected hot water consumption of 65 gallons per day per household would need a 65 gallon storage capacity). Designated location must be selected to minimize heat losses between hot water heater (within 5 feet of hot water heater or on the roof if ICS or thermosiphon is selected).
c) Minimum (1) 15A 120V receptacle on its own circuit within 5’ of the solar storage tank location for solar water heating pumping and controls.
d) Minimum (1) 50A 240V circuit terminating within 5’ of the water heater location for electric/heat pump water heater.
e) Solar water heater piping: either a chase of a minimum 12” x 12” dimension from within 5’ of the storage tank location to a location even with or within 3’ below the bottom of the designated solar collector location; or a pair of ¾” type M copper pipes plumbed and pressure tested to 100 psi from within 5’ of the storage tank location to a location even with or within 3’ below the bottom of the designated solar collector location.
f) Solar water heating conduit: provide a ½” EMT conduit with pull twine from the solar storage tank location to the roof exit location for solar control wiring. Seal the conduit against weather where it is exposed to the exterior.

g) Solar pool heating: Space must be allowed either on the roof or on the ground for a collector area that is 70% of the anticipated surface area of the pool, facing between 110° (E) to 270° (W). A pathway should be identified for (2) 2" pipes and (1) ½" conduit from the pool equipment area to the bottom of the designated solar collector location, and if feasible the pipe pathway should be sloped such that water could continuously drain back to the pool equipment area.

h) The above provisions are intended to be additive to the solar ready provisions of the existing BEES, except in those cases where they contradict, preclude or replace existing provisions, in which case these provisions supersede.

4) Cleaner Insulation

a) **Insulation free of organohalogen flame retardants.** No insulation used on the project can contain halogenated flame retardants.

b) **Low global-warming-potential insulation.** No insulation can have a lifetime global-warming-potential greater than .05/sq. ft.* R based on chart below developed by Building Green and the Inventory of Carbon & Energy (ICE), Version 2.0, by Prof. Geoff Hammond & Craig Jones

Rationale: Organohalogen flame retardants (sometimes also called halogenated flame retardants, or HFRs) are a class of chemical that is commonly used as flame retardants in polyurethane and polystyrene materials, including insulations. They are also found in some polyisocyanurate insulations. These chemicals have been linked to a host of serious health and developmental problems and also lead to the formation of toxic halogenated dioxins and furans in fires or during thermal processing (Shaw et al, 2010; US EPA 2014; Weber & Kuch, 2003; Ebert & Bahadir, 2003). Many are persistent and bioaccumulative. Building insulation, including disposal at end of useful life, is estimated to be a significant source of these chemicals in the environment (ECHA 2009). 22 chemicals have been banned internationally under the Stockholm Convention on Persistent Organic Pollutants: all are organohalogens, and one is commonly used in polystyrene insulation materials. The American Public Health Association has issued a policy statement calling for reduced use of these flame retardants to protect public health (APHA 2015).

Embodied energy is the measure of the energy that goes into harvest/extraction, manufacture and transport of a product. Reducing and minimizing the embodied energy of materials used in construction, reduces the carbon footprint of the buildings. Reducing the carbon footprint of buildings reduces GHG emissions at the start of a building's life, when they are needed most. Because of the delayed impact of GHGs and the self-reinforcing loops that GHGs trigger, reductions now are more significant than reductions in the future. By limiting the global-warming potential of insulation materials to .05/sq. ft./R, highly insulated buildings will 'pay back' the added carbon footprint of this extra insulation generally in 5 years at most. Most extruded polystyrene board currently available in the U.S. and HFC blown, closed cell spray polyurethane currently don't meet this standard.

The extremely high lifetime global-warming potential is caused by the chemicals used as blowing agents to expand the foam. In a 2010 study by Buildinggreen.com ("Avoiding the Global

Warming Impact of Insulation," by Alex Wilson, Environmental Building News, Vol 19.6), the payback from using foam plastic with these blowing agents as an additional insulation layer on the outside of a 2 x 6 framed and insulated house was a minimum of 30 years for a house in a very cold climate like Boston. With less than half of the heating and cooling loads of Boston, the payback time in Berkeley for a similar house would be a lot longer.

Another study by Passive House researcher Rolf Jacobson, shows payback periods of 20+ years from using these high global-warming-potential insulations to meet Passive House energy efficiency goals. ("Comparing 8 Cold Climate PH Houses," by Mary James, Home Energy Magazine, Oct. 2014)

Manufacturers are developing safer alternative methods of expanding the foam.

