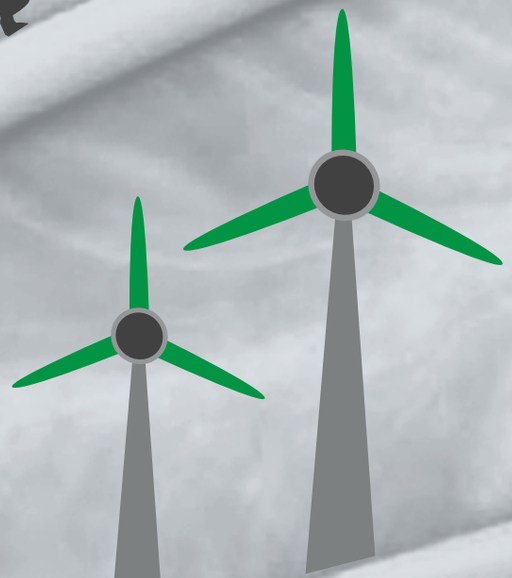
Pathways to Green India

Innovative Ideas for Public Spaces

Volume II



EARTH DAY NETWORK

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December 15, 2017

Dear Reader

Growing out of the first Earth Day (April 22, 1970), Earth Day Network now engages with over 50,000 partners in 195 countries to broaden, diversify and mobilize the environmental movement. Over one billion people take part each year in Earth Day activities making it the largest civic observance in the world.

In keeping with our conviction that Earth's future relies on implementing green sustainable practices, Earth Day Network, India, has put together this eBook that showcases innovative ideas adopted for public spaces. We hope you enjoy reading the 24 case studies that cover a plethora of subjects, from waste and water management, use of renewable energies, site orientation and materials, to the judicious use of resources (in one case, even discarded ones), increase of green cover and many more. Read about how factories, commercial and religious spaces, parks, watersheds, hospitals, police stations, management schools, research organizations, government buildings and others have chosen to go green.

This volume covers varied case studies—those that talk about coming full circle to adopt traditional green building practices in modern structures, and those that extol the use of modern, cutting edge technologies to make their spaces environment-friendly.

Taking from ancient practices, the system of underground tunnels for cooling India's 17th century Red Fort is now built into a structure in Gurugram (formerly Gurgaon). Much before the invention of air conditioning, this and other systems helped keep buildings cool in spite of the searing heat outdoors. You will find several references to the incorporation of "jallies" (lattice screens made of stone, once common in Western India), into the walls of modern structures. As architects explain, these not only provide privacy, but also act as thermal buffers. The antibacterial limestone or "chunna" paint for walls has made a revival because it is now understood that it allows walls to breathe. Minarets as wind scoops, "baghs" or gardens around factories to help conserve biodiversity and build the green cover, recycling "kabaad" or discarded items to set up new buildings—all these and more are described in this eBook.

With global warming threatening the planet and resources running out, perhaps it is time to study how historical edifices such as the one at Burhanpur, where Mumtaz Mahal was first interred for months, and also her final resting place, the famous Taj Mahal at Agra, were acclimatized. In a time when water scarcity threatens India, perhaps we can revive the "tankhas" or underground water reservoirs that stored enough water to see people through dry spells, something the Ahmedabad Municipal Corporation has begun to do. Can we recreate "baoris" (stepwells) that once provided a salubrious-environment to weary travelers?

The water at the bottom of stepwells evaporates, taking the heat with it, thus providing cool spaces for those who walk down. Could we revive the architectural design of “nadumuttams” or central open courtyards that help circulate air and thus reduce air conditioning cost?

There are also numerous examples of the use of the most innovative modern green technologies that many case studies tell us about. For example, benefits of Radiant Cooling, how construction designs maximize daylight entering a building, and site orientations catch the wind, making savings in cooling costs. Energy-efficient lighting systems, Sequential Batch Reactor technology, techniques to procure biomethane from waste food and low water use valves are just a few of the examples you will read about in this eBook.

Apart from being green and economical, all of the case studies are adaptable and replicable as well. To help connect you to those that can increase your understanding of the techniques described, we have included the contact details of the relevant person at the end of each chapter.

Earth Day Network is very grateful to all those who contributed to the eBook, and to our India Team, which worked tirelessly to put together this volume. Furthermore, we are very grateful to Wysiwyg Communications for designing the eBook for us as part of their Corporate Social Responsibility program.

Regards,

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President

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Country Director, India

A Benchmark

A Benchmark

The Government of India's Ministry of Environment, Forest and Climate Change (MoEF&CC) is responsible for planning, promoting, coordinating and overseeing the implementation of the country's environment and forest policies and programs. It is guided by the principle of sustainable development and the enhancement of human well-being.

In 2014, in New Delhi, the Ministry inaugurated the Indira Paryavaran Bhawan. This is India's first On-Site Net Zero Energy Building. It reflects the Ministry's philosophy of efficiency in the use of natural resources and the minimization of the impact of construction on human habitats and the environment. The Indira Paryavaran Bhawan has won accolades for doing this and a 5 Star Rating by Green Rating for Integrated Habitat Assessment (GRIHA). It has also received Platinum Rating from India's Green Building Council.

Right from the planning stage, parameters were laid down to ensure that the design was environment-friendly yet state-of-the-art. To develop the over 9,000 square meter site, only a bare minimum number of trees that earlier stood on it were cleared. The building allows free ventilation across its entirety and its architectural design uses durable and highly recyclable building materials. The construction supplies (such as sandstone), were sourced locally, avoiding carbon footprint resulting from transportation. The terrace has high reflectance tiles, while the outer walls have rock wool insulators. Low heat transmission glass and window panes that are hermetically sealed make for cooler spaces. The blueprint assures 75 percent daylight with the result that there is a reduction of conventional lighting. The electricity required is generated by a 930 kWp on-site solar power generating unit. Mono-crystalline photovoltaic panels cover an area of 4,600 square meters. Solar Passive Architecture with the best orientation and fenestrations keep the building cool. The Indira Paryavaran Bhawan is one of the rare projects in which Fly Ash Blended concrete is used as well as Fly Ash bricks. Aluminum, known to have high embedded energy, is avoided. Door frames and shutters are made of renewable, jute-bamboo composites. Only Low Volatile Organic Compound paints, sealants and solvents are used to enable better air quality. An Intelligent Building Management System to optimize energy consumption is also an integral part of the design.

Indira Paryavaran Bhawan is a Net Zero Energy Building. As is required by all such buildings, it first reduced its energy demand by using energy efficient technologies and then utilized renewable energy sources to meet the remainder. The energy conservation measures adopted by the building to optimize the overall design load include the following: use of energy-efficient T-5 and LED lights; light shelves for diffused lighting; an innovative chilled beam system that cools by using convection currents; a system that loads fresh air into the chiller plant by using a heat recovery wheel; and water cooled chillers. Double skin air handling units with variable frequency drives, further help lessen energy requirements. Around 200 boreholes, dug in the periphery of the structure, enable geothermal heat ex-

change and heat rejection from the air conditioning system. The method allows hot air to cool before it reaches the cooling towers. Thus, there is minimal loss of water, which would normally take place in the cooling towers. Energy is saved since the make-up water pumping and treatment is eliminated as there is hardly any loss of water by evaporation and leakages. The Indira Paryavaran Bhawan has innovative, energy saving regenerative lifts—the first of their type to be installed in any Indian government building. The second criterion of Net Zero Energy Buildings of meeting the required energy demand by renewables is also fulfilled. High efficiency solar panels generate enough energy to meet the annual demand of 1,400,000 kWh.

The precious natural resource, water, is also conserved. The water conservation measures adopted include low discharge water fixtures and dual flushing cisterns, drip irrigation systems for green areas, water tanks for chiller plants, a waste water treatment plant, geothermal heat exchange systems to heat water and rain water harvesting to feed fresh water requirements. Furthermore, the flora planted outdoors is of the type that requires less water.

A robotic car park accommodates 330 vehicles with slots for electric cars. Importantly, the building is earthquake resistant, because New Delhi is located in Earthquake Zone 4—a high damage risk zone.

Over half of the outdoor space has plants and grass growing on it. Roads and pathways have grass paver blocks to enable ground water recharge. A beautiful terrace garden on the seventh floor adds even more greenery to the building. The front and rear blocks of the building are separated by a large, open, central courtyard with a huge atrium that is four storeys high in the front block.

The landmark Indira Paryavaran Bhawan truly epitomizes how buildings can be green and help in reducing their carbon footprint. It is a benchmark for sustainable urban structures.

Ministry of Environment, Forest and Climate Change
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A Green Space Research Organization

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The National Remote Sensing Centre (NRSC) is a full-fledged center of the Indian Space Research Organization (ISRO). This premier organization in the field of space research is located in Hyderabad, Telangana. NRSC is responsible for remote sensing satellite data acquisition and processing, data dissemination, aerial remote sensing and decision support for disaster management. It also sets up data reception stations for acquiring data from remote sensing satellites and engages in collaboration projects with stakeholders from different sectors such as education, weather, mining, transportation, disaster management, among others.

The NRSC planned to develop a new campus at Shadnagar, a town close to Hyderabad. The officials were eager that this facility incorporate sustainable features and green building technologies. A renowned R&D facility such as NRSC that runs operations 24x7 has its own challenge in terms of uninterrupted operations. To design, build and operate a facility that included environment-friendly performance and sustainability requirements was a difficult obstacle to overcome. Nevertheless, the NRSC Team was insistent about one thing: the new facility had to be designed to be a green building. And, not just any green building, but one that met the Platinum Rating standards set up by LEED (Leadership in Energy and Environmental Design), because a LEED plaque on a building is recognized the world over as an attestation of quality and achievement in green buildings.

LEED certification allows for the design, construction, operation and maintenance of resource-efficient, high-performing, healthy, cost-effective buildings. It is the triple bottom line in action benefiting people, planet, and profit. LEED certified buildings mean healthier, more productive places, reduced stress on the environment by encouraging energy-efficient and resource-efficient buildings, and savings from increased building value, higher lease rates, and decreased utility costs.

All LEED projects earn points across nine basic areas that address key aspects of green buildings—integrative process, location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation, and regional priority. Based on the number of points achieved, a project earns one of four LEED rating levels: Certified, Silver, Gold, or Platinum.

Conserve Consultants Pvt Ltd—a global consulting firm in the business of planning, design, development and maintenance of energy-efficient, sustainable, high performance green buildings and organizations—was awarded the contract. From the design stage itself, all ideas and strategies were developed around the goal of attaining a LEED Platinum Rat-

ing. The blueprint kept in mind that minimum heat ingress and maximum natural lighting (without glare) were a part of the design. Envelope materials such as aerocon blocks for the walls, high reflective paint with under deck insulation of the roof, high performance glazing, efficient lighting design, occupancy sensors and day lighting controls, a variable air volume system, efficient water-cooled centrifugal chillers, secondary chilled water pumps with VFD, renewable energy through photovoltaic panels, were all incorporated to LEED mandates.

After conducting numerous analyses, the NRSC's building was designed in a circular manner to ensure minimum heat ingress. The window-to-wall ratio was designed by a space-by-space analysis to identify where the incoming daylight was optimum. The natural day lighting requirement met the stringent LEED mandatory compliance that 75 percent of the area should be naturally day lit. To overcome dark pockets, effective skylight locations and light pipe technology were used. Lighting sensors were positioned for automated control that did away with human intervention. This, along with the high-efficiency lighting fixtures, led to a savings of 64 percent lighting power consumption over the ASHRAE (Energy Standard for Buildings Except Low-Rise Residential Buildings) baseline. The provision of cavity walls with an air gap on certain faces was done to minimize the heat load due to the envelope. Up to 90 percent of all regularly occupied spaces were designed for visual access to the outdoors to ensure high productive and healthy working areas.

