

TOPIC

Sustainable Building Materials

INTRODUCTION: What makes a building sustainable?

Everywhere today architects are incorporating sustainable ideas into design projects. This process has become more commonly known as “building green”. But what makes a building sustainable? A green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. One of the biggest components of a sustainable building is the material efficiency.

What are green building materials?

Green building materials offer specific benefits to the building owner and building occupants such as reduced maintenance and replacement costs, energy conservation, improved occupant health and productivity, lower costs associated with changing space configurations, and greater design flexibility. Building and construction activities worldwide consume three billion tons of raw materials each year or forty percent of total global use. Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

So what constitutes a green building material? Green building materials are composed of renewable, rather than nonrenewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product. Depending on the project and the specific goals that need to be accomplished, the green materials chosen may involve an assessment of one or more of the following criteria: resource efficiency, indoor air quality, energy conservation, water conservation, and affordability.

Resource Efficiency

This section of assessment can be met by making sure that the material meets the following criteria:

Recycled Content: Products with identifiable recycled content, including postindustrial content with a preference for postconsumer content.

Natural, plentiful or renewable: Materials harvested from sustainably managed sources and preferably have an independent certification (e.g., certified wood) and are certified by an independent third party.

Resource efficient manufacturing process: Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product packaging), and reducing greenhouse gases.

Locally available: Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.

Salvaged, refurbished, or remanufactured: Includes saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product.

Reusable or recyclable: Select materials that can be easily dismantled and reused or recycled at the end of their useful life.

Recycled or recyclable product packaging: Products enclosed in recycled content or recyclable packaging.

Durable: Materials that are longer lasting or are comparable to conventional products with long life expectancies.

Indoor Air Quality (IAQ)

Indoor air quality is just as important during construction as it is in the finished building. As such, the materials used have to meet the following specifications:

Low or non-toxic: Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.

Minimal chemical emissions: Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions.

Low-VOC assembly: Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards.

Moisture resistant: Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.

Healthfully maintained: Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning.

Systems or equipment: Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

Energy Efficiency

One of the main goals of green design is to reduce the amount of energy consumed by buildings. According to Edward Mazria in his presentation "Resuscitating a Dying World", he states that building use 49 percent of the overall building consumption of the US. If this number can be reduced it can have a drastic effect on global warming. As such the criteria for energy efficiency is any material, component, or system that helps reduce energy consumption in buildings and facilities.

Design strategies to contribute to this goal include but are not limited to:

- Passive design strategies can dramatically affect building energy performance. These measures include building shape and orientation, passive solar design, and the use of natural lighting.
- Develop strategies to provide natural lighting. Studies have shown that it has a positive impact on productivity and well being.
- Install high-efficiency lighting systems with advanced lighting controls. Include motion sensors tied to dimmable lighting controls. Task lighting reduces general overhead light levels.
- Use a properly sized and energy-efficient heat/cooling system in conjunction with a thermally efficient building shell. Maximize light colors for roofing and wall finish materials; install high R-value wall and ceiling insulation; and use minimal glass on east and west exposures.
- Minimize the electric loads from lighting, equipment, and appliances.
- Consider alternative energy sources such as photovoltaics and fuel cells that are now available in new products and applications. Renewable energy sources provide a great symbol of emerging technologies for the future.
- Computer modeling is an extremely useful tool in optimizing design of electrical and mechanical systems and the building shell.

Water Efficiency

Water conservation in design is seen as products and systems that help reduce water consumption in buildings and conserve water in landscaped areas. The following list states methods that can be instilled in a building for designing for water conservation:

- Design for dual plumbing to use recycled water for toilet flushing or a gray water system that recovers rainwater or other non-potable water for site irrigation.
- Minimize wastewater by using ultra low-flush toilets, low-flow shower heads, and other water conserving fixtures.
- Use re-circulating systems for centralized hot water distribution.
- Install point-of-use hot water heating systems for more distant locations.
- Use a water budget approach that schedules irrigation using the California Irrigation Management Information System data for landscaping.
- Meter the landscape separately from buildings. Use micro-irrigation (which excludes sprinklers and high-pressure sprayers) to supply water in nonturf areas.
- Use state-of-the-art irrigation controllers and self-closing nozzles on hoses.

Affordability

Affordability can be considered when building product life-cycle costs are comparable to conventional materials or as a whole, are within a project-defined percentage of the overall budget. There are certain environmental and economic assessment tools that are designed to

help you measure the cost of environmental benefits of sustainable products and design strategies.

Building for Environmental and Economic Sustainability

Organization: National Institute of Technology and Standards (NIST)

A design tool used to measure the environmental performance of building products by using the environmental life-cycle assessment approach specified in ISO 14000 standards. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Economic performance is measured using the ASTM standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal.

Green Building Advisor

Organization: Building Green and Design Harmony

Database of design strategies to improve environmental performance and cost-effectiveness.