References:

Shaw, S. D., Blum, A., Weber, R., Kannan, K., Rich, D., Lucas, D., … Birnbaum, L. S. (2010). Halogenated flame retardants: do the fire safety benefits justify the risks? *Reviews on environmental health*, 25(4), 261–305.

American Public Health Association (APHA) (2015). Policy Statement 20156: Reducing Flame Retardants in Building Insulation to Protect Public Health. Available at: http://www.apha.org/policies-and-advocacy/public-health-policy-statements

Ebert J, Bahadir M. Formation of PBDD/F from flame-retarded plastic materials under thermal stress. *Environ Int*. 2003;29:711–716

European Chemicals Agency (ECHA) (2009). Data on Manufacture, Import, Export, Uses and Releases of HBCDD as well as Information on Potential Alternatives to Its Use. ECHA, IOM Consulting, Helsinki, Finland.

U.S. Environmental Protection Agency (EPA) (2014). Flame-retardant alternatives for hexabromocyclododecane (HBCD): final report. Available at: http://www.epa.gov/dfe/pubs/projects/hbcd/hbcd-full-report-508.pdf. Accessed December 20, 2015

Weber R, Kuch B. Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated-chlorinated dibenzodioxins and dibenzofurans. *Environ Int*. 2003;29:699–710

http://greensciencepolicy.org/topics/flame-retardants/

http://e360.yale.edu/feature/pbdes_are_flame_retardants_safe_growing_evidence_says_no/2446/

http://www2.buildinggreen.com/blogs/avoiding-global-warming-impact-insulation

http://www.homeenergy.org/show/article/nav/issues/magazine/139/id/1993

Lifetime Global Warming Potential of Insulations

Insulation Material	R-value R/inch	Density lb/ft³	Emb. E MJ/kg	Emb. Carbon $kgCO_2/kg$	Emb. Carbon $kgCO_2/ft^2 \bullet R$	Blowing Agent (GWP)	Bl. Agent kg/kg foam	Blowing Agent GWP/ bd-ft	Lifetime GWP/ $ft^2 \bullet R$
Cellulose (dense-pack)	3.7	3.0	2.1	0.106	0.0033	None	0	N/A	0.0033
Fiberglass batt	3.3	1.0	28	1.44	0.0165	None	0	N/A	0.0165
Rigid mineral wool	4.0	4.0	17	1.2	0.0455	None	0	N/A	0.0455
Polyisocyanurate	6.0	1.5	72	3.0	0.0284	Pentane (GWP=7)	0.05	0.02	0.0317
Spray polyure-thane foam (SPF) – closed-cell (HFC-blown)	6.0	2.0	72	3.0	0.0379	HFC-245fa (GWP=1,030)	0.11	8.68	1.48
SPF – closed-cell (water-blown)	5.0	2.0	72	3.0	0.0455	Water (CO_2) (GWP=1)	0	0	0.0455
SPF – open-cell (water-blown)	3.7	0.5	72	3.0	0.0154	Water (CO_2) (GWP=1)	0	0	0.0154
Expanded polystyrene (EPS)	3.9	1.0	89	2.5	0.0307	Pentane (GWP=7)	0.06	0.02	0.036
Extruded polystyrene (XPS)	5.0	2.0	89	2.5	0.0379	HFC-134a[1] (GWP=1,430)	0.08	8.67	1.77

1. XPS manufacturers have not divulged their post-HCFC blowing agent, and MSDS data have not been updated. The blowing agent is assumed here to be HFC-134a.

http://www.greenbuildingadvisor.com/blogs/dept/energy-solutions/avoiding-global-warming-impact-insulation

5) Pre-remodel BESO assessment of home energy efficiency.

Submit paperwork from BESO assessment with permit application for remodel.

