Sustainable Design:
The United States Subscribes to Europe’s Green Revolution

A “green” movement is taking the U.S. by storm. Whether it is using public transportation, buying environmentally friendly products, or even constructing energy efficient and ecological sustainable buildings, Americans are zealously embracing sustainability like it was the next hip fashion trend. Indeed, only in the past few years has the “green” movement gone from being derided and denounced to being embraced by the public and glamorized by the media. This excitement is driving the development of “green” technologies at unprecedented rates, elevating “green” design from its previous status as a novel inconvenience to the realm of practicality.

Unfortunately, sustainable design in the United States continues to lag behind European nations such as Germany and England. Europe has been leading the sustainability movement since the very beginning, dating back as far Greek and Roman architects who used passive design methods to maximize daylight and thermal retention. There are many speculations as to why Europe has been so dominant. Some say that it is because the EU has been so involved in developing sustainable design principles and European nations are feeling more pressure to innovate. Others cite the material abundance that has characterized American life in contrast to the relative lack that existed in many European countries only a few decades ago as an explanation for Europe’s more sustainable lifestyle. There is also a strong contingent that believe that profit driven corporate structure behind lobbying efforts in the U.S. has squashed green development as unprofitable and therefore undesirable. Nonetheless, the green movement has caught the U.S.’s attention, and companies and industries are finding themselves drawn into the more profitable green market.

According to the World Commission and Environmental Development or Brundtland Report, Our Common Future, sustainable design is an effort to meet the requirements of the present without compromising the needs of future generations by encouraging the wise and prudent use of renewable resources, alternative strategies for energy production and conservation, environmentally friendly design, and intelligent building technology. Green or ecological design means building with minimal environmental impact, and where possible, building with positive, reparative and productive consequences for the natural environment, while at the same time integrating the built structure with all aspect of the ecological systems of the biosphere over its entire life cycle (Yeang, 1999). It adds that, “Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the
direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs” (Ali 3).

Europe is a great model for green technology. They have been constructing green buildings for quite some time and with this they have acquired great examples of technologies and ideas that can be used all over the world. England and Germany are leaders in green technology with England having the “greenest” building in Europe and Germany have the leading manufacturer of prefabricated private environmentally friendly homes. Europe is advanced in comparison to the United States primarily because Europe has seen environmentally friendly houses as a lifestyle where as the US has been doing it for better standings in society until just recently. In the US, Chicago, Illinois and New York, New York are among the leading green cities and green movement regions that are striving towards more sustainable living.

One of the leading green commercial buildings in Europe is The Green Building in Manchester, United Kingdom. Conveniently located for the city centre, the Green Building provides a mixed-used complex, created for comfortable, modern and sustainable use. In addition to 32 apartments, there is a 120-place pre-school nursery, a doctor’s surgery and 1870 sq. ft., of commercial accommodation set over three floors. The Green Building is one of the most advanced ecological residential and educational developments in Britain. The design offers the smallest surface area related to the volume of the structure, providing optimum insulation and making measurable energy consumption savings possible year-round. Every aspect of the construction and maintenance of The Green Building has been examined to minimize energy waste through radical design. Day-to-day energy use is minimized ‘passively' through the design of a highly energy efficient envelope wrapping the structure of the building and 'actively' through installing highly efficient equipment for heating, ventilation and light. The structure is cylindrical in shape, reducing surface-to-volume ratios and reducing fabric losses. Its truncated roof faces southwards, deriving maximum benefit from solar energy. The reinforced concrete structure acts as a temperature regulator. Energy is absorbed into the thermal mass of the structure during warm weather and released during cooler periods. The use of natural materials ensures low embodied energy and thermal performance. The atrium is at the heart of the building's natural ventilation system. Wind pressures and stack effects mean that during the cooler seasons air moves in from low-level intakes and out at high-level openings. The glazed top of the atrium ensures that all main circulation areas are naturally lit, reducing energy consumption. Heat build-up in the atrium is regulated by motorized dampers at roof level. Low flow technologies are used throughout in kitchen and bathroom fittings. Showers, rather than baths, are provided, cutting water consumption Waste separation is supplied and separated items are transported to recycling centers Appliances have been chosen to minimize water and energy consumption. Lighting to the apartments is from sockets at low-level and fixed-connection wall points. 50W low-voltage lights are provided in bathrooms and lobbies. Communal and external luminaries and apartment pendants incorporate low-energy, compact fluorescent lamps. Communal areas are controlled via PIR automatic switches. Heating to the apartments are by a system of embedded floor pipes. Each room, including bathrooms, has its own loop provided by
the SAV modules. This appliance uses sensors in the floor to provide accurate and efficient temperature changes in the rooms.

