A Paradigm of Self-Sufficiency—INDIRA PARYAVARAN BHAWAN

Deependra Prashad and Saswati Chetia explore the Indira Paryavaran Bhawan situated in New Delhi, which is based on the concept of Net Zero Building (NZEB). This building aims to be self-reliant in every aspect of its overall functioning as a sustainable structure.

In this era of climate change and environmental degradation, a large variety of mitigation measures such as, initiatives targeting sustainable building are urgently required. These include the construction of green buildings, utilization of building rating systems, energy codes, and many other prescriptions. With this background, there are projects which have been developed at the cutting edge of sustainable building and are developing a new paradigm of self-sufficiency. Net Zero Building projects (NZEBs) are targeting to push the envelope further, by being self-sufficient, not just in terms of their electricity consumption but with an overall minimal dependence on other resources.

Background
Indira Paryavaran Bhawan, the new structure, housing the Ministry of Environment and Forests (MoEF) is targeted as the first large-scale building in the country to achieve the Net Zero and Energy Positive tag and also the first government building to do so. This building, which includes the minister’s office and various administrative sections of the ministry, is located at Aliganj on Jor Bagh Road in South Delhi (Picture 1).

The land on which the building is constructed, was originally a single storey decrepit government housing which under a change of land use was reassigned.
to the government office function. Despite the change in land use, the mandate of the Ministry’s building remained as providing minimum change and disturbance to the surrounding ecosystem, including the predominantly green character of the surroundings, while still optimally utilizing the tight urban site of almost a hectare.

This building reflects the growing role of the ministry in regulating and channelizing India’s development into a sustainable paradigm. This mandate was carried forward by the Central Public Works Department (CPWD) and the sustainable design consultants, Deependra Prashad, Architects and Planners (DPAP) at every level to design a building which is not just energy efficient but is also able to create more energy onsite than it consumes over a functional year. Apart from aiming to be a Net Zero Building, the project has also achieved the 5-star GRIHA Green Rating and is targeting the LEED India NC Platinum rating system through a slew of measures both in the passive and the active design of building envelope, the usage of materials, service provision, and also by following a range of environment-friendly processes within the construction programme.

Developing Indira Paryavaran Bhawan

One of the first design considerations was to try and preserve as many numbers of the existing trees as was possible, given the site constraints of the building without compromising on its functional efficiency and user comfort. The building design went through various iterations with the final design being a twin North-South facing blocks with a large open space court in the center (Figure 1). The maximum allowed ground coverage was used to keep the building height in tune with the surroundings. Although permission was granted for cutting down 46 trees, the proposed design and measures helped reduce the chopping to only 19 trees. Even so, a large number of native trees, much higher than the basic GRIHA requirement of three times those cut, have been replanted onsite. The project landscaping has been designed not just to act as a climate modifier but to also showcase the plant diversity within the country (Picture 2).

Water Efficiency

The site management and landscaping also contribute to a water-efficient site. Planting native species and utilization of efficient irrigation systems, lead up to a 50 per cent reduction in landscaping water requirement. This reduced demand will be met by recycling, reusing the building’s waste water, and rainwater harvesting. The building’s water requirement has been brought down by the usage of water-efficient fixtures. The emphasis here is not just on water-efficiency but effective site water
management and zero-discharge with no water being let out into the city storm water system or the sewer system (Figure 2).

Figure 2: Efficient water-use and reuse cycle in Indira Paryavaran Bhawan makes it a zero-discharge building

Besides being water-efficient in design, the building’s construction managers, i.e., the CPWD have been quite innovative in its construction process. It involved a large dewatering process of the construction pit due to the high groundwater level of the site which is 9m tall. To ensure that the dewatering process does not deprive the local ecosystem of water, the extracted water was recharged into the ground at a distance of 250m from the site. In addition, this extracted water was also supplied free of cost to the New Delhi Municipal Corporation (NDMC) water tankers on a regular basis to augment the water supply of the city. This contrasts with the usual practice of pushing the water into municipal drains which creates an added burden on the city’s infrastructure.