Green Building Resource Guide

Organization: The Architectural Machine

A price index for sustainable building materials.

Green City Buildings: Applying the LEED Rating System

Organization: XENERGY Inc.

Study of potential costs and benefits realizable had 3 city buildings been designed green according to the LEED Rating System.

Standard Practice for Measuring Life Cycle Costs of Buildings and Building Systems

Organization: ASTM Standard Designation: E 917-94

Procedure to complete several life-cycle cost methods.

How is a building material considered "officially" green?

Each material has to go through a product selection process involving three main steps. First, research is done on the product, gathering technical information including Material Safety Data Sheets (MSDS), Indoor Air Quality (IAQ) test data, product warranties, source material characteristics, recycled content data, environmental statements, and durability information. Also, this may require doing further research on other issues such as environmental issues, building codes, government regulations, building industry articles, model green building product specifications, and other sources of product data. Doing this research helps the designer to know the full range of the products capabilities both positive and negative. Secondly, the material has to go through an evaluation process which involves a confirmation of the technical information gathered in the research. A life cycle assessment (LCA) is an evaluation of the relative "greenness" of building materials and products. LCA addresses the impacts of a product through all of its life stages. Although rather simple in principle, this approach has been difficult and expensive in actual practice. One tool that uses the LCA methodology is BEES (Building for Environmental and Economic Sustainability)

software. It allows users to balance the environmental and economic performance of building products. The last step in making a product officially green is the selection process. This often involves the use of tables and matrices to score the specific environmental criteria. The total score of each product will show the product with the highest environmental attributes.

Green Building Materials

The following matrix is courtesy of the Integrated Waste Management Board. It is a list of green materials from several building projects that placed an emphasis on achieving environmental benefits.

Building Project Notation:

Cal/EPA=California Environmental Protection Agency Headquarters

EEP=East End Project Block 225

FTB=Franchise Tax Board/ Butterfield Project

GAP=Gap Building

PA= State of Pennsylvania

RG=Ridgehaven Building

Comments/Environmental Attributes Notation:

PC= postconsumer

PI= postindustrial (secondary material)

RC= total recycled content

Product Category (organized by CSI MasterFormat Divisions)	Product Type	Recycled content levels adopted for each project	Comments / Environmental Attributes	Product availability
CSI Division: 01: General Requirements				
CSI Division: 02: Site Construction				
Asphalt concrete pavement/ Rubberized asphalt concrete (RAC)		EEP: 14%	RAC ~ Requires less material for overlay (typically 2" for RAC vs. 4" for standard AC), longer lasting product, reduces braking distance and decreases noise from tires and creates a market for used tires.	CIWMB sources: <ul style="list-style-type: none"> • http://www.ciwmb.ca.gov/Tires/Products/ • www.ciwmb.ca.gov/RCP/ (search for asphalt, concrete) This material is a locally available from Sacramento-based asphalt batch plants, including Granite Construction Company.
Portland Cement Concrete	Pavement and Flatwork	EEP: 25%	Up to 25% of fly ash replaced some Portland cement. Fly ash has less embodied energy than Portland cement and creates a superior product by reducing water permeability.	EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.
Reclaimed paving materials	Pavement		100% RC Reclaimed paving materials reduce demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	Cal Trans Standard Special Provisions allow up to 100% reclaimed paving materials for aggregate subbase and base. <ul style="list-style-type: none"> • Cal Trans Standard Special Provisions
Walk, Road, and Parking Appurtenances	Wheel Stops and Speed Bumps: Plastic and/or Rubber	EEP: Parking Bumpers: 30-35% PC 65-70% PI Speed Bumps: 96-100%	100% RC ^[5] PC & RC plastic/rubber make efficient use of existing feedstock and helps create a market for recycled plastic, while decreasing demand for nonrenewable virgin resources.	CIWMB sources: <ul style="list-style-type: none"> • www.ciwmb.ca.gov/TireRecycling/Products/ProdList.htm • www.ciwmb.ca.gov/RCP/ (many listed) EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.
Walk, Road, and Parking	Wheel stops:		Generally, 20 to 30% RC, but could be	EPA's research shows that