Rationale: BESO requires building owners to complete an energy performance assessment and publicly report the building performance information via an electronic reporting interface controlled by the Director of Planning and Community Development or their designee. Energy assessment is carried out by registered energy assessors who provides recommendations to improve the energy performance of the building. For BESO energy assessment one of the following is required:

a) Home Energy Score: Home Energy Score is developed by LBNL and rates homes on a scale of 1 to 10, 10 indicating excellent energy performance. Home energy Score includes the score, energy use breakdown, data collected and recommendations to improve energy performance.
b) Energy Upgrade California (EUC) Advanced Assessment: Home Upgrade has a network of qualified energy assessors in the bay Area who can assess homes and identify opportunities for energy performance improvement.

c) High Performance: If a qualified energy upgrade has been completed or if the building is already very energy efficient, the owner can submit evidence of these upgrades or this efficiency in lieu of the BESO audit.

The BESO assessment informs owners on the building's energy performance and provides a roadmap for improvement. Assessments are carried out by registered assessors using advanced diagnostic tools. While encouraging them, the system makes it voluntary to incorporate performance improvement measures. Reducing one's carbon footprint, improving comfort in the house and saving on energy bills are all incentives for building owners to carry out recommended changes. Improved marketability of energy efficient residences is a further incentive to owners to implement recommended energy conserving measures.

6) Post remodel energy, comfort, and air quality monitoring (operational rating)

a) For a period of one year following completion of construction, monitoring will be carried out for the following parameters: hot water use, appliance loads, space heating loads, interior temperature, relative humidity and CO2 levels. Consider requiring entry of projects as case studies into the NZEC-NESEA inventory, for which all case studies are QA'd by NREL before publishing.

b) Project must document energy use meets target expectations to be eligible for incentives from the City.

c) Monitoring data will be included in a public database (that protects privacy) and compared to pre-construction projected energy use in bi-annual reports. Reporting could potentially be less frequent if incorporated into NZEC-NESEA inventory.

Rationale: The intention of Berkeley Deep Green Building is to radically improve the comfort, performance and indoor air quality of buildings throughout the City of Berkeley. However, without a means to track these improvements, it may not achieve the outcomes required to reduce our global carbon emissions. Therefore, the program includes a mandatory monitoring for all participants. A list of devices for tracking both energy performance and indoor air quality are included below.

Bi-annual reports examining the data will help to direct future improvements to Berkeley Deep Green Building.

Energy Use Monitoring Systems:				
Name	Website	Cost	#circuits	Cost/circuit
eGauge EG3010 (Residential)	http://www.egauge.net/	$544	12	$45.33
eGauge EG300	http://www.egauge.net/	$494.00	12	$41.17

(commercial)				
SiteSage	http://powerhousedynamics.com/	tbc	44	
PowerSave Envi	http://www.currentcost.net/	$129	10	$12.90
Lgate	http://locusenergy.com/	tbc	2	
EnergyCloud	http://bluelineinnovations.com/	$89	1	$89.00
TED 5000	http://www.theenergydetective.com/	$199.00	1	$199.00
TED Pro Home	http://www.theenergydetective.com/	$300.00	32	$9.38
Wattvision	http://www.wattvision.com/	$99.00	1	$99.00
(Highlighted cells are the ones that look most viable and informative for tracking home energy use)				
IAQ Monitoring Systems:				
Foobot	http://foobot.io/	$199.00		
Elgato Eve Room	https://www.elgato.com/en/eve/eve-room	$75.00		
Netatmo Home Weather Station	https://www.netatmo.com/	$148.00		
			updated:	3/2/2016

http://www.homepower.com/articles/home-efficiency/electricity/tracking-your-energy-use

7. FSC-certified wood

FSC-certified wood and wood products are to be used when available.

Rationale: FSC is an independent member-led group that advocates use of wood sourced from sustainably managed forests (see us.fsc.org/en-us). FSC-certified wood aligns with the Berkeley Deep Green Building requirement for sustainably sourced materials and offers the following benefits:

- FSC standards for forest management discourages harvesting wood from old-growth forests, thus preventing loss of natural forest cover.
- The standards extend to protection of water bodies and prevention of use of hazardous chemicals, such as Atrazine, that are otherwise allowed in the US.
- FSC requires forest managers on both private and public lands to involve the local community and protect indigenous people. It requires the local community to be part of the decision-making on impacts of operations and certification.

- FSC audit reports on public and private lands are available to the public.

FSC wood and wood and cabinetry and windows made with FSC wood are available from many local sources. A list of these sources, updated annually, is available from the Ecology Center on San Pablo Ave.

Note: the SFI certification is not a comparable alternative and cannot be used as a substitute certification program.

8. Water Conservation

All new plumbing fixtures to be 100% extra-low flow fixtures and appliances.

