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Green Buildings – New Services and Products from Market Transformation



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Basic Statistics

- **Construction expenditures ~\$5 trillion per year worldwide (New and Renovation/rehabilitation)**
 - US construction expenditures
 - ~\$1.1 trillion in 2007
 - ~8% GDP (US Census, 2007)
 - China construction expenditures
 - ~\$0.6 trillion in 2007
 - ~7% of GDP (State Statistics Bureau)
- **US building construction expenditures ~ 75% of total**
 - Residential ~ \$450 mil in 2007
 - Other building ~ \$374 mil in 2007



Sustainability and Buildings

“Buildings account for more than 40% of US energy use..[and] produce 40% of atmospheric emissions...”

Resource Use	Share of Total (%)	Pollution Emissions	Share of Total (%)
Raw Materials	30%	Atmospheric	40%
Energy Use	42%	Water effluents	20%
Water Use	25%	Solid Waste	25%
Land	12%	Other releases	13%

Source: National Research Council, “Green Schools: Attributes for Health and Learning”, 2007.



Sustainability and The Quality of the Built Environment

“It is estimated that Americans spend more than 85% of their time indoors...The quality of indoor environments – levels of indoor contaminants {...}, temperature and humidity, lighting, noise level, furniture and equipment design – can influence a person’s health, comfort, and ability to perform his or her job, to learn, to heal.”

Federal Facilities Council, “Implementing Health-Protective Features and Practices in Buildings”, 2005.



Attributes of Green/Healthy Buildings

- **Sensitive to Natural Environment**
- **Effective with resources, including water, energy, and material**
- **Contribution to community**
- **Durable and Dry (avoid accumulation of excessive moisture)**
- **Comfortable, in air quality and temperature**
- **Quiet with improved acoustical quality**
- **Well-lit, with adequate natural and artificial light**
- **Well-maintained in surfaces and systems**



Sources: National Research Council, "Green Schools: Attributes for Health and Learning", 2007; The Center for Health Design, "Designing the 21st Century Hospital", 2006.

Expected Benefits From Sustainable Buildings (USGBC)

Environmental benefits:

- * Enhance and protect ecosystems and biodiversity
- * Improve air and water quality
- * Reduce solid waste
- * Conserve natural resources

Economic benefits:

- * Reduce operating costs
- * Enhance asset value and profits
- Improve employee productivity and satisfaction
- * Optimize life-cycle economic performance

Health and community benefits:

- * Improve air, thermal, and acoustic environments
- * Enhance occupant comfort and health
- * Minimize strain on local infrastructure
- * Contribute to overall quality of life



