**DUPLEX USING GREEN TECHNOLOGY**

PROJECT

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*DIPLOMA FINAL YEAR*

*DELHI*

**PROJECT OVERVIEW**

PROJECT OWNER: ANAMIKA SARKAR

LOCATION: XYZ

PROJECT COMPLETION DATE: 20XX

PROJECT CATEGORY: ADAPTIVE REUSE

PROJECT SITE CONTEXT/ SETTING: URBAN, PREVIOUSLY DEVELOPED LAND

PROJECT TYPE: RESIDENTIAL DUPLEX

BUILDING OR PROJECT GROSS FLOOR AREA:

HOURS OF OPERATION: 8 a.m. – 5 p.m.

TOTAL PROJECT COST AT A TIME OF COMPLETION, EXCLUDED LAND:

**ABSTRACT**

A green duplex, which is also known as a sustainable building is designed to meet some objectives such as occupant health; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. It is an opportunity to use the resources efficiently while creating healthier buildings that improve human health, build a better environment, and provide cost savings. All the development projects lead to over-consumption of natural resources.

**Keywords:** sustainable duplex, human health, natural resource, energy, etc.

**OBJECTIVE OF GREEN DUPLEX**  
Green duplex are designed to reduce the overall impact on human health and the natural environment by the following ways using energy, water and other resources efficiently. By reducing waste, pollution, and environmental degradation.

**GREEN DUPLEX FEATURES**  
Eco-Friendly-by least disturbance to eco system. Energy efficient-through the natural lighting ventilation and solar passive designs efficient use of water-through recycling and water harvesting use of renewable energy-through photo voltaic systems and solar system etc. Nontoxic material in door environment, use of recycle/recyclable materials, efficient waste utilization and disposal.

**PRINCIPLES OF GREEN DUPLEX**

* Sustainable site design
* Water quality and conservation
* Energy and environment
* Indoor environmental quality
* Material and resources

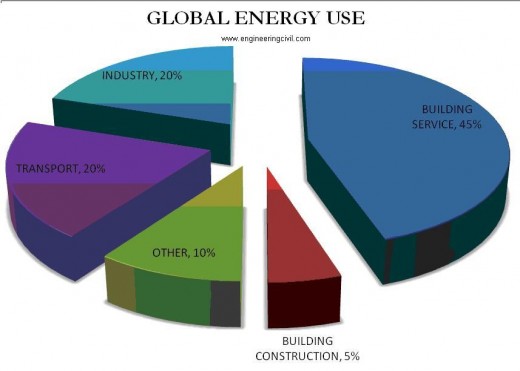
**GREEN BUILDING PROJECT IN INDIA**  
• Suzlon Energy Limited-Pune  
• Biodiversity Conservation India-Bangalore  
• Olympia Technology Park-Chennai  
• Rain tree Hotels-Chennai  
• Rajiv Gandhi International Airport-Hyderabad  
• Hiranandini-BG House, Powai  
• ABN Amro Bank, Chennai  
• Palais Royale at Worli, Mumbai  
• Punjab Forest Complex, Mohali

**DIFFERENT FROM OTHER DUPLEX**  
The design, maintain and construction of duplex have tremendous effect on our environment and natural resources. Green duplex is different from the other duplexes because it use a minimum amount of nonrenewable energy, produce minimal pollution, increases the comfort, health and safety of the people who work in them. It also minimize the waste in construction by recovering materials and reusing or recycling them

* **INCREASING GREEN DUPLEX IN INDIA**  
  Today more than 1053 green duplex (as on April2011) are being constructed all over India. Of which 147 green duplexes are certified and fully functional.
* **BENEFITS OF GREEN DUPLEX**

Duplexes have a large effect on the environment, human health and the economy. The successful adoption of duplex developed can maximize both the economic and environmental performance of the duplex.

* **ENVIRONMENTAL BENEFITS**  
  Protect bio diversity and eco systems, improve air and water quality, reduce waste streams, conserve natural resources.
* **ECONOMIC BENEFITS**  
  Reduce operating cost, create, expand, and shape markets for green product and services, improve occupant productivity.
* **SOCIAL BENEFITS**  
  Enhance occupant comfort and health, heighten aesthetic qualities, minimize strain on local infrastructure, Improve overall quality life.
* **NATURAL RESOURCES**  
  • According to surveys conducted in 2006, 107.3 million acres of total land area is developed, which represents an increase of 24 percent land covering green buildings over the past 3 years.  
  • In terms of energy, buildings accounted for 39.4 percent of total energy consumption and 67.9 percent of total electricity consumption.  
  • Reduce operating costs Create, expand, and shape markets for green product and services Improve occupant productivity.

