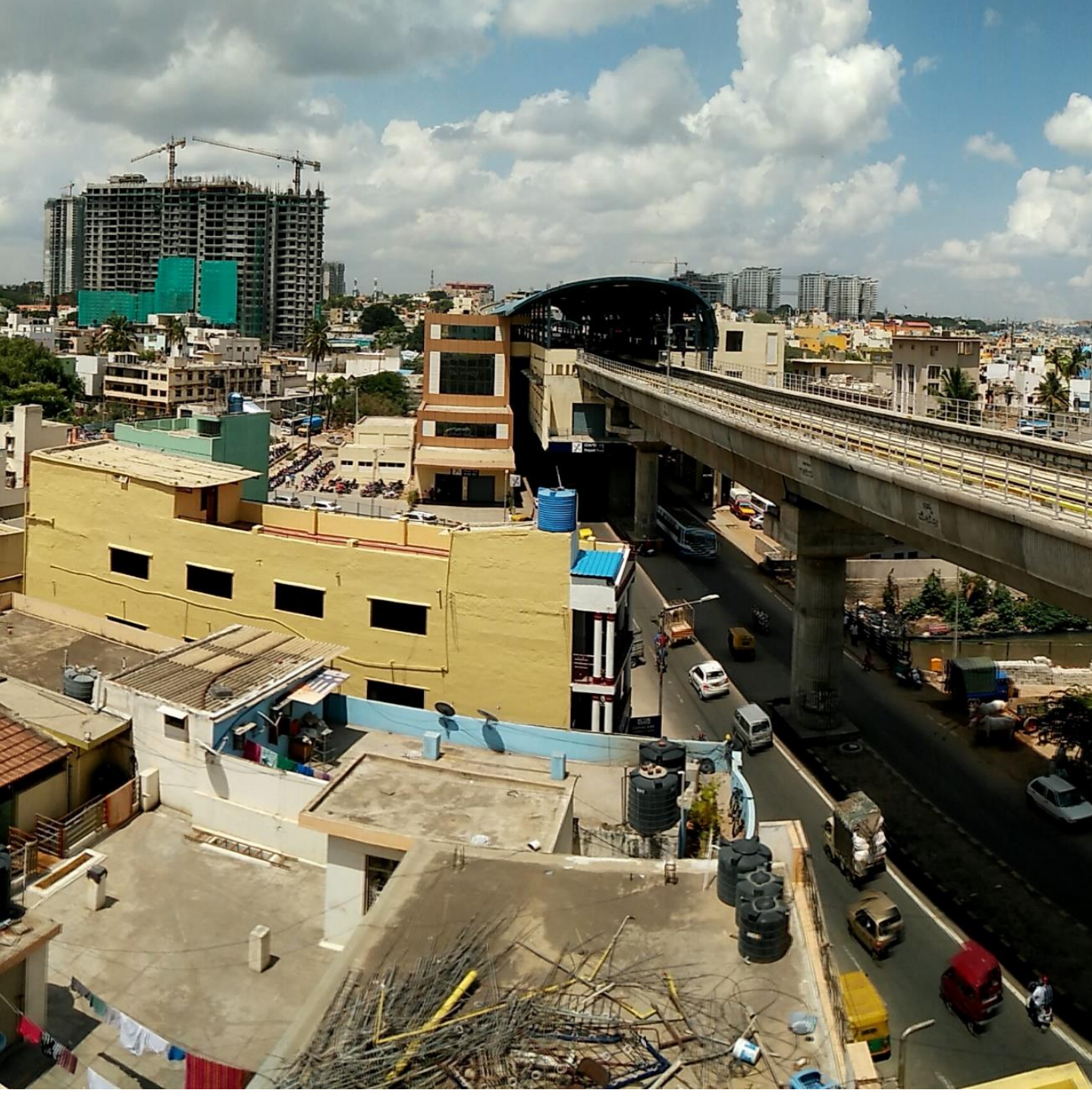

CASE STUDIES

Green Buildings, Mobility, Air Quality

Prepared by WRI India

Ministry of Housing
and Urban Affairs
Government of India

Smart City
MISSION TRANSFORM-NATION

WRI INDIA

WRI India is a research organisation with experts and staff who work closely with leaders to turn big ideas into action to sustain a healthy environment - the foundation of economic opportunity and human well-being. We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Green Building