Examples of Benefits Accruing From Sustainable Buildings

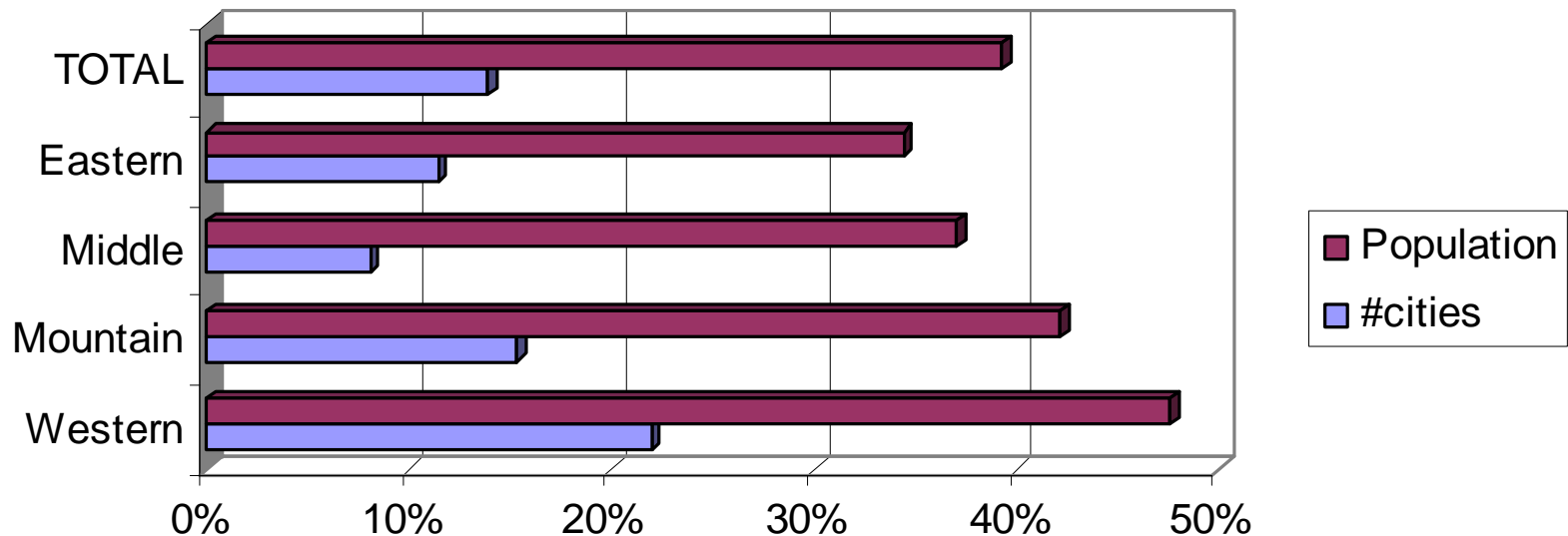
- “Good landscaping aesthetics and large shade trees add an average of **7% to rental rates.**” (FiBRE, “Financing and valuing sustainable property,” 2007)
- Over **50% cost savings** (per s.f.) from reductions in O&M costs for waste removal, cleaning supplies and labor, electricity, air filters, water, landscaping (Sheehy, “Lessons Learned: Costs and Benefits of High Performance Buildings”, 2006, p. 95)
- “Performance of simulated office work was **increased 6-9%** by the removal of common indoor sources of air pollution [...] while increasing the clean air ventilation rate.” (NRC, “Green Schools,” 2007, p. 64.)
- **14-17% ROI** from energy use reductions, and 5-17% from water, sewer and stormwater reduction on new university building at Portland State University (Gregory, “Lessons Learned: Costs and Benefits of High Performance Buildings”, 2006, p. 111)



Trends in Green Buildings

- ~2% of all Buildings are “Green” (USGBC, McGraw-Hill, 2006)
- Expected: 82% of US corporations will green at least 16% of their building portfolios by 2009 (McGraw-Hill, 2007)
- Growth in City Government Green Programs

Percent of Population (Cities) with Green Building Programs



Source: AIA, “Local Leaders in Sustainability”, Nov 2007

Green Buildings – Rating Systems

- **US Green Building Council**
(www.usgbc.org) **LEED**
(Leadership in Energy and Environmental Design)
 - Types:
 - New Buildings
 - Existing Buildings
 - Quantity
 - Single Building
 - Multiple Buildings
- **UK BREEAM**
(www.breeam.org)
- **Australia Green Star**
(www.gbcaus.org)



Rate Your Home

(Based on LEED for Homes Pilot and Green Guide for Health Care 2.1 Pilot)

Certified: 30-49 Silver: 50-69 Gold: 70-89 Platinum: 90-137	Category	Maximum Points	Immediate Points Improvement	Mid-term Points Improvement
	Location and Linkages	10		
	Sustainable Site	14	7	7
	Water Efficiency	12	1	10
	Indoor Environmental Quality	24	1	1
	Materials and Resources	25	10	3
	Energy and Atmosphere	45		6
	Homeowner Awareness	3	2	
	Innovation and Design	4	4	
	TOTAL	137	25	27