Fixture	Flow rate mandated by California Energy Commission (gpm)	Maximum flow rate recommended by Berkeley Deep Green Building (gpm)
Faucet	1.2	.5
Shower	-	1.25
Kitchen Faucet	1.8 that can be increased to 2.2	1.8 (for functional reasons such as pot filling)
Toilets	1.28	1

Permeable paving. Maximize permeable paving. Paving materials such as gravel, pervious concrete or asphalt, spaced paving blocks, loose materials, or tire spurs allow storm water to percolate and infiltrate into the ground, allowing for groundwater recharge and reduction in runoff and flooding. When choosing a permeable paver, consider Americans with Disabilities Act (ADA) access requirements and the anticipated vehicular load in hardscape areas. Areas with very high traffic or very heavy anticipated loads may not be suitable for pervious paving strategies. Examples of permeable paving are: Pervious concrete or asphalt, an open-grid pavement system with at least 50% permeability, permeable materials, such as gravel, decomposed granite, or sand.

Water conserving landscape. Post construction landscape design shall be designed to achieve the following:

1. Areas disrupted during construction are restored to be consistent with native vegetation species and patterns.

2. Limit Turf areas to 10 percent of the total landscaped area.

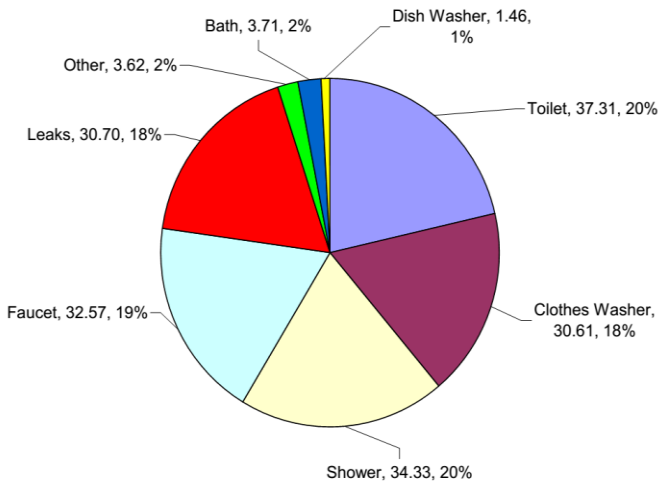
3. Utilize at least 75 percent native California or drought tolerant plant and tree species appropriate for the climate zone region. Areas devoted to edible landscape exempt because of importance of localizing food supply.

4. Plants to be hydrozoned by water needs.

Laundry-to-landscape greywater and greywater-ready tub and shower plumbing. Install laundry to landscape greywater system. New showers and tubs to be plumbed to be greywater ready: i.e. greywater piping kept separate from black water piping in such a fashion as to provide easy access for diversion into a greywater system at a future date.

Rationale: It is estimated that the average resident in Northern California uses 171 gallons per day for indoor use and 125 gallons per day for outdoor use. It is also estimated that residents of the Bay Area use less than 171 gallons of water for indoor use (California Single Family Water Use Efficiency Study, 2011).

The following chart presents a perspective on the average residential water use in California.



A state of emergency was declared in California in 2014 due to drought conditions. Record low precipitation in 2014 affected drinking water reserves in the state. Precipitation in subsequent years has not been enough to bring California out of the drought situation. This emergency prompted the State to take corrective actions and make the water efficiency standards in buildings and in agricultural practices more stringent. It is imperative that all new and existing buildings honor this commitment by the State. The water efficiency goals of the Berkeley Deep Green Building program will be in line with the State's commitment and requirements.

Water-permeable paving allows infiltration of rainwater into the ground and helps recharge ground water. It prevents excess storm water runoff that overloads the capacity of our wastewater treatment plants (where there are combined sewer and stormwater systems). Additionally it filters pollutants from runoff thus improving the quality of storm water runoff and preserves ground water quality.

Limiting turf area conserves water as turf has high irrigation needs. Native turf varieties are recommended instead because of their lower irrigation needs. Limiting turf area will allow the owner to explore alternate irrigation options such as drip irrigation which work well with other landscaping species

More efficient irrigation can be achieved by clumping species with similar irrigation needs together in the landscape.

Re-use of greywater for landscape irrigation has been estimated to offset from 16 to 40% of municipal potable water use.

