Economic Benefits of Green Building Design and Construction

A primer for government decision makers
Economic Benefits of Green Building Design and Construction

A primer for builders and project managers
Why “Green” Building?

• **Purpose:** To enhance a building’s overall performance while improving comfort; indoor air; energy, water and materials efficiency; and the bottom line.

• **Buildings use or produce:**
  - 30% of total energy use
  - 60% of electricity
  - Billions of gallons of water daily
  - 30% of solid waste generated
Economic Factors

- **First Costs/Savings** = costs and savings from incorporating green features into a building

- **Life-Cycle Costs/Savings** = costs/savings over a building’s or feature’s useful life

- Relative costs components of a commercial building over 30 years
  - Design & building = 2%
  - Operations, maintenance, finance & employees = 98%
  - Key point: more should be spent on better design
First Costs of green buildings: will vary significantly depending on the specific project goals.

While there are many significant benefits that are ‘no additional cost’ (e.g., South facing windows), some features will cost more in both design and materials costs.

Estimates for additional first cost are as low as 0-3%, for LEED™ Certified, to 10% or more for higher LEED™ ratings.

Existing incentives aimed at offsetting additional first costs range from 3% (Federal Office of General Services and California DGS) to 6% (NY State tax credit).
Economic Factors

- Life-Cycle Savings from:
  - Energy & Lighting Efficiency
  - Water Efficiency
  - Materials Efficiency
  - Employee Productivity
  - Employee Health
  - Construction & Debris Recycling
Energy Efficiency & Lighting

- Energy savings up to 80%
- Sources of Savings:
  - Lighting
  - Windows
  - HVAC Systems
- Efficient lighting & better windows can lead to smaller and less costly HVAC system
Energy Efficiency & Lighting

- Energy savings from efficient lighting:
  - Payback period can be < 2 years
  - Average investment return 50-80%

- Energy efficient buildings
  - Investment return usually 20-40%
  - Higher property asset value
Energy Efficiency & Lighting

Example: US Postal Service, Rodeo, CA

• Total lighting load ↓ 71%
• ↓ in both ambient and task lighting
Energy Efficiency & Lighting

Example: Energy Efficient Windows
Can decrease heating costs by 40%

*Compared to the same 2000 sq. ft. house with clear single glazing in an aluminum frame.
Energy Efficiency & Lighting

Example: Energy Efficient Windows
Can decrease cooling costs by 32%

[Graph showing annual cooling energy cost for different window types with bars indicating 5%, 9%, and 32% less cost compared to single clear aluminum frame.]
Energy Efficiency & Lighting

Example: Schools

- Spend more than $6 billion annually on energy
- DOE estimates possible 25% savings through:
  - Energy efficiency
  - Renewable energy technologies
  - Improved building design
- Daylit schools vs. non-daylit schools:
  - 22%-64% energy cost reductions
  - Payback for new daylit schools < 3 years
  - Increase in student performance
Water Efficiency

- **Water savings from:**
  - Water-efficient fixtures and appliances
  - Water-efficient landscaping
  - Rainwater collection systems

- **Benefits include:**
  - ↓ water bills
  - ↓ volumes of wastewater
  - ↓ energy costs for hot water
Water Efficiency

Example: Municipal Plumbing Incentive Programs

• New York City Toilet Rebate Program
  - Water demand ↓ 50-80 million gallons/day
  - Wastewater flow ↓ 7%
  - $393 million investment
  - $605 million saved from deferral of expansion projects

• Santa Monica, CA Toilet Replacement Program
  - 15% ↓ in average total water demand
  - 20% ↓ in average total wastewater flow
Water Efficiency

**Example: Water-Efficient Landscaping**

- **Denver, CO**
  - Low water landscaping cost = 1/2 standard irrigation
  - Almost eliminates water use in lawns
  - Also saves labor, fertilizer, herbicides & fuel

- **Palm Desert, CA Water-Efficient Median Strips**
  - Well-received by the public
  - 85% ↓ in water & maintenance costs
Water Efficiency