Green Buildings in Hot & Dry climatic zone- CII Sohrabji Godrej Green Business Centre

Green Buildings

Project Highlights

- Nearly 20% of the building's electricity needs are met by onsite solar generation
- Circular form of the building offers an orientation to the sun for optimum solar gain which is 25% less than the conventional buildings.
- 77% of the building materials use recycled content
- Two wind towers are designed and constructed to improve natural ventilation in the building

Background

CII-Sohrabji Godrej Green Business Center (GBC) was constructed in the cyber city of Hyderabad with the purpose of educating the masses about the significance of embracing a green culture to try and reverse the devastation earth has experienced over the past century. The design concepts rely heavily on traditional architecture styles to make use of the best practices facilitating meaningful interactions between buildings and the nature.

Project Location
Hyderabad

Building Use
Office Building

Climatic Zone
Hot and Dry

Project Objectives

- Make use of the traditional architectural concepts to minimize the carbon footprint of the building in its life cycle
- Propagate a green culture by demonstrating high energy efficiency through traditional passive design concepts
- Onsite solar power generation for meeting a portion of the operational energy demands of the building

Project Approach

- The structure is centrally located on the flattest part of the site. This allowed the developers not to interfere with the site features during construction
- A central courtyard and colonnaded corridors ensure that the hot air cools before entering the interiors
- Two wind towers were erected where air is cooled up to 8 degrees by sprinkling water and this cool air is circulated inside the building, minimizing cooling load
- Additionally, 55% of the roof is covered with terrace garden, helping reduce the indoor temperature
- 90% of the building interior gets direct day lighting and outside views, reducing need for artificial lighting
- Nearly 75% of the building materials use recycled or recyclable content like fly ash, broken glass and tiles, recycled paper and aluminum etc.

- Perfectly oriented facades with double glazed glasses helps the building to minimize the heat gain
- Use of highly efficient water fixtures help GBC to save nearly 30% of municipally supplied potable water

Project Achievements

- GBC is the first Platinum rated building in India
- CII-Sohrabji Godrej Green Business Center is unofficially considered as one of the greenest buildings in the world, one of the best examples of the passive design.

Figure 1: Colonnaded Corridors and Jalis allowing controlled passage of air and light

Long Term Impacts

- The green building design strategies will help to maximize energy savings and minimize the operational cost of the buildings
- The vegetations within the building premise will help to reduce the negative impacts of Urban Heat Island effects
- Water efficient design strategies will help not to impact the water resources of the locality in a negative manner

Figure 2: Wind tower at the GBC campus

Use of passive design strategies for energy efficient buildings in cold climatic zone- Himurja Building

Green Buildings

Project Highlights

- No electrical energy is consumed for heating, lighting and hot water during the daytime marks a substantial reduction in building's energy requirement
- Classic example of using passive design strategies to overcome the challenges offered by the cold climatic zone

Background

Himurja office building in Shimla, Himachal Pradesh is a building that stands apart, among others. Built at an altitude of about 2000 m above sea level, in the middle Himalayas, the Himurja building, is a classic example of an energy efficient green building. Considering the climate in Shimla, which is generally cold and cloudy almost throughout the year, a green building to have all energy efficient facilities at this altitude is a little unimaginable. The building would therefore require heating almost throughout the year and good ventilation during summer. Despite the climate, this building has been provided with all the necessary features that are required to make it an energy efficient green building.

Project Objectives

- Overcome challenges of maintaining thermal comfort in a cold climate with passive design strategies and energy efficiency
- Demonstrate the opportunities of being an energy efficient building to create awareness among the building communities within the cold climatic zone

Project Location
Shimla

Building Use
Office Buildings

Climatic Zone
Cold

Project Approach

- The passive design of the building allows for maintains comfortable temperature inside the building and ample daylighting
- Air heating panels are designed to provide effective heat gain through a close connective loop in the southern wall panels
- To optimize the ventilation system, the connective loop is coupled with solar chimneys which are an integral part of the roofing of the building.
- Proper insulation is maintained in the building using 5 cm thick glass wool and minimum fenestration on the northern side to prevent any heat loss. Double glazed windows were considered to prevent heat losses.
- Solariums are designed to exploit a scenic view, others to collect sunlight for warmth and light