These and other green strategies helped the project achieve an overall energy savings of 29 percent over the ASHRAE baseline. This has led to a full 10 points for the optimization of energy performance credits. Overall, in the energy module, the building achieved a rare feat of 16 points out of 17. The total stood at an award of 59 points where the maximum was 69 points.

Is there any wonder then that the NRSC facility at Shadnagar received the LEED India Platinum Award from the Indian Green Buildings Council? The building has the distinction of being the first green building among all ISRO centers. The NRSC is proud of this first-of-its-kind effort and hopes that other research buildings will follow the example set.

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Architecture that Breathes

Architecture that Breathes

Nimish Patel and Parul Zaveri, architects and interior consultants, say that ever since they started their practice, they have been aware of the increasing gap between the growing need for electrical energy and its availability in India. Taking cognizance of this, it has always been their endeavor to work toward bridging this gap. This, they have done by ensuring that almost all the buildings designed by them use minimum electrical energy for light and ventilation. The Torrent Research Centre (TRC) in Gandhinagar, Gujarat, that uses Passive Downdraft Evaporative Cooling (PDEC) as an alternative to cooling without traditional methods such as air conditioning, is an example of their work.

For many years the duo have tried to negate the assumption that mechanical methods (many detrimental to the objective of resource conservation, particularly in developing countries such as India) are the only ways to cool and illuminate spaces. “In fact, there are other ways, for instance PDEC, which is more economical” they say.

The weather in and around Gandhinagar is usually hot and dry through most of the year. The TRC building design in this area incorporates the PDEC method. Each building in the complex is a sealed structure. There are designated inlets and outlets for the movement of air. Hollow towers that act as shafts have been constructed on the exterior of the building to facilitate the movement of air. Naturally heated air rises and is allowed to escape through the shaft tops. This is replaced by air from used spaces. The vacuum created is filled with air from the centrally located concourse area that has inlets for fresh air. The incoming air is sprinkled with a fine mist of water on hot days. The cooled air then makes a downward movement. At each floor level, sets of hopper windows designed to catch the descending air are used to divert some of this cooled air into the adjacent work spaces. The air then exits through high-level glass louver openings that connect directly to the perimeter exhaust shaft towers that take in the air and create a natural circulation across the building, ensuring that there is a continuous supply of fresh air right through the day.

During the warm, humid, monsoon season when the use of water mist is inappropriate, ceiling fans are used to provide additional air movement to the offices and laboratories. In cooler times, the operating strategy is designed to control the ventilation, particularly at night, to facilitate night purging of air. This is done by adjusting the hopper windows and openings in individual spaces to meet on-the-spot requirements.

Overall control of the reduction in solar heat gain is achieved with the judicious design of the building and its glazing. The fixed glass windows are minimized and strategically located to bring in natural light at appropriate levels of the building. The overhangs and the projecting towers increase the shaded areas thus decreasing the heat ingress. The buildings

in Reinforced Concrete Cement (RCC) framed structure have greater thermal mass through insulated cavity brick infill walls, plastered inside and out, and also have hollow concrete blocks filling the roof slab coffers. Vermiculite, a natural mineral with insulating qualities, has been used on the roofs and the lintel plaster. External surfaces and the walls are painted white, and the roof uses a China mosaic finish.

The outcomes of this major experiment have been under observation since the initial occupation of the buildings. It will continue in the coming years as well. What was observed in the first 5 years was that in the summer, the interior temperature did not exceed 31–32°C even when the outside temperature was as hot as 44°C—a drop of 12–13°C. The temperature fluctuations inside the building have rarely exceeded 3–4°C over a 24 hour period while the temperature fluctuations outside were as much as 14–17˚C.

The economic viability of the project is demonstrated by indicators computed on the basis of results from the buildings under observation. The additional civil works cost of the project (insulation etc included) is approximately 12–13 percent more than that of a conventional building. The air conditioning plant capacity saved is about 200 metric tons. When added, the additional cumulative capital cost of the civil works and the cost of the air conditioning plant worked out to just ₹5,000,000 over that of conventionally designed buildings.

The annual savings in the total electrical consumption, including the savings on account of reduced need for artificial lighting during the day, was projected to be approximately ₹6,000,000. A net gain here alone. The payback period for the additional capital cost worked out to less than a year. The payback period for the cost of the construction of the entire complex, from the savings of the electricity consumption as well as plant replacement costs is about 15 years.

This establishes that it is possible to make a difference to human comfort conditions without having to depend on the excessive use of electrical/mechanical energy and with basic and elementary architectural design methods. The process of achieving human comfort levels was based on the fundamental understanding that comfort conditions are not dependent on absolute figures of parameters, but on the difference felt on the human skin, in terms of temperature and humidity. The process, on the one hand, minimizes the ingress of external heat through adequate measures of insulating the building's external fabric, and on the other hand creating an effective system of passive down draft evaporative cooling ensured comfort.

The Torrent Research Centre demonstrates excellent environmental outcomes. The findings of the post-occupancy survey show that this building, completed over 20 years ago, continues to satisfy expectations for a contemporary workplace of high quality while being simultaneously energy efficient. In the Indian subcontinent, where there is currently a large scale development of "glass boxes" that are both energy intensive and inappropriate for the climate, building performance outcomes at TRC clearly reinforce the value of a climate-responsive approach to building design.

This is just one of the examples of their work which they term "architecture that breathes, while also ensuring healthy returns on investment as well." They also advocate using available resource as solutions to problems while constructing.

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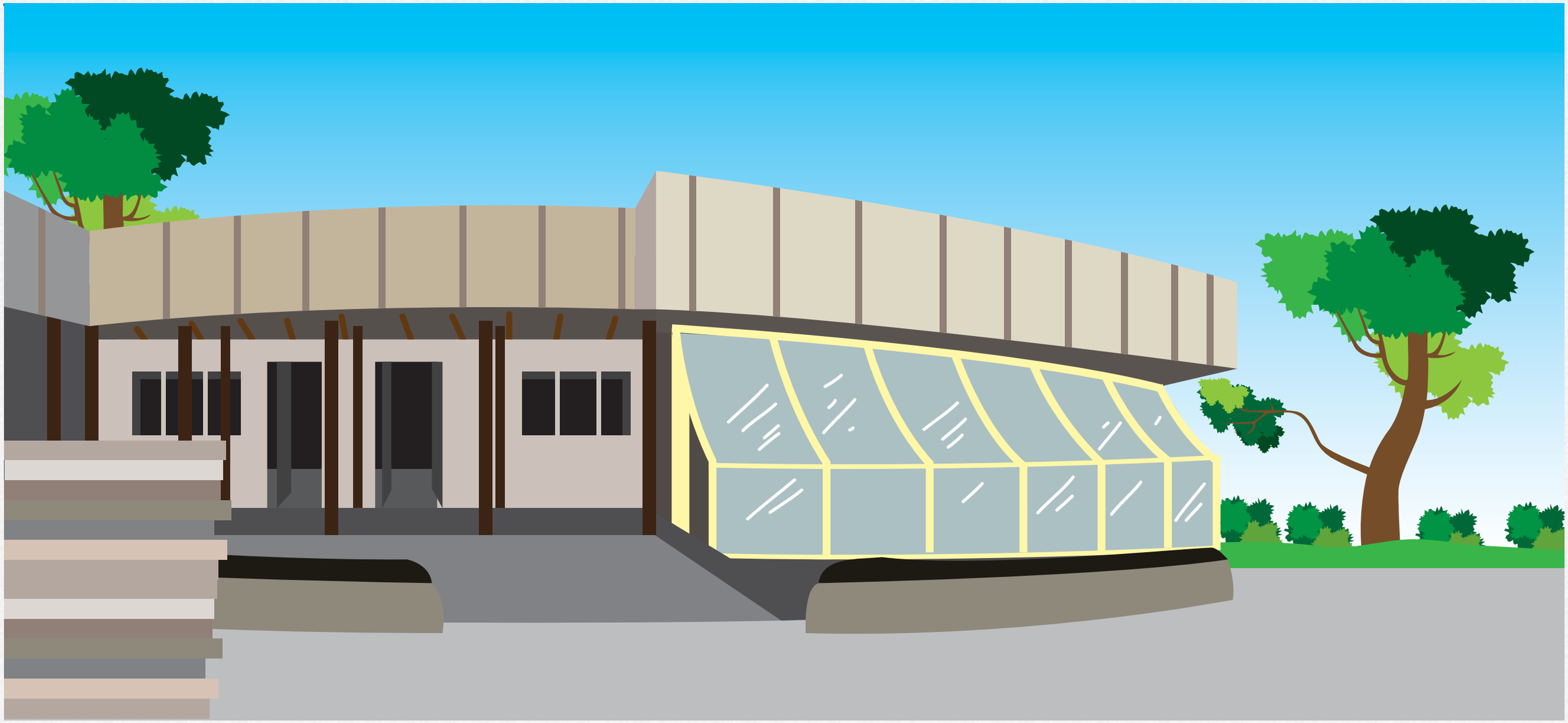
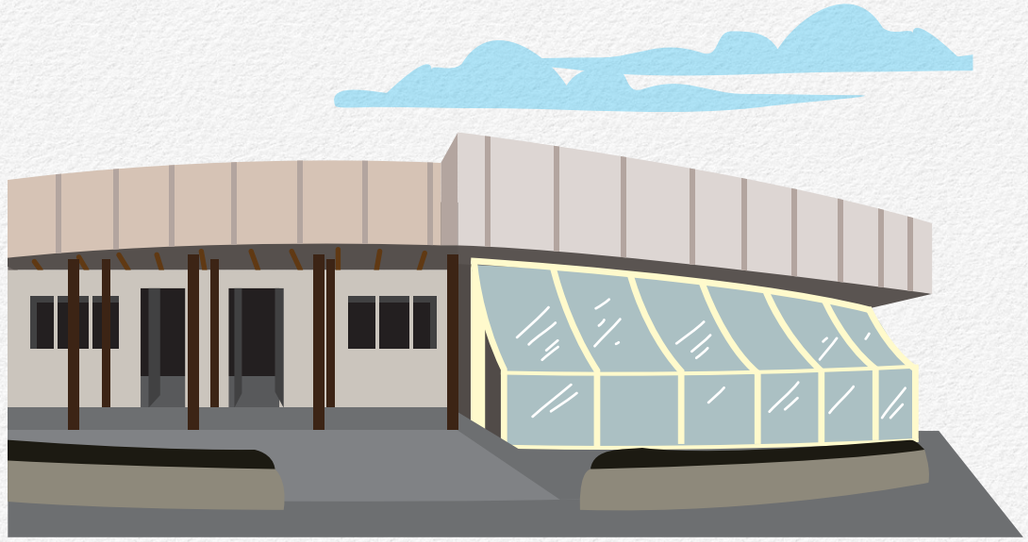
Benefits of Kabaad and Jugaad





Benefits of Kabaad and Jugaad

In Kolkata, West Bengal, a unique building has come up that utilizes the Indian traditions of taking “Kabaad” (discarded items), and puts these to use through “Jugaad” (frugal engineering). These green initiatives are wonderful ways to make judicious use of resources and minimize waste going into landfills with a life for items ensured beyond discard. Unfortunately, in the modern world of short-term use-and-throw habits, where new consumer items are up for sale in just a wink, “Kabaad” and “Jugaad” are things of the past. iLead, the management and media studies Institute of Leadership, Entrepreneurship and Development, has revived these and showcased their usefulness for building an additional campus.

iLead is located in Tangra, a neighborhood of Kolkata that once was chock-a-block full of leather tanneries. A couple of years ago, the tanneries were relocated to the Bantalla Leather Complex, leaving behind empty structures that were converted into Chinese restaurants and other commercial enterprises. iLead needed to expand its facilities as demand for admissions to its courses had expanded in leaps and bounds rendering its existing infrastructure inadequate. A 50,000 sq ft facility was required that would have classrooms and a skill development center to provide free classes under the Pradhan Mantri Kaushal Vikas Yojna.