Example: Rainwater Collection System

• Residence -- Austin, TX
  ▶ Rainfall collected from roof
  ▶ 84,000 tank can provide 100 gallons/day
  ▶ Met all 2-person household needs since 1988
  ▶ Worked well during 3-year drought
  ▶ Cost of system < drilling well or connecting to water district
  ▶ Can ↓ fire insurance premiums
Employee Productivity

- Green buildings ↑ worker productivity

- Environmental factors impacting productivity
  - Indoor air quality
  - Climate control
  - Lighting, esp. daylighting
  - “Biophilic” features -- views, plants, etc.
Employee Productivity

Case Study: US Post Office, Reno, NV

- Energy efficient lighting and dropped ceiling
- Cost = $300,000
- Energy savings $22,400/year, payback 13 years

- **Impact on productivity**
  - Sorting errors dropped to 0.1%
  - 8% ↑ in mail sorted per hour
  - Annual productivity gains $400-500K
  - Payback period < 1 year
Employee Productivity

**Case Study: Herman Miller SQA Building**

- 295,000 s.f. office & manufacturing center
  - Extensive daylighting
  - Interior “street” with plants
  - Passive heating & cooling
  - $35,000+ annual energy savings

- Impact on productivity
  - ↑ worker effectiveness and productivity
Employee Productivity

Example: Daylighting & Student Performance

- ↑ Daylighting, windows, skylights
  - 15-25% faster progress on math and reading tests
  - 7-18% higher test scores
- Students in daylit facility for multiple years
  - 14% ↑ on standardized tests
Employee Health

- US EPA ranks indoor air quality (IAQ) as one of top 5 environmental risks to public health.

- Indoor contamination levels can be 25 times as high as outdoors.

- Solutions: eliminate sources and increase ventilation
Employee Health

Factors contributing to poor IAQ

- Inadequate ventilation
- Chemical contaminants from indoor sources
  - VOCs, smoke, other toxics
  - Sources: building materials, cleaning products
- Chemical contaminants from outdoor sources
  - Vehicle & building exhausts thru vents & windows
  - Combustion products from garages
Employee Health

Factors contributing to poor IAQ

- Biological contaminants
  - Bacteria, molds, pollen, & viruses

- Inadequate temperature, humidity & lighting
Employee Health

- **“Sick Building Syndrome”** (SBS)
  - Health & comfort linked to time in building
  - No specific illness or cause identified

- **“Building Related Illness”** (BRI)
  - Symptoms of diagnosable illness identified, (e.g., asthma, upper respiratory infections)
  - Directly linked to airborne building contaminants
Employee Health

World Health Organization says SBS affects

- 1.34 million U.S. office buildings (OSHA)
  - 20 million U.S. workers daily (OSHA)
  - 20-35% of workers in modern buildings (EPA)
  - Costs California about $6 billion annually (LBL)
Employee Health

Healthy buildings can ↓ illness and costs

• Estimated annual productivity ↑ $30 - 150 billion
• 10 - 30% ↓ respiratory diseases
• 20 - 50 ↓ SBS symptoms
• .5 - 5% ↑ office worker performance
• $17 - 43 billion annual health care savings
• $12 - 125 billion direct ↑ in worker productivity
Materials Efficiency

Efficient use of building materials & land

Environmental benefits

- Saves “embodied” energy
- Saves energy & water over life of building
- Use of non-virgin or recycled materials
  - ↓ Depletion of natural resources
  - ↓ Mining & manufacturing pollution
Materials Efficiency

Efficient use of building materials & land

Economic benefits

- ↓ Initial costs
  - “Right-sizing” of infrastructure and mechanical systems
  - Optimum value engineering (OVE)
    - ↓ labor & materials in foundations, framing & finishes
    - ↓ wood in framing 25% without ↓ performance

- ↓ Life-cycle costs
  - ↓ costs for energy & water
  - Durable materials last longer, ↓ costs
Materials Efficiency

Case Studies

- Emeryville, CA affordable housing development
  - Framing at 24” instead of 16”
  - Significant saving on volume of wood used
- 50,000 sq. ft. school
  - Costs of carpet vs. durable floor compared
  - Includes installation, maintenance & replacement costs
  - Over 40 years, durable flooring saves $5.4 million
Scope of the Problem

