NEW YORK CITY COLLEGE OF TECHNOLOGY

CITY TECH

WHERE CAN TECHNOLOGY TAKE YOU?

May 11,2015

Econ 2505 Environmental Economics

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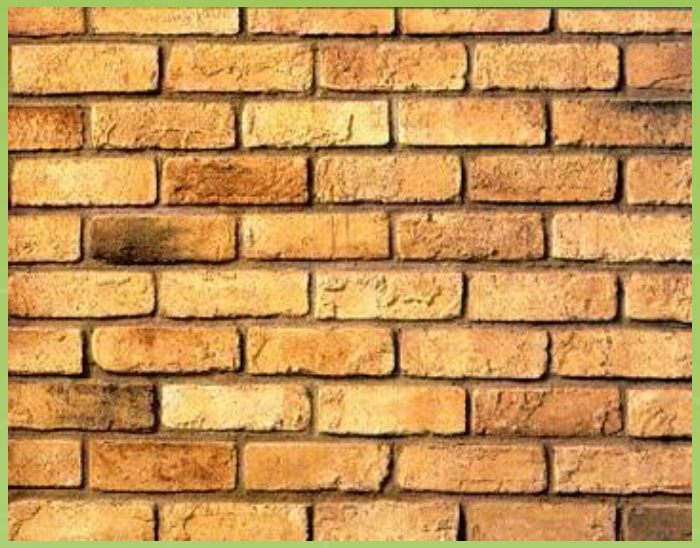
Prof.S.MacDonald



Econ 2505

Topic

BUILDING DESIGN & LAND USE

"LESS IS MORE"

Building Design:

Sustainable Material

1. Resource Consumption
2. Construction & Demo (C&D) Waste
3. Impact of Building Materials
4. Human Health & Safety
5. Life Cycle Assessment
6. Public Health & the Environment
7. Recycled Content
8. Embodied Energy / Carbon
9. What Makes a Material Green?

Renewable Energy

1. Solar

Water:

1. How Do Buildings Use Water?
2. Case study: the solaire

Sustainable Materials: **Impact of Building** Materials

Resource Consumption

Buildings account for:

- 40% of the Virgin Minerals consumed
- 25% of the Virgin Wood consumed
- Significant energy and water use for materials extraction, manufacture
- Significant air, water, and land pollution

Sustainable Materials: Impact of Building Materials

Construction & Demo (C&D) Waste

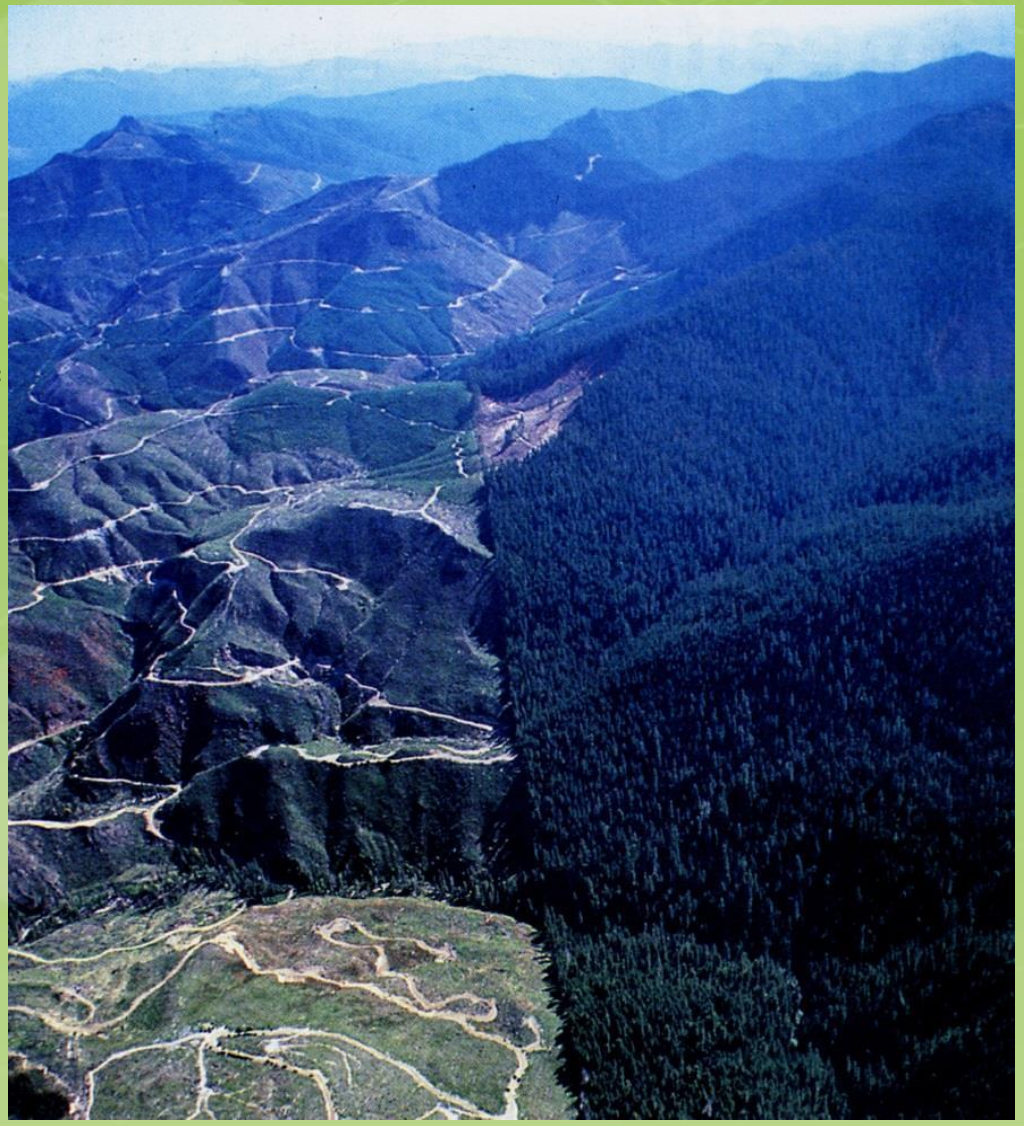
- Represents 40% of total solid waste stream in US
- 60% of the total NYC Waste Stream
- US: generate > 4.5 lbs. waste per person per day

Sustainable Materials: Impact of Building Materials

Resource Consumption

•In the space of just one generation, the earth has lost 30% of its natural wealth of forests, fisheries and biodiversity.

World Wildlife Fund, Living Planet Report 1999



Sustainable Materials: Impact of Building Materials

<u>Human Health & Safety</u>

•Materials impact Indoor Air Quality (IAQ)

-We spend over 90% of our time indoors
-Poor air quality reported in up to 30% of new/renovated bldgs.
-Products “off-gas” emissions of volatile or semi-volatile compounds
-Indoor pollutants can result in eye, skin or respiratory irritation