Laundry-to-landscape greywater systems are easy to install, economical, and do not require a permit so long as explicit guidelines are followed.

Tub/shower greywater can readily be diverted for re-use in the landscape so long as the drainage piping is accessible and there is adequate space in the piping to install a backwater valve and diverter valve. If not anticipated with the installation of "greywater ready plumbing", it can become cost prohibitive in the future to attempt to capture that greywater for re-use. Where a new tub/shower is situated on a slab, the drain piping can be routed to an area (even outside the building footprint) where access can be provided before it joins black water drain piping. Similarly, upstairs tub/showers can have drainage piping extend into lower walls or the crawlspace to provide that access, before combining with black water piping.

Ideally, landscaping would be designed to optimize greywater re-use from various sources in the home using the least expensive types of greywater irrigation systems.

References:

Stormwater fact sheet.pdf by Bay Area Stormwater Management Agencies Association

California Code of Regulations Title 23, Division 2, Chapter 2.7. Model Water Efficient Landscape Ordinance. (https://govt.westlaw.com/calregs/Document/I8403E54417874B8B94843C8A8341823B?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1)

DWR offers rebates to replace turf with other native species. (http://www.saveourwaterrebates.com/turf-replacement-rebates.html)

Berkeley Deep Green Building: Level 2

1. Higher above code energy efficiency (performance component)

Establish even lower energy use intensity maximums than tier 1
for both new construction and remodels above a certain threshold in size. See item 1. above for rationale.

2. Reduced embodied energy (prescriptive measures)

a. **Reduce concrete use (reduce concrete use for hardscape and other nonstructural applications).** Consider prohibition on use of materials high in

embodied energy such asnew concrete and kiln-fired brick, pavers, etc., for non-structural purposes.

b. **Low embodied-energy concrete.** Specify concrete with global-warming potential 30% or more below standard mixes as established by the NRMCA.

"Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is 30% or more below the GWP of a reference building using Benchmark mixes as established by NRMCA and available for download at www.nrmca.org. Submit a summary report of all concrete mixtures, their quantities and their GWP to demonstrate that the total GWP of the building is 30% or more below the GWP of the reference building. Contractor may use the Athena Impact Estimator for Buildings software available at www.athenasmi.org or other similar software with the capability of calculating GWP of different mix designs."

c. **Wood in lieu of steel/concrete:** Where it is possible to substitute, wood (including cross-laminated timber and other engineered wood products) will be used in lieu of concrete and steel structural systems.

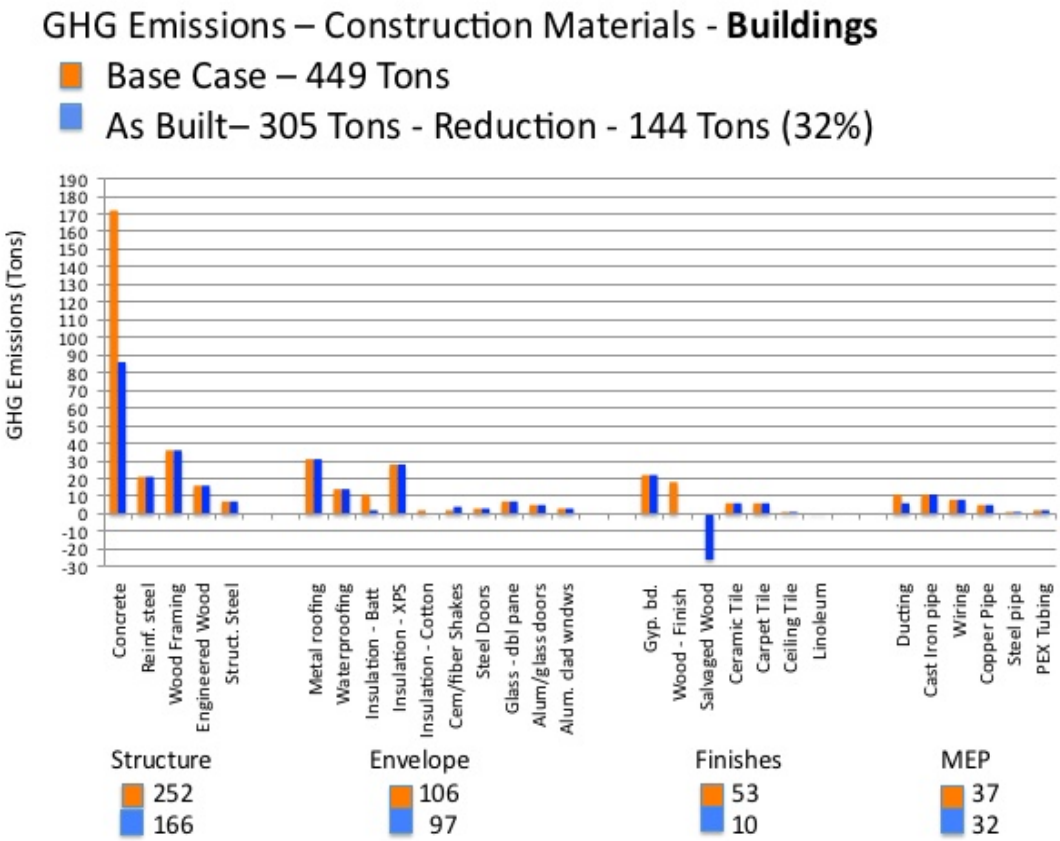
d. **Petition for consideration of alternative measures for reducing embodied energy. For example, salvaged siding, earth finishes, high recycled content, locally sourced, rapidly renewable materials, and remodeling rather than constructing new.**