- 136 million tons of building-related C&D debris (1996)
- 43% from residential sources, 57% non-residential
- Demolition = 48%, renovation = 44%, construction = 8%
- 20 - 30% recovered for processing & recycling
- Most often recycled: concrete, asphalt, metals, wood.
- “Deconstruction” → highest diversion rates (76%)
C & D Debris Recycling

Environmental Benefits

Reuse or recycling (vs. dumping) C & D debris:

- Saves “embodied” energy in materials
- \( \downarrow \) Demand for virgin resources
- \( \downarrow \) Need for limited landfill space
C & D Debris Recycling

Economic Barriers to Increased Recovery

- Cost of collecting, sorting, and processing
- Contamination of recovered materials
- Value of recycled material vs. cost of virgin material
- Low cost of C&D debris landfill disposal (tipping fees)
Economic Benefits of Debris Recovery

- Cost often < hauling and dumping as waste
- Daily pick-up by recycling company
  - Keeps site cleaner
  - ↑ Work efficiency & safety
- ↑ Compliance with landfill disposal reduction ordinances
- Landfill disposal (tipping) fees are increasing
- Revenue from sale of recovered materials
C & D Debris Recycling

Case Study: New Construction - Union City, CA

- Development of 95 large, single-family homes
- Builder worked with recycling subcontractor
- 85% of construction waste recovered and recycled
- 1,000 tons of materials diverted from landfill
C & D Debris Recycling

Case Study: Deconstruction - Riverdale, Maryland

- Disassembly & salvage of common building materials
- 2,000 square foot, 4-unit residential building
- Costs competitive with demolition
- Labor most significant cost
- Minimized soil & vegetation disturbance
C & D Debris Recycling

Case Study: Demolition, Milwaukee County Stadium

- 2,000 truckloads of recyclable debris
- 30,000 tons of concrete crushed on site
- Crushed concrete used as infill at new stadium
- $2 million budgeted for demolition
- Final cost only $800,000
- Recycling of concrete saved $1.2 million
Cost/Benefits of Green Building

- Most benefits now accrue to owners & tenants
- Green practices sometimes \( \uparrow \) cost of building
- State and local policies can
  - \( \downarrow \) Builder/contractor “first costs”
  - Help builders/contractors share in life-cycle savings
“First Cost” Incentives

ESCOs (Energy Services Companies)

- Respond to existing energy price signals, but don’t address integrative approaches
- Construct & monitor energy-efficient systems
- Performance contracting
  - Compensation based on results measured over building life
  - ↑ savings from ↓ energy consumption
  - Minimizes customer risk and initial capital expenditures
“First Cost” Incentives

Local Green Building Incentives

- Expedited ("fast track") permit review for local building permits; environmental features may also address larger permit issues such as CEQA
- ↓ Inspection fees
- Subsidized training in green building practices
- Free professional advice & design assistance
“First Cost” Incentives

Other Local Policy Initiatives

• Fees based on estimated energy use
  ➢ Adjusted for size of building
  ➢ Waived if on-site renewable energy system installed

• Standards and regulations
  ➢ Bigger the building, more green components required
  ➢ Minimum recycled content (in concrete, etc.) required
  ➢ Old-growth wood, high VOC materials prohibited
“First Cost” Incentives

State Green Building Incentives

• Tax credits for developers
  ▶ Environmental performance criteria must be met
  ▶ Approach minimizes state overhead costs

• NY State AB 11006
  ▶ 6% for fuel cells, photovoltaics, non-ozone depleting refrigerants
  ▶ Energy use must be no more than 65% of code

• Portland ‘Green Building Standard’
  ▶ $20,000 per commercial project to help with green design, LEED certification and energy modeling costs
  ▶ $3,000 per residential home
Conclusion

- Demonstrable benefits exist in many projects
- Life cycle benefits must be considered to justify higher first costs
- Expedited permits and tax incentives are straightforward and can be effective when well-designed