Appurtenances	Concrete containing coal fly ash		up to 40%. 15% when used as a partial cement replacement as an admixture in concrete.[6] Fly ash has less embodied energy than Portland cement and creates a superior product by reducing water permeability.	the items are of high quality, widely available, and cost-competitive with virgin products.
Walk, Road, and Parking Appurtenances	Wheel stops: Concrete containing? ground granulated blast furnace slag		25-70% RC[7] Granulated blast furnace slag has less embodied energy than the Portland cement, which it replaces a portion of.	EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.
Porous paving products			Recommend conducting research on these products for possible inclusion on projects. Porous paving products help reduce storm water runoff and increase infiltration rates resulting in groundwater recharge.	There are several porous paving products listed in www.OIKOS.com with up to 100% recycled content (search under products by CSI code).
Bike Racks			Recommend conducting research on these products for possible inclusion on projects. Bike racks accommodate alternative modes of transportation, which lead to decreased production of greenhouse gases, and help improve air quality.	There are several bike racks listed in www.OIKOS.com with recycled content (search under products by CSI code).
Outdoor Furniture			Recommend conducting research on these products for possible inclusion on projects. PC & RC furniture decreases pressure on forest resources and is a long lasting, maintenance free (no sanding or painting) alternative to wood.?	There are several outdoor furniture products listed in www.OIKOS.com with recycled content (search under products by CSI code).
Fencing			Recommend conducting research on these products for possible inclusion on projects. PC & RC fencing decreases pressure on forest resources and are a long lasting, maintenance free (no sanding or painting) alternative to wood	There are several fencing products listed in www.OIKOS.com ? with recycled content (search under products by CSI code).
Compost and Mulch	Urban compost[8]and mulch made from grass clippings and landscape trimmings.		Use landscape trimmings and grass to produce compost and mulch and apply on site. Purchase 100% urban compost and mulch as needed. Compost and mulch improve soil quality, act as pesticide free weed suppressant, reduces soil erosion, and decrease evaporative water loses.	Urban compost and mulch is widely available. The City of Sacramento operates a compost facility. The CIWMB maintains a list of compost and mulch producers that can be provided to the landscape contractor or visit this web site:

				www.ciwmb.ca.gov/Orga nics/Products/
Irrigation materials	HDPE or PVC pipe and fittings		Fittings are expected to be more widely available than pipes. Recommend conducting research on these products for possible inclusion on projects.	
Irrigation materials	Rubber and/or plastic soaker hose		60-70% postconsumer ^[9] 100% recycled tire rubber soaker hoses are available. PC & 100% recycled tire hoses decrease demand for virgin petroleum products and require less energy in production than a virgin product. Creates markets for materials typically disposed.	CIWMB sources: www.ciwmb.ca.gov/RCP/ (many listed) www.ciwmb.ca.gov/TireRe cycling/Products/ProdList.htm EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products. Also see attachment "Products manufactured with tire rubber."
Lawn and garden edging	Rubber and/or plastic		30-100% ^[10] Plastic bender board is making up more of market. PC & RC garden edging materials decrease pressure on forest resources and are a long lasting, maintenance free alternative to wood.	Epic Plastics, Richmond, CA. EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.
Tree stakes	Plastic	FTB; 30%	PC & RC tree stakes decrease pressure on forest resources and are a long lasting, maintenance free alternative to wood	Envirosafe Products, Livingston, NJ. Also see resources for plastic lumber.
Site furnishings and trash receptacles	Plastic lumber that can be used in benches, tables, chairs, trashcans, etc. Certified redwood and western red cedar is an option for landscape furnishings as well.	FTB: 90% (plastic) EEP: 90% (plastic slats: benches & trash receptacles)	75% minimum recycled content overall; 50% postconsumer material. ^[11] Many products are available with 100% recycled content. PC & RC furniture decreases pressure on forest resources and is a long lasting, maintenance free (no sanding or painting) alternative to wood. Certified wood products are from timber harvesters that meet a stringent set of environmental criteria that minimize deforestation, habitat destruction, loss of biodiversity, soil erosion and pollutant runoff which result from intensive, noncertified, wood harvesting.	Call 800-243-5790 to order the <i>Recycled Plastic Products Source Book</i> by the American Plastics Council. Some product suppliers are listed at their Web site: www.plastics.org AERT, manufacturer of ChoiceDek (wood/plastic composite) (501)750-1299 Akron, OH BTW Industries, Inc. (888) 685-7570 Earth Care Recycled Plastic Site Furnishings (800) 65-EARTH Eaglebrook Plastics, Inc. (312) 491-2500