Pradeep Chopra, the chairman of iLead, zeroed-in on an abandoned tannery as the perfect site for setting up an additional campus for iLead. Once acquired, everyone waited for the demolition of the old structure to take place. People were convinced that a new, sleek construction would come up in its place. However, Mr Chopra had other plans. He had often pondered on the need to encourage iLead’s students to be stewards of the environment. And, the conclusion he came to was “lead by example.” So he decided to make the new campus serve as a model. All efforts would be made to use discarded material in its construction. Demolishing was not an option. Retrofitting was.

The thought was noble, but how was it going to work? It was easier to make it happen, as the construction company contracted for the project was PS Group, of which Mr Chopra is the co-founder. He directed his team to look around the many construction sites where the Group worked and select leftover material (discarded was another word for it), but which could be put to good use in the new iLead campus. And there were a plethora of sites to select from as the Group is commissioned to construct IT Parks, green buildings, hi-tech commercial buildings, retail spaces, hotels, self-sustaining townships, and more. “Kabaad” would be acquired either directly from these, or even bought from “Kabaadiwallas” (sellers of used goods), or shops that sold second-hand items. With “Ju-

gaad", the items would be adapted to become useful material. The purchase of new material would be limited to items that incorporated the latest technologies for an improved environment. For that was the ultimate goal: maximum benefit for the environment.

It was a challenge (and yet a paramount need) to keep both utility and the aesthetic sense in focus while developing the campus. The iLead staff and PS Group workers used their ingenuity and creativity to incorporate the jumble of materials available to them into the design, rather than do what is considered "normal", that is, draw up a shopping list of things needed. "Instead of going with a rigid architectural design, let's moderate it to make use of what we find available. Perhaps the original blueprint had a smaller window, but if there is a larger frame available, let's fit that in instead," is what Mr Chopra advised.

And so it was achieved. The drawing plan kept evolving with the discovery of yet another lot of material that could be put to good use instead of dumped and carted away to landfills. Carpenters customized frames for the different sizes of glass that was brought in from a glass toughening factory where sheets and panes of different sizes lay piled up in the "rejected items" lot. The glass was of excellent quality, but was discarded because it was not of the right size, or not the right color, or not of the transparency required. At iLead's second campus, this wasn't an issue. A use could be found for just about anything. Doors were sourced from traders selling furniture from demolished buildings. If a door was too small, it was expanded by using extensions. "Turn it useful but keep it pleasing to the eye." Upcycling became the mantra.

Just a shell of reused material was not the only green strategy Mr Chopra employed. He had the architect figure out ways to ensure maximum use of natural light so that there was a reduced load on both the demand for energy as well as on running costs. The rooftop was insulated with astroturf grass and became the sports field. Discontinued currency notes that the Reserve Bank of India shredded were placed between the bricks. This was a win-win situation as the bank had a problem in the disposal of old currency notes and the architects were able to save on insulation material. The flooring was made with a stock lot of materials from other sites. Tiles of not just one color, but of three were available, so it was back to the drawing board to develop a design using these. Old furniture was modified (cut, built upon) to produce items that had utilitarian uses and were beautiful as well. Vertical gardens using discarded PET bottles made for an interesting, green facade. By trial and error, plants that flourished best in the prevailing conditions were chosen. A Reverse Osmosis system for drinking water had special pipes incorporated so that the overflow was channeled for flushing toilets.

Although the building was constructed using old and discarded materials, some new, top-of-the-line items such as energy efficient air conditioners that don't guzzle electricity and low consumption LED lights were also installed. In addition, the fire-fighting equipment is the most modern available. The electric wiring is the latest. This is not concealed but goes through discarded pipes that have been painted to give an attractive look.

If you are wondering about costs, then, be ready for a surprise! Whereas the average cost for such a building would have been around ₹4,000-₹5,000 per sqft, the actual cost plummeted to about a sixth of that (₹700- ₹800 per sqft).

The iLead campus is a laboratory that helps build environmental stewardship, and not just a green structure. The move toward caring for the environment gains momentum day-by-day. Students have acquired it more

by witnessing the many green initiatives undertaken, than from books. They now think twice before randomly discarding items and instead, stop to work out uses for what earlier might have been flung out without a second thought. And acquiring knowledge is not limited to just the students. The construction teams say it has been a learning curve for them as well because they acquired skills in using “Kabaad” and exercised their minds on ways to adapt and solve problems to enable “Jugaad.”

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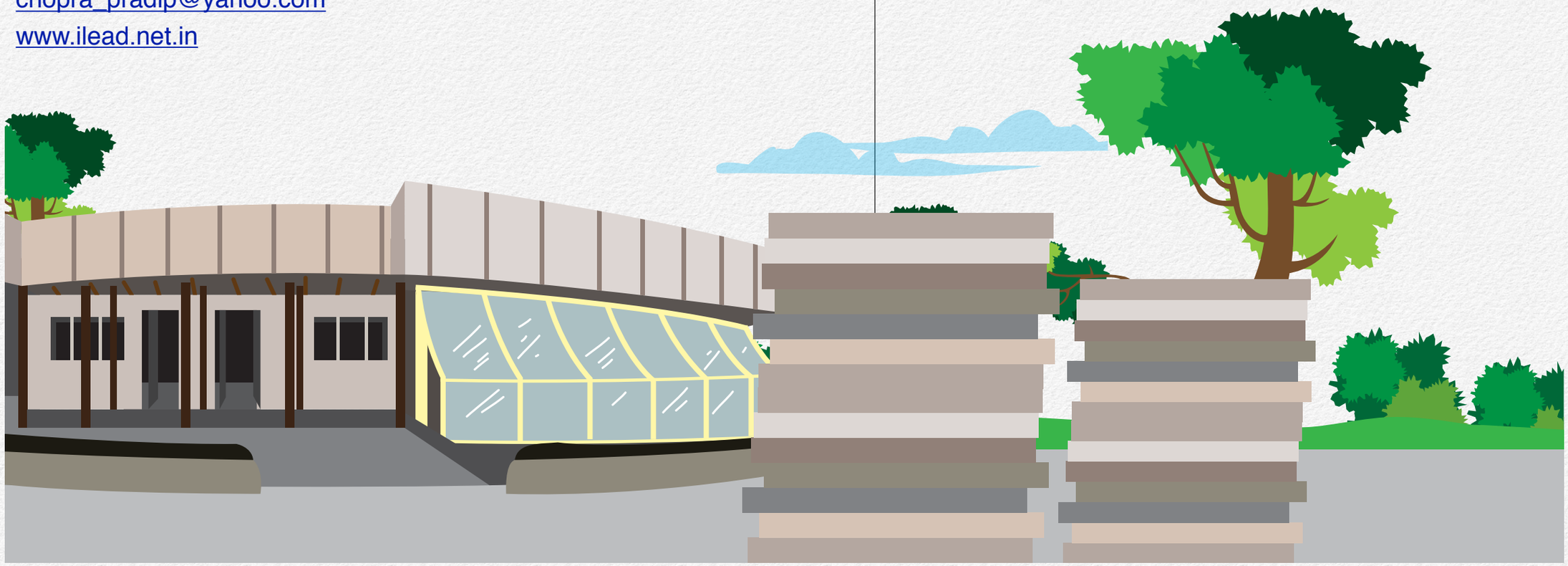

Biodiversity at the Factory

Biodiversity at the Factory

An excerpt from the company's annual Corporate Sustainability Report reads, "Our plants stand testimony to our commitment to enhance the biodiversity value of the area where we operate. We have established environmental cells at each of the manufacturing locations, which ensure that the biodiversity value of the areas in which we operate is maintained and enhanced by our presence." This environmentally conscious company is Tata Motors!

The Tata Motors factory at Lucknow, Uttar Pradesh is testimony to this commitment. Although it is a working space with all the nitty-gritty of machine shops and offices, the Company ensures that a profusion of biodiversity surrounds the area. The natural environment developed and maintained by Tata Motors has native scrubland and dense plantation habitats, water bodies and manicured and landscaped areas. Within these are found varied flora, avian, reptile, fish, animal and Lepidoptera species.

While machines whirl inside, when you step out of the factory buildings, the senses are overwhelmed by the wondrous nature around. The fragrance of flowers from the 18,000 square meter of gardens around perfumes the air. Your eyes are drawn to the waters of the 14,000 square meter lake. Varied trees join herbal plants and foliage to add to the flora. These include those flowering in different hues, such as the flamboyant Gulmohar; ones laden with fruit (the very special mangoes of Lucknow included); medicinal ones (the efficacious Neem for example) and many others. Cock your ear and you can hear birdsongs by the different avian species. Migratory birds fly in on brief visits. Others, for example the Black-crowned Night Heron, come to roost on the water's edge. There are permanent avian residents as well. Stand still and you may even glimpse a jackal darting by, one of the many animals that have made this space their home.

It would have been very easy for Tata Motors to utilize the area as factory space. Nevertheless, this would have gone against their ethos of conserving and preserving nature and of providing their employees an opportunity to appreciate its bounty. Thus, the low-lying area was not filled in and constructed over. Instead, it was developed into a lake with beautifully landscaped gardens at its periphery. Tata Motors decided that it was a far greater benefit to the Company that its employees get to witness fish swimming and birds in the trees during their workday than just another concrete-heavy landscape.

A system is in place to maintain the lake: it is largely recharged by rainwater with additional irrigation provided by a continuous discharge of processed clean water. Water from the lake is not pumped out for any purpose instead it is maintained as an admirable ecological system.

There is an abundance of biodiversity throughout the plant's premises and Tata Motors understood that to sustain that valuable natural capital, it needed to be documented first. To ensure that the biodiversity increases, and in no way gets reduced, it was important to tabulate and study what already existed. This was done by using the Shannon Wiener Index, which mathematically measures both the diversity and density of species. The job of doing so, amazingly, was not outsourced, but conducted by a dedicated team of employees under the guidance of a qualified horticulturist. The team is actively involved on a full-time basis and following a standard procedure to sustain the biodiversity in a scheduled manner. The horticultural team's documentation has greatly helped Tata Motors monitor ecological changes and identify areas that need additional support.

Some 35 species of birds, 8 types of butterflies, as well as mammalian and reptilian species were recorded. The most commonly sighted birds are the Rufous Treepie, Red-vented Bulbul, and Jungle Crow. What is astonishing is that the Orange-breasted Green Pigeon and Jungle Owlet, birds that generally stay away from industrialized areas, were also spotted. The biodiversity assessment team has also recorded 47 trees, 22 shrubs and 39 herb species at the Tata Motors, Lucknow unit. The trees in plentiful numbers include Terminalia arjuna (Arjun), Dalbergia sissoo (Shisham), and Delonix regia (Gulmohar). Invasive species such as Leucaena leucocephala (Subabhul), Prosopisjuli flora (Vilayti Kikkar) and Lantana camara (Raimuniya) are also found. The common shrubs widely spread include Hamelia patens, Justicia adathoda (Adulsa) and Clerodendrum inerme. In the landscaped area, there is a predominance of ornamental plants. Several herbs, such as Oxalis corniculata (Indian Sorrel), Amaranthus spinosa (Spiny Amaranth) and Cynodon dactylon (Doab) also grow here.