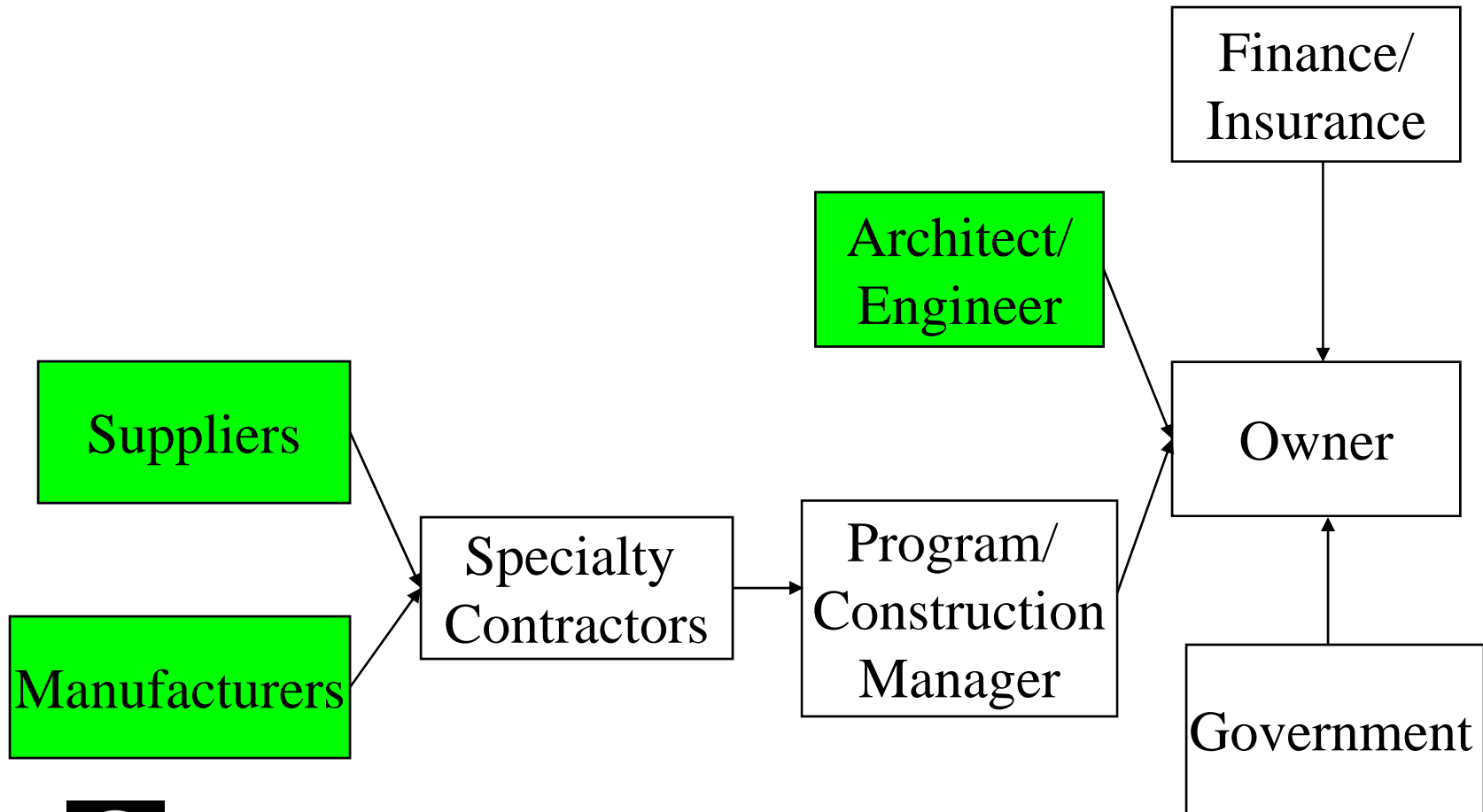


Immediate and Mid-Term Improvements in Your Home

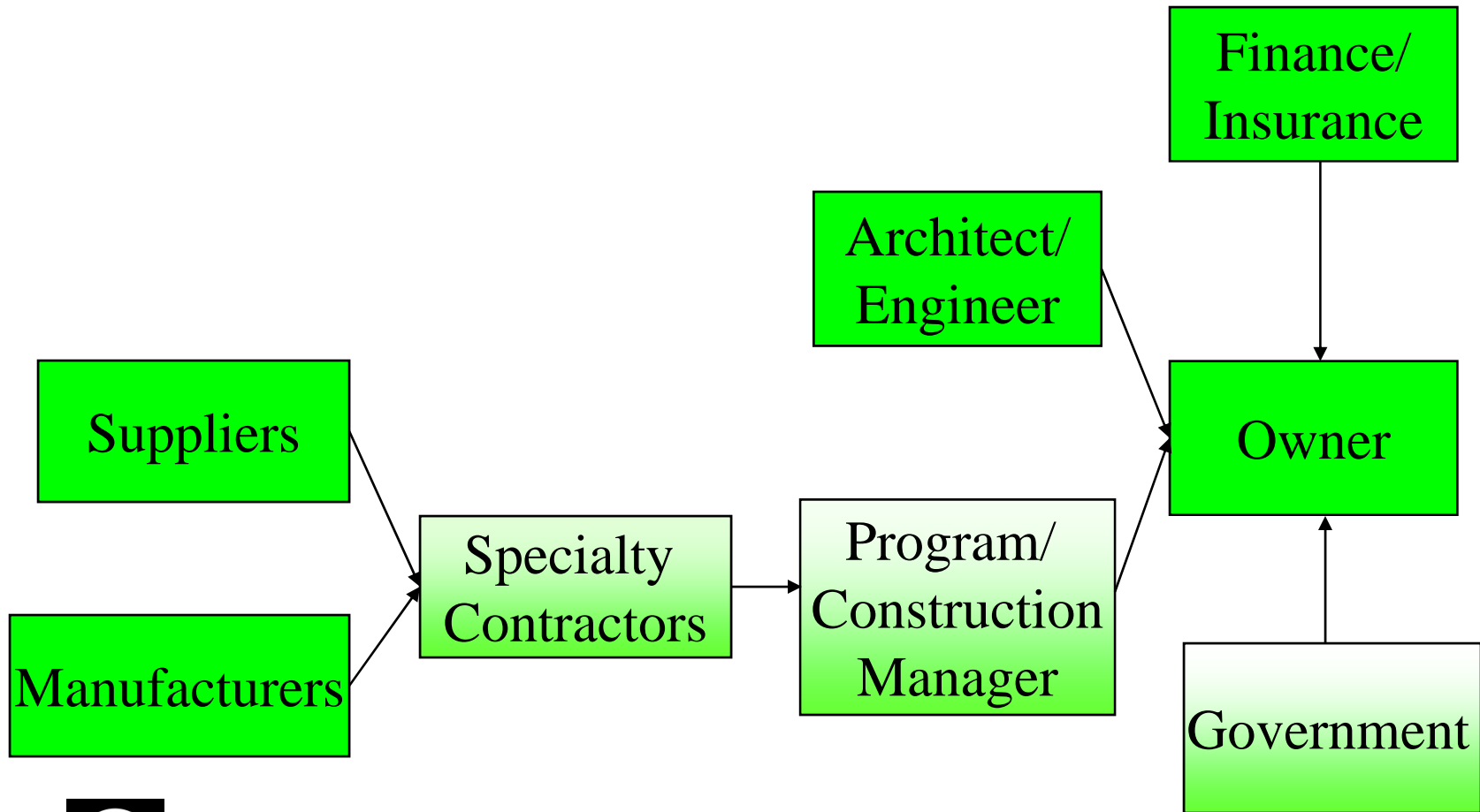
3 to 4 Inches of Mulch Applied Around Plants	1
Limited Turf or Lawn	3
Minimum Landscape Water Demand	2
Trees to Shade Hardscapes	1
Permeable Paving Materials	3
Minimal Soil Runoff From Rain	2
Use Alternative Insect and Pest Controls	2
Rainwater Harvesting System	1
High Efficiency Irrigation System	3
Rain Sensing Controls	1
High Efficiency Fixtures (Toilets, Showers, and Faucets)	3
Very High Efficiency Fixtures (Toilets, Showers, and Faucets)	6
Timer / Automatic Controls for Bathroom Exhaust Fans	1
Permanent Walk-Off Mats OR Central Vacuum	1
CONSUMABLES PRODUCED WITHIN 500 MILES	3
Third-Party Verification of Implementation of Durability Plan	3
Environmentally Preferable Cleaning Products	4
TOTAL WASTE REDUCTION 15%	1
TOTAL WASTE REDUCTION 25%	2
TOTAL WASTE REDUCTION 35%	3
Energy Efficient Fixtures and Controls	1
ENERGY STAR Advanced Lighting Package	3
High Efficiency Appliances (Refrigerator, Stove, Dishwasher, etc.)	2
Very Efficient Clothes Washer (MEF > 1.8, AND WF < 5.5)	1
Avoided CFCs - to Minimize Ozone Depletion and Global Warming Contributor	1
FOOD ORGANIC OR SUSTAINABLE	1
LOW Volatile Organic Compounds (VOC) FURNISHINGS (RUGS, FURNITUR	1
Innovative design, components, materials, processes - up to 4 points	4



Value Chain for Buildings: Green Transformation



Value Chain for Buildings: Green Transformation



New Green Building Services

- **Finance**
 - Green Building Financing Services (e.g. Bank of America)
 - Green Building Insurance Services (e.g. Fireman's Fund)
 - Green REITs (e.g. Revival Fund Management)



New Green Building Services

- **Design**
 - Green Building Special Design (e.g. Energy Smiths)
 - Green Building Modeling (e.g. Whole Building Design Guide – Tools, <http://www.wbdg.org/tools/tools.php>)