For private use the Baufritz company can help you out. Originating in Germany and now adding another office in the UK, Baufritz has established a great clientele base throughout Germany, Austria and now slowly spreading through the UK. They offer pre fabricated houses developed with cutting edge green technology, making them extremely environmentally friendly. Baufritz uses non-chemically treated building materials, natural products and building methods that ensure good ventilation and protection from harmful electromagnetic radiation. This practice seems a little intense but it is one of their main technologies that people buy into. Baufritz makes regular checks for radioactivity, formaldehyde, chemical wood preservation methods (use of PCP, Lindane) on all its building products and materials to ensure they are not present. The company exclusively uses pollutant-tested, high-quality and environmentally-friendly construction and insulation materials and components. As one of Germany's first companies to produce off-site manufactured timber houses, Baufritz has focused upon the idea of "healthy-living homes". Today all the homes are built entirely from bio-constructive, efficient and natural materials which radically affect the air quality within the home. Baufritz only uses natural products, ensuring the good health of their customers. For instance, Baufritz uses their own patented insulation material, Hoiz S45, which is a certified insulation made from wood shavings, sprayed with whey and soda to make them fire, fungus and pesticide resistant.

Good ventilation is also essential. Conventionally constructed buildings very often use materials that are non permeable, e.g. plastic membranes, which prevent the extraction of condensation created within the house. As a result these buildings very often suffer from high levels of humidity, mould and fungi and therefore a reduced air quality. Baufritz uses a permeable (breathable) wall construction that extracts condensation quicker than it is created. The construction therefore remains at the right moisture level which improves the durability and lifespan of the construction and guarantees the right air quality inside the house. Since dust-mites cannot survive below 55% humidity, this can help people who are allergic to dust.

These tactics can be very helpful in creating more energy efficient homes throughout the world but with many countries behind Europe, U.S. being one, the idea of having a "green" world can only be considered an idea. Primary obstacles that differ Europe from the United States is climate, politics, culture and economics. Most of the innovative European technologies come from countries that have cold winters and mild summers. They only have to heat in the winter and very little cooling in the summer. Skyscrapers in the U.S. are sealed glass structures that have to be heated and cooled all the time. The U.S. has more varied temperature regions which makes the European models obsolete and only useable in specific regions. The heat and humidity are big factors for design in the U.S. whereas Europeans don’t have to deal with it as much. Europeans aren’t as sensitive to temperature excursions in the workplace as is the American culture of wearing the same clothing year round. Europeans are more engaged with their building having more natural lighting and natural ventilation while Americans are so
keen on their jobs that they haven’t been moved towards having a “healthy green” building. The high price in energy in Europe as well as the “Kyoto” protocol has been a catalyst for their use of "greener" technology while the rise in energy cost for the U.S. has provoked interest in “greener” energies. And a final difference between European technologies and the United States is that European buildings are expected to last 100 years. The fees of the designers and engineers are higher compared to American architects and engineers thus allowing for a longer overall process for the building.

Cities throughout the world are growing rapidly, creating unprecedented pressure on material and energy resources. Architects and planners alike have responded by developing new guidelines for ecologically sustainable design. However, while such guidelines can and have been readily transferred from vernacular buildings to small modern building types such as houses, schools, and community buildings, they are less easily transferable to large modern building types for which there are no historical precedents, either of scale or complexity (Abel, 2003). Until recently, tall buildings have been viewed as mega-scale energy consumers with little regard for sustainable architecture. However, this is changing with a new generation of high-rise buildings that have been designed with energy conservation and sustainability as their principal criteria (Ali 3).

U.S. planners, developers, and designers are beginning to grasp the concept that building “green” can be more than just sustainable but profitable as well. Because of advancements in technology, “green” buildings now have the potential to recuperate their high initial investment multiple times over. Although the initial costs may be higher than that of conventional design with incomplete integration, its benefits are immense in that operating costs are lower and energy costs could be substantially lower compared with conventional solutions?

4 Times Square is a modern skyscraper adjacent to Times Square in Midtown Manhattan. The building, whose 48 stories stretch 809 feet into the air, is the 12th tallest building in New York City and the 41st tallest building in the United States. 4 Times Square is significant because it was the first skyscraper to be built and operated in an environmentally responsible manner (Riley, et. al., 2003). The Durst Organization, in conjunction with Fox & Fowle Architects, developed the project with the aim of instituting indoor ecology, using sustainable materials, implementing responsible construction, prescribing sustainable maintenance procedures, and building a highly energy-efficient building (Ali 17).