The Company believes in sharing and thus invites its employee's children and other students to enjoy the vistas and be inspired to become environmental stewards who appreciate nature and take care of it. To build appreciation and understanding, beautifully designed boards explain what they might chance upon.

What an amazing space! One where a manufacturing plant exists side-by-side with natural habitats that stand protected, thanks to the noble vision of Tata Motors.

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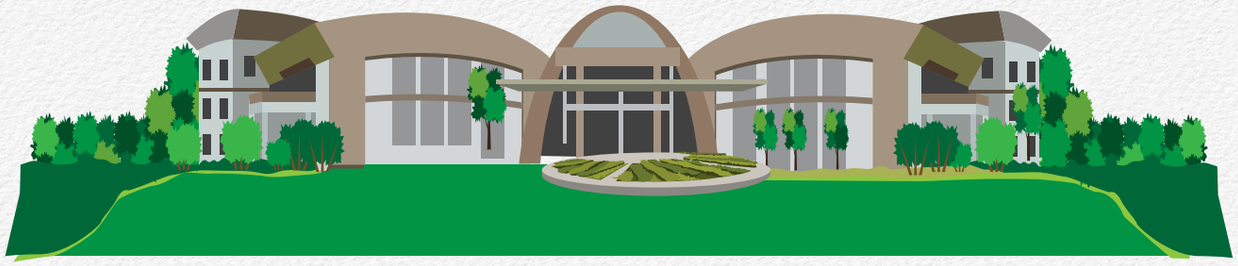
Catch the Wind



Catch the Wind

The GNRC Institute of Medical Science in Guwahati, Assam is North-east India's first green-rated building and possibly the country's green-est hospital. This super specialty medical facility has world class, environment-friendly facilities that are set-up for the benefit of the less privileged.

The uniqueness of GNRC stems from the fact that when it was planned, there were hardly any green hospitals in India for it to emu-late. The design and construction firm Ecologikol, (recognized for the outstanding work they do for green buildings) along with the manage-ment of GNRC, had to work together to create a blueprint that would make the best use of environment-friendly practices. This meant choosing site positions that make the best use of nature's endowment. Pioneering work indeed!

Infrastructure aside, the incorporation of green practices into the running of the hospital proved to be a mammoth task. The concept of green build-ings was unheard of in a region that is only lately developing after many years of disruption of normal life due to insurgency. Intense sessions were conducted to make the employees aware of why it was essential to go green. "Save electricity, save costs" was something difficult to con-vince a populace that generally paid small electricity bills—not because they were careful about switching off appliances and lights when not in use—but because power outages were common, resulting in very limited supply. As the area is flood-prone, campaigns to promote the judicious use of water were taken with many pinches of salt, for after all, where was the scarcity? It was certainly not visible as water was there in plenti-ful quantities.

The mission to bring about a change in mindsets took time. There were so many questions to answer and doubts to assail, but slowly and surely an understanding emerged. "Difficult, but satisfying" is how the author-ities described the process. Next, the administration worked to ensure that green practices learnt became second nature to the people. "It is easy to lapse back to old ways, but our continuous efforts to ensure this doesn't happen has succeeded," they say.

A unique aspect of the hospital is the orientation of the buildings. These are aligned to form catchment pockets. GNRC is constructed to ensure that the cool Northeastern winds that blow down from the cold Tibetan plateau first pass through the hospital and only then flow out to meet the Brahmaputra river. In the normal course, the winds would have swept along the river's natural course as both flow in the same direction. Design-

ing the hospital with tunneling and catchment pockets, and placing it in the path of wind flows, has ensured significant wind rush into the facility. The embodied heat of the building is transferred to the wind and is carried away, thus naturally or passively cooling the site.

The GNRC Institute's site is naturally lush and green. Sustainability and engineering designs were drawn up to maximise these features of the prevalent landscape and ecosystem. The approach was to conserve as much as possible of what already existed. A prime example of this was the preservation of the largest tree on the grounds. A huge rainwater harvesting pond at the far end doubles up as a source of fresh water fish which is a staple form of protein for the locals. A dedicated waste segregation facility makes stacking, reuse, resale and disposal a hassle-free process. The abundant and self-renewing, bamboo growths on the banks of the river are extensively, yet responsibly used for aesthetical appeal. Shrubs and trees planted in all open areas result in around 40 percent of the site falling in the green belt. All this, while ensuring that scenic vistas of the mountains, lakes and lush greenery are not blocked, but there for all to view and admire as the administration believes that a connect with nature results in faster healing.

In the current scenario, where green buildings continue to be perceived as being more expensive to build, GNRC is probably one of the few facilities in the country that has actually cut costs by going green. Analysis of the facility by using state-of-the-art simulation tools helped identify design elements that needed corrective alteration. The result: air conditioning tonnage is now down by 22 percent. Further simulations facilitated a reduction by another 4 percent, achieved by lining the roof with treated bamboo. Selection of this rapidly renewable, locally grown material ensured both heat reflection and insulation. The bamboo cladding used extensively on the building's exterior acts as a natural insulator that allows the hospital to do away with air conditioning in common areas such as lobbies and the reception. Enhancing the envelope insulation by procuring fly-ash bricks from a manufacturing unit close by contributed to a further drop of air conditioning tonnage, which now stands at an overall of 30 percent. With over 50 percent water savings and 35 percent energy savings, GNRC exemplifies the fact that green buildings need not be capital intensive. The huge savings of expenditure on resources has allowed GNRC to move many steps ahead of the mandatory requirements for the green rating to install state-of-the-art energy efficient medical equipment. Microsoft founder Bill Gates has tweeted his appreciation of this.

It has always been a part of GNRC's core philosophy to promote concepts that further enhance the sustainable value of the green hospital. They believe that irrespective of how green the envelope is, the operation of the facility is what fulfils the purpose of a green building. By providing shuttle services to employees, promoting cycling with dedicated stands as well as change rooms, free pickups and drops to the closest rail, road and ferry points, they ensure that environmental practices go beyond the hospital's boundaries.

These and many more environment-friendly initiatives make GNRC the model green hospital it is. GNRC credits the team from the Indian Green Building Council for the tremendous help its members provided in bringing GNRC's dream of a green hospital to reality. Frequent visits from the

members ensured regular awareness programs and opportunities for discussions with the rest that sustainable construction practices are not at a standstill but continuously upgraded.

This green footprint is now the shining beacon that many more are emulating in northeast India.

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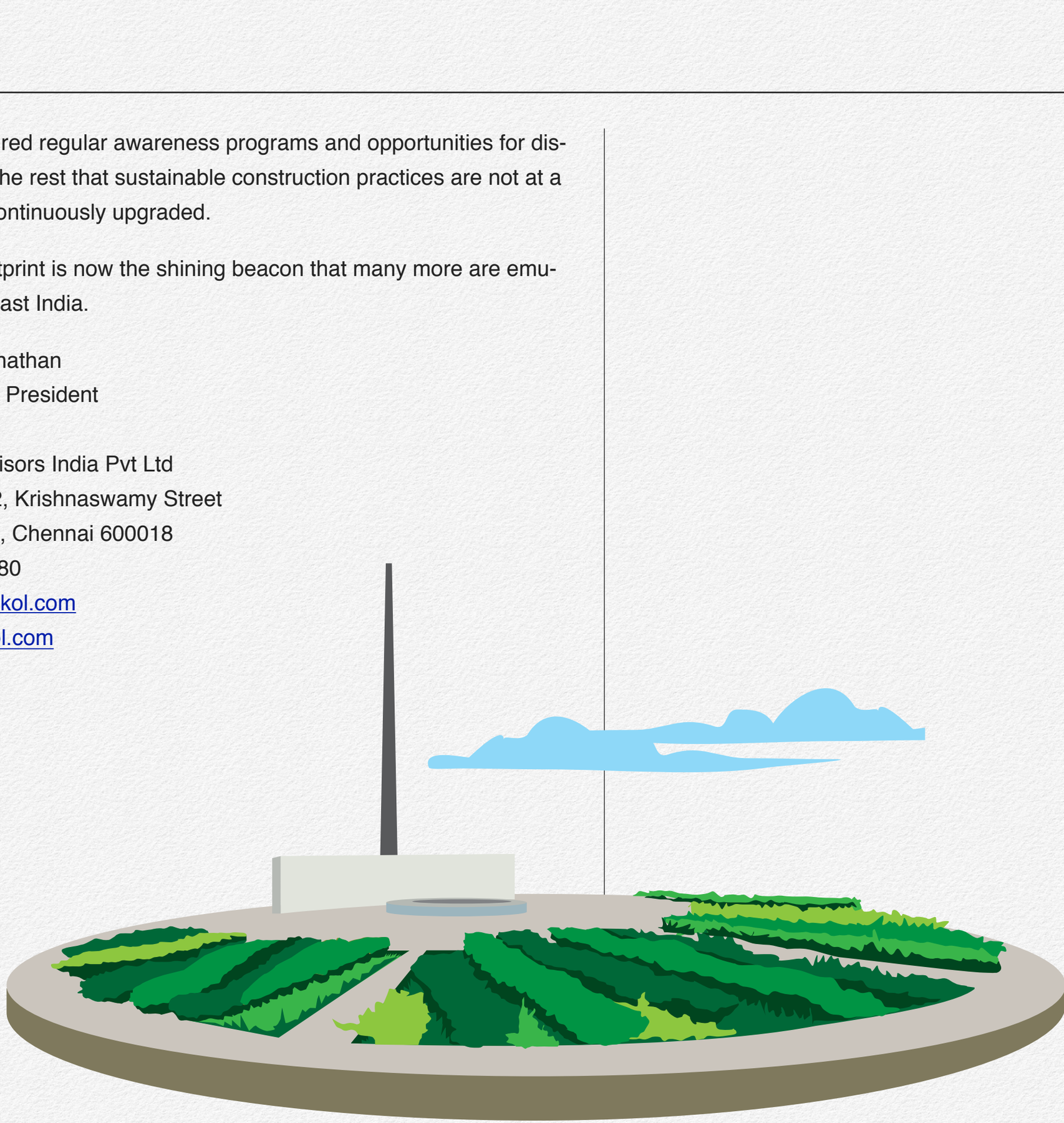

Edible Urbanscapes

Edible Urbanscapes

Industrial activity and its associated residential development has impacted the natural environment in urban areas. With food items generally not grown in backyards, but out of sight, can we vouch that what we ingest doesn't have a heady mix of synthetic pesticides? And, everyone is aware of the ill effects of artificial chemicals on human health! To grow your own vegetables and fruit would be ideal, but with the rapid mushrooming of real estate in cities, green patches are a rarity. Even if an urbanite wants to grow these for family consumption, where is the space?

Dr BN Viswanath has a ready answer. "On roofs in concrete jungles," he says.

In 1995, Dr Viswanath's flight to Bengaluru was forced to circle round the airport a couple of times before it could land. Looking out of the window, all he could see was a sea of concrete rooftops. It certainly didn't look like a "Garden City," for that is the name Bengaluru is known by. Dr Viswanath began to ponder on what could be done. It was a Eureka moment when he realized that growing food on rooftops was the solution.

What started that day has snowballed into a lifetime dedicated toward foodscapes (edible landscapes as some call them) on rooftops—the perfect space to grow healthy plants because of the abundant sunlight. If techniques such as hydroponics (growing plants without soil), and aquaponics (a combination of fish and plant production) are added to the traditional methods of growing, rich harvests could be reaped from roofscapes.