•Materials affect all humans who come in contact with any part of the process

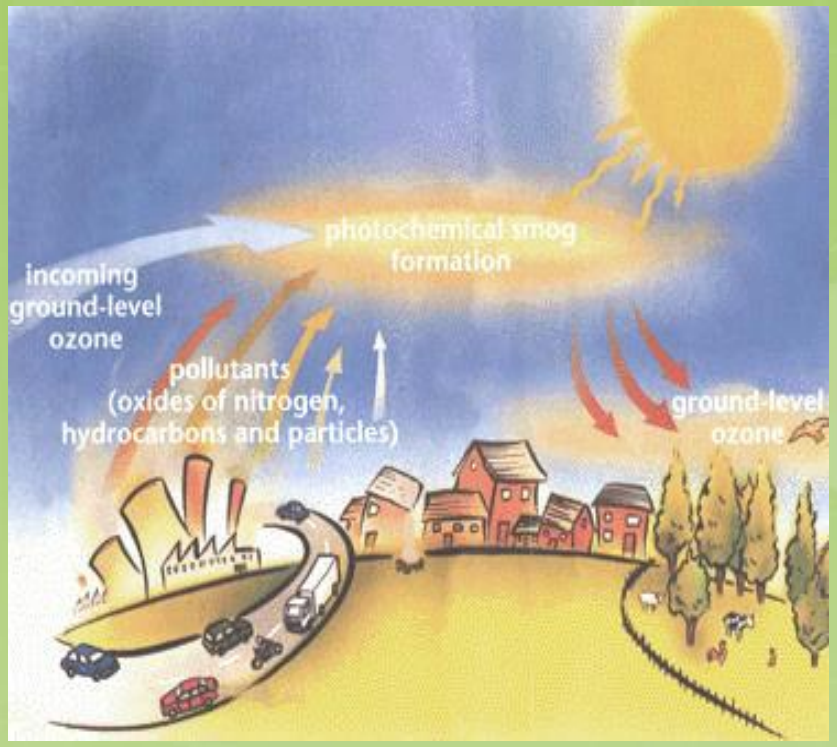
-Occupy the building and community
-Construct the building
-Manufacture the products that go into buildings
-Live in communities that are impacted by raw material extraction, manufacturing, or construction

Sustainable Materials: Impact of Building Materials

Public Health & the Environment

•Products may contain carcinogens, reproductive toxins, or other hazardous substances

•Product emissions can contribute to exterior air pollution



Sustainable Materials: What Makes a Material Green?

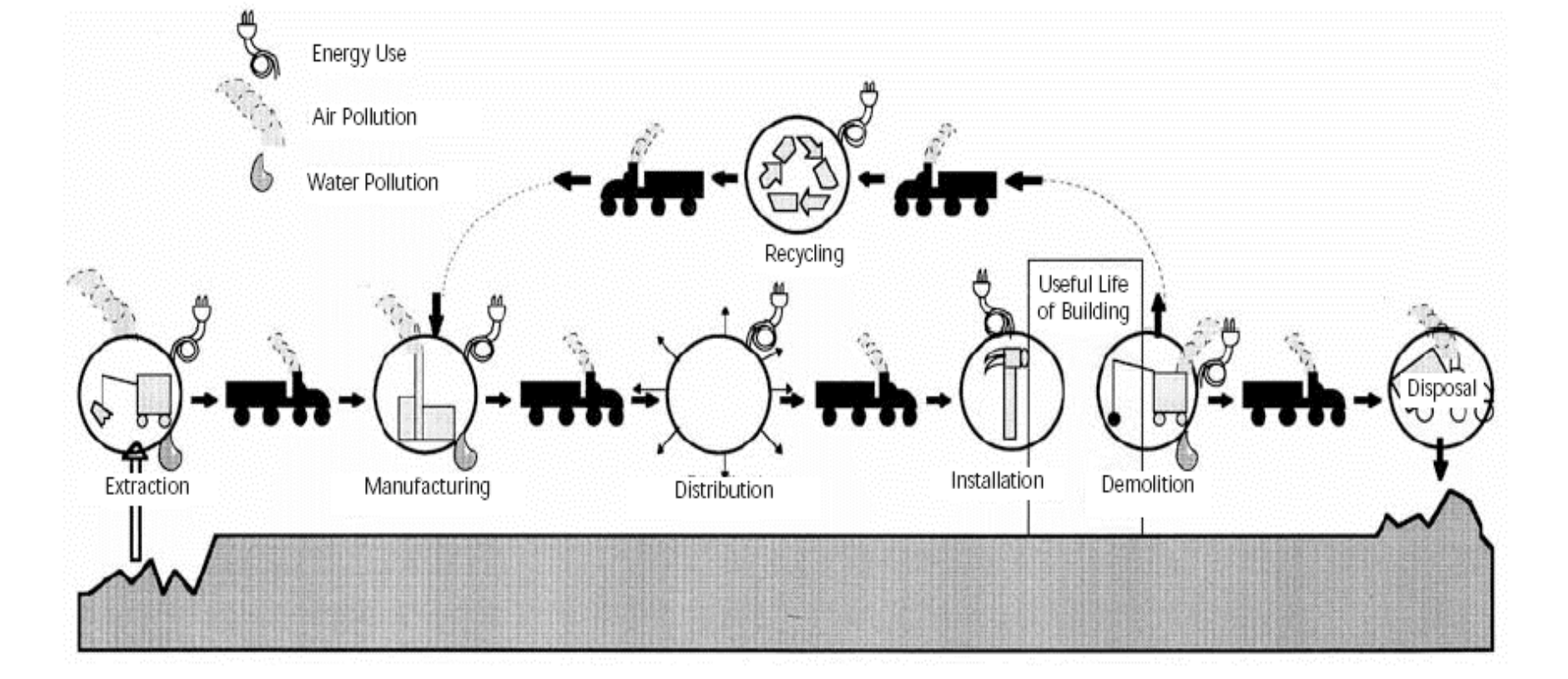
- Exceptionally Durable
- Incorporates recycled content
- Salvaged from buildings for reuse
- Made using natural and/or renewable resources
- Low "embodied energy"
- No highly toxic compounds
- Obtained from local resources and manufacturers
- Sustainable harvesting practices (for wood products)
- Easily reused or recycled
- Biodegradable
- Minimally processed

Sustainable Materials: What Makes a Material Green?

Life Cycle Assessment

•Most green products have specific “green attributes” that separate them from competing products

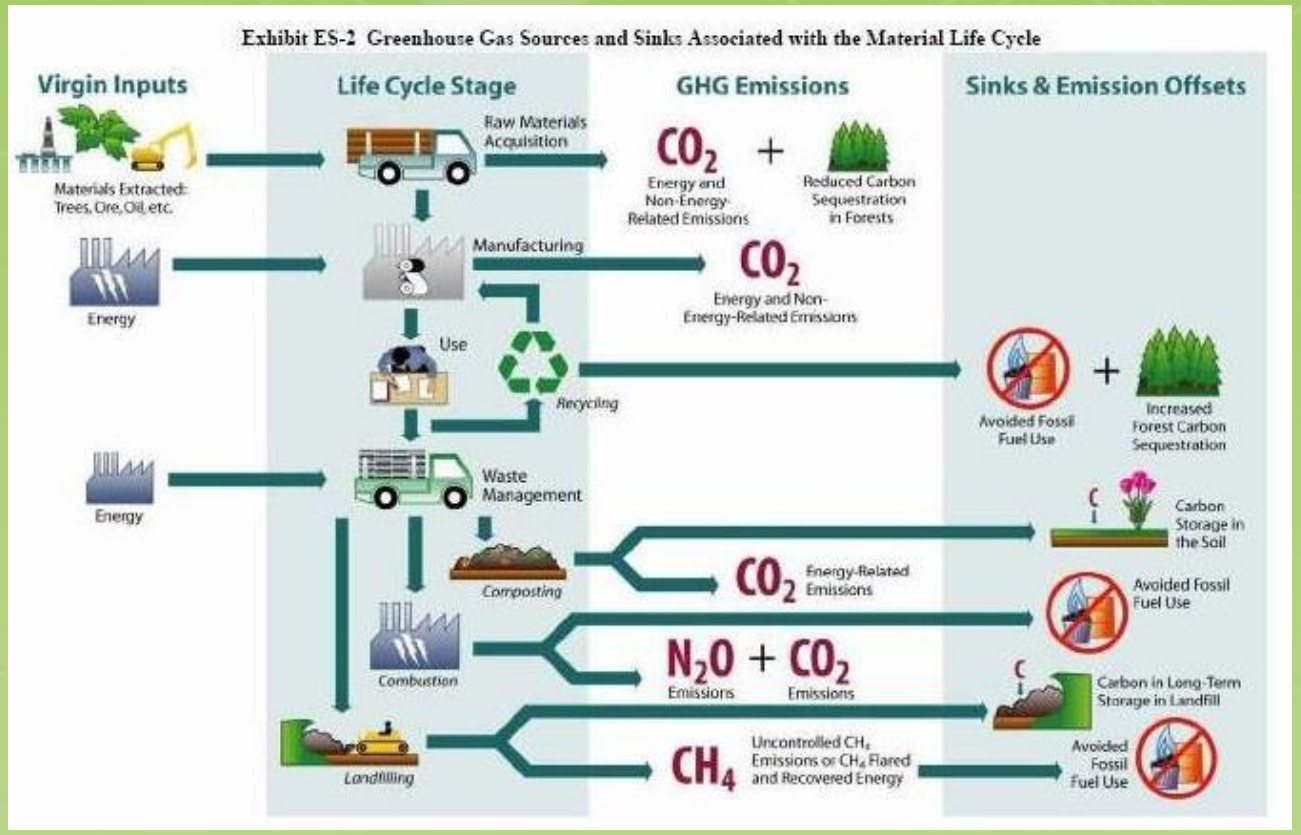
•The “green attributes” are typically defined based on the concept of Life Cycle Assessment