				<p>Envirowood (888)357-8392 Hammer's Plastic (800) 338-1438 Phoenix Recycled Plastics (610) 940-1590 The Plastic Lumber Company (800) 886-8990 Plastic Pilings (909) 874-4080 Polywood: structural plastic (800) 915-0043 Trex (800)BUY-TREX Numerous other sources in CIWMB database: www.ciwmb.ca.gov/RCP/</p>
Playground surfaces, running tracks	Plastic or rubber	EEP: 40%	<p>90-100%^[12] CIWMB playground grant program: www.ciwmb.ca.gov/Playgrounds/ PC & RC playground surfaces and running tracks decrease demand for virgin petroleum products and require less energy in production than a similar product made from virgin materials. PC & RC products also create markets for materials that are typically disposed.</p>	<p>CIWMB sources:</p> <ul style="list-style-type: none"> • www.ciwmb.ca.gov/TireRecycling/Products/ProdList.htm • www.ciwmb.ca.gov/RCP/ <p>EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.</p>
CSI Division 03: Concrete				
Concrete reinforcement	Reinforcing Steel	FTB: 60% EEP: 77%	PC & RC steel reduces demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	
Cast-in-place concrete		EEP: 25% & 40%	Fly Ash replaced up to 25% cement content by weight. At concrete used in mat foundations, fly ash replaced up to 40% of cement content by weight	
Precast concrete for nonstructural use. Utilize high level of fly ash		EEP: 25%, high vol. Fly ash 30% in draft RFP	<p>Fly ash has less embodied energy than Portland cement and creates a superior product by reducing water permeability of concrete. www.buildinggreen.com/features/flyash/index.html</p>	<p>Fly ash is not a California waste product, but it is available on the west coast in Washington and Utah. Austin, TX guide www.greenbuilder.com/sourcbook/Flyash.html</p>
High volume fly ash concrete			Fly ash has less embodied energy than Portland cement and creates a superior	

			product by reducing water permeability of concrete. www.buildinggreen.com/features/flyash/index.html King County, Washington Environmental Purchasing Program Fly Ash in Concrete Bulletin #63	
CSI Division 04: Masonry				
Marble		EEP: 31,000 sq. ft. reused	Reused marble reduces demand on nonrenewable virgin resources.	
Brick, Stone, Etc.			Reuse: salvaged materials available. Reused brick and stone makes efficient use of existing materials and reduces demand for virgin resources.	Used red clay brick: Sepulveda Building Materials, Torrance, CA Austin, TX guide: www.greenbuilder.com/sourcbook/EarthMaterials.html
CSI Division 05: Metals				
Structural Steel		FTB: 60% EEP: 90% PC	PC & RC steel reduces demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	No CA manufacturers. 23 manufacturers located out of State.
Light Gauge Steel Framing		Cal/EPA: 28% postconsumer RG: 50% overall recycled content	PC & RC steel reduces demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	8 CA manufacturers, e.g., Angels Metal Systems, California Metal Systems
Metal Decking	Steel Deck	FTB: 25% EEP: 60% PC	PC & RC steel reduces demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	
Aluminum			Recommend conducting research on this material for products to include on projects. PC & RC aluminum reduces demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources. RC & PC aluminum requires less energy in smelting process than virgin aluminum.	
Metal Framing	Cold-formed metal framing	FTB: 25% EEP: 12.8%	25% RC, 16% PC PC & RC steel reduces demand for	10 CA manufacturers

		PC 14.7% PI	virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	
CSI Division 06: Wood and Plastics				
Engineered structural products	Laminated wood chips or strands and finger jointing.		Recommend conducting research on these products for possible inclusion on projects. Engineered wood products use trees more efficiently than traditional products and help reduce demand for virgin timber.	CIWMB sources: www.ciwmb.ca.gov/RCP/ (many listed) Austin, TX guide: www.greenbuilder.com/sourcebook/EngStruct.html
Architectural Woodwork	Lumber and wood products	EEP: 100%	Products from Forest Stewardship Council (FSC) certified sustainably harvested sources. They also meet the indoor air quality tests of the Special Environmental Requirements specification Section 01350 . The FSC is the only 3rd party organization who certifies sustainably harvested wood from environmentally responsible forest management.	
CSI Division 07: Thermal and Moisture Protection				
Building Insulation	Cellulose	RG: 100% PC, recyclable	100% PC cellulose building insulation makes efficient use of existing feedstock and helps create a market for recycled newspaper. Sustainable Building Sourcebook/Austin, TX guide: http://www.greenbuilder.com/sourcebook/Insulation.HTML#CELLULOSE	2 manufacturers located in CA: Greenstone /Louisiana Pacific Company of Benicia, CA BMCA Insulation Products of Ontario, CA.
Building Insulation	Fiberglass Thermal Batts	FTB: 30% RC EEP: 30% RC	Insulation was manufactured without formaldehyde resins.	Johns Manville GridShield Fiberglass Insulation (batt), 25% RC with 18% PC, manufactured in Willows, CA. CertainTeed Corp. InsulSafe FiberGlass Insulation (loose-fill), 30% PC, manufactured in Chowchilla, CA.
Composite Panels	EEP: Aluminum Face Sheet: 75% Standard Polyethylene Core: 6% Extruded Aluminum Trip: 25%			

