Greening of Godrej Bhavan

External view of Godrej Bhavan

By Rumi P. Engineer
Associate General Manager - Green Building Consultancy Services
Godrej & Boyce Mfg. Co. Ltd., Mumbai

Godrej Bhavan (GB) is located in the busy downtown Fort business area of South Mumbai. Constructed in 1972, it houses offices from first to sixth floors, and an exclusive retail showroom for the company's products on the ground floor. The basement houses the utilities. GB has a built up area of about 41,000 sq ft, of which about 23,500 sq ft is air conditioned.

The journey towards greening of GB started work two years back, when it was decided to convert it into one of the most sustainable buildings in India. The decision to go in for USGBC LEED certification in the Existing Building category brought about a focus that guided the retrofit strategy.

The first step was to evaluate and understand the existing operations and maintenance (O&M) processes. Thereafter, planning and scheduling for retrofits was chalked out with the project team, to be executed in a phased manner. Innovative solutions were worked out for the unique challenges involved. The past year's comprehensive records on energy, water, purchase and waste management were compiled and submitted for certification assessment, to serve as the baseline for measuring improvements.

Green Building Consultancy Service (GBCS) division of Godrej & Boyce was the driving force behind the project, guiding diverse functions like construction, gardening, procurement, waste management, electrical, HVAC and maintenance together with building occupants.

Breathing New Life into Godrej Bhavan
Highlights of Project Achievements

- Energy saving of 15%
- Water saving of 30%
- Reduction in waste from land refill: 90%

First building in Mumbai and sixth in India to achieve
Gold Certification under USGBC LEED - EB O&M V.2

Key Green Features of Retrofit

Good building envelope

- Roof garden
- Natural day-light harvesting in the occupied areas
- Natural surrounding with trees, which helps to maintain the microclimate
- Operable windows for fresh air
- Recessed glazing and shading devices

Electro - mechanical System

- Energy efficient screw chillers with primary variable pumping system
- Retrofitted T-8 fluorescent tube lights with T-5 (HE) low-mercury tube lights

About the Author

Rumi Engineer is Associate General Manager – Green Building Consultancy Services & Energy Management Services at Godrej & Boyce, Mumbai. He is LEED AP (USGBC), BEE certified Energy Manager, and Certified Sustainability Assurance Practitioner by CII-ITC Centre of Excellence for Sustainable Development.

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Water Savings

- Low flow/ flush water fixtures
- Reduction in potable water usage
- Non-potable water for landscaping, flushing and cooling tower make up

Waste Management

- Collection and segregation of recyclable waste
- Diversion of dry waste to authorised recyclers, and wet waste to vermin-composting plant
- Disposal of e-waste in an environment-friendly way

System Retrofit Details

There were three major systems in the building which required attention:

a. HVAC System
b. Electrical System: power distribution and energy metering and monitoring
c. Plumbing & Water Management

One of the major challenges was that there were no Architectural, Electrical, HVAC or Plumbing drawings available. We had to start from scratch, by preparing as-built drawings of the building structure.

HVAC system

The retrofit objective was to redesign the HVAC system to bring about energy efficiency enhancement, improved thermal comfort and indoor air quality, flexibility in operations and ease of maintenance. The improvements made in the HVAC system and their impact in terms of energy saving and other benefits are enumerated below:

Condensing Unit/Chiller Package

Old:

Central DX plant with reciprocating compressor, having mechanical unloading in steps. Rated capacity 120 TR.

R-22 refrigerant.

New:

Screw chiller package with 5.5 COP; specific power consumption 0.65 kW/TR, having electronic expansion valve with fine linear control over loading and unloading. Rated capacity 152 TR.

R-134a refrigerant which addresses ODP/ GDP concerns.

Condenser

Old:

Water-cooled. Fixed speed condenser pumping system (1 working +1 standby). Water flow meters were not provided.

New:

Water-cooled. Variable condenser pumping system (1 working + 1 standby). So as not to compromise on condenser fouling or rise in condensing pressure, water flow meters have been installed in the condenser header which restrict the modulation of condenser water pump (CWP) and maintain a minimum water flow rate across the condenser at all times.

Cooling towers: 2 x 80 TR – not replaced.

a. Fills and motors changed.
b. Conductivity meter installed to control total dissolved solids (TDS) by auto blow down.
c. Temperature controller installed to cycle the operation of CT fans w.r.t. set point of condenser entering temperature.

AHUs

Old:

Two DX central units of 228,000 CFM each for cooling the entire six floors and retail showroom, with:

a. Common supply GI duct encased in masonry duct which acted as common return (see *Figure 1*).
b. No individual temperature control on each floor.
c. If one floor required cooling, all other floors had to be unnecessarily cooled.
d. Electro-mechanical thermostat was installed in return air to cycle the compressor, which was ineffective as a control.

