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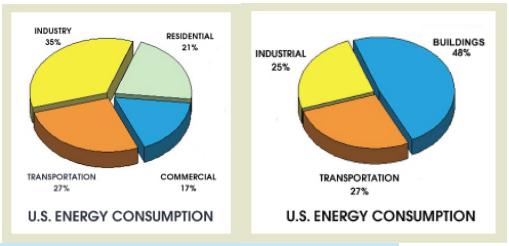
Sustainable (Green) Design Overview

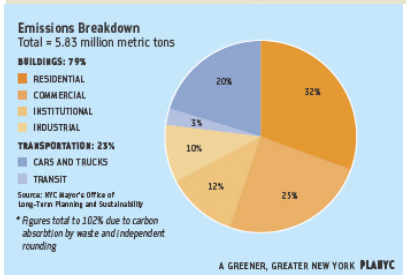
WHAT IS SUSTAINABLE OR GREEN DESIGN?
Classic Definition:
"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
Brundtland Commission
AIA Definition:
"The ability of society to continue functioning into the future without being forced into decline through exhaustion or overloading of the key resource on which that system depends."
Web Definition: Sustainable design is the art of designing physical objects to comply with the principles of economic, social, and ecological sustainability. It ranges from the microcosm of designing small objects for everyday use, through to the macrocosm of designing buildings, cities, and the earth's physical surface.

WHY DO WE NEED TO BUILD SUSTAINABLE OR GREEN BUILDINGS?

I. To Reduce impact on the Environment, by:

1. **Reducing dependence on the ever depleting finite fossil fuel resources**
2. **Curbing Green House Gas (GHG) Emissions which are leading to Global Warming**





- Data from the US Energy Information Administration illustrates that buildings are responsible for almost half (48%) of all energy consumption and GHG emissions annually; globally the percentage is even greater.
- Seventy-six percent (76%) of all power plant-generated electricity is used just to operate buildings.
- In NYC Buildings contribute to 79% of GHG emissions annually.

II. Creating a healthier community and improving Indoor Environment Quality to benefit the health of the people residing in these buildings and communities:

Research has shown that Green Buildings are not only beneficial to the environment but also help improve the health and productivity of the communities and its residents. Health and productivity of residents/communities can be improved by:

- Improved Outdoor Spaces by increased green and landscaped areas to improve the immediate air-quality around the building.
- Improved ***Indoor environmental quality (IEQ);*** which refers to the quality of the air and environment inside

buildings, based on pollutant concentrations and conditions that can affect the health, comfort and performance of occupants -- including temperature, relative humidity, light, sound and other factors. Good IEQ is an essential component of any building, especially a ***green building***. Creating a better indoor environment can help building owners, managers, occupants, architects and builders to minimize or eliminate the negative health effects, liability, bad publicity, and costly renovations and repairs often associated with IEQ problems.

WHO IS GETTING INVOLVED IN THE "GREENING" OF BUILDINGS?

Multiple State and local Authorities

- California enforces the country's most stringent energy efficient regulations with Title 24. San Jose California requires LEED Silver standard for new city facilities over 10,000 sf.
- Chicago requires that all new public buildings be designed and built according to the "Chicago Standard", a set of guidelines derived from the USGBC's LEED Rating System. All public buildings are expected to meet or surpass LEED Certification. It's City Hall sports the nation's first municipal green roof.
- Washington, D.C. requires that both private commercial development and public projects adhere to the standards of the LEED certification program. All commercial development of 50,000 sf or more is to meet LEED standards starting in 2012. All publicly owned buildings or publicly funded buildings are to meet ENERGY STAR benchmarks.
- As of January 2007, Boston requires that all buildings larger than 50,000 sf must be able to meet LEED-Certified standards.
- President Bush signed into law the Energy Policy Act of 2005 which requires new federal buildings to be designed using 30% less energy than the minimum requirements of the IECC relevant 2004 ASHRAE standard.

Here at home in New York…

- Mayor Bloomberg signed into law in November 2005 Int. 324-A, requiring City buildings that cost more than $2 million to be built according to green building standards that are as stringent as LEED.
- Gov. Pataki signed Executive Order 111 in 2001, that orders a reduction in energy consumption by 35% by 2010, relative to 1990 levels. It also states that State agencies and other effected entities engaged in the construction of new buildings shall achieve at least 20% improvement in energy efficiency performance relative to levels required by the State's Energy Conservation Construction Code.