**WHY IT IS NECESSARY TO MAKE A DUPLEX GREEN?**   
**[](http://www.engineeringcivil.com/wp-content/uploads/2014/10/global-energy-use.jpg)**  
CONSTRUCTION INDUSTRY CONTRIBUTES TO NEARLY 50% OF ENERGY CONSUMPTION

**DESIGN AND INNOVATION:**

The key issue for duplex was seeking ways to combine environmental, financial and social sustainability. As such, the design team focused on strategies that simultaneously addressed these goals. These strategies included reducing long term energy use and costs, creating healthy living environments, and maximizing seismic resilience.

Design innovations such as a solar canopy and resilient post-tensioned shear walls contributed toward meeting these goals. This project demonstrates how sustainable design can reinforce the goals of providing healthy and nurturing residences and services for disadvantaged citizens that are integrated into a local community.

At the same time, a duplex can also serve as a model for integrating supportive services into housing for the formerly chronically homeless. By locating elevators and an access stair deep into the duplex, residents pass by and are exposed to the supportive and community spaces along a wide passageway dubbed “Main Street”. The daily transition between house and neighborhood provides opportunities for social interactions between residents, support staff and management.

Overall, it has a highly efficient layout that conserves public funds as well as resources while providing a dignified and uplifting home.

**REGIONAL/ COMMUNITY DESIGN**

A duplex site is an irregular shaped site that was a parking lot where a freeway off-ramp once stood. The urban site has excellent transit and bike lane access. In response, the green duplex design provides secure bike parking but no automobile parking in keeping with the city’s transit first policy.

Being located in a seismically active area, a duplex was designed with special enhanced seismic resiliency to increase the likelihood that residents can shelter-in-place in the event of a major seismic event. A duplex’s mechanical, plumbing, egress stairs all allow for lateral movement. The concrete structure has an innovative post-tensioned shear wall system. The post-tensioning reinforcing will re-center the building as seismic drift decelerates. By leaving the duplex plumb, the chances of continued habitability is increased.

**MATRICS**

***Estimated percent of occupants using public transit, cycling or walking:****90%*

**LAND USE AND SITE ECOLOGY**

Located in a very urban setting.

A duplex contributed to this new ecosystem by replacing the existing paved parking lot and by dedicating all new horizontal exterior surfaces to either people, plants, water absorption or renewable power generation including providing a significant vegetated roof over its southern wing. The green roof provides an attractive outlook for neighbors as well as the building residents. At the same time, the green roof provides substantial roof insulation and storm water management and filtration.

The new green roof ecology is composed of three different sedum or sod tiles – a composition of red, green/yellow and blue. Each color consists of three species of sedum with different tolerances for sun, shade and moisture. This design mix has built in diversity and resiliencies, with ability to adapt to the urban conditions including deep shade from tall buildings, intense heat and reflection, and uncertain maintenance and irrigation procedures.

**BIOCLIMATIC DESIGN**

The bioclimatic design strategies focused on solar gain, thermal mass, ventilation and daylighting. Due to the moderate climate, residential cooling was achieved without air conditioning. In response to the low laying air pollution, ventilation air intake was at the roof level. The central air ventilation system delivers filtered and tempered air continuously to all occupied spaces. In addition, ceiling fans and operable windows are provided at all apartments. High performance window and skylight glazing is generous for daylighting and to take advantage of passive solar gain from the concrete structure.

 A thermal comfort study provided a solution: add an active radiant panel to the perimeter soffit. This not only addressed the added thermal load at the perimeter, but also provided a higher degree of thermal comfort and more uniform temperatures throughout the depth of the space.

During the thermal comfort survey, the team found reflected light and heat from an adjacent building that was not present during the design process. The survey indicated that the lowest thermal comfort response was from the lower, east-facing floors across from the new building, while the most positive thermal response was from the same floors to the south. Flexibility built into the original design allowed for a post-occupancy rezoning, which allowed for increased cooling in this area.