New:

Dedicated AHUs for each floor; VFD and chilled water modulating valves to control temperature and RH in occupied space for better thermal comfort. Fresh air provision in each AHU room, leading to improvement in indoor air quality.

> **USGBC (United States Green Building Council)** is a non-profit organization committed to a prosperous and sustainable future, through cost-efficient and energy-saving green buildings. To propagate the message of sustainability, a rating system has evolved.
>
> **LEED (Leadership in Energy & Environmental Design)** is the rating system for various types of construction:
>
> - **LEED NC/CS** (New Construction/Core & Shell) for new buildings being constructed. The emphasis is on design aspects of the building.
> - **LEED–EB O&M** (Existing Buildings Operations & Maintenance) for retrofits of existing buildings. The emphasis is on best management practices in Operations and Maintenance of the building. Optimization of key resources like energy, water, policies and implementation of sustainable purchase and waste management etc. play significant roles in the rating.
>
> In an existing building, the architectural design, facade, glazing, HVAC system, and lighting are already in place. Hence, the challenge is not best design, but to best utilise the design and Operations & Maintenance (O&M) of systems. The rating system for existing buildings under USGBC is referred to as LEED – EB O&M.

Chilled water system

Variable chilled water primary pumping system (1 working +1 standby); reference from DP in chilled water line modulates the primary chilled water pump, contributing to energy efficiency.

Minimum flow is maintained at any given time across the chiller; primary pump flow is varied by operation of chilled water modulating valve across the AHU; water flow is diverted to chiller by a decoupler line and a modulating valve installed at the chiller header.

Integration with Building Management System

There is a control panel displaying all the operating

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parameters and energy used. BMS has transformed the Operations & Maintenance practices in the building. Facilities staff have been able to notch up productivity to a higher level. Increased accountability has been institutionalized amongst the Facilities & Maintenance staff.

Challenges in implementing the retrofit

- Replacement of the existing system with the building being operational and without shifting the occupants
- Safety
- Construction waste management

It took more than six months to complete the retrofit as some of the major work could only be carried out on weekends.

Strategy to overcome retrofit challenges

1. Screw chiller was installed with chilled water and condenser water pumps and cooling tower. The high side system was integrated with AHUs in a phased manner.
2. Chilled water line was installed in the masonry duct and kept ready with connections at each floor.
3. Existing GI ducting of the DX system was dismantled from sixth floor downwards; simultaneously, the installation of AHUs with connection to the chilled water line was done for the respective floor. This was the most critical activity in the HVAC retrofit exercise.
4. Both the systems – reciprocating DX and screw chiller - were operated in parallel during de-commissioning of old ducting and commissioning of new AHUs.
5. Meticulous planning and thorough understanding of electrical controls was required, to operate the two systems in parallel considering safety interlocks etc.
6. Subsequently, the new system was gradually integrated with the BMS.
7. Custom made screens for monitoring of all AC parameters were developed, to ensure the following:
   a. Understanding and analysis of data by the Facilities staff
   b. Correlation of energy consumption with the operations
   c. Reports to display the defined set values against process values, to enable the operator take corrective action

Figure 1 and *Photo 1* depict the old supply duct common for all floors, and the reciprocating compressor. *Photo 3* shows the new screw chiller that replaced the old reciprocating condensing unit shown in *Photo 2*.

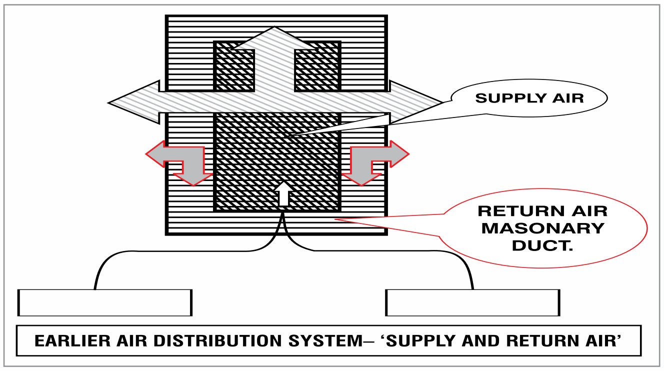

Figure 1: Old GI supply air duct encased in masonry duct that served as common return air passage from all floors

Photo 1: Old main duct from AHU

Photo 2: Old reciprocating condensing unit

Photo 3: New screw chiller that replaced the old condensing unit

Photo 4: Old HT panels

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Photo 5: New LT Panels

Photo 6: New HVAC panel that houses VFDs and digital energy meters

Electrical System

The incoming electrical supply to Godrej Bhavan is at 11kV from Brihanmumbai Electric Supply & Transport Undertaking (BEST). The power is distributed in the premises by two transformers of 250 kVA each. The improvements made in the electrical system and their impact in terms of energy saving and other benefits are listed in *Table 1*.