Another major design intervention was zero tolerance to surface parking as planned by the design team. A state-of-the-art three level parking is provided to cater to peak load during office hours with preferred parking for CNG/electric vehicles and carpools. This along with the proximity of the site to the bus and metro-transit lines also provides incentive to use the public transport system rather than private vehicles.

The building is also planned to provide preferred front entrance directly, in a way creating a ‘priority for the pedestrians’. Vehicles enter from the side and need to go to the back for entering the basement. This decision taken by the client and the architect has resulted in less paved area on the site, wherein grass pavers have been provided all around. Instead of the usual concrete grass pavers, a large number of polymer plastic grids have been provided, which make the surface completely soft, resulting in the reduced surface run-off and increasing water percolation (Picture 3). Another tangible benefit of less paved area is a lower contribution of the building to the Urban Heat Island (UHI) effect. The UHI effect leads to an overall build up of temperatures in highly urbanized/concretized areas by the absorption and reradiation of solar heat on hard surfaces. The parking itself has been planned as a compact robotic parking, which due to efficient usage of space, accommodates the required cars within three storeys, as compared to the six basement storeys provided in usual basements.

Building Configuration and Envelope: Passive Means of Reducing Operational Energy

The building configuration and the passive design of the building envelope are planned to reduce its operational energy requirements. The building orientation, which is
developed primarily as North–South, by dividing it into two long blocks, reduces the heat ingress into the building and develops a shaded central landscaped court (Figure 3). This central courtyard, along with the large lower level punctures into the building envelope, aid in cross ventilation (see Figure 3).

Figure 3: The courtyard serves multiple purposes. It creates a landscaped connection with the rest of the vegetation on the site, aids cross ventilation within the building and acts as a human interaction area. The hot air escapes easily, while the cool air is preserved.

Some of the other significant design measures include:

- The fenestration shading design is appropriate for the entire building and the reduction in the window-to-wall ratio helps to lessen the heat gain as well the need for a high efficiency glass.
- The window shading and the courtyard openings are designed to reduce summer heat gain and also to allow in the winter sun. Most of the fenestration and habitable areas are located on the outer periphery, which permits good daylighting and view of the scenic surroundings from most of the locations of the office floorplate (Figure 4).
- A large number of spaces including passages and lobbies are developed as non-conditioned spaces with provision for natural cooling and shading through stone jaalis. These designed stone jaalis also showcase a strong craft tradition of the country (Picture 4).

Figure 4: The shaded and vegetated passages in one of the upper floor plans.

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Figure 5: The terrace garden utilizes preserved top soil extracted during the initial excavation.

Picture 4: Brown and beige coloured stone jaalis covering the vertical movement cores, thus eliminating the need to air condition these spaces.
Green Material Choices

The choice of materials is governed by two main criteria—reduction in embodied energy of the construction and further reduction in the operational energy. The first criteria necessitated using materials with:

- Recycled content viz., PPC (fly ash-based cement), AAC blocks which uses fly ash in its constitution in place of the normal bricks for the walls, Terrazo tile flooring which includes reusing waste stone pieces.
- Local availability of materials viz. Kota stone, marble from Rajasthan, Jhansi granite, and simultaneously avoiding granite from afar, say South India.
- Rapidly renewable content viz, bamboo jute composite doors wherein bamboo is a natural resource which can be replenished faster than regular timber trees.

The reduction in operational energy by reduced HVAC load occurs by utilizing good insulation in the building interiors, for instance, AAC blocks for the walls have been chosen. Similarly, high albedo tiles are used on the roof and UPVC windows with composite sections are used for better insulation which reduces the cooling requirement of the building.