These situations both offer an important lesson: design for future possibilities as well as current conditions.

**LIGHT AND AIR**

One design strategy that has proven to benefit house occupants is the use of light shelves and reflectors to enhance the building’s daylighting design. High occupant satisfaction on the upper floors on the house’s west side illustrates the success of the vertical reeds. According to the occupant survey, 65% of duplex occupants report satisfaction with the amount office daylight. Additionally, a third-party study showed that in addition to energy savings, the effects of the daylighting helped with circadian entrainment.

Another major design strategy, use of hydronic radiant ceiling panels with DOAS, was estimated to save 10% to 15% of total house energy use when compared to a variable air volume mechanical system. Although the system provides a high level of thermal comfort and indoor air quality, it was predicted that occupants accustomed to noisily blown cool or warm air (as in traditional systems) would perceive a problem linking minimal air movement to a lack of cooling. One way this was corrected during the post-occupancy work was to adjust the range of temperature allowed to improve the balance between energy savings and occupant comfort.

Fresh air is provided continuously to all habitable spaces from the roof where it is filtered and tempered. Because of the moderate climate, ceiling fans and operable windows combined with the fresh air ventilation system to eliminate the need for air conditioning in the apartments. As a whole, 68% of the habitable areas are naturally ventilated and the remaining residential areas are ventilated with filtered outside air.

**MATRICS**

**Daylighting at levels that allow lights to be off during daylight hours:**

75%

**Views to the Outdoors:**

96%

**Within 15 feet of an operable window:**

51%

**WATER CYCLE**

Programmatic requirements resulted in the house covering the entire site. Storm water is managed through detention, combined storm and sanitary sewer system. A large detention tank is located below the ground floor courtyard to help manage storm water surges. The extensive green roof also contributes to rain water retention.

Water use is reduced through a combination of low-flow fixtures and drip irrigation. In addition, all house toilets (as well as the irrigation system) are plumbed with purple pipe that will be connected to a future municipal reclaimed water system.

**MATRICS**

**Percent reduction of regulated potable water:**

28%

**Is potable water used for irrigation:**

Yes

**Percent of rainwater from maximum anticipated 24 hour, 2-year storm event that can be managed onsite:**

25%

Reducing energy costs is a critical goal for the non-profit house owner and the very low income residents.  
Duplex high performance house envelope with its continuous insulation and rainscreen cladding reduces unwanted energy loss and gain. A hydronic heating system provides heat efficiently to the all portion of the house.

Residential cooling is provided by continuous fresh air ventilation, ceiling fans and operable windows rather than air conditioning.

A large portion of the water heating is provided by a row of solar hot water panels running down the spine of the solar canopy.

High efficiency lighting is used throughout the house for a lighting density less than 1 watt/square foot. Exterior lights and ground floor common areas are controlled by time clocks and daylight sensors.

The rooftop solar canopy allows for a significant photovoltaic renewable energy system in addition to the solar hot water panels Along with the other energy efficiency.

**MATRICS**

**Total pEUI:**56 kBtu/sf/yr

**Net pEUI:**24 kBtu/sf/yr

**Percent Reduction from National Median EUI for house Type (predicted):**55%

**Lighting Power Density:**watts/sf

**MATERIALS AND CONSTRUCTION**

One of the systems selected both for its benefits to human health and for its energy efficiency was the radiant heating and cooling system. While better for indoor air quality than conventional systems, and incredibly efficient, one of the perceived negatives of the radiant panels was a lack of air movement, which many people equate with cooling. An important lesson learned was the importance of educating tenants on what to expect in their new environment. To facilitate this, the property management team incorporated the GSA’s green leasing and operations policy into a program highlighting the building’s green features and the impacts they have.

One focus of this program was tenant-led waste diversion. In addition to standard recycling of paper, plastic, glass, etc., the building also participates in the offsite composting of landscape organics.

**LONG LIFE, LOOSE FIT**

As permanent support housing for a vulnerable population, duplex was designed for a long life span. Durability and ease of maintenance are top priorities for the non-profit owner with a limited operations budget.

At the same time, the construction does allow for future adaptability. The concrete structural system allows all walls to be non-load bearing for future remodeling and adaptation. The interior partitions and exterior finishes are all screwed or riveted together which would allow for future disassembly.

**PROJECT CONTACT INFORMATION**

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