SUSTAINABLE DESIGN STRATEGIES

1. Energy Efficiency
2. Water Conservation
3. Healthy & Eco-friendly Materials
4. Indoor Environment Quality
5. Site & Landscaping
6. During Construction
7. Building Operations

Abbreviations used:
HVAC- Heating Ventilation & Air-Conditioning
DHW- Domestic Hot Water
SEER- Seasonal Energy Efficiency Ratio (Efficiency rating; higher the better)
Low E- Low Emissivity coating (reduces thermal conductance)
R-Value- Measure of thermal resistance (higher the better)
U-Value- Measure of thermal conductance (lower the better)
VOC- Volatile Organic Compound

ENERGY EFFICIENCY

A good energy efficiency target for a high performance building for is being 30% better than NYS Energy Code. Various components of the building that aid in this improvement are:

A. **DESIGNING A BETTER & TIGHTER BUILDING ENVELOPE:** Number of factors aid in achieving a tight envelope. All are very important.
   a) **Exterior walls with good insulation:** Strategies that help achieve this are cavity walls, with continuous rigid insulation & batt insulation in the studs, which can lead to an R-value of 14-15. Care should be taken that insulation is properly installed.
   b) **Seal the building very well from floor to floor and from inside to outside**, to reduce any unnecessary infiltration and mold problems. There should be proper sealing of pipe chases, recessed lights, chimney penetrations, top of interior and exterior walls, duct penetrations etc.
   c) **Specify Energy Efficient Windows** frames like fiberglass or aluminum with thermal breaks which have a maximum U-value of 0.45, and have double pane, argon filled Low E coated Insulated Glazing.
   d) **Mitigate thermal bridging** by careful detailing of the envelope. Places of concern are when metal studs combine with masonry walls, and corners and joints in the envelope.

B. **SPECIFYING A BETTER HVAC & DHW SYSTEM:**
   a) Ideal HVAC system should consist of **Central heating and cooling plants with sealed combustion chamber** or individual HVAC units that include air-conditioners with sealed combustion chamber within each unit/zone. No air-conditioning sleeves should be used.
   b) **Heating and DHW equipment should be sized appropriately**. Over sizing of equipment leads to wastage of energy. **High efficiency Condensing boilers** are a good option for heating & DHW.
   c) Alternates to Sleeve A/C are individual unit split system with A/C sized properly to load and SEER 12 or more, OR **Central cooling sized to load and provided through fan-coil** or ducted system in each apartment.
   d) Another excellent option is to have **geothermal heat exchange wells** in place of cooling and heating plants.
   e) Ventilation Systems: Size ventilation systems properly, use **high efficiency Energy Star fans** and run them continuously.
   f) Refrigerants used in HVAC & Refrigeration systems should be **CFC & HCFC free** to help reduce impact on the ozone layer.

C. **POWER AND LIGHTING:** Energy Star Lights and Appliances cost almost the same as standard lights and appliances but use about 75% less energy.
   a) Compact Fluorescent Lights (CFL) and Fluorescent Lights are ideal for offices. *Incandescent bulbs cost.50 cents and last 1200 hours; CFL's cost $4 and last 10,000 hours*.
   b) Specify as much Energy Star lighting as possible (including fixtures, bulbs and exit lights)
   c) Specify only Energy Star Appliances including refrigerators, washers and dryers, dishwashers and ventilation fans.
   d) Photovoltaic panels can be integrated into the design of the building or can be installed post construction. Several grants are available for offsetting the initial cost of the panels.

WATER CONSERVATION

Today numerous methods for water conservation are available for buildings. Using large volumes of water increases maintenance and lifecycle costs for building operations and increases consumer costs for additional municipal supply and treatment facilities. Water efficiency measures in commercial buildings can easily reduce water usage by 30% or more. Ways to achieve this 30% reduction are listed below:

A. **Water Efficient Water Closets (Toilets):** Typical toilets use 1.6 Gallons Per Flush (GPF). Water efficient fixtures from popular brands like Kohler, Crane etc. are easily available:
   a) High Efficiency Gravity toilets providing 1.28 GPF.
   b) Air-assisted Toilet providing 1.1 GPF
   c) **Dual Flush Toilets** providing full and half flushes of 0.8/1.6 GPF (Recommended)

B. **Waterless Urinals** using no water are available. Also low flow urinals with 0.5 GPF are available.

C. **Water Efficient Faucets**: Typical bathroom & kitchen Faucets are 2.2 Gallon Per Minute (GPM)
   a) Electronic Faucets are available for 0.5 GPM
   b) Manual faucets are now available with aerators 1.0 or 0.5 GPM.

D. **Water Efficient Showers**: Typical Showers use 2.5 GPM of water. Now fixed and hand showers are available which use only 1.8 or 2.0 GPM.