- Artificial lighting is not required most of the times in south orientation which are extremely well lighted during summer working hours
- Solar water heater system having a capacity of 1000 litre/day has been erected on the roof top to meet the hot water demand of the building's occupants
- The photovoltaic system of 1.5kWp has been installed to meet the energy requirements for lighting the building

Figure 1: Himurja Office Building, Shimla

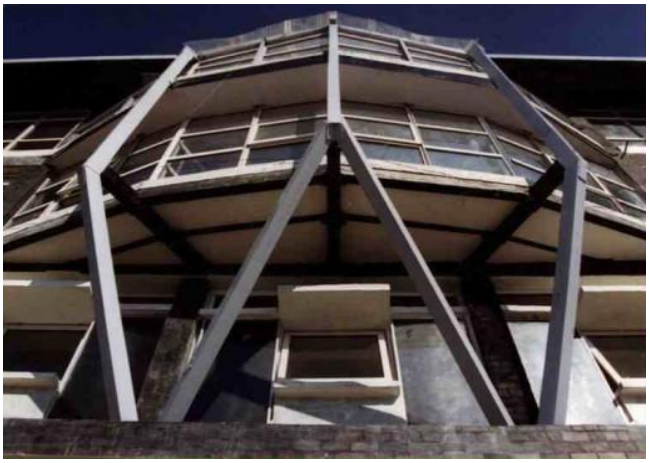

Figure 2: Solarium in Himurja

Government NZEB -Akshay Urja Bhawan, HAREDA office

Green Buildings

Project Highlights

- The building has been constructed on solar passive design techniques having Building Integrated Photovoltaic (BIPV) system to become a Net Zero Energy Building (NZEB)
- The building has been constructed in compliance with the Energy Conservation Building Codes (ECBC) and with five-star rating of Green Rating for Integrated Habitat Assessment (GRIHA) rating system for green buildings

Background

This building houses the offices of the Renewable Energy Department and Haryana Renewable Energy Development Agency (HAREDA). The building has been constructed in compliance with the Energy Conservation Building Codes (ECBC) and with 5-star rating of Green Rating for Integrated Habitat Assessment (GRIHA) rating system for green buildings. The building has been constructed on solar passive design techniques to achieve high energy performance.

Project Objectives

- Utilize onsite solar power generation along with solar passive design strategies to build a Net Zero Energy Building
- Demonstrate the opportunities of being an energy efficient and independent building to create awareness among the building communities

Project Location
Panchkula

Building Use
Office Buildings

Climatic Zone
Composite

Project Approach

- Building Integrated Photovoltaic(BIPV) System with 42.50 kW capacity to supply total annual energy consumption
- Well oriented site and building along cardinal directions
- South glazing provided with horizontal shades and louvers used to maximize the daylight
- To optimize the ventilation system, the connective loop is coupled with solar chimneys which are an integral part of the roofing of the building.
- High insulated building envelopes including double glazed walls for facades are used to reduce the cooling load
- Aerated concrete blocks and insulated roof tiles are used as construction materials

Key Stakeholders

- Haryana Police Housing Corporation
- Architects- Edifice Architects ; MEP Consultants- Green Horizon Consulting
- Department of Renewable Energy/HAREDA

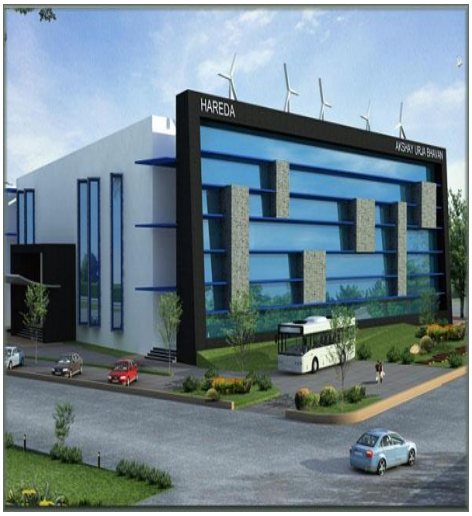

Figure 1: Akshay Urja Bhawan, HAREDA

Figure 2: Solar Power generation at Akshaya Urja Bhawan

Project Achievements

Benefits

- Atal Akshay Urja Bhawan is an iconic landmark building symbolizing energy efficiency and renewable energy with high energy savings

Co Benefits

- For its exemplary design practices, the project has been awarded with five-star rating of Green Rating for Integrated Habitat Assessment (GRIHA) rating system for green buildings