Dr Viswanath was convinced. He now wanted to share these findings with others as well. To enable that, Garden City Farmers (GCF), an NGO that promotes Organic Terrace Gardening and Urban Farming was formed. Increasing awareness was not an easy task. While the method of developing foodscapes on rooftops is simple, much convincing was needed before people adopted the technique. Questions such as "Will it damage the rooftop?" and "Is it very expensive?" were a constant refrain.

GCF's foot soldiers went from building to building making presentations and speaking to all who had even a little time (or some interest) to listen to their explanations. More than this, what was particularly effective was the use of social media as most of those who joined the movement were predominantly IT professionals. A core Facebook group, Organic Terrace

Gardening, was formed and members started writing blogs that highlighted varied gardening experiences. This emerged as a platform for answering questions and clearing doubts as well. Today the Facebook page boasts 30,000 members.

Aside from conducting gardening workshops on a regular basis, GCF organizes “Oota from your Thota” (Food from your Garden) events in different areas of Bengaluru. These bring rooftop gardeners under one umbrella to exchange information on what works and what doesn’t, which plants grow best, how to deal with pests etc. The gardening fairs feature just about anything related to gardening. People can take home everything they need to start a food garden. There are steps to educate children as well. “Chinnara Kaithota” are specially designed workshops for them. Gardens are also set up in schools so that students get hands-on experience. Students of the BM English School, for example, grow vegetables that are then sold to their teachers and parents.

GCF members realize that it is essential to collaborate with government and other large institutions to enable wider impact in minimal time. With this in mind, a joint “Urban Krishi Mela” (Farmer’s Fair), the first of its kind in India, was held in collaboration with the University of Agricultural Sciences, Bengaluru. Over 200,000 visitors visited it. GCF also keeps in regular touch with policy makers to work out ways to set up foodscapes in municipal parks and other spaces. One of GCF’s biggest challenges is to keep the momentum going. This they do by encouraging innovative gardening methods.

The good news is that the efforts have translated into many positive results. Over 1,000 workshops and training sessions have been conducted. 20,000 rooftop gardeners have emerged in Bengaluru alone, and 50,000 around the country. 20 start-ups have adopted urban gardening as their core business activity and in the process, very effectively promote foodscapes on rooftops. 24 garden fairs have been held in Bengaluru, alone.

The concept of urban farming is gaining momentum over the years. The thought of getting food that is readily available, nutritious and chemical-free has inspired residents to cultivate their own fruits and vegetables. The city also benefits as a whole, with green cover filling in the vastly depleting urban green spaces. GCF hopes that those in authority will seriously consider the concept of rooftop farming and ensure that policies are drawn up to widely encourage it.

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Full Moon Nights

Full Moon Nights

How many of us step outdoors on a full moon night to witness the beautiful glow that permeates the sky above us, even though it comes from as far away as 384,400 km? Do we marvel at this wondrous light from earth's sole natural satellite as it reflects the rays of the sun to bathe our planet in a silvery sheen? Have you ever thought of saying "Thank You for beaming us light without any charge?" Perhaps not.

In bygone days, folktales and other sources tell us how our ancestors would take advantage of the moonlight to work between twilight and dawn. Without the moon's luminescence, this would not have been possible because, unlike some other species, humans lack nocturnal sight. The moon's full phase offers its maximum illumination, and a Harvest Moon is bright enough for farmers to continue to reap crops well after sundown. The world famous Taj Mahal featured a moonlit pleasure garden named "Mehtab Bagh" (Moon Garden), a place to be enjoyed by moonlight. Some of the greatest minds of the 18th century formed the Lunar Society of Birmingham in England. Its members met on full moon nights so that, in the absence of streetlights, moonlight made their journeys home easier and safer.

With the invention of electricity this dependence on the moon was not as significant any more. With the click of a switch, municipal corporations ensure that street lights are on at night to allow citizens to move about in ease. But does all of the lighting capacity have to come from an energy source, renewable or otherwise? Mr Anil Sole, the Mayor of Nagpur City realized in 2014 that moonlight is not just a phenomenon to admire and wax eloquent about. It could also be a source of light to be taken advantage of. He rightly reckoned that streetlights in the city didn't have to be on full power on full moon days, as plentiful moonlight was already streaming in. Instead, he proposed that street lights of selected squares be dimmed on full moon nights to the capacity required and thus electricity be saved.

What a brilliant idea! So was conceived the "Poornima Diwas" (Full Moon Day) campaign that received a second endorsement from the next Mayor of Nagpur City, Mr Pravin Datke. Ever since, the Nagpur Municipal Corporation, in collaboration with the NGO Green Vigil Foundation, marks full moon nights with special programs. Every "Poornima Diwas" the Municipal Corporation selects a prominent square of Nagpur City, where the streetlights are dimmed. Members of the NGO are on hand to interact with citizens (shopkeepers, residents, and others) on the need to conserve energy and natural resources. They also share tips for people to implement and save energy. These may be as simple as ensuring

fans, lights and non-essential electrical appliances are switched off when not in use, but each act counts nevertheless. “Energy conservation is the need of the hour,” they say. The team also warns of a looming crisis of inadequate energy to meet future needs should energy be wasted today. With statistics ready at their fingertips, they explain to the people how much goes into the production of just 1 unit of electricity. “On an average, to produce 1 unit of electricity, 500 grams of coal is burnt and 7.5 liters of water used. Even worse, 1 kg of carbon dioxide is emitted to make just that 1 unit of electricity,” they explain.

In addition to dimming the lights, there is an appeal made to citizens to switch off lights for one hour, between 8 and 9 pm on full moons nights, and to abstain from using electronic gadgets during that time. It is similar to what is done for Earth Hour, but while that is just one night in the year, “Poornima Diwas” occurs at least 12 times a year!

The citizens of Nagpur City are convinced about the benefits of the campaign and have come forward in large numbers to respond to the call for energy conservation. It has enabled the city of Nagpur to save 113,871 units of electricity. That translates into savings of 57,000 kg of coal and 850,000 liters of water. Above all, it has prevented carbon emissions from being released into the atmosphere.

What a simple, yet effective campaign! This is something that all cities can implement. Its benefits caught the attention of Prime Minister Narendra Modi, who spoke about it in a broadcast to the nation.

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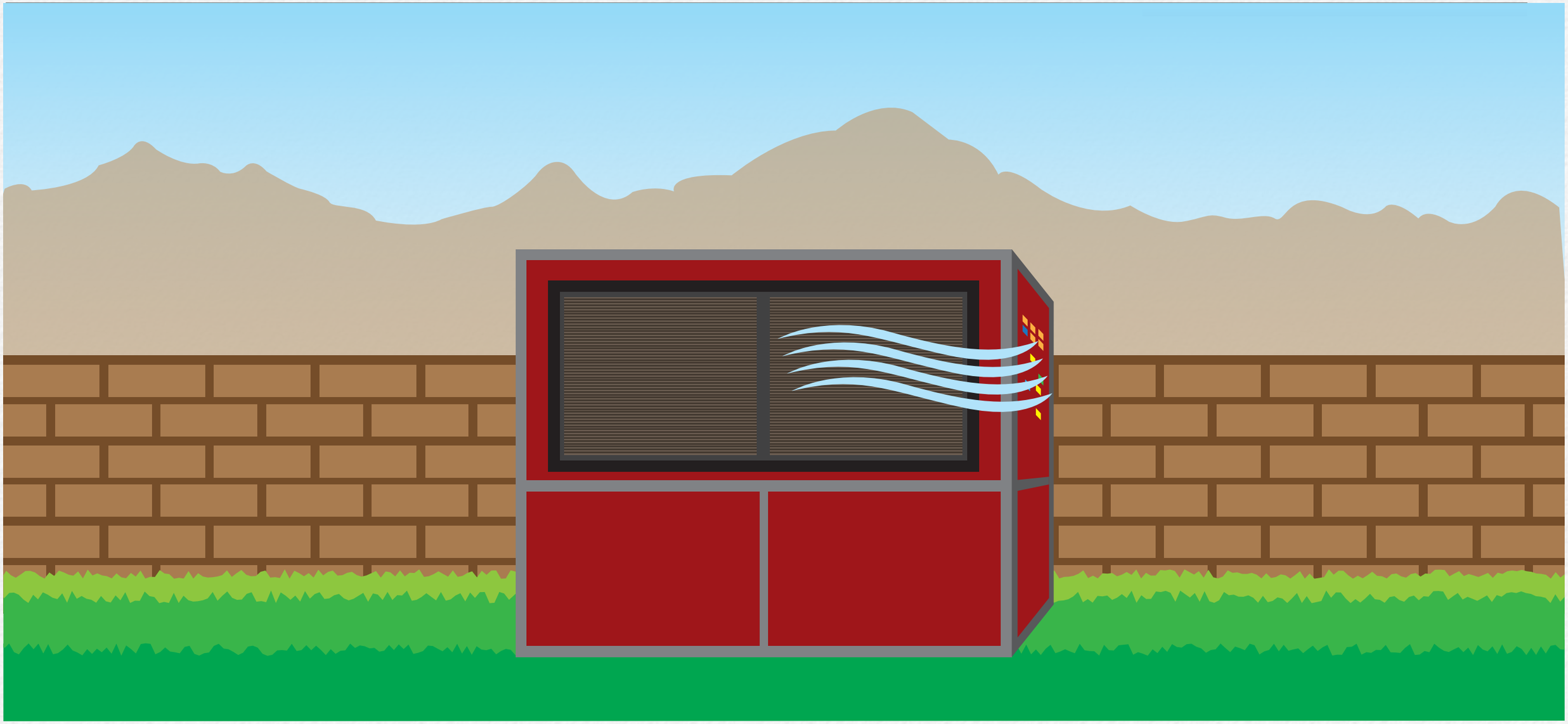
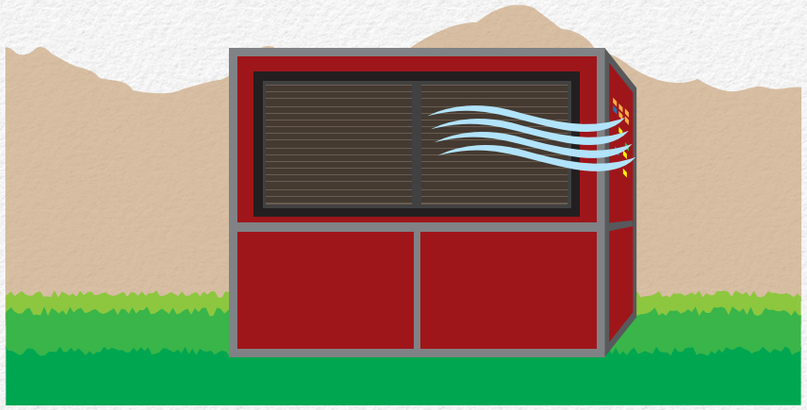
Global Cooling





Global Cooling

The Prajapita Brahma Kumaris Ishwariya Vishwa Vidyalaya, the Brahma Kumaris in short, is an international non-governmental spiritual organization headquartered at Mount Abu, a hill station in Rajasthan.

They propagate the use of green and efficient technologies for use at all their centers. For over two decades they have conducted training, research and development related to renewable energy technologies. They are the first organization in the world to introduce solar steam cooking systems that feature 770 newly developed 60 square meter parabolic dishes for thermal storage. The plant generates enough heat and power for a campus of 25,000 people—a milestone in decentralized and clean power generation in India. Inspired by their leaders, the followers of the Brahma Kumaris have also made big strides in going solar. It is clear that the call has been heard when one looks at the data: 15,000 solar lanterns, 500 home lighting systems and 1,000 solar box cookers.