E. If Irrigation is required, **efficient irrigation systems** like drip irrigation systems should be used.

F. Other methods of conserving water are:
   a) **Rain Water Harvesting**: Collecting rain water in cisterns and using it to flush toilets
   b) **Gray Water Treatment**: Reusing gray water by treating it to tertiary standards on site and using the resulting water for flushing toilets and irrigation.

HEALTHY & ECO-FRIENDLY MATERIALS

Selection of the materials is important for the health of the inhabitants of the building and for encouraging a trend in environment friendly practices like using recycled materials, reused materials, regionally produced and rapidly renewable materials. Also some products emit VOC which affect the Indoor Air Quality.

A. Using Materials with **Recycled Content**: Most materials now like drywall, tiles etc are now available with high Recycled Content (R.C.). Typical materials with high-recycled content are Structural Steel (95% R.C.), Drywall (95-100% R.C.), Tile Backer Board (85% R.C.), and Various Tiles like ceramic, recycled glass and terrazzo are available with high R.C. Other materials like carpet, rubber tiles etc. also have some R.C.

B. **Rapidly Renewable Materials**: Materials that are made from plants that are typically harvested within 10 year cycle or shorter i.e. Rapidly Renewable like Bamboo, Cork, Linoleum and Wheat board should be used in the building.
C. **Regional Materials**: As much as possible materials that are gown and harvested within 500 miles of the site should be selected to encourage use of local materials and reduce transportation fuel emissions.
D. **Low- Emitting Materials**: Products like Paints, Coatings, Carpets, Adhesives and Sealants should be Low VOC. Acceptable VOC limits should be specified.
E. **Composite Wood**: All wood products should be Urea-Formaldehyde free.
F. **Certified Wood**: Organizations like the Forest Stewardship Council (FSC) ensure sustainable forest practices and enforce that no part of the lumber be wasted during the manufacturing process. Hence if possible ensure that at-least 50% of all wood products used in the building is FSC Certified Wood.
G. **Reused/Salvaged Material**: Reusing materials that have been salvaged either from site or from other buildings is highly recommended. Reclaimed wood, reusable tiles and slate are easily available.

INDOOR ENVIRONMENT QUALITY

A. **Prohibit Smoking** in the entire building.
B. Install **permanent entry systems** like grills and grates that catch dirt from people entering the building
C. Give **control of temperature and lights** to each office or zone by installing operable windows, thermostats and individual light switches. Blanket air-conditioning and lighting in a large area should be avoided.
D. Design large operable windows for ample **daylight and views**.

SITE & LANDSCAPING

A. Only **Native and Drought resistant plants** should be used in the entire project. These plants consume less water for irrigation.
B. Consider having a **Green Roof** in the project. Green roofs reduce urban heat islands by making the environment much cooler, make the life of the roof membrane much longer, and provide an outdoor garden for the inhabitants. Modular green roofs available in trays, which can be simply placed on the roof, are available. If green-roofs are not installed then the roof should be light colored finish for **cooler roofs**. Dark asphalt roofs should be avoided.
C. Installing **Bike Racks** on site encourage residents to cycle to work which in-turn reduces the need to burn fuel in automobiles.

DURING CONSTRUCTION

A. **Construction Waste Management**: At least 50% of non-hazardous construction waste should be diverted from landfill and sent to recycling haulers/organizations.
B. **Construction IAQ Management**: Reduce air-quality hazards during construction, by protecting absorptive materials, using temporary ventilation systems during construction and following SMACNA guidelines for cleaning and housekeeping.

BUILDING OPERATIONS

A. **Storage & Collection of Recyclables**: Every floor should have space for recycling minimum paper, cardboard, glass, metal & plastics.
B. **Green Power**: Generating renewable energy on site is the best option but if that is not feasible, renewable energy can be bought off-site. Green Power is derived from solar, wind, geothermal, biomass, or low impact hydro sources. A project should provide at-least 35% of its power needs by engaging in a 2-year contract with a Green power source.
C. **Trained Staff/Superintendent:** It is very important to have trained staff or superintendent who knows the intent of installing this equipment and makes sure the systems run as designed. It is advisable to have a detailed Operations Manual that explains the functioning and intent of these systems; and clearly shows how to maintain equipment via diagrams or video.