Between-slab waterproofing		FTB: 25% EEP: 25%		
Below-grade waterproofing		FTB: 25% EEP: 25%		
CSI Division 08: Doors and Windows				
Hollow metal doors and frames		FTB: 25% EEP: 49% RC 18% PC, 31% PI	PC & RC metal doors and frames reduce demand for virgin nonrenewable resources and the environmental degradation commonly associated with the mining of those resources.	13 CA manufacturers
Wood doors		FSC Sustainably Harvested	The FSC is the only 3rd party organization who certifies sustainably harvested wood from environmentally responsible forest management.	
Exterior glass and glazing		FTB: 35%	PC & RC glass decrease demand for virgin materials and require less energy in production than a virgin product. Creates market for materials typically disposed.	Austin, TX guide: www.greenbuilder.com/sourcbook/WindowsDoors.html
Glazed aluminum curtain walls		EEP: 58-75% RC		
CSI Division 09: Finishes				
Gypsum Board	Fiber Gypsum wallboard (FiberBond and VHI (high impact drywall))	FTB: 10% (FiberBond and VHI (high impact drywall)) EEP: 100% recycled paper face, recyclable product RG: 5% postindustrial 100% recycled paper face, recyclable product	Can go with higher recycled content if purchased out of state.	CIWMB sources: www.ciwmb.ca.gov/RCP/ (several listed) Some in CA listed. Only Pabco Gypsum, located in Newark CA, reported using post consumer gypsum for filler material. Other CA based plants are Georgia Pacific of Antioch CA, National Gypsum Company of Richmond CA, and United States Gypsum (USG) of several locations in CA.
Finish Carpentry	Medium density fiberboard, Type I		90% RC, 12% PC Must meet HUD, HPVA, and NPA guidelines on formaldehyde emissions RC & PC fiberboard reduces demand for virgin forest products and helps minimize deforestation, habitat destruction, loss of biodiversity, soil erosion and pollutant runoff which result from intensive, noncertified, wood	CA Manufacturers Pacific MDF Products of Rocklin, CA. Louisiana-Pacific of Oroville CA. Medite Corp. of Medford, OR.

			harvesting.	
Finish Carpentry	Medium density fiberboard, Type III (nonstructural)	RG: 90% preconsumer recycled wood, recyclable	100% PC Must meet HUD, HPVA, and NPA guidelines on formaldehyde emissions RC & PC fiberboard reduces demand for virgin forest products and helps minimize deforestation, habitat destruction, loss of biodiversity, soil erosion and pollutant runoff which result from intensive, noncertified wood harvesting.	CA Manufacturer: Can-Fibre, Riverside, CA. Medite Corporation, Medford, OR. Homasote Company, West Trenton, New Jersey. Wood Recycling, Inc., of Boston, MA.
Finish Carpentry	Particleboard		100% reclaimed wood or agricultural fiber Must meet HUD, HPVA, and NPA guidelines on formaldehyde emissions RC & PC fiberboard reduces demand for virgin forest products and helps minimize deforestation, habitat destruction, loss of biodiversity, soil erosion and pollutant runoff which result from intensive, noncertified wood harvesting.	Willamette Industries, Albany Oregon. Temple-Inland Forest Products of Dibold, Texas. Natural Fibre Board of Minneapolis, MN
Finish Carpentry	Cellulose Honeycomb core (nonstructural panel)		100% PC paper fiber PC cellulose honeycomb core reduce demand for virgin forest products and helps minimize deforestation, habitat destruction, loss of bio-diversity, soil erosion and pollutant runoff which result from intensive, non-certified, wood harvesting.	CA Manufacturer: Gridcore of Long Beach, CA. Bellcomb Technologies of Minneapolis, MN.
Acoustical ceiling tile (ACT)		FTB: 79% EEP: 82% Cal/EPA: 82% PA: 50% PC RG: 10% Post industrial, recyclable	PA specs: http://www.gggc.state.pa.us/building/DGSspecs.doc Must be formaldehyde-free (Section 09510 of RFP for the EEP) Alternatively, eliminate ACT to expose ceiling and reduce material use.	CIWMB sources: www.ciwmb.ca.gov/RCP/ (three listed) No CA manufacturers. Armstrong World Industries of Lancaster PA, Celotex of Tampa Florida. USG mentioned for Cal/EPA building.
Ceiling	Ceiling panes	GAP: 25% from mineral wool and newsprint (newsprint is 50% post consumer)	PC & RC material make efficient use of existing feedstock and helps create a market for recycled newspapers.	
Plastic electrical device wall plates		EEP: 20% in draft RFP	PC & RC material make efficient use of existing feedstock and helps create a market for recycled plastic.	