Sustainable Materials: Life Cycle Assessment (LCA)

Life Cycle of a Product
- Raw material extraction
- Material processing, manufacturing
- Transportation to building site
- Installation in a building
- Use
- Repair
- Replacement
- Disposal

Life Cycle of a Building
- Demolition
- Construction
- Use / Operations
- Demolition



Sustainable Materials: Life Cycle Assessment (LCA)

<u>Extraction Phase</u>

•Mining -e.g., bauxite to make aluminum

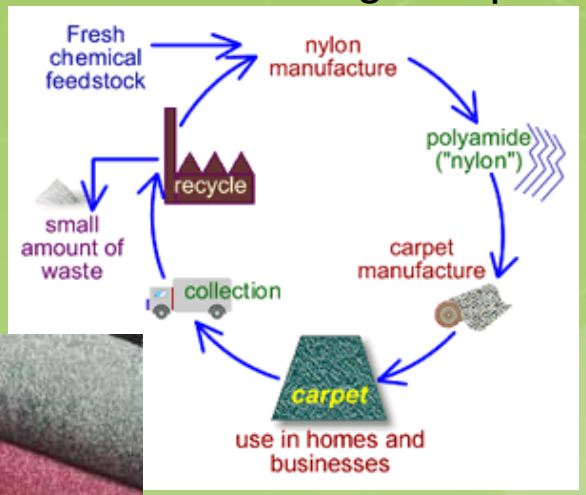
•Logging -wood products

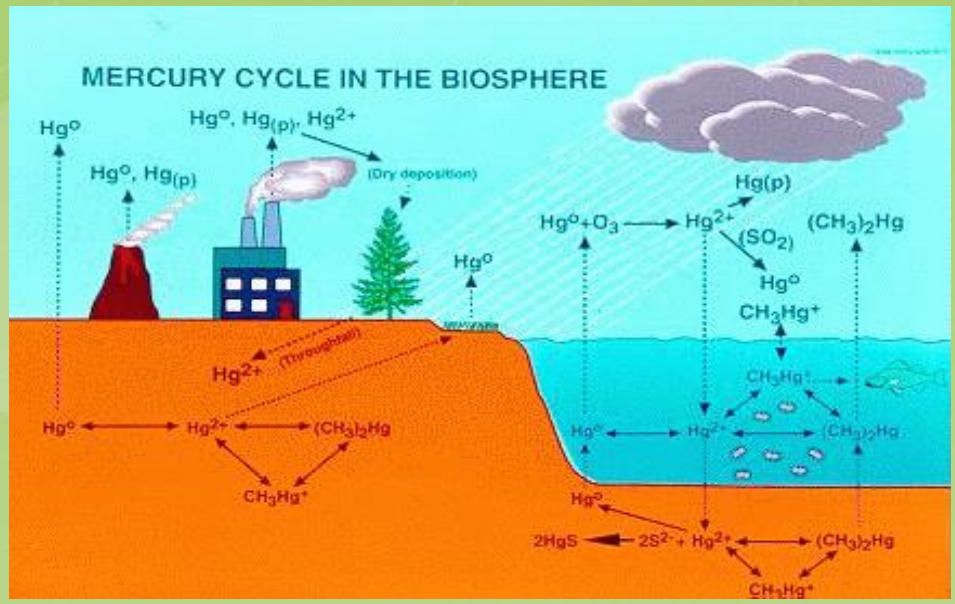
Sustainable Materials: Life Cycle Assessment (LCA)

Disposal Phase

- Toxic ingredients -e.g., fluorescent lamps
- Recycling & reclamation -e.g., carpet industry

Fluorescent lamps





Sustainable Materials: Definitions

Recycled Content Materials

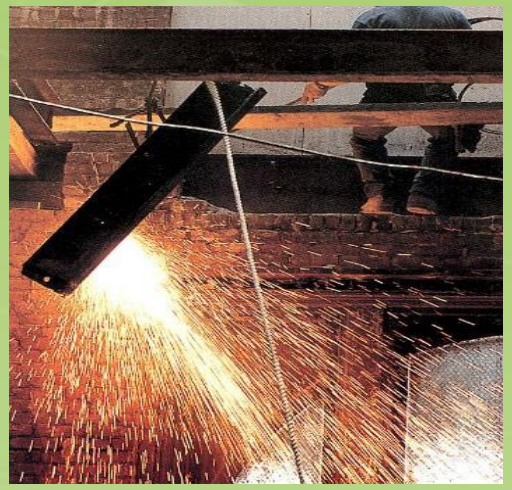
- Products that utilize existing material “waste” streams to replace virgin raw materials

- <u>Products that incorporate</u>:

-Post-consumer recycled materials
-Post-industrial materials
-Recovered materials
-“Recycled content” ≠ “Recyclable”

Carpeting

Recycled Ceramic/Glass Tiles



Steel

Recycled-content Ceiling Tiles

Sustainable Materials: Recycled Content

Steel

- According to Steel Recycling Institute: Each year, more steel is recycled in the US than paper, plastic, aluminum and glass combined.

Secondary Cementious Materials (SCMs)

•Used as replacement for Portland cement in concrete mixes

•Environmental benefit: reduced carbon footprint of concrete (by replacing Portland cement)

Types

•Fly Ash

-Post-industrial waste product from coal power plants

-Environmental benefit: reduced carbon footprint of concrete (by replacing portland cement)