CASE STUDY - SUSTAINABLE DESIGN UPGRADE - STARTUP COST ANALYSIS

PLEASE NOTE *** The items listed below require minimal to no redesign of the systems. Ideally a project would start design with close collaboration between the HVAC, plumbing and electrical engineers to set energy efficiency goals. The building should be designed as an integrated system with all components, including the envelope and architectural design, working to acheive these sustainable goals. This would allow much greater long-term savings.**

SUSTAINABLE UPGRADE ITEM	BENEFITS	STANDARD ITEM	COST DIFFERENTIAL	NOTES
ENERGY EFFICIENCY				
HVAC	**IDEALLY A PROJECT DESIGN WOULD START WITH CLOSE COLLABORATION BTWN THE ARCHITECT, HVAC, PLUMBING AND ELECTRICAL ENGINEERS, IN ORDER TO SET AND MEET ENERGY EFFICIENCY GOALS.**			
Condensing Boilers	recaptures condensation for use within boiler, runs at 95% efficiency, run on a "low-heat system"	Conventional Boilers - run at 75% - 80% efficiency, run on a "high-heat" system	To Be Determined	would require minimal redesign due to high heat versus low heat systems; requires stainless steel or plastic duct work
PTAC	an upgraded system as heating and cooling are combined into one unit, not necessarily sustainable	AC sleeves & baseboard	compared to AC unit and baseboard the materials are slightly less that 2 x the cost and the installation cost is slightly less	would require minimal piping to redesign but no change to the boiler
ENVELOPE				
Fiberglass Windows w/7/8" insulating glazing, low E coating	higher R value, no thermal bridging	Aluminum Windows w/ 7/8" insulating glazing, low E coating	2 x the cost of standard aluminum	
Fiberglass Windows w/7/8" insulating glazing, low E coating, heat mirror	higher R value further increased, no thermal bridging	Aluminum Windows w/ 7/8" insulating glazing, low E coating	2.5 x the cost of standard aluminum	7/8" versus 1" glazing - great cost difference but not a significant difference in R-value
Rigid Insulation, Isocyanurate	higher R value	Rigid Insulation, Extruded Polystyrene	no change	
POWER AND LIGHTING				
Gen 2 Elevator/Eco Spec	much lower energy costs, less noise & vibration & smaller machine room dimensions and bulkhead	Standard Traction Elevator w/machine room	ranges from 25% less to 25% more in cost	a hydraulic elevator is still less expensive start-up cost for a low-rise building
Energy Efficient lighting - CFL's in apartment bathrooms & entries		Standard incandescent lighting in apartment entries	8 x as much in cost, but lasts 10 x longer	
Bilevel lighting in stairwells	energy savings when stairwell unoccupied, light shines at 30% when unoccupied and turns to full brightness when occupants enter, does not require separate occupancy sensor wiring and system, occupancy sensor integrated into light	Standard lighting in stairwells	2 x the cost of standard fluorescents	
Lighting Control sensors in residential corridors	Separate occupancy sensor system and wiring?	-	cost of sensor system To Be Determined	
WATER CONSERVATION				
Water Conserving Fixture - Dual Flush Toilet, ADA compliant toilets		Standard ADA compliant toilet	2.5 x the cost	have to educate the user on how to use dual flush, more appropriate for long term tenants
Water Conserving Fixture - High-Efficiency Toilets (1.4gpm)		Standard ADA compliant toilet	2.6 x the cost	
Water Conserving Fixture - High-Efficiency Toilets (1.28gpm)		Standard ADA compliant toilet	1.6 x the cost	
Water Conserving Faucet - 0.5 gpm aerators		Standard faucet	minimal	
Water Conserving Shower Head - 2.0 gpm aerator		Standard shower head	To Be Determined	
Water Conserving Shower Heads - 2.0 gpm self-pressurizing		Standard shower head	To Be Determined	
ECO-FRIENDLY MATERIALS	**MANY OF THE MATERIALS FOR THIS PROJECT WERE ALREADY ECO-FRIENDLY. IF THIS WERE NOT THE CASE ON A PROJECT, SUSTAINABLE FINISHES ON A PROJECT CAN EASILY BE SUBSTITUTED FOR TYPICAL MATERIALS**			
White Reflective Roof coating (Acrylic)		Standard Roof Finish	additional $2/sf of roof	
Recycled content- 35% Flyash	reuse of post-industrial products	Standard Concrete	negligible	requires more detailed system of submittals
Recycled content- 80-90% recycled steel	reuse of post-industrial products	Standard Steel	negligible	requires more detailed system of submittals
Recycled content- 100% recycled drywall & tile backer board	reuse of post-industrial products	Standard GWB	negligible	if National Gypsum Co. is used, GWB would have to be shipped from Shippingport, PA plant
50% FSC Certified wood	use of sustainable lumber	Regular wood	negligible	requires more detailed system of submittals
Wheatboard - cabinet interiors	reuse of post-industrial products from agriculture	Melamine cabinet interiors	1.5 x the cost	