Telecommunications cabling		EEP: 20% in draft RFP	PC & RC material make efficient use of existing feedstock and helps create a market for recycled plastic.	
Resilient flooring	Rubber flooring	FTB: 5% Cal/EPA: 100%	PC & RC rubber decreases demand for nonrenewable resources while creating a market for recycled rubber.	CIWMB sources: www.ciwmb.ca.gov/RCP/ (many listed, search by CSI code, rather than key word) Austin TX guide: www.greenbuilder.com/sourcbook/FloorCoverings.html
Resilient flooring	Linoleum Sheet Flooring	RG: 10% post industrial, natural and renewable resource	PA specs: http://www.gggc.state.pa.us/building/DGSspecs.doc Linoleum is a renewable resource with significantly longer life than vinyl alternative and is a biodegradable product. For optimal performance, building maintenance professionals should be educated on appropriate cleaning procedures for linoleum.	Austin TX guide: www.greenbuilder.com/sourcbook/FloorCoverings.html
Wood flooring		GAP: maple from certified well-managed forests	Certified wood products are from timber harvesters that meet a stringent set of environmental criteria that minimize deforestation, habitat destruction, loss of biodiversity, soil erosion and pollutant runoff which result from intensive, noncertified wood harvesting.	CIWMB sources: www.ciwmb.ca.gov/RCP/ Austin TX guide: www.greenbuilder.com/sourcbook/Woodfloor.html
Tile flooring		PA: 70% post industrial and PC glass in a ceramic matrix RG: 58%	PC & RC glass decrease demand for virgin materials and require less energy in production than a virgin product. Creates market for materials typically disposed.	Stoneware Tile Company or approved equal in PA specs. Austin TX guide: www.greenbuilder.com/sourcbook/FloorCoverings.html
Carpeting and pad/ Carpeting	Carpeting (and pad) Type I--Integral cushion roll goods or carpet tile	FTB Butterfield project: 50% EEP: 50% RC, 10% PC, 100% Recyclable	50% RC this is an overall minimum content standard that would include both the backing and the yarn. Must meet VOC emission requirements (See Section 09680 of RFP for the EEP) CIWMB recommended 40-45% for the Cal/EPA building. We prefer the higher end of this range. Testing information from Interface, Collins & Aikman, and Milliken, indicate they all meet or beat the 300-microgram standard for VOCs. PC & RC carpet creates markets for	CIWMB sources: www.ciwmb.ca.gov/RCP/ (many listed) No Type I recycled-content commercial carpets are manufactured in CA. CA manufacturers produce residential grade carpet. Produced out of state by: Interface Flooring Systems of LaGrange Georgia, Collins and Aikman of

			recycled materials and some manufacturers will also take back carpet at end of useful life for recycling, reducing disposal costs and preserving landfill space.	Dalton GA, Shaw Carpet of Dalton GA. Milliken, LaGrange, GA has a 100% remanufactured carpet. Austin TX guide: www.greenbuilder.com/sourcebook/FloorCoverings.html
Carpeting	Tiles	RG: 13% postindustrial nylon, reusable, recyclable after useful life GAP (tiles used, recycled content not provided) PA: 100% recyclable Cal/EPA: 52%	PA specs: http://www.gggc.state.pa.us/building/DGSspecs.doc PC & RC carpet tiles create markets for recycled materials and some manufacturers will also take back carpet at end of useful life for recycling, reducing disposal costs and preserving landfill space.	CIWMB sources: www.ciwmb.ca.gov/RCP/ Austin TX guide: www.greenbuilder.com/sourcebook/FloorCoverings.html
Carpeting	Base	RG: 10% post-industrial rubber, recyclable	PI rubber decreases demand for nonrenewable resources while creating a market for recycled rubber.	Austin TX guide: www.greenbuilder.com/sourcebook/FloorCoverings.html
Acoustical Insulation	Fiberglass	EEP: 29% PC, 4% PI	Manufactured without formaldehyde resins.	
Exterior Latex	Exterior latex maintenance paint	FTB: 80% EEP: 80% (in garage areas)	CIWMB sources: www.ciwmb.ca.gov/RCP/ Note: CA PUBLIC CONTRACT CODE SECTION 12170-12171 requires recycled latex paint to contain a minimum of 50% postconsumer paint. If agencies can not find 50% PC paint, they are to buy 10% PC paint. Kelly-Moore is under contract to provide their recycled paint, E-COAT paint, to northern California state facilities. VOC emissions are same as other latex paint. This paint must meet current VOC limits. (See Section 09901 of RFP for the EEP). RC & PC content paints create a market for recycled content material.	Manufacturer located in Northern CA, at least 7 statewide. Austin, TX guide: www.greenbuilder.com/sourcebook/FinishesAdhesives.html
Interior Latex Paint	Interior Latex Maintenance Paint	Cal/EPA: zero VOCs,	To our knowledge, Zero-VOC paints with recycled content are not available.	Manufacturer located in Northern CA (Kelly