Photo 4 shows the old HT panels, which were replaced by panels and digital energy meters with BMS connectivity, shown in *Photo 5*. *Photo 6* shows the new HVAC panel with VFDs and digital energy meters.

Plumbing & Water Management

Water Quality

Water quality plays a vital role in sustaining energy efficiency in any water cooled system. Total dissolved solids (TDS) in water are critical components to be monitored on a continuous basis through water quality tests. We used a water softener to treat the water for hardness, and conductivity meter at cooling tower for auto bleed-off to maintain TDS level in the circulating water.

In the absence of close monitoring of softener functioning, it was experienced that the condenser approach rose to 5°C (10°F) against the normal value of 1.5°C (3°F). This adversely impacted the energy efficiency of the system. The approach was brought back to 1.5°C (3°F) after descaling and proper maintenance of the softener.

The idea was to keep a close watch on the condenser approach, water quality and TDS level in the circulating and make up water. BMS screens have been configured such that real time-of-day and historical data capture these parameters.

Water Distribution

GB has two sources of water; municipal water for potable use, and ground water for non-potable purposes.

Table 1: Improvements in the Electrical System

System component	Existing system	New system	Improvement in terms of annual energy saving/ other benefits
HT Incomer	11 kV OFS a. No indication of voltage, current, tripping on fault b. Limited protection level c. Spares obsolescence	RMU (Ring Main Unit)	i. Indication of incoming/ outgoing supply ii. Protections like overload, short circuit, earth fault
HT Outgoing	11 kV Isolator	RMU	Same as above
Transformer	2 x 250 kVA	2 x 250 kVA (retained)	---
Switchgear	Difficult to access for operations & maintenance	Relocated HT/ LT switchgear room	Ease of operations & maintenance
LT System	Improper distribution, did not facilitate accountability of energy use, limited protection	Incomer: 2 nos. Bus coupler: I no. Outgoing feeders: dedicated for each load point	a. Facilitated metering of each of the load points in building b. Enhanced protection features c. Flexibility in operations
Energy metering	Only main incoming supply metered	All energy meters BMS compatible	Accountability for all energy end use
Lighting	FTL: T-8/12 lamps with electromagnetic ballast	a. FTL: T-5 HE (high efficiency) lamps with electronic ballast: Lamp life : 27,000 burning hours Mercury content : 1.4 mg/ tube b. Timers to switch off lights after office hours	This measure has helped in direct reduction of energy, and indirect heat load on AC system

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Distribution of LEED - EB O&M Rating Points Awarded to Godrej Bhavan

Sustainable Sites	7/12
Water Efficiency	9/10
Energy & Atmosphere	18/30
Materials and Resources	10/14
Indoor Environmental Quality	7/19
Innovation & Design	5/7
Total (Out of a possible 92 points)	**56**

Earlier, in absence of water metering, there was a lack of understanding of the end use of water in the building.

The end use of water is as follows:

a. Potable water
b. Flushing
c. Cooling tower make up
d. Landscape
e. Cleaning

Measures to save potable municipal water:

i) Water meters were installed on all the risers to monitor the end use. It was observed that significant quantity of potable water was used for cooling tower make up, flushing, landscape and cleaning.
ii) Plumbing system was modified to switch over from municipal to ground water for these applications.
iii) Dual flush, low-flow fixtures with sensors or Pressmatic controls were installed.
iv) Conductivity meter at cooling tower bleeds off water in a controlled manner to maintain TDS.
v) Building occupants were sensitized to these measures.

These measures reduced municipal water consumption by 30%.

Conclusion

The best practices institutionalized during the journey towards USGBC LEED EB – O&M certification provided an outline for enhancement of building performance. The certification process helped to identify the gaps in operations and maintenance, and to develop a viable strategy to bridge the gaps. The benefits reaped in the process include:

i) Optimization of energy, water end use and natural resources
ii) Environment friendly waste management
iii) Improvement in indoor environment
iv) Continual focus on operating efficiencies
v) Improvement in the building's systems performance
vi) Focus on cost streams associated with building operations
vii) Improvement in occupant comfort resulting in employee productivity
viii) Awareness among building occupants and visitors regarding the benign impact on environment
ix) Public recognition for leadership in sustainability
x) Showcasing for other corporates to emulate