-Environmental concerns: toxicity and disposal

-Performance impacts: slower setting time, but higher ultimate strength

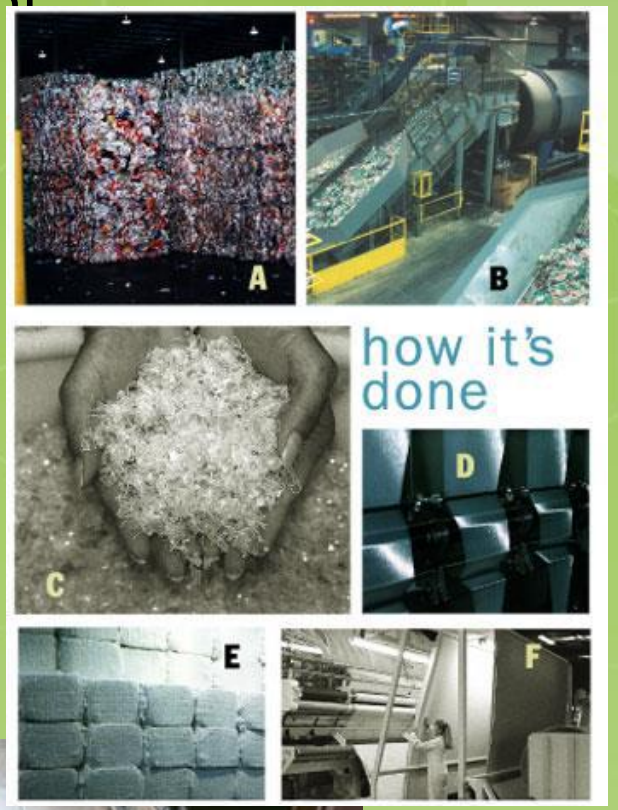
•Ground Granulated Blast Furnace Slag (“slag”)

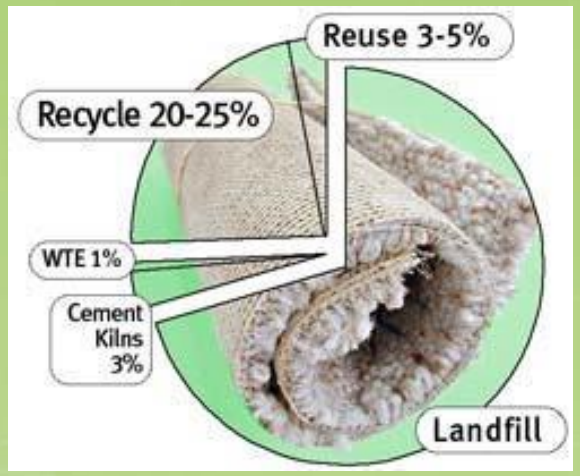
-Post-industrial waste product from steel mills

Sustainable Materials: Recycled Content

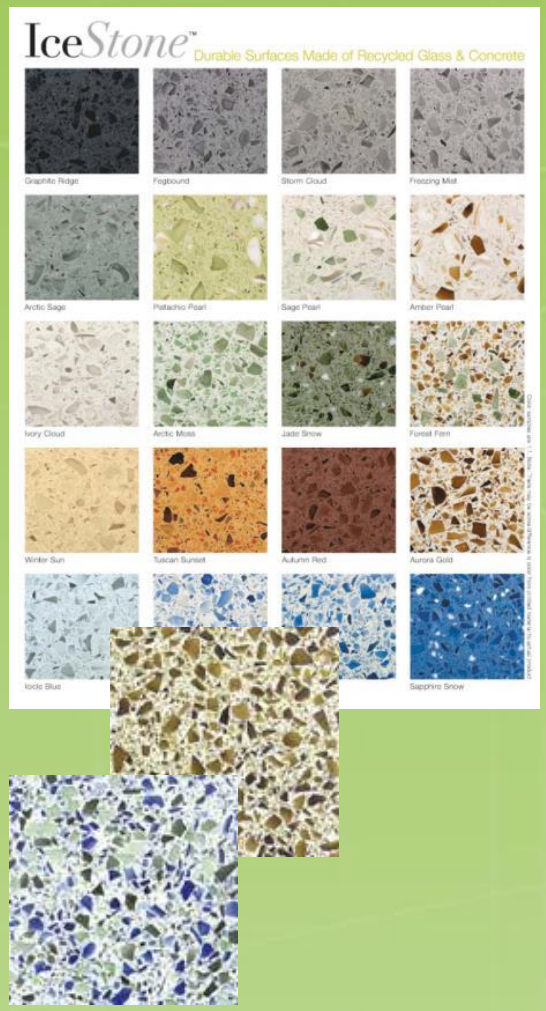
Carpet Industry Initiatives

- Recycled content backings
- Recycled content face fiber
- Refurbished Carpet Tiles
- Carpet Leasing
- Environmentally-Preferable Standards





Sustainable Materials: Recycled Content



Recycled glass countertops

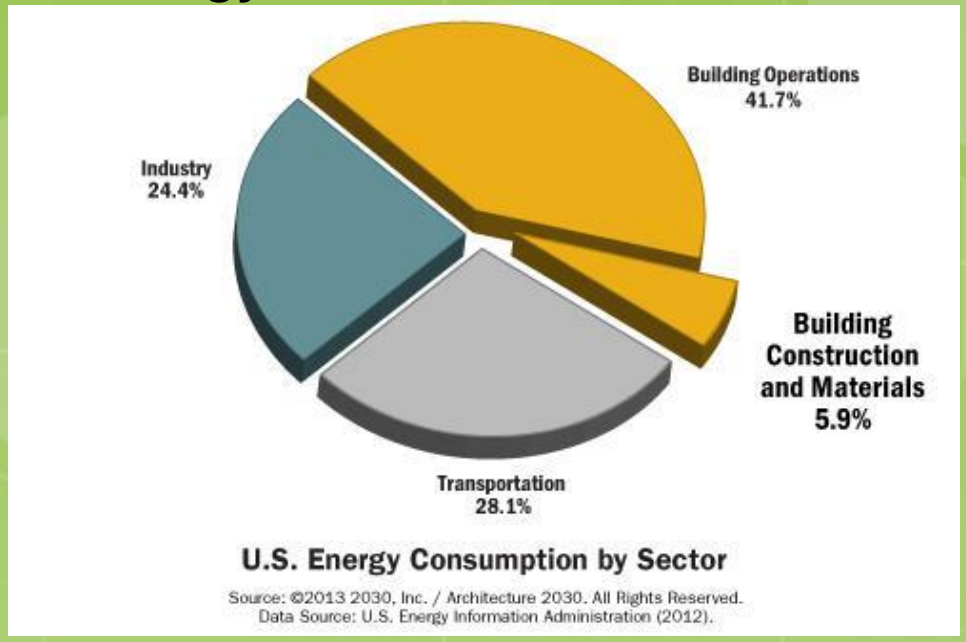
Recycled plastic decking

Recycled rubber pavers

Recycled-content insulation

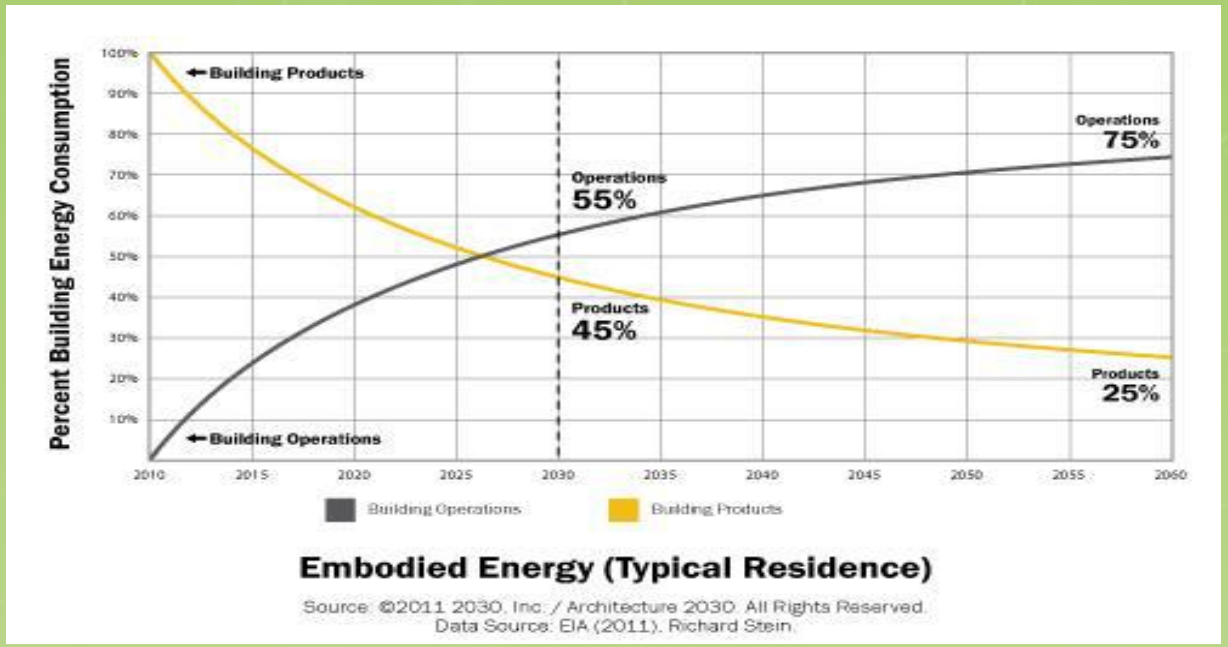
Sustainable Materials: Embodied Energy / Carbon