Mount Abu is set on a high rocky plateau in the Aravalli Range and has a cool, salubrious climate. Its ancient name is “Arbudaanchal” or Mountain Place. Earlier this decade, the Supreme Court of India declared Mount Abu an Eco-sensitive Zone. This was done to protect the area’s significant ecology. There are forests of deciduous and evergreen trees and the flora and fauna comprises rare and endemic species. The Supreme Court’s specific notification included a blanket ban on all wood burning activities, whether within the precincts of the Brahma Kumaris complex, or outside it. This posed a major problem during the monsoon and winter seasons when cloud cover and limited sunshine resulted in the solar water heaters not running at full capacity. Previously, the practice was to supplement the solar energy installed water heating system with wood fires to heat the water. Hot water is a necessity as temperatures in Mount Abu can drop as low as 5˚C. The sylvan forests around Mount Abu assured an abundant supply of firewood: a much cheaper option when compared to lesser carbon-emitting forms of fuels. It thus became the popular choice.

But now there was a ban! A solution to the dilemma was needed. Was there a viable alternative available? The Brahma Kumaris researched to find an answer. It came in the form of Air Water Heaters that can heat water up to 55˚C. Unlike Solar Water Heaters that need sunlight, these work with environmental/atmospheric air. The system can operate regardless of cloud, fog and rain conditions. It can be installed anywhere—on the rooftop, inside a flat or even in the basement—and needs as little as 3 square meters of space to heat 40,000 liters of water per day. Air Water Heaters are capable of extracting heat even from sub-zero temperatures as low as -30˚C. The system uses only 20 percent of the electricity of any

conventional water heating technology. Its shell and tube heat exchanger make it usable with hard water too. The system is compact and lightweight, making it easy to transport.

All these advantages and economic ones too! The 100 percent indigenized technology has low installation costs. In areas with more than 65 non-sunny days, its power consumption over a 12-month period is less than that of a Solar Water Heater. The running costs for heating 100 liters of water to a temperature of 35˚C are a mere ₹5.29.

How does the Air Water Heater system work? The Air Water Heater Operating Cycle has four stages. First, it uses evaporation to harvest the latent heat present in atmospheric ambient air. By compression, the pressure and temperature of energy rich vapors are raised. What leaves the compressor is very hot gas. Condensation then helps release the energy in the water to increase water temperature to the level required. Lastly, expansion is used to convert heated fluid to cold fluid, which is then fed to the evaporator and the circuit circulation starts all over again.

The Air Water Heater at the Brahma Kumaris complex is perhaps the world's largest single location installation. 1,100,000 liters of water get heated every day. And this is achieved without using any other source of energy. Thanks to this technology, the Brahma Kumaris annually help save 29,000 trees, 58,000 people get more oxygen to inhale, the atmosphere gets dehumidified, cold air and carbon emissions that emanate from the use of carbon-emitting fuels such as firewood are vastly lowered.

In acknowledgment of the Brahma Kumaris' outstanding conservation and protection of our planet with the Air Water Heater, the Indian Business Committee awarded it with the 2010 "Parivartan Award". Keeping in mind that the complex will expand from accommodating 25,000 people today to many, many more over the years, the Brahma Kumaris have already begun the process of installing additional Air Water Heaters.

What a wonderful way to tackle climate change with systems that lead to global cooling (not warming).

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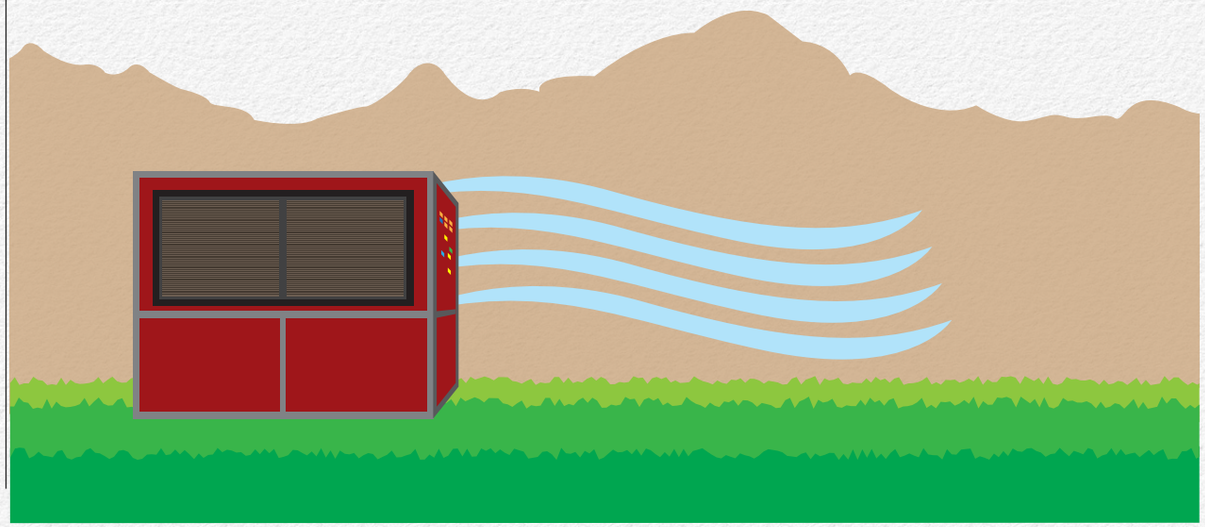
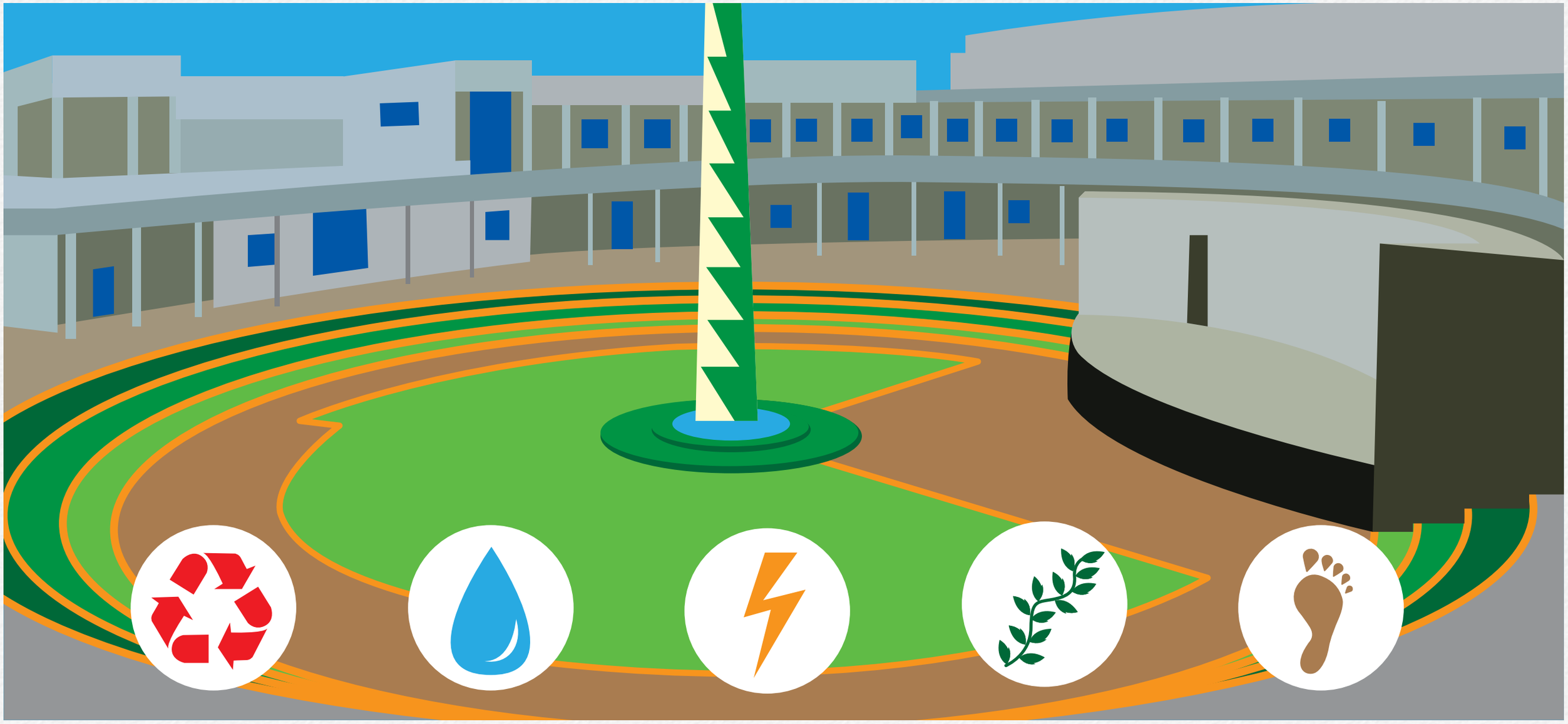
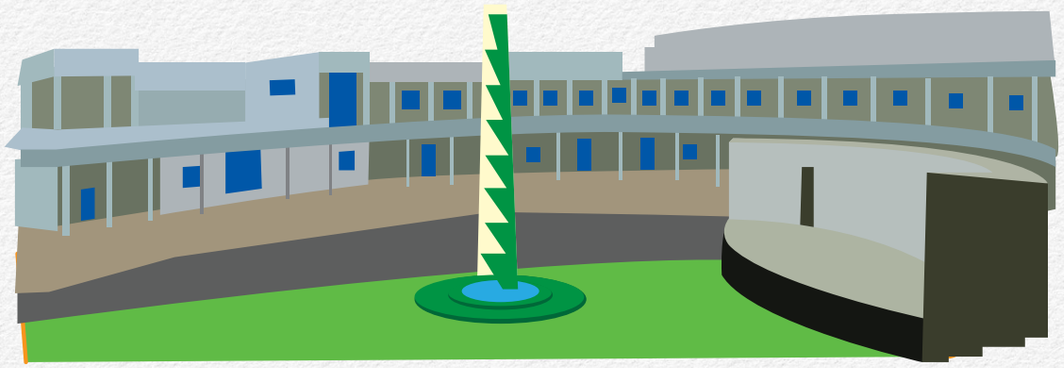


Global Mindset, Indian Roots





Global Mindset, Indian Roots

Great Lakes Institute of Management is a top ranked business school that aims to provide the corporate world with business-ready leaders. The Institute has great concern for the environment. It demonstrates its way toward this by ensuring that it goes green locally at its facilities that are located in a rural setting some 50 km from Chennai in the state of Tamil Nadu.

The Institute was built brick-by-brick incorporating the best of sustainable development and other environment-friendly initiatives. As it stands today, it is 100 percent eco-friendly—a classic example of how sustainability, when integrated into a building design from the concept stage itself, can help minimize energy use, water use and greenhouse gas emissions, and thereby reduce the negative impact on the environment. It is no wonder that the Institute is the proud recipient of South Asia's first LEED certified Platinum Rating for educational institutions.

The Great Lakes Institute's 27-acre campus has many green features. For example, the way it makes judicious use of water, a resource that is very precious for this low rain-fed area. Every effort is made to minimize water usage by installing water efficient fixtures such as low flow dual-flush toilets. All urinal outlets have battery-operated Solenoid Valves that work as sensors. These and other features help reduce water consumption by a third. 100 percent wastewater is treated on site to tertiary standards that also include using Sequential Batch Reactor technology. The grey water is then used for flushing toilets and to water the beautifully landscaped grounds that are planted with native or adaptive species. Each Institute block has rain water drains from the terrace level. These are connected to a four-foot diameter harvesting pit at a depth of five feet below the ground level. Three open wells that are well cared for further augment water availability.