In their search for models that incorporate sustainable design principles, many designers and planners have looked to passive systems of climate control, which have been integral to architecture for thousands of years (Ali 4). Passive systems rely upon the design or architecture of the building itself to ensure climate control by way of natural thermal conduction, convection, and radiation. Examples of passive systems include the use of shading and increased thermal massing of walls, utilization of natural light through large glass window panes, and natural ventilation and plantings. The facade of 4 Times Square is mostly glass, and the ceilings are higher than normal to
maximize daylight, thus decreasing the need for electrical lighting. The windows are high-performance windows that let in light but retain their air temperature (Clean Air Counts).

4 Times Square is also revolutionary in its methods for generating power. The building generates power using photovoltaic panels located in the spaces between the windows on the top 19 floors of the building. Additional panels are located on the southern and eastern façades. These photovoltaics are expected to generate 15 kWhour of power (Green Design). The building also has two 200-kW fuel cells, which use natural gas to generate power through a chemical reaction. Located on the fourth floor, the cells provide 100% of the nighttime electric demand without combustion, and hot water and carbon dioxide are the only by-products. The hot water is used to help heat the building during winter and to help heat domestic hot water. In the United States, 42% of all energy produced is lost as waste heat in combustion and transmission; generating energy on site and without combustion avoids substantial energy loss (Columna).

The central HVAC (Heating, Ventilation, Air Conditioning) system at 4 Times Square further reduces non-sustainable energy demands. Natural gas-powered absorption chillers/heaters located on the roof supply chilled and hot water to cool and heat the building. Comprising an absorber, a generator, a pump, and a recuperative heat exchanger, the chillers do not use ozone-depleting chlorofluorocarbons (CFC’s). As for air filtration, 4 Times Square exceeds the New York City code for air quality four times over (U.S. Department of Energy). The outside air enters the building well above street level, at 80 feet and 700 feet, to avoid street exhaust, where it is then filtered to remove 85% particulate matter. The air is delivered at .20 cfm per usable square foot and an additional .05 cfm can be delivered by the occupants request through the air shafts (Durst Organization).

4 Times Square designers emphasized environmentally responsible construction, choosing non-toxic and biodegradable materials as well as sustainably harvested wood and low-water-use equipment (U.S. Department of Energy). Recycled materials compose 20% of the buildings fabric, and approximately 65% of construction debris was recycled (Columna).

Many planners and designers in the United States have been hesitant to pursue ecologically sustainable design because of concerns for high initial costs. However, as more and more buildings are being built “green”, it is becoming apparent that the benefits of building “green” are typically more than enough to recuperate the high initial investment. The Sustainable Task Force, a group composed of 40 state agencies in California, released a study based on 33 completed green buildings. It found that while it costs nearly 2% more on average to construct a green building than one using conventional methods, the green building can be expected to yield a savings of more than 10 times the initial investment during the life of the building (Ali 19). 4 Times Square had a quick return on its initial investment, recuperating the upfront costs in
approximately five years (Columna). According to studies conducted in 2001 by the National Renewable Energy Laboratory, 4 Times Square uses 40% less energy than a comparable conventionally designed building. This has resulted in lower energy usage (20,841,269 kWh/year energy use saving) and costs ($1,760,000 annual energy cost saving), and a reduction in CO₂ emissions (9,191 tons/year) (National Renewable Energy Laboratory 2001). Furthermore, having excellent indoor air quality improves productivity and minimizes absenteeism, increasing the investment value for leasing businesses.

The Solaire, located at Battery Park on the Hudson River in New York City, is a 27-story, 293-unit luxury apartment building developed by the Albanese Organization and designed by Cesar Pelli & Associates. Completed in 2003, it was the first residential high-rise building in the U.S. to integrate green features in a comprehensive way (Ali 18).

The Solaire is exemplary in its use of both passive and active systems to achieve energy efficiency. Photovoltaic panels, which are installed on the front facade as well as the roof, are capable of generating 5% of the building’s base electric load (“20”). The panels also function as a cladding system, increasing thermal mass so as to moderate thermal fluctuation (Ali 19). Gas-fired absorption chillers further reduce electrical demands by 65% during peak hours, which in turn helps to reduce overall CO₂ emissions. In addition, they contain no chlorofluorocarbons or hydrochlorofluorocarbons, so they won’t damage the ozone layer (“Governor”). By looking at the systems as a whole in terms of energy efficiency at the earliest level of the design process, the team determined that it could reduce energy consumption by 35% over the New York State energy code (Ali 19).