Rationale: As operational energy goes down, the significance of energy embodied in materials increases. Currently over a buildings whole life, embodied energy accounts for roughly 20% of a building's total GHG footprint. However, in the first 20 years of a building's life, this can be 50% or more. In addition, as we approach zero net operating energy, these numbers increase, eventually reaching 100%.

Low-carbon materials provide net GHG emissions reductions now, when GHG emissions reductions are most effective and are needed most because of the delayed impact of GHGs and the self-reinforcing loops that GHGs trigger.

Low-carbon construction can reduce the embodied energy by 30 to 50%, with 20% achieved through simple substitutions.

Rapidly renewable plant materials, wood, earth and stone are the primary low-carbon construction materials. Use of rapidly renewable plants and wood products actually sequesters atmospheric carbon and could be assembled to create a carbon negative house. Metal and plastics in general have a very high carbon footprint and should be avoided where possible. Concrete, while lower in embodied energy per pound, is used in such great quantities that its global warming impact tends to dwarf that of other materials used in construction. A detailed analysis of the embodied energy of a building recently designed by Siegel and Strain Architects shows the relative significance of various components:



Berkeley Deep Green Building focuses on reducing concrete in nonstructural uses because there are many good low-carbon alternatives. It encourages use of wood instead of concrete and steel structurally because structural systems contribute most to a building's overall embodied energy. Where concrete is essential structurally, many methods exist to reduce the embodied energy of concrete significantly without compromising its performance.

Finally, where wood is use mainly for the structure, advanced framing techniques can be employed that can reduce the amount of lumber used by up to 25%. Advanced framing components include:

- Framing walls with studs at 24" on center.
- Designing windows and doors on the plywood/sheetrock module
- Single top plates instead of double top plates
- Single stud at window
- No headers over doors and windows in nonbearing walls
- No cripple under windows
- Hang window and door headers instead of using Jack studs
- Use only 2 studs for corners

Additional information about this construction technique is available in **Efficient Wood Use in Residential Construction: A Practical Guide to Saving Wood, Money,**

and Forests by Ann Edminster and Sami Yassa, 1998. Natural Resources Defense Council

References:

"Greenhouse Gases and Home Building: Manufacturing, Transportation, and Installation of Building Materials," by Warren Carnow, National Home Builders Association, September 2008 http://www.nahb.org/en/research/housing-economics/special-studies/archives/greenhouse-gasses-and-home-building-2008.aspx

Lessons Learned from Recent LCA Studies, SEAOC 2013 Convention Proceedings, by Frances Yang

SEAOC LCA Study: Comparing Environmental Impacts of Structural Systems, SEAOC 2013 Convention Proceedings, by Anthony Court, Lisa Podesto, Patti Harburg-Petrich

http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2011/09/0426.xml&printable=true&contentidonly=true