- Embodied energy: total energy consumed during a product's life cycle
- Embodied carbon: quantity of CO_2 emitted during a product's life cycle
- The energy used (or carbon emitted) during the entire life cycle of a product, including manufacture, transportation, installation, and disposal
- The inherent energy (or carbon) captured within the product itself



U.S. Energy Consumption by Sector

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).



Embodied Energy (Typical Residence)

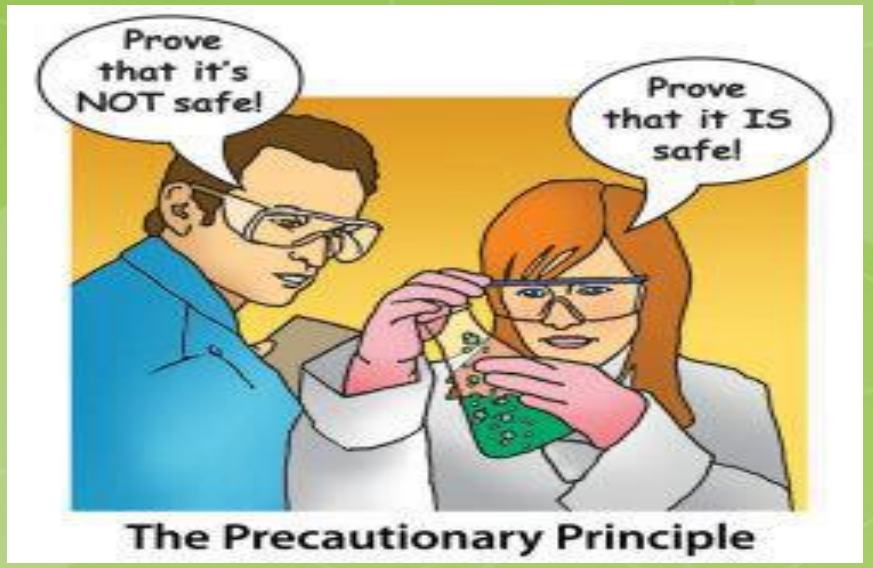
Source: ©2011 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: EIA (2011), Richard Stein.

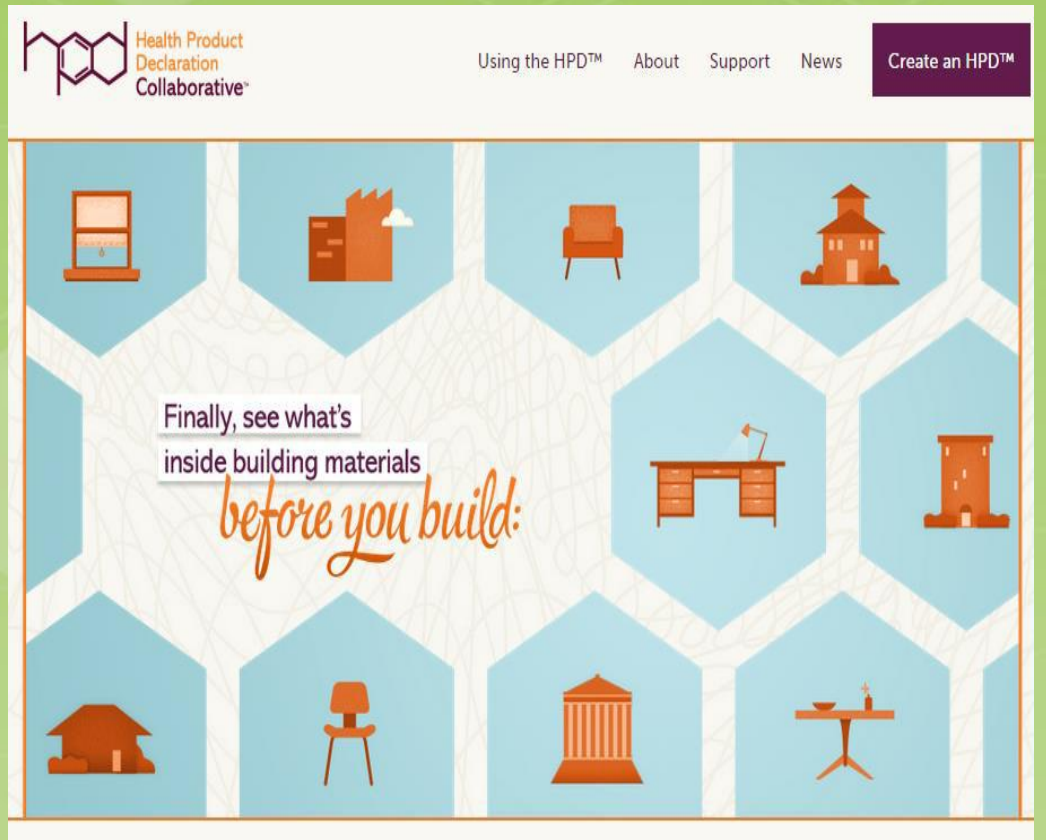
Sustainable Materials:

Material Health

Transparency Movement

- What's in our building materials?
- Precautionary Principle
- Health Product Declaration (HPD)
- Material Red List -Living Building Challenge