The Solaire employs the use of a “semi-intensive” green roof system. The planted roof helps to insulate the building from thermal gain, absorb CO₂ and generate O₂, and alleviate the heat island effect common to most urban environments (Ali 19). A “semi-intensive” green roof has deep enough soil depths to accommodate shrubs and trees. As a result, they require slightly more maintenance and irrigation, but have greater thermal massing and water retention. The Solaire avoids the water requirements for irrigation though the use of a storm water catchment system that provides all of the necessary water. The roof system beneath the plants was designed to retain nearly 70% of rainwater for eventual use by the plants. The process of evapotranspiration contributes to a cooling effect in the garden’s microclimate (“20”).

The Solaire further reduces its water usage though the use of an on-site black water treatment and re-use system, which recycles nearly 100% of the building’s waste water (“20”). The system will capture approximately 170,000 gallons of water per year, which is used to irrigate the green roof and to supply both the cooling tower and the building’s toilets with water (“Governor”). As a result, the Solaire requires 50% less potable water than a conventional high-reis residential building (“20”).
About 50% of the total building material used to construct the Solaire was recycled content, and close to 67% of all material including the concrete, was manufactured within 500 miles of the job site, helping to cut down on the fossil fuel energy requirements for transporting the material (“The Solaire”). To help meet recycled content standards for all applicable green guidelines, the project team designed a concrete mix to supplement cementitious content with 18% fly ash for most of the structure. In the foundation, fly ash was used at 40%, a typical application used to control the heat of hydration in mat foundations and mass concrete. More than 93% of the construction waste for the project was recycled (“20”).

The BPCA determined that the initial costs for a sustainable residential high-rise building would be 8% to 12% higher than for a conventional building. As an incentive for the developers to “go green”, the New York State Energy Research and Development Authority (NYSERDA) was willing to pay up to 70% of the incremental cost of energy efficiency measures that would reduce the use of electricity and assisted the developer in materials sourcing for the project (Ali 19). It is anticipated that the Solaire will recuperate its initial investment within a 10 year period, and will experience massive energy and monetary savings over its lifespan, which is estimated to be between 75 ad 100 years. This compares favorably to existing high-rise apartment buildings in New York City, with many highly desirable buildings over 70-80 years old (“20”).

The Bank of America Tower at One Bryant Park is a 1,200 ft (366 m) skyscraper currently undergoing construction in Midtown Manhattan adjacent to the site of 4 Times Square. Construction is expected to be complete in 2009 (Hughes). It has been designed to be one of the most highly efficient and ecologically friendly buildings in the world, and is the first skyscraper designed to attain a Platinum LEED Certification. The BOA Tower will lead the change in the way that high-rise buildings are built (“Bank of America”).

Perhaps the most revolutionary aspect of the BOA Tower is its air filtration system, which removes 95% of particulates as well as ozone and volatile organic compounds (“Green”). The system is unique because it will also clean the air that is exhausted, making the tower a giant filter for Midtown Manhattan (Cook).

The BOA Tower is powered by a 4.6-megawatt cogeneration plant, which will provide part of the base-load energy requirements (“One”). Energy use will be abated through the use of floor-to-ceiling glass walls that contain heat and maximize natural light. Perimeter daylight dimming and LED lights will also help to reduce electric usage (“Green”).

The BOA Tower features a greywater system, which captures rain water and reuses it (“Bank of America”). The greywater system will eliminate about 40% of the fresh water use a conventional skyscraper would need (“Bank of America’s Bold Statement in Green”). Water conservation features in the tower include waterless urinals, which are estimated to save 8 million gallons of water per year and reduce CO2 emissions by 144,000 lbs/year (“Water”). Overall, the building will save 10.3 million gallons of fresh
water per year, enough to meet the annual needs of 125 households ("Bank of America’s Bold Statement in Green").

The BOA Tower will be made largely of recycled and recyclable materials ("Bank of America"). The building is being constructed using a concrete manufactured with 45% slag, which is a byproduct of blast furnaces. The use of slag cement reduces damage to the environment by decreasing the amount of cement needed for the building, which in turn lowers the amount of CO$_2$ greenhouse gas produced through normal cement manufacturing (One ton of cement produced emits about one ton of CO$_2$ into the atmosphere) ("EF Technology").

At Bank of America Tower, “going green” tacked on 5% in costs. At roughly $60 million, that's a serious add-on, yet it's one that the partners expect to recover through energy savings and improved worker productivity in a matter of years ("Bank of America’s Bold Statement in Green").