Science Supporting the Economic and Environmental Benefits of Using Wood and Wood Products in Green Building Construction, y Michael Ritter, Kenneth Skog, and Richard Bergman, USDA, Forest Products Laboratory, GTR FPL-GTR-206, page 4 http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr206.pdf

http://www.woodworks.org/why-wood/

http://www.rethinkwood.com/

"Clock is Ticking," by Larry Strain, greensourcemag.com, May/June 2011, http://www.siegelstrain.com/site/pdf/201105_ClockisTicking-LStrain.pdf

http://archpaper.com/2016/04/time-to-experiment-anew-david-benjamin-on-embodied-energy-and-design/#gallery-0-slide-0

http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/26449.pdf

http://www.apawood.org/data/sharedfiles/documents/m400.pdf

http://www.usahers.com/pdffiles/VEFraming1-17-01.pdf

3. Solar photovoltaic (PV) system and/or a solar thermal system sufficient to achieve zero net energy for the building, where sufficient solar access exists

Where sufficient solar access exists, install a solar PV and/or solar thermal system, sized as required to achieve zero net energy for the building, including excess inverter capacity for expansion.

Photovoltaics: The PV system shall be sized to offset 100% of on-site electrical loads, and in addition shall include either 1) inverter capacity for the PV modules needed to supply power for at least 2 EVs which travel 30 miles per day round trip, or 2) adequate space and breaker capacity at the main service panel to add this inverter capacity later. If the system uses micro inverters then no added inverter capacity is required. Prioritize usage of roof areas which have a 90% or greater annual solar access; if those areas prove insufficient, utilize areas with not less than a 70% solar access. System sizing should be done using one of the nationally accepted solar calculator tools, such as PVWatts, PVSyst, Helioscope, and SAM.

Solar thermal: A solar thermal system will typically offset between 50% and 70% of a residence's annual hot water loads. If the building design indicates a need for solar thermal to achieve zero net energy, then the system must be installed in a way that achieves a minimum 50% solar fraction. Any SRCC OG300 certified system may be used; however, if the system involves hot water storage on the roof then the roof structural design must be proven adequate to carry the additional load. If there is going to be a swimming pool on the property there should also be an adequately sized unglazed or glazed solar pool heating system.

4. Reduced toxicity through avoidance of Living Building Challenge Red List chemicals

Projects cannot use products that contain chemicals on the Living Building Challenge Red list. These chemicals are:

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs)
- Chloroprene (Neoprene)
- Chromium VI
- Formaldehyde (added)
- Halogenated Flame Retardants (HFRs)
- Hydrochlorofluorocarbons (HCFCs)
- Lead (added)
- Mercury
- Polychlorinated Biphynels (BCPs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- Short Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products (above specified amounts)

The International Living Future Institute, which manages the Living Building Challenge, grants temporary exceptions for many Red List Chemicals owing to current limitations in the materials economy. These same exceptions, as outlined in the Living Building Challenge 3.0 Materials Petal Handbook, shall apply in Berkeley Deep Green Building. However, no exceptions shall be made for halogenated flame retardants (HFRs) in insulation given the availability of alternative materials that do not contain HFRs.

Rationale: The International Living Future Institute has assembled a list of chemicals it identifies as the "worst in class" materials, chemicals, and elements known to pose serious risks to human health and the greater ecosystem." Ultimately, they should be phased out of production because of toxicity concerns. A growing body of research is demonstrating the role of chemical pollutants in the development of a broad array of childhood and adult diseases (e.g. neurodevelopmental disabilities, asthma, allergies, psychiatric disorders, immune deficiencies, birth defects, cancers, diabetes, endometriosis, infertility, and Parkinson's disease). The time of greatest vulnerability is during pregnancy, when minute exposures to the fetus during critical developmental windows can set a child up for a lifetime of chronic illness.

Unfortunately, there is very little federal regulation to ensure the safety of the >85,000 synthetic molecules developed since WWII. When Toxics Substances Control Act (TSCA) was passed in 1976, 62,000 chemicals were simply grandfathered in as being permissible to use in commercial products. Of the 20,000 plus new chemicals developed since then, health data has been generated on only 15% of them. Since the passage of TSCA, the EPA has outlawed only 5 chemicals under this law.

Building consumes 40% of raw materials globally (3 billion tons annually) and therefore contributes substantially to the extraction, manufacture and use of materials in our environment. Avoidance of building products containing ILFI Red List Chemicals helps to create safe environments in our homes and redirects manufacturing to a more sustainable future.