Energy Efficiency strategies in affordable housing projects- SMART GHAR-3

Green Buildings

Project Highlights

- Smart Green Housing at Affordable Rate (GHAR)-III is a housing project under PMAY (Pradhan Mantri Awas Yojana) which incorporates energy efficiency through green technology design strategies
- 1176 energy efficient dwelling units are being built under this project
- Classic example of providing affordable indoor thermal comfort in a climate friendly and energy efficient way

Background

Smart GHAR III (Green Homes at Affordable Rate) is an affordable housing project in Rajkot under the Pradhan Mantri Awas Yojana (PMAY) Untenable Slum Redevelopment. The project is being executed by the Rajkot Municipal Corporation (RMC). The charrette for this project was held in September 2016.

Project Location
Rajkot

Building Use
Residential

Climatic Zone
Hot and dry

Project Objectives

- Demonstrate opportunities in energy efficiency in affordable housing projects in the country
- To effectively use low-cost energy efficient measures in affordable houses to achieve thermal comfort and energy savings

Project Approach

- The walls and roofs are insulated using external insulation (40mm polyurethane) to reduce heat gain
- Partially glazed casement windows are used to provide better natural ventilation as they are 90% openable
- Service shafts are being used between two flats to aid natural ventilation (10 air change rate)
- Rooftop solar photovoltaic (PV) system has been installed by the Rajkot Municipal Corporation for electricity requirements of the common services
- RMC has also provided ground recharge system for rainwater harvesting

Project Achievements

Benefits

- The reduction in the electricity use of the Smart GHAR-III project produces six times the corresponding reduction in CO2 emissions that the same reduction in electricity would produce in Switzerland
- Low-cost measures that reduce the need for active cooling of buildings are especially useful in emerging economies and developing countries like India where air conditioners are often unaffordable for the economically weaker sections

Figure 1: Smart GHAR-III Project- Rajkot

Key Stakeholders

- Bureau of Energy Efficiency
- Swiss Agency for Development and Cooperation on behalf of Swiss Government
- Rajkot Municipal Corporation (RMC)
- Effin 'Art Sarl, Lausanne
- Greentech Knowledge Solutions Pvt. Ltd, New Delhi

Mobility

E-Bus Mobility initiatives in Kerala State RTC

Mobility

Project Highlights

- The Kerala electric vehicle policy has special focus on shifting the public transport fleet to a electric by 2025, also Kerala State Road Transport Corporation proposed to shift it entire fleet to Electric bus by 2025; this pilot project involving 10 Electric Bus is the 1st towards fulfilling this long term goal.

- Procured 10 numbers of 9 meter, AC e-bus and Started Operation at Sabarimala hilly Ghats Roads from December 2018.

Background

Following the Kerala state EV Policy being published, the Kerala State RTC looked into viable routes to conduct pilot project with Electric Bus and the Tender was put out and 10 Electric buses were procured on GCC contract. In an effort to shift to a more sustainable and clean energy transport Kerala State RTC conducted Pilot on Sabarimala hilly Ghats Roads to check the viability of using E-Bus for Public Transport

Project Objectives

- To transition to a Clean energy transport
- Planning operations for efficient and sustainable travel experience

Project Location

Kerala, India

Project Duration

Year of Start: 2019

Key Stakeholders

Kerala State Road transport Corporation (Kerala State RTC) and Kerala State Electricity Board (KSEB)

Project Approach

In an effort to create a more efficient and sustainable public transport services for Kerala; Kerala State RTC undertook a pilot project with 10 electric buses being run on a seasonal high traffic route.

The Pilot was undertaken in order to gauge the efficiency of Electric buses being run on Kerala State RTC.

The outcomes of the pilot were to feed into the state wide shift to Electric bus fleet. The Performance of the buses were constantly monitored and accordingly report was made for acceptability of Electric bus of these routes.

E-Bus Mobility initiatives in Kerala State RTC

Mobility

Financial Structure

- The Project was funded by KSRTC.

Project Achievements

Benefits

- It buses were found viable at Sabarimala due to better fare and occupancy (24 Hr operation).
- The power consumption was @ 1.2 Kw/Km
- It was the first pilot of project implemented in Kerala, and learning from the project is the primary benefit of the project.
- It was noticed that success of the Sabrimala Ghat Roads was primarily due to heavy passenger loads that arrive at the location for pilgrimage trips.
- The efficiency of E-Bus in City routes is yet to be explored, these buses are now running on Thiruvananthapuram – Cochin Route (220 Km – one side route length).