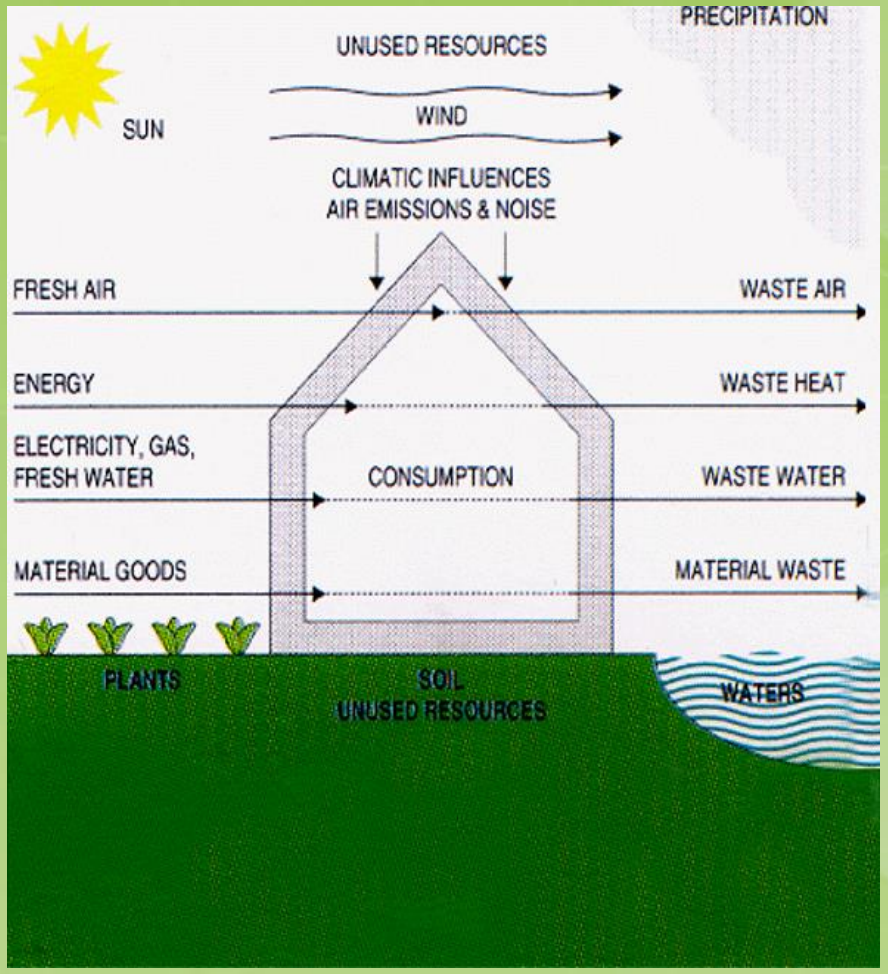


Renewable Energy: Supply

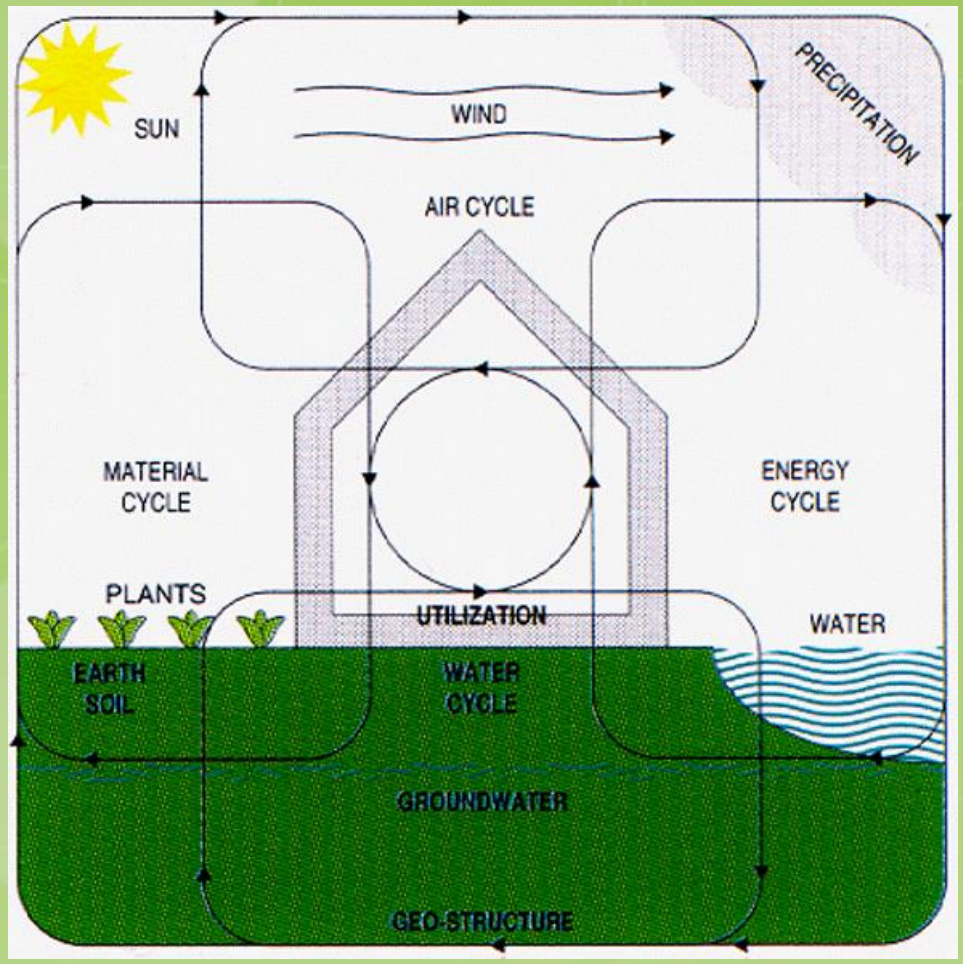
Solar

- Every hour the sun provides energy to satisfy global energy needs for an entire year
- Solar photovoltaic (PV): generate electricity
- Solar thermal: generates hot water
- Utility scale: Concentrating solar plants (CSP):
  - the heat boils water, drives steam turbine, generates electricity
- Downside: not at night (without batteries)
- World leaders: Germany, Spain, US, China
- US States: California, NJ
- Manufacturing leader: China, then Germany

Water: How Do Buildings Use Water?