References:

www.greensciencepolicyinstitute.org

www.braindrain.dk

http://jama.jamanetwork.com/article.aspx?articleid=185391

http://www.healthandenvironment.org/about/consensus

http://arjournals.annualreviews.org/e...

https://www.youtube.com/watch?v=E6KoMAbz1Bw Little Things Matter by Bruce Lanphear, MD, Prof at Simon Fraser University, Published on Nov 11, 2014

5. Advanced Water Conservation Measures

a. **Operational tub and shower greywater system**. Direct all shower/tub water to permitted outdoor greywater system.

b. **Operational rainwater collection for non-potable domestic use.** A minimum 1000 gallon rainwater system to be installed for use for toilets and/or laundry.

Rationale:

California enacted the Rainwater Recapture act in 2012 which allows residents to capture and use rainwater collected onsite. There are many benefits to capturing and reusing rainwater onsite:

- Rainwater use offsets the demand on the potable water supply which is under a great strain because of the State's drought conditions.
- While the individual capacities of rainwater barrels or cisterns are inadequate for agricultural or industrial purposes, they are adequate for residential non-potable applications. If every home in the City of Berkeley collected and used rainwater, at the minimum for outdoor irrigation, the water saved in the reservoirs could be diverted to other applications that do not offer much flexibility, such as agricultural and industrial applications. Consequently this relieves the demand on the potable water supply.
- Rainwater is a free and clean source for irrigation. It is low in sodium and chloramine and is fluoride free.
- Additionally, basic filtration and treatment makes rainwater fit for other uses such as toilet flushing and cleaning laundry (subject to permitting requirements).
- Capturing rainwater reduces the speed of flow in storm water systems and into the Bay. This helps in preventing changes in the local ecosystem.

Greywater is lightly used water from tubs, showers, sinks and clothes washers: so long as care is taken in the choice of cleaning products it can be effectively re-used for outdoor irrigation. Using municipal water twice lowers the embodied energy/carbon footprint per use, reducing the chemicals and costs involved in treating water initially to potable standards and later in treating it before release back into the environment.

Fortunately there are many systems available ranging in price and suitability for different types of landscapes. The simplest and least expensive sends the greywater directly to the garden as it is produced, via gravity or using the pump already in the washing machine. Mulch basins in the landscape allow the greywater to infiltrate into the soil, and are best suited for irrigating larger trees, shrubs, vines, perennials.

More expensive systems utilize tanks, pumps, filtration and sophisticated controls in order to distribute the greywater in regulated amounts through special drip tubing. Some require that the homeowner clean the filters, others provide automatic back flushing of filters using potable water (with cross connection protection) or air.

There are even specialized greywater systems that can be installed under turf. Other whole house systems gather the greywater, treat it onsite to the NSF 350 standard so that it is no longer technically greywater, and utilize it for toilet flushing.

It is wise to anticipate the desired type of system (and budget) and design/plumb accordingly—some systems require space for necessary equipment to be installed, either indoors or out, and require that all greywater piping lead to one location.

Even if there is no plan to implement a system, installing plumbing to be 'greywater ready' is a courtesy to all future owners of the property when greywater re-use may be mandatory.

Currently all systems require a permit except the laundry-to-landscape system, which must abide by code-specified guidelines to be exempt.

References:

The Water Wise Home, by Laura Allen, Storey Press, 2015

Stormwater fact sheet.pdf by Bay Area Stormwater Management Agencies Association

http://www.ci.berkeley.ca.us/Planning_and_Development/Energy_and_Sustainable_Development/Rainwater_Harvesting.aspx

Ideas from community input session 06.14.2016

Level 1

1. Bike parking to be included in both new and existing homes
2. Clause to be added on EUI with respect to number of bedrooms.
3. Carbon sequestration (need more inputs on how this can be achieved without cluttering the program). One is encourage residents to separate recyclables, composting and landfill trash, similar to what is done in San Francisco. (http://sfenvironment.org/zero-waste/recycling-and-composting/residential-recycling-and-composting) However, not sure if this accounts to carbon sequestration.
4. Secondly under carbon sequestration, we could add construction waste recovery and recycling, which requires collecting construction waste and sending all recyclable waste to authorized recyclers and / or send reusable materials to other construction sites. This is to minimize waste going to landfills. This is similar to the measures in LEED.

Level 2

1. Incorporate EV charging points in all multifamily homes and newly constructed single family homes
2. Reduce number of parking spaces in homes within 0.25 miles of public transit.