Despite the large quantity of material and energy involved in its production, the skyscraper’s smaller footprint and large vertical surfaces offer an opportunity to balance our urban environment through renewable energy use, resource conservation, and waste management ("The Ecological Skyscraper"). The concept of building tall is an energy conservation strategy in itself, not only for savings in the transportation and the use of materials, but also for the encouragement of transit-oriented developments. The creation of skyscrapers is the best economical and physical solution for the densification of our cities. The lessons that can be learned from these buildings will be an invaluable resource to the developers, planners, and designers of future sustainable high-rise buildings. Current trends indicate that the skyscraper as a building type will continue to be built in most World cities. Europe is leading the way currently, because energy costs and zoning regulations have required tall buildings to meet stringent guidelines relative to sustainability and “green” architecture, including daylighting, natural ventilation, energy consumption, water usage and treatment, and other sustainable goals (Ali 20). The question remains then how can the architect today design these massive building types to be ecologically responsive to avoid otherwise multitudes of high-energy consuming, polluting, and waste-producing buildings (Columna).

Chicago, Illinois, nicknamed the Windy City, is also among the group of leading green cities in the United States. While this city does not have as many green skyscrapers as New York City, Chicago is making progress towards the addition of more sustainable architecture, including residential, public and commercial infrastructure. Since 2006, Chicago is home to 27 LEED (Leadership in Energy and Environmental Design) certified buildings and is in the top category for users of green, renewable, energy in the United States. Chicago also holds the lead in the U.S. for the city with the greatest area of green roofs, gardens. Since then, interest and implementation in sustainable building has only increased.

The ‘Green Movement’ efforts of Chicago were initiated by Mayor Richard Daley who was elected into office in 1989. Through his efforts Chicago has been able to create a
green McDonalds, green schools, libraries and more green public buildings. The city has even gone the extra step and now require that construction projects, both private and public, become certified as a sustainable building (if they want the city’s help in financing the project) or have a green roof. Some argue that green roofs will contribute to urban heat reduction and may be able to bring the city temperature down in the future. One of the first initiatives made towards the ecological movement was placing a green roof on top of City Hall in the years 2000-2001. The roof was successful in plant survival and was able to save City Hall a few thousand dollars a year on utility costs. Green roofs are now sitting atop a Chicago Apple store, Wal-Mart and even a police station.

The Chicago Center for Green Technology was previously an abandoned industrial site which was later transformed into a sustainable, technologically advanced building that offers the public education and information on gardening and green efforts. The building was designed by Farr Associates and Urban Design, who are located in Chicago. Close to $10 million dollars was spent towards cleaning up the astonishing amount of waste that was left behind from the previous site. The building is able to filter storm water through the use of a natural habitat along with the use of gardens and solar energy.

The Center uses less energy than similar buildings photovoltaic panels as sun shade among many other features. Recycled materials were used during the construction of the building, which also contains an irrigation system. Other environmental features of the building include a green roof, geothermal heating and cooling and smart lighting. The Chicago Center was the first public building in the United States to receive a Platinum rating from LEED, the U.S. Green Building Council, thus becoming an ideal model for sustainable technology and design.

Another green roof project in Chicago is Millennium Park, a nearly $500 million dollar project. The park is 24.5 acres and sits on top of two parking garages as the largest “green roof” in the world. Millennium Park is thought of as a giant playground that includes modern landscape art and design, a skating rink, an indoor performance center, modern architecture, many gardens and full sized trees. In the year 2005, Millennium Park won the 2005 Green Roofs for Healthy Cities Award of Excellence.

An additional green building case study in Chicago is the Tarkington (Elementary) School of Excellence. This was the first school in Chicago to be built towards the achievement of the LEED certification. On the third floor of the school there is a roof covered with a garden of plants that are drought resistant. The roof is used as an energy saving insulation and as a teaching tool within the school community. In the future, Chicago Public Schools will use the Tarkington School as a model for sustainable construction.

The first green residential skyscraper in Chicago was completed in 2007. 340 on the Park is a 64 story all-residential building designed by Martin Wolf through the Solomon Cordwell Buenz architectural firm. The building includes large glass doors and walls, a
winter garden, and a terrace overlooking Millennium Park. The skyscraper allows for better indoor air quality and more natural light.

Chicago is far from complete sustainability and environmental greatness, but real initiatives have been made presently and in past time towards a healthier, greener city. However, all of the green efforts and the direction the city buildings are going in have really helped the community attitude towards the urban environment. The green movement has started a new design and look that is widely approved of.