Conventional building: Wasteful use of resources

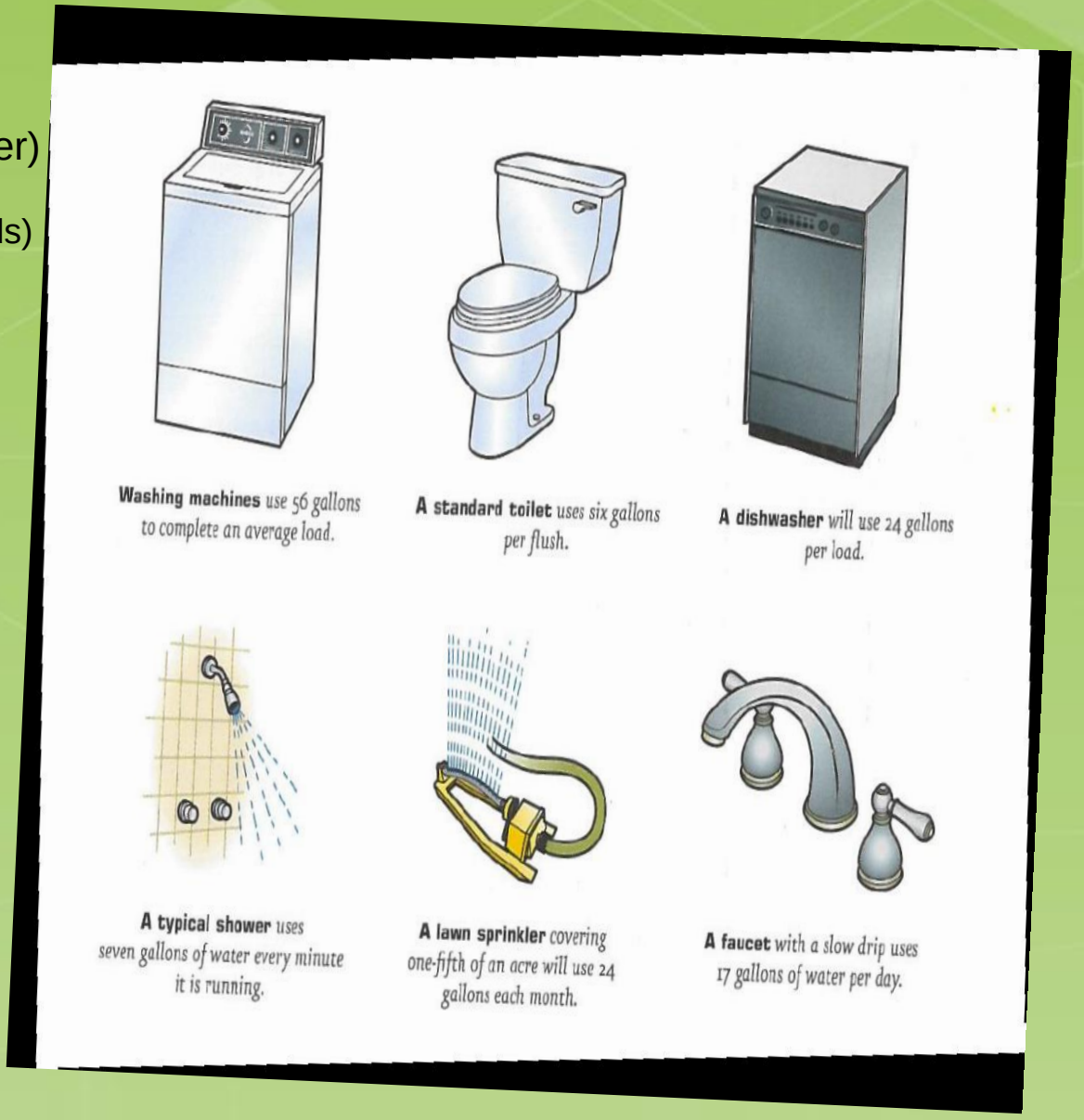


Sustainable building: Cyclical use of resources

Water: How Do Buildings Use Water?

Residential

- Plumbing fixtures (domestic water)
  - Flush fixtures (toilets)
  - Flow fixtures (faucets, showerheads)
- Heating (service water)
- Clothes washers
- Dishwashers
- Sprinklers for plants



Water: Water Use Priorities

First #1, then #2...

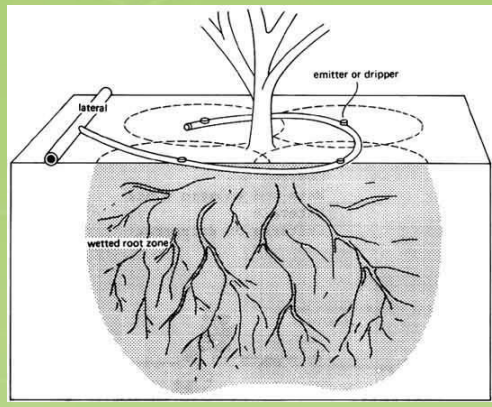
1. Reduce demand for potable water (conserve water)

-Low flow plumbing fixtures
-Drought tolerant plants on site (native or adaptive)
-Efficient irrigation for plants (drip with smart controllers and rain sensors)
-Water efficient mechanical systems
-Water efficient kitchen, laundry, etc.

2.Increase supply of available water (recycle water)

-Collect or harvest water (stormwater, greywater, backwater, cooling condensate)
-Reuse water for non-potable uses(instead of using potable water)

Drip irrigation



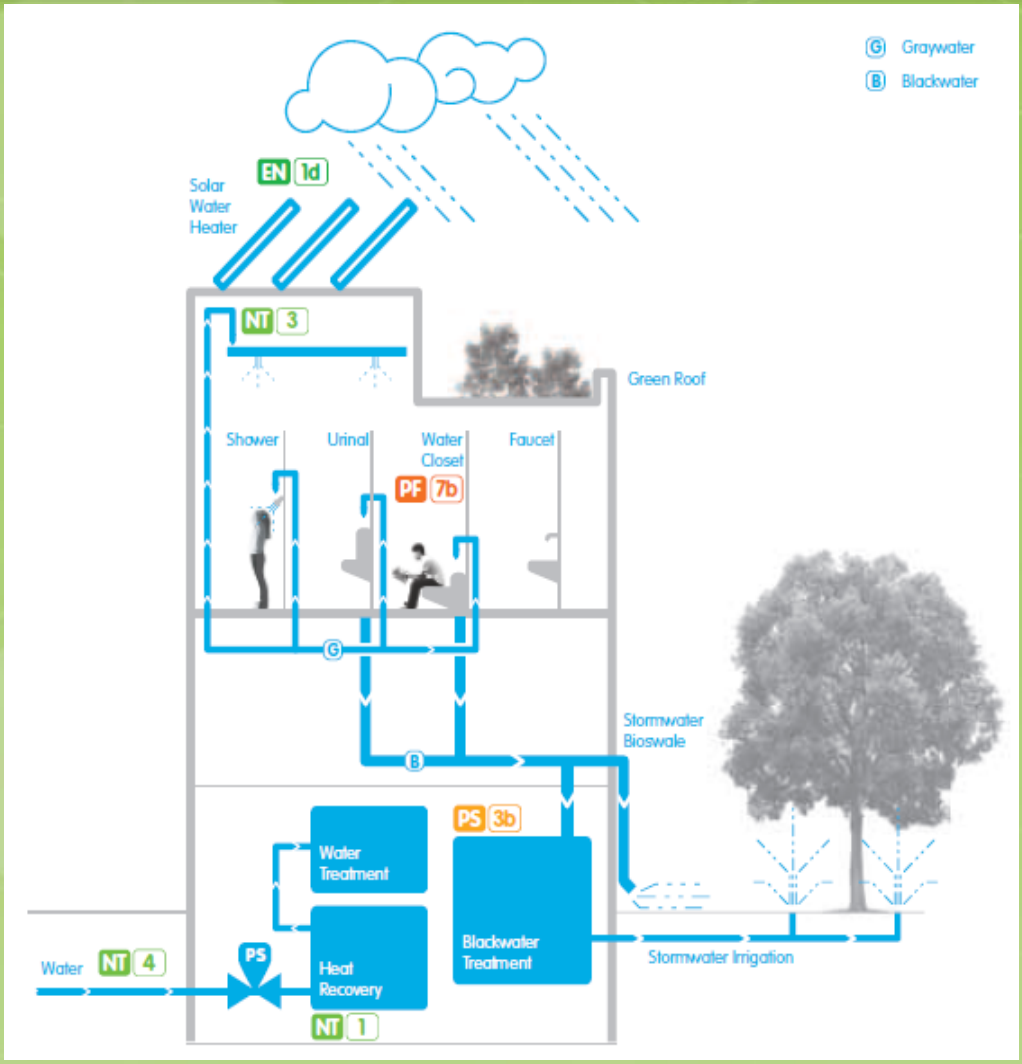
Rain sensor

Water: Efficient Strategies

• Require special design, installation, and operation

•Storm water management (green roofs)
•Water collection ("harvesting")
-Stormwater
-Greywater
-Cooling condensate

•Water reuse systems
-Irrigation
-Mechanical system (cooling towers)
-Flushing fixtures



NYC Dept. of Design & Construction: Water Matters, June 2010

The good news is …It's Getting Easier to Be Green again!!!