		not recycled EEP: zero VOC	Investigating. Specify paints containing 0 g/l VOCs as measured by EPA Reference Test Method 24. Paints shall contain no formaldehyde, perchloroethylene and 1,1,1 trichloroethane. Shall meet or exceed Federal Standard TTP-2846 of 150 scrubs. (See also Section 09901 of RFP for the EEP). Zero VOC paints protect indoor air quality.	Moore: Enviro-Cote) Glidden (Glidden 2000): investigating Sherwin Williams: investigating Frazee-Envirokote: mentioned for Cal/EPA building Glidden Spread 2000: mentioned for Cal/EPA building Benjamin Moore: mentioned for Cal/EPA building Austin, TX guide: www.greenbuilder.com/sourcbook/FinishesAdhesives.html
Ceramic tile	Glass bonded ceramic tile	FTB: 55% EEP: 58% RG: 70% post industrial and PC glass, recyclable	CIWMB sources: www.ciwmb.ca.gov/RCP/ 60% minimum recycled glass content (Terra Green). Trying to verify if other companies make recycled ceramic tile and the recycled content levels. PC & RC glass bonded ceramic tile decrease demand for virgin materials and require less energy to produce than a virgin product. Creates market for existing feedstock.	No CA manufacturers located. Only 2 manufacturers located nationwide--Daltile Corporation of Dallas, Texas and? TerraGreen Ceramics of Richmond, IN
Loading dock bumpers		FTB: 100% RC EEP: 100% PC	PC & RC material make efficient use of existing feedstock and helps create a market for recycled plastic, and decreases demand for nonrenewable virgin resources.	
Countertops		RG: 10% post industrial recycled acrylic content, recyclable GAP: 41% post industrial and PC, cement based composite.	PC & RC material make efficient use of existing feedstock and helps create a market for recycled materials.	
CSI Division 10: Specialties				
Toilet partitions	Metal	EEP: 20%	16% PC, 20 RC[13] (steel)	EPA's research shows that

		PC, 5% PI	Recommend allowing other materials besides metal.	the items are of high quality, widely available, and cost-competitive with virgin products.
Toilet partitions/ Toilet compartment and screens	Single polymer and/or Comingled plastic	FTB Butterfield Project: 20% RG: 70% preconsumer and post consumer HDPE, no formaldehyde, recyclable. PA: 50% recycled HDPE	20-100% PC[14] PA specs: http://www.gggc.state.pa.us/building/DGSspecs.doc PC & RC plastic make efficient use of existing feedstock and helps create a market for recycled plastic, and decreases demand for nonrenewable virgin resources.	No CA manufacturers. Yemm and Hart of Marquand MO, Laforce Hardware of Green Bay WI, Santana Products of Scranton PA, Comtec Industries of Moosic, PA. EPA's research shows that the items are of high quality, widely available, and cost-competitive with virgin products.
Signs	Plastic	FTB Butterfield Project: 100% RC EEP: 100% RC 60% PI, 40% PC	PC & RC plastic make efficient use of existing feedstock and helps create a market for recycled plastic, and decreases demand for nonrenewable virgin resources.	2 manufacturers located in CA: San Pedro Sign Co, Wilmington, CA; Syndesis, Santa Monica, CA; Out of state includes: Plastic Lumber Co., Akron, OH; Yemm & Hart Green Materials, Marquand, MO.
Signs	Biofiber	Cal/EPA: 100%	PC & RC material make efficient use of existing feedstock and helps create a market for recycled materials.	Phenix Biocomposite
Locker Room Benches	Plastic	EEP: 90% PC HDPE		
CSI Division 11: Equipment				
Auditorium Acoustical Fabric Panels		Cal/EPA: 100% recycled beverage bottles	PC & RC plastic make efficient use of existing feedstock and helps create a market for recycled plastic, and decreases demand for nonrenewable virgin resources.	Knoll Frequency
Loading Dock Bumpers	Tire-derived Rubber	EEP: 100% PC		
CSI Division 12: Furnishings				
Auditorium seating		Cal/EPA reconditioned chairs	Reconditioned chairs extend life of existing products, conserving natural resources.	American Seating
Furnishings	Modular Office Furniture Moveable wall	EEP: 40% RC	State of California developed a modular furniture specification that will be published on the website in 2001.	Modular office furniture: 1 manufacturer located in Oakland, CA.

	partition Workstation Components			Moveable wall partitions: No CA manufacturers. Only 1 manufacturer located nationwide-- Iriswall of Solon, OH. PA specs: http://www.gggc.state.pa.us/building/DGSspecs.doc
Furnishings	Modular Systems Furniture Panel Fabric	Cal/EPA: 100%	PC & RC material make efficient use of existing feedstock and helps create a market for recycled materials.	Haworth: Basketweave Collection
Locker benches	Plastic in bench planks	FTB: 50% RC EEP: 90% PC	PC & RC material make efficient use of existing feedstock and helps create a market for recycled materials.	
Building Recycling Containers	Plastic	Cal/EPA: 100%	PC & RC plastic make efficient use of existing feedstock and helps create a market for recycled plastic, while decreasing demand for nonrenewable virgin resources.	
Floor Mats and Frames	Stainless steel entrance grates	EEP	Used to reduce pollutants from entering building.	