The project team of Great Lakes (responsible for campus maintenance) incorporates several green and energy efficient features. It has eco-friendly infrastructure that facilitates air ventilation and waste management effectively. The campus is spread horizontally and has been built keeping in view the air corridors that help in cooling the temperature inside, thus reducing power consumption. The efficient Variable Refrigerant Volume (VRV) air conditioning system has helped the institute cut power consumption by nearly 20 percent. The large, circular academic block leads through a passage of green, with creepers forming a natural canopy, both in the hostels and the other blocks that also contain the executive housing.

Energy efficiency measures include insulated and high reflective roof, high-performance glazing, aerocon block walls, and efficient lighting with day lighting and occupancy controls. 100 percent of the roof area is covered with a highly reflective material to reduce the heat island effect and to minimize the impact on microclimate and human habitat. An energy efficient heating, ventilation, and air conditioning (HVAC) design, including high coefficient of performance VRV systems, are in place to save comparatively more energy than conventional systems. The selection of chlorofluorocarbon and hydrofluorocarbon-free refrigerants helps avoid global warming and ozone depletion. Measures incorporated in the building that further contribute to energy efficiency include reduced overall conductance of walls and roofs, high performance glass with optimum shading coefficient and visual transmittance, overhangs and shading to reduce solar gains, and energy recovery. Remarkably, Great Lakes discharges near zero smoke into the atmosphere and zero waste (paper, organic, sewage) to the ecosphere. All garbage is recycled. Up to 95.87 percent of the total debris after construction has been recycled or reused, thereby keeping it away from landfills. Housekeeping practices are also environment-friendly since only biodegradable chemicals are used. This ensures that the health of the maintenance staff as well as the occupants of the building is not compromised with the use of harsh chemicals.

In keeping with the vision of the Institute, the Great Lakes Institute of Management will soon introduce a course on “Global Energy and Environment Management.” The institute also takes initiatives to educate the staff, students, building occupants, visitors and business leaders on the various sustainability measures so that there is a combined effort to keep the campus environment-friendly. Great Lakes is a residential campus and thereby reduces the need for students to commute daily. This lowers their carbon footprint. In addition, buses are run for faculty members who would otherwise have arrived in cars, another way to minimize the carbon footprint.

The management of the Great Lakes Management Institute says going green is their small way of saying “Long live planet Earth!”

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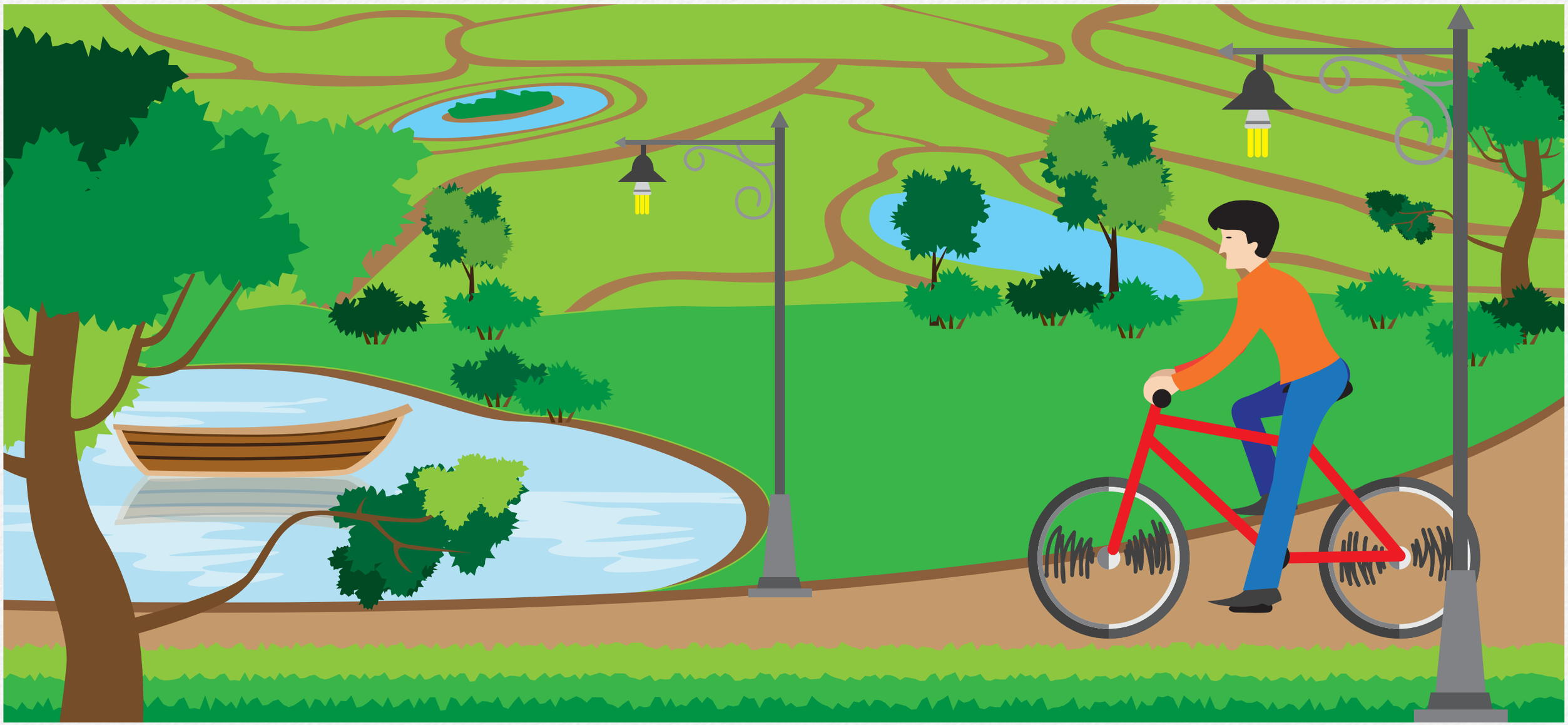
Green in the Midst of Grey



Green in the Midst of Grey

Over the years, there has been a significant increase in people relocating from rural to urban areas. The landscape these migrants witness is drastically different. Sights of concrete jungles are the norm, not vistas of the natural world. The residents of Kolkata and its surroundings are no exception in this regard. Building over building is what their eyes generally fall upon, with the occasional glimpse of greenery. There is apprehension that the city dwellers may lose their connection with nature without abundant opportunities to mingle with it—to rest in the cool shade of the trees, to admire the beauty of the flowers, to hear birds chirping or see squirrels chasing each other. This is indeed a dilemma, but with foresight, vision and political will, the Government of West Bengal has gifted its citizens a wonderful natural space, right in the midst of urbania. This is the 480-acre Eco Park that was set up in New Town, an area close to Kolkata. Today, this Park has the distinction of being the only one in India with membership to the World Urban Parks Network.

Designing and creating such a huge green space for visitors to savour nature and openness was an immense challenge. Staving off the pressure of real estate development and infrastructure requirements and nixing ideas for amusement parks were still greater hurdles. The Eco Park, however, has been successful on all accounts. Four years after its inauguration, it proudly counts 8 million footfalls. And, this number continues to grow every day. What is surprising is that all these visits have taken place without the Park having a single roller-coaster or Ferris wheel or carousel, all so familiar must-haves in large parks these days.

In a design competition conducted on behalf of an agency of the Ministry of Housing and Poverty Alleviation, Government of India, the Eco Park ranked among the top two in the country. The master plan was woven round a 112-acre lake, ringed by a six-meter-wide promenade and areas with fine grass. There are 47 zones in the plan, each beckoning the visitors to explore these. The overarching theme within projects bio-diversity in a way that interests city dwellers, as it lets people witness the beauty of nature, something not readily available in urban jungles.

More than anything else, the Eco Park adds a delightful relief of green in the dull grey urban scape and provides experiences that are rare today in the normal lives of city children. The diversity and vastness of it never fail to amaze everyone, in particular, the young ones. There is an orchard with different types of fruit trees such as banana, mango, pomegranate, and grape-vine—all native to Eastern India. There is also a grassland zone and different gardens such as herbal, rose, mist, tea, heliconia, rock, sculpture, mask, bamboo, and Japanese. The butterfly garden has 400 different species of butterflies living in their very own ecosystem. The Eco Park also has a rainforest and a deer park.

The blue lake is delightful. Boats of all types—shikaras, kayaks, paddle-boats—provide an opportunity for a sunset boat ride. A houseboat restau-

rant, water-scootering and catch and release fishing are other ways in which people interact with the water body. Musical fountains aerate the water for the aquatic life. These also delight tourists with the music that plays in sync with the dancing fountains. The 7-acre island in the middle of the lake has a fine restaurant that can only be reached by boat.

All lights in the Eco Park are energy-saving LEDs. Other than the security lights, the rest are switched off when the park closes for the day. A 500 kW canal-top solar plant generates enough energy to feed the street lights and those at the periphery. Inside the Eco Park, battery powered golf carts are used to transport visitors. Cycling is encouraged. Tandem bicycles are available and are hugely popular. Grade-separated bicycle trails follow the entire length of the park's front. Cycle and boat races, and fishing contests are popular attractions.

The dense urban growth around the Eco Park does put pressure on encroachment while real estate promoters put up signs (without permission) such as "view amazing Eco Park greens" to enhance the value of their properties. Promoters have even tried to set up direct entry points into the Eco Park from their estates by making illegal breaks in the Eco Park's fencing. So far, the authorities say, they have been able to fight this and know that with the rock-solid backing of the government, they will prevent the Eco Park turning into a promoter's paradise with huge food courts, shopping malls, 7D screen delights and adrenaline-pumping rides of all types.

The Eco Park innovates as it grows. The Tea Garden with its exquisite tea lounge did not exist in the original master plan. The Mist Garden was added to irrigate the trees and to cool the visitors. The Segways are a unique attraction. The Eco-Iskate rink is a skatable sheet of green ice that is just like real ice but doesn't need a huge amount of electricity to form and maintain.

As the underlying theme of the Eco Park is to bring people back to the greens and blues of nature, the management is constantly developing examples of sustainable development to create zones that continue to draw in the average urbanite. To ensure the continuity of the Eco Park, planning parameters have also been changed. Now in the periphery of the Eco Park, the maximum allowable Floor Air Ratio is 0.25 and the tallest building allowed to be constructed is up to the height of the treetops. The use of ethnic natural materials is also encouraged.