The Solaire

CASE STUDY: THE SOLAIRE

SUMMARY INFORMATION

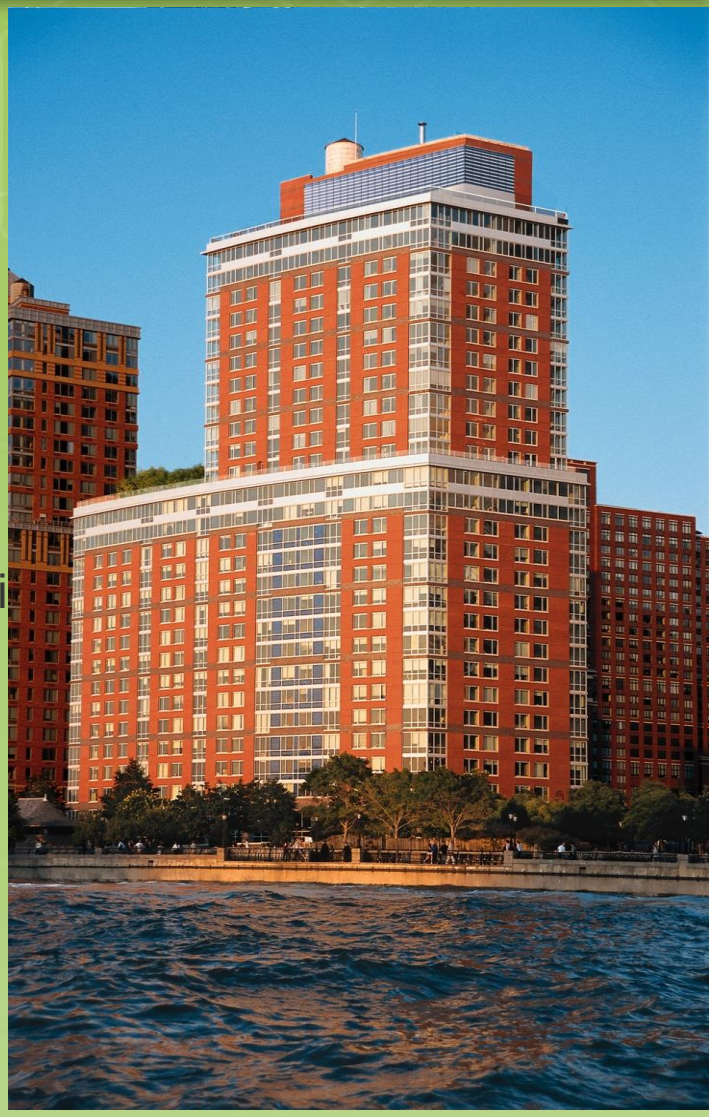
Located in Manhattan's Battery Park City

Occupancy : 27-story residential tower with 293 units
Size 357,000 sq. feet.

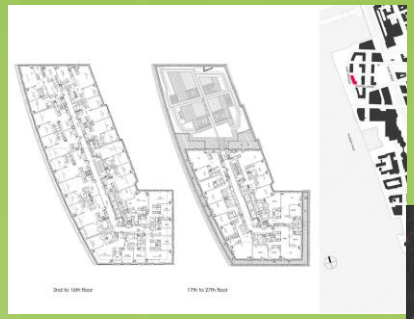
- Completed August 2003
- Owner River Terrace Associates, LLC
- Developer Albanese Development Corporation
- Architect Schuman, Lichtenstein, Claman, Efron Archi
- Awards and Ratings LEED Gold certification
- Green Project Award (2004)

The Solaire offers its residents

- convenient access to public transportation,
- on-demand hybrid rental cars, bicycle parking
- electric vehicle charging



Project overview



building-integrated photovoltaic panels and how they are an important design element in the building's main façade

maximize the thermal efficiency of the wall

the exterior building materials used REVEALED

detail of the facade and the photovoltaic panels within it

Materials choices, furniture selections

the building envelope, and details environmentally sustainable features. These include sustainable strategies for the mechanical systems, exterior building materials and systems, and roof-level landscaping, irrigation, and heat reduction strategies

the green roof and the landscape garden plan, including the variety of plant materials used in the project

The building…help

- Reduce potable water demand by 50 percent overall,
- The building uses recycled wastewater for its cooling tower.
- Low-flow toilets and for irrigating landscaping.

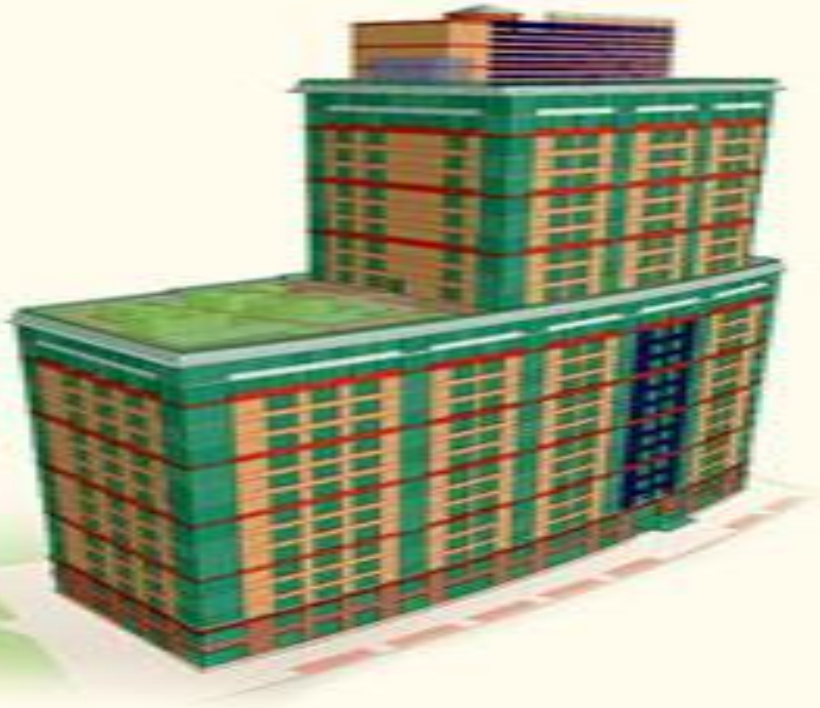
- Cut its energy demand by 35% using automatic dimming fluorescent lights.
- High-performance windows.
- Day lighting and other strategies; west-facing photovoltaic panels supply 5% of the building's energy needs

- Gardens of native shrubs, perennials and bamboo cover 75 percent of the roof, helping to lower heating and cooling loads and increase tenant satisfaction

- 93% of the construction waste for the project was recycled.
- 60 percent of the building materials were made from recycled content.

- To maintain superior air quality, the building features filtered fresh air.
- Operable windows and controlled humidity

FACT :



- One of only seven buildings to benefit from the New York green building tax credit initiative
- A total of 66.79% of the building materials (by cost) were manufactured within a 500-mile radius of the building
- First building designed in accordance with new environmental guidelines instituted in 2000 by the Battery Park City Authority (BPCA),
- The project's annual pollution was reduced by 1,662 tons/yr of CO, 1.9 tons/yr of NOx and 1.9 tons/yr of SOx

COSTS AND SAVINGS

Construction Costs

Total: $114,489,750 (without land)

Per square foot: $321

Greening Costs

Total: $17,250,000

Per square foot: $44.57

Photovoltaic system: $375,000 4-year payback period.

Low-e windows: $1,500,000 7-year payback.

Lighting control system: $125,000 4-year payback

Economic view

Scenario A

• No customer cost benefit until sometime after 2016

• Developer experiences $1 million of additional capital expense with no economic benefit and a payback period of over 20 years[3]

Scenario B

• Immediate customer cost benefit

• Reduced capital expenditure from approximately $1 million to $300,000

• Payback period is still approximately 10 years

Scenario C

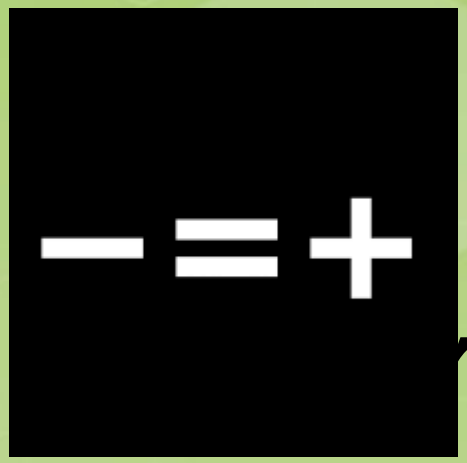
• No customer cost benefit until 2014

• Developer experiences $1 million of capital expense with a payback period of over 20 years

ALWAYS REMEMBER in Building Design & Land use

"LESS IS MOERE"

Mies van der Rohe



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