Co-Benefits

The Kerala Private Bus owners association has submitted a proposal requesting seed funding to set up Kerala E-Bus Pvt. Ltd.

Success Factors

- Well accepted by Public in its passenger comfort, pollution and noise free operation.
- The revenue collected was fair
- The bus could run up to 240Km in a full charge.

Limitations

Since the routes are not rationalized there is limitations to selection of routes, for electric bus deployment.

Future Prospects

The Government of Kerala proposes for introducing e-buses in Thiruvananthapuram City (State Capital) by withdrawing the existing diesel buses.

Air Quality

Continuous Ambient Air Quality Monitoring stations (CAAQMS) in Delhi

Air Quality

Project Highlights

- 38 Continuous Ambient Air Quality Monitoring stations (CAAQMS) in Delhi
- Provides real-time air quality data
- Mass awareness to public on air quality

Background

Delhi, the capital of India, has been facing high air pollution from last 2 decades. To provide information on existing air quality on real-time basis, CPCB along with DPCC and IMD has installed 38 Continuous Ambient Air Quality Monitoring stations (CAAQMS) in Delhi (population: 1,67,87,941 as per 2011 census) out of 191 in India.

Project Objectives

1. To augment monitoring of air quality in Delhi

2. To disseminate air quality information to general public

Project Location

Delhi

Project Duration

Year of Start: 2007

Key Stakeholders

Central Pollution Control Board (CPCB), Delhi Pollution Control Committee (DPCC), Indian Meteorological Department (IMD)

Project Approach

CAAQMS are spread out in Delhi on different locations to monitor air pollution levels. The 03 organizations manage their stations separately, however data goes into a single portal of CPCB servers (https://app.cpcbccr.com/ccr/#/caaqm-dashboard/caaqm-landing).

- Monitoring data is collected every 15 minutes.
- Measured ambient concentration of a pollutant is scrutinized before publishing in public domain to eliminate any error.
- Monitoring instruments are calibrated regularly to get accurate air quality data.
- Data is communicated in the form of Air Quality Index (AQI) in simple terms of one number and one color for general public.
- Citizens can access air quality data on website and on a mobile "Sameer" by location
- CAAQMS is a tool for effective communication of air quality status to people

Continuous Ambient Air Quality Monitoring stations (CAAQMS) in Delhi

Air Quality

Financial Structure

Project Achievements

Benefits

- 38 (out of 191 in India) Continuous Ambient Air Quality Monitoring stations (CAAQMS) in Delhi covers a population of 1,67,87,941 (as per 2011 census) (with 4,41,788 population per sensor)
- Provides air quality data on real-time basis (on 15 minutes interval).
- Apart from monitoring of Sulphur Dioxide (SO2), Oxides of Nitrogen as NO2, Respirable Suspended Particulate Matter (RSPM / PM10) and Fine Particulate Matter (PM2.5), other parameters, such as NO, NO2, NOx, CO, CO2, Ozone, Black Carbon, Benzene, Toluene, Eth-Benzene, Xylene, Temp, SO2, VWS, NH3, MP-Xylene, RF,P-Xylene, O Xylene, ETH,CH4, NMHC,THC are also being monitored
- Due to availability of real-time data, Air Quality Index is available on 24-hours basis.
- Health advisory is being communicated to public regularly and make public aware of the pollution situation.
- Media has started reporting the air quality in the country on day-to-day basis.
- Through "Sameer" mobile app, air quality can be accessed location wise

Co-Benefits

- Archived air quality data is available
- Monitoring of meteorological parameters Wind Speed, Wind Direction, Gust, Variance, Atmospheric Temperature, Relative Humidity, Solar Radiation, Pressure, Power, Rack Temperature are also being monitored.
- Better linkages among emissions, weather, pollution.

Success Factors

- Strong and stable leadership
- Technical innovations

Limitations

- Only provides air quality constituents concentration. Hence, can't identify exact sources of pollution.
- Sometimes data is missing for long periods of time with no description for the reasons behind missing data

Future Prospects

- Air quality forecasting
- Monitoring of Ultrafine particles
- Satellite information can be corelated with ground air quality monitoring stations covering larger area
- Better siting and addition of more stations can be leveraged for exposure and health assessment studies