CSI Division 13: Special Construction

CSI Division 14: Conveying Systems

CSI Division 15: Mechanical

Access flooring system	Underfloor air plenum system	PA: in specifications GAP: payback period is 3 years EEP, Block 225: 30% PC raised floor panels 20% RC, 3% PC cement fill 20% PC raised floor pedestals	The inherent efficiency of underfloor air supply systems provides energy savings relative to standard overhead air delivery systems. Higher energy efficiency is attributed to the fact that chillers can be operated at higher temperatures and chilled air is restricted only to occupied space. These systems also do a better job of removing indoor air contaminants compared to overhead supply air systems that tend to mix the indoor air. Stale, contaminated air is gradually displaced in underfloor systems, which leads to a more thermally comfortable indoor environment for building occupants. Lastly, underfloor air systems promote ease in reconfiguring space during building renovation and remodeling. This can lead to more resource efficient buildings and reduced construction & demolition (C&D) waste generation.	http://www.gggc.state.pa.us/building/DGSspecs.doc for copy of PA specs
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Greywater Recycling			Greywater recycling maximizes usefulness of water and decreases demands placed on local wastewater treatment plants.	There are several grey water irrigation products listed in www.OIKOS.com that have recycled content (search under products by CSI code).
CSI Division 16: Electrical				
Other				
Corrugated packaging	Corrugated Packaging	EEP	At least 30% total recycled content, at least 10% postconsumer. This excludes specialty containers that can't support recycled content (e.g., wet strength container board) ^[15] This goal should be very achievable. The average recycled content is about 40%. 25% ^[16] Postconsumer is the low end of EPA's range guidelines. PC & RC corrugated cardboard make efficient use of existing feedstock and helps create a market for recycled fiber while decreasing demand for virgin resources.	Products are widely available; the Fibre Box Association indicates that 95% of boxes have 25% recycled content.

Footnotes

¹ Dept. of General Services, State of California, "Sustainable Design Measures." This is a section in the Request for Proposal for the Capitol Area East End Project, July 15, 1999.

² Swinerton & Walberg, "Environmental Green Construction." Handout provided at tour of Gap Building, November 1999.

³ Dept. of General Services, State of Pennsylvania, "Green Buildings, Model Green Office Leasing Specifications." Commonwealth of Pennsylvania. Specification downloadable from Web site: www.gggc.state.pa.us, June 22, 1999.

⁴ Lynn M. Froeschle, CSI, AIA, "Environmental Assessment and Specification of Green Building Materials." Article downloadable from Web site: www.csinet.org/xp/p-cs/l-current/a-940367539/article.view#sub2, November 12, 1999.

⁵ 1997 Buy Recycled Series, Transportation Products, U.S. EPA, EPA530-F-97-036, November 1997, pg. 3.

⁶ Ibid.

⁷ Ibid.

⁸ Urban compost/mulch is derived from green materials diverted from landfill disposal. It includes residential yard trimmings, commercial landscape trimmings and tree prunings.

⁹ 1997 Buy Recycled Series, Landscaping Products, U.S. EPA, EPA530-F-97-034, November 1997, pg. 3.

¹⁰ Ibid.

¹¹ King County Environmental Purchasing Program, www.metrokc.gov/procure/green/plastic.htm#4, May 11, 1999. This Web site has sample specifications.

¹² 1997 Buy Recycled Series, Park and Recreation Products, U.S. EPA, EPA530-F-97-032, November 1997, pg. 3.

¹³ 1997 Buy Recycled Series, Construction Products, US EPA, EPA530-F-97-035, November 1997, pg. 5. To make it easier to buy recycled, the U.S. Environmental Protection Agency (U.S. EPA) updates the Comprehensive Procurement Guidelines (CPG) each year. Through the CPG, U.S. EPA designates items that must contain recycled content when purchased by federal, state, and local agencies or by government contractors using appropriated federal funds. U.S. EPA's research shows that the items designated in the CPG are of high quality, widely available, and cost-competitive with virgin products. EPA also issues a nonregulatory companion piece--the *Recovered Materials Advisory Notice (RMAN)* that recommends levels of recycled content for these items.

¹⁴ Ibid.

¹⁵ Mary Opfer, Fibre Box Association, personal communication, May 12, 1999, (847) 364-9638.

¹⁶ 1998 Buy Recycled Series, Paper Products, U.S. EPA, EPA530-F-98-012, November 1997, pg. 5.

RESOURCES

Green Design and Construction. <http://www.ciwmb.ca.gov/GreenBuilding/>

Building with reclaimed components and materials : A Design Handbook for Reuse and Recycling

By William Addis

Strategies for Sustainable Architecture

By Paola Sassi

Sustainable Construction: Green Building Design and Delivery

By Charles Kibert

Leadership in Energy and Environmental Design. <http://www.usgbc.org/LEED/>