Active Measures of Promoting Energy Efficiency

With the building designed to reduce the energy demand, the next step automatically was to equip it with efficient mechanical and lighting systems. The HVAC system at IPB has used the Adaptive Comfort Model that accounts for our physiological capacities to adapt to a wider range of temperature and humidity conditions in real life. Using this model, the performance parameters for different electrical uses was made more efficient in comparison to the conventional standards for instance, air-conditioning load is designed for 450 sq. ft per TR instead of 150 sq. ft per TR, lighting power density at 0.5 W per sq. ft instead of 1.1 W per sq. ft and other electrical loads at 4.5 W per sq. ft instead of 10 W per sq. ft (Picture 6).

An important decision by the ministry was to regulate the set point temperature to 26 °C ± 1 with an emphasis on lowering the thermal shock when moving between outdoors and indoors. This is more appropriate than the usual 20–22 °C and also promotes a climatically appropriate lifestyle. The other measures proposed for making the space conditioning in the building energy-efficient are:

- Part condenser water heat rejection by geothermal mechanism with a closed loop piping which minimizes the need for make-up water. This also helps in water conservation in cooling towers for the HVAC system.
- Chilled beam technology which reduces energy consumption by utilizing radiative cooling panels that depend on localized induction cooling by chilled water. This also reduces the AHU/FCU fan power consumption as it avoids the need for large quantities if air travel from the user space to the heat exchange point.
- Chilled water pumping system through DPS (Differential Pressure Sensor) and VFD (Variable Frequency Drive) which allows for separate control for the various spaces.
- VFD on cooling towers fans and air handling units
- Pre-cooling of fresh air from the toilet exhaust air through sensible and latent heat energy recovery wheel.
Other measures promoting energy-efficient systems (Figure 6) include:

- Better daylighting of the workspaces.
- Energy-efficient lighting fixtures fittings (T-5/T-8/LED lamps, etc.) improving the requirements as enshrined in the Energy Conservation Building Code, 2007 to reduce energy demand.
- Use of Lux level sensor to optimize operation of artificial lighting.
- Integrated Building Management System (IBMS) for optimizing energy consumption, performance monitoring, etc.
- High-efficiency Cast Resin Dry Transformers for electric substation. DG sets for captive power generation.
- Regenerative lifts which also produce some power in the course of their functioning.
- Entire hot water generation through solar hot water heating system.
- Shared usage of office equipment.
- Promotion of usage of BEE rated appliances within the building.
- Usage of ‘thin client’ systems which provide only terminals to the end-user with common servers for groups of terminals. This highly reduces power usage of separate computer CPUs.
- Solar-powered external lighting.

**Going Beyond Energy-efficiency**

With the goal of not just being energy-efficient but also energy-positive, the MoEF seeks to set an example of energy conservation and best practices regarding the same. A solar photovoltaic system of 930 kWP is installed on the rooftop and on cantilevers protruding out from the building. Highly efficient solar panels above the terrace and the southern façade would produce more energy than required by the building over the period of a functional year. The photovoltaic panels, besides producing energy, also shade the roof, some parts of the walls and the courtyard, thus creating a cooler ground space (Picture 7). It is hoped that this endorsement of large-scale rooftop photovoltaics shall lead to research and development and manufacturing of indigenous high-efficiency solar panels in the future and their widespread usage in a decentralized manner.

**A Larger Vision**

The Indira Paryavaran Bhawan is an ambitious endeavour to direct future building growth towards a path that is sustainable in all respects, be it self-sufficiency in energy and water or in ensuring the least possible environmental damage in developing urban areas. As a best practice for disseminating ideas incorporated, a separate website has been created for the project, which highlights its construction updates, features, and green provisions.

As described above, the challenges of creating a Net-Zero building on a tight urban site are not just to do with a provision of an on-site energy generation—in this case a solar photovoltaic system—but more to do with a systematic reduction of electrical loads through passive and active measures at all levels of the building and service design. The success of this endeavour is expected to pave the way for many other decentralized urban initiatives aimed at self-sufficiency in energy and other resources within the built environment.

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