New Green Building Services

- **Construction**
 - Green Construction Management (e.g., CH2MHill)
 - Waste Management (e.g. Gypsum Recycling Internt'l)
 - Commissioning (e.g. Building Commissioning Assoc)



New Green Building Services (cont'd)

- **Operations**
 - Post-occupancy evaluations
 - Occupancy sensors and controls (e.g. Aircuity)
 - Energy Service Companies (ESCO) (e.g. Natl Assoc of ESCO)
 - Reliability-Centered Maintenance (e.g. Trane Corp)
 - Remote Operations Monitoring and Control (e.g. Johnson Controls and **Gridlogix**)
 - Green cleaning (e.g. Seventh Generation)
 - Integrated pest management



New Sloan Building (E62) Sustainable Design Elements

Expected to qualify for a “LEED Silver” or higher rating.

- **Lighting at an average energy use below 1 watt per square foot (sq.ft.),**
- **Cooling at over 700 sq.ft. per ton,**
- **Heating at about 10 BTUH/sq.ft.,**
- **Control of heat gain by high performance glazing supplemented by motor-operated window shading in critical application**
- **Occupancy sensing and demand-based ventilation**



New Sloan Building (E62)

Sustainable Design Elements

- **Careful sizing of pumps and fans to reduce parasitic loads.**
- **Operable windows**
- **Individual space temperature control.**
- **Water-based terminal units like chilled beams and radiant panels**
- **Partial “Green” roof**
- **Potential: Photovoltaic panels**
- **Diverted demolition and construction waste**



New Green Building Product: Green Roofs

- Soil layer with shallow root plants captures rainwater and reduces runoff
- Lowers roof (and building) temperature, lowering cooling loads

New Green Building Product: Chilled Beams

- **Chilled tubes circulate cold water**
- **As hot air rises, it hits the tubes, cools, and falls**
- **Expected energy savings: 20-50%**
- **Potential cost reduction: 10%+ (compared to VAV)**
- **Higher air quality and comfort**

New Green Building Product: Building Integrated PV

- **Translucent glass with PV elements allows light into building and generates electricity**
- **3.9 peak watts per square foot (ASI Glass Solar Modules for Building Integrated Photovoltaics, Schott, Elmsford, NY)**



New Green Building Product: Permeable Paving

- **Provide storm water absorption into groundwater**
- **Reduces storm water runoff**
- **Can be made with recycled materials (asphalt, concrete, plastic)**

New Green Building Product: Bamboo Flooring

- Rapidly renewable
- Nontoxic in fabrication
- Easily cleaned
- Durable

New Green Building Product: Grey Water Capture and Re-Use

- **Captures gray water from showers, sinks, washing machines, and cleans it for re-use for toilets or landscape**
- **Reduces water use by 35-40%**



New Green Building Product: Aerated Concrete Blocks

- **Autoclaved aerated concrete blocks**
- **Uses sterile mine tailings**
- **High insulative value**
- **Easy to stack**

New Green Building Product: Moisture and Insulative Wrap

- **Lightweight structural sheathing panels**
- **100% recycled cardboard and aluminum-foil facings.**
- **Pressure-laminated with a special water-resistant, nontoxic adhesive.**



Steps to Improve Built Environment

- **Inventory building(s) in resource use (e.g., energy, water, solid waste), performance, and condition (deterioration, change in use)**
- **Reduce => Eliminate waste**
- **Increase resource use efficiency**
- **Replace resource use where possible**
- **Upgrade to enhance attributes of healthy buildings**
- **Monitor performance**
- **Continually upgrade operations and building(s) to meet objectives**

Resources

- **Building Green (www.buildinggreen.com, available thru MIT Libraries)**
- **National Research Council, “Green Schools: Attributes for Health and Learning,” National Academies Press, 2007.**
- **Federal Facilities Council, “Implementing Health-Protective Features and Practices in Buildings,” National Academies Press, 2005.**
- **The Center for Health Design, “Designing the 21st Century Hospital: Environmental Leadership for Healthier Patients and Facilities,” Center for Health Design, 2006.**
- **Andrea Putman and Michael Philips, “The Business Case for Renewable Energy: A Guide for Colleges and Universities,” APPA, 2006**
- **Earth Day New York, “Lessons Learned: The Costs and Benefits of High Performance Buildings,” Earth Day New York, 2006**
- **McGraw-Hill, “Education: Green Building Smart Market Report,” McGraw-Hill, 2007.**