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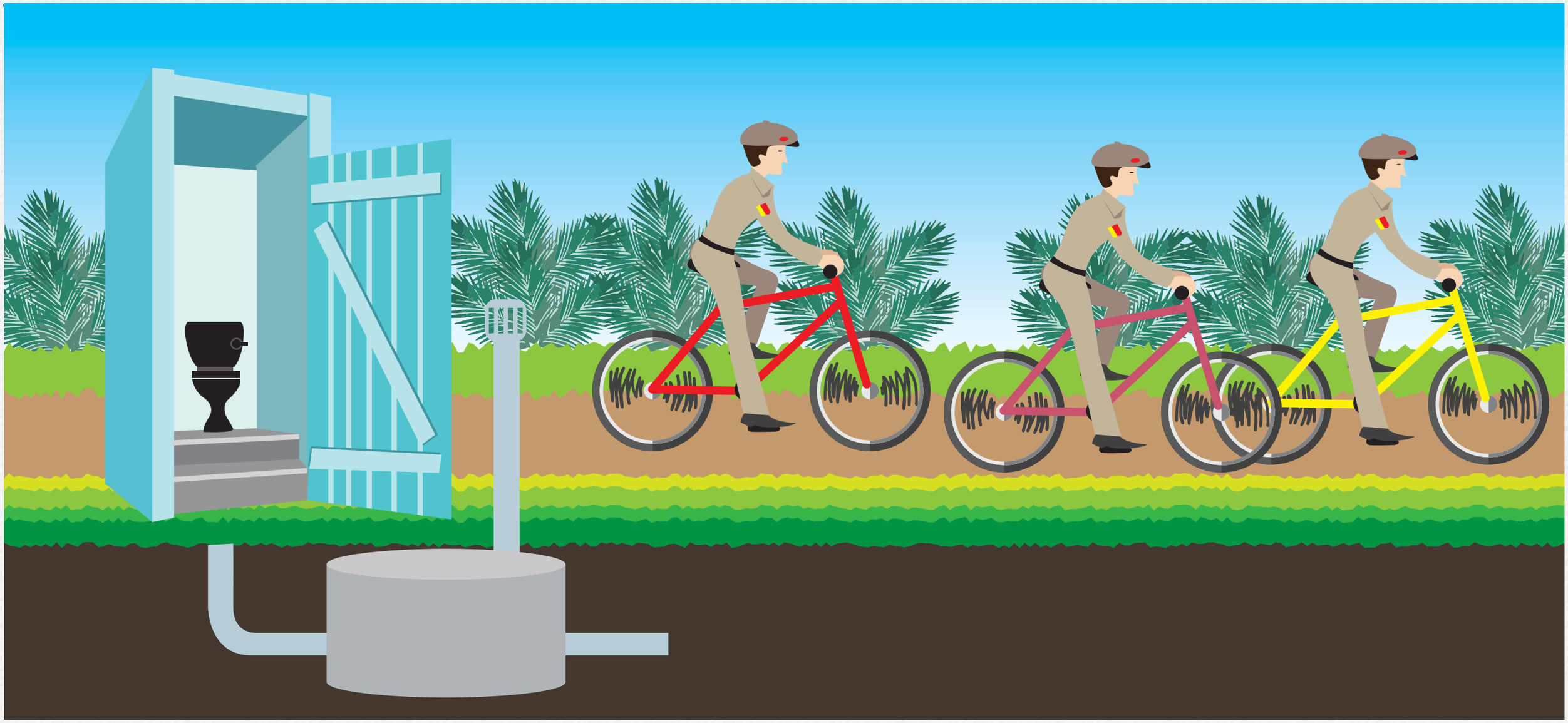
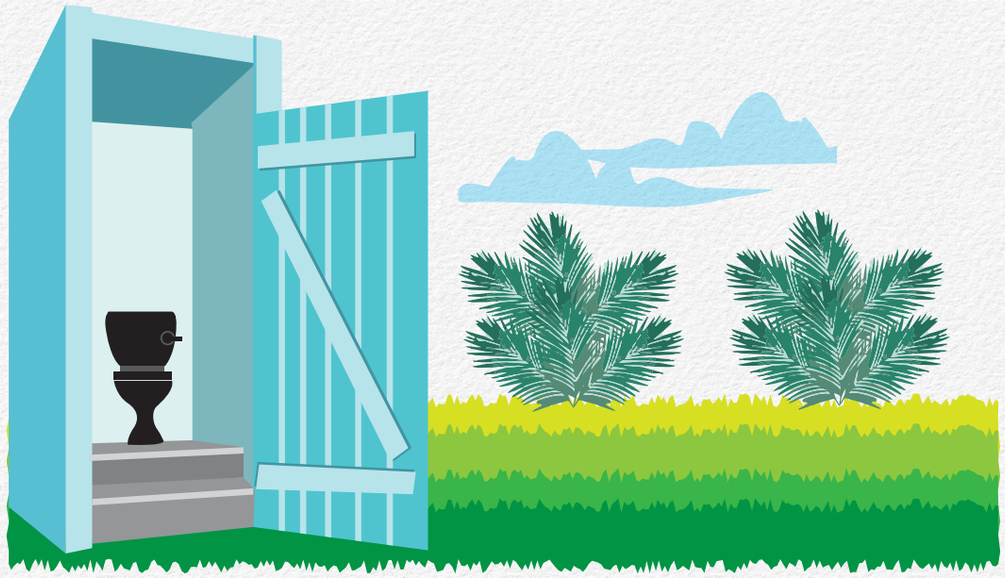
Green Police Station





Green Police Station

Times have changed for the Maurice Nagar Police Station in Delhi. Once, there were wide and open spaces around it. Today, it is located on the brink of a polluted, open drain. The polluted air affects its air-conditioners and other electronic gadgets which, as a result, frequently go out of order.

The police force looked at simple ways to turn the building green. A beginning was made in 2015 with the placing of 400 Areca Palm trees across the length and breadth of the building. These are known for their ability to refresh air by releasing huge amounts of oxygen during daylight hours. Just four plants can provide enough oxygen needed for one person on an average day. The greenery contributes to keeping the place cool with the added advantage of it removing pollutants such as xylene and toluene from the air around.

This was the first step to curtail the putrid smell and high levels of polluted air surrounding the building. Inspired by its success, the administration of the Police Station decided to look to implementing other strategies as well so that the Maurice Nagar Police Station became a model.

To ensure that the Maurice Nagar Police did not contribute waste to the drain, it installed the country's first bio-toilet in a police station.

A bio-toilet was set up on the premises for the use of the staff. Invented and certified by the Defense Research and Development Organization, the toilet decomposes solid waste into water and biogas, which can then be used for gardening. With a continuous biological process occurring inside, the solid waste becomes 100 percent discharge free, eliminates disease-causing pathogens and gets converted into gray water. The bio-toilet uses oxygen-loving bacteria that are naturally present in human waste to do all the work. The entire system is 100 percent maintenance free. Furthermore, it does away with manual handling of human waste. The bio-toilet is easy to transport and reinstall anywhere. Best of all, it is economically viable. As a further step, the Maurice Nagar Police Station is in the process of installing mechanisms that will convert the waste liquid into water for nurturing plants.

With the aim of reducing its carbon footprint to zero, the Maurice Nagar Police Station found simple solutions to other immense problems and implemented them. 100 hanging plants were put up in pots. The old electrical fittings were replaced with LED lights, 5-star rated fans and the related energy efficient fixtures. The roof was painted white with a coating of fresh lime. This increases the albedo of the station, reduces its heat and saves on the electricity needed to cool the premises. There is a plan to install solar panels, replacing conventional power with renewable en-

ergy. Furthermore, all the furniture in the Police Station is made from environment-friendly cane.

The Police Station also encourages routine patrolling by their staff on bicycles rather than in petrol or diesel vehicles. This saves a minimum of 20–30 liters of fossil fuel a day. In compliance with the policy of all the Police Stations in Delhi, the Maurice Nagar Police Station also recycles its entire paper waste.

An informal internal survey carried out by the station authorities concluded that their efforts have resulted in happier and healthier staff. All of these green initiatives are simple and can be easily implemented by the hundreds of police stations across the country as well. No doubt that would go toward making a great difference to climate change at the national and global levels. The Indian government is committed to working for a green and clean India. The steps taken by the Maurice Nagar Police Station may seem small, but are actually huge as they work in tandem with achieving the larger objective of meeting the commitments of the Government of India.

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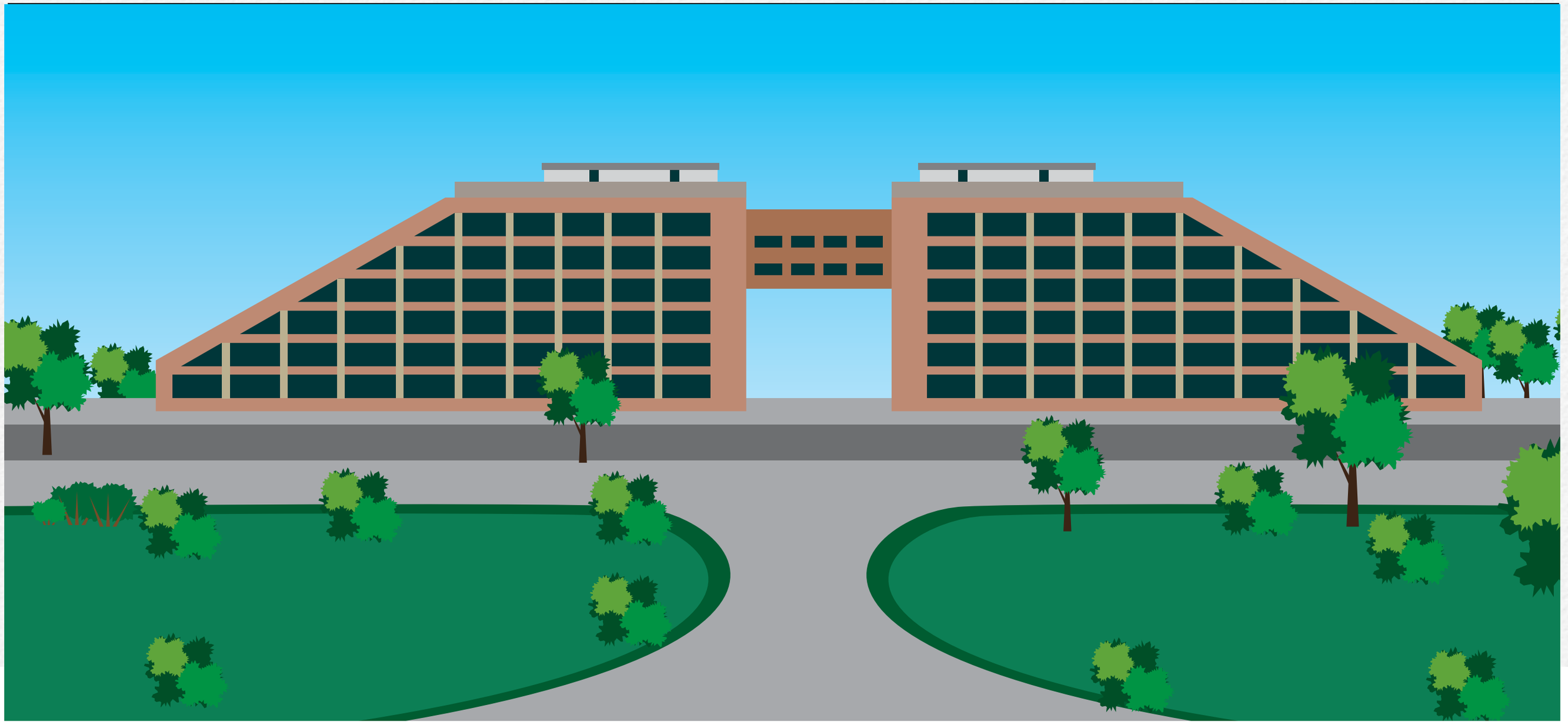
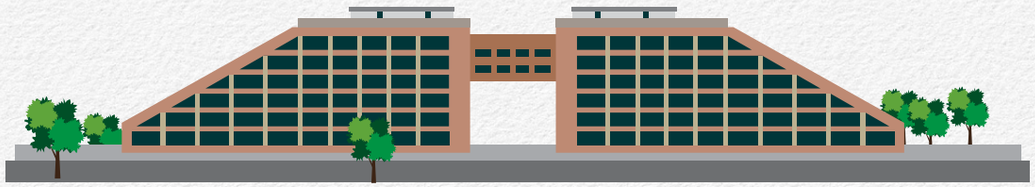
High Performance Buildings





High Performance Buildings

In India, over the last two decades, the commercial sector has seen a significant boom. This is a result of several factors: increasing foreign direct investments; a growing economy; and the enhanced affordability of consumers included.

The building industry is one of the largest energy-intensive sectors in India. It accounts for 30 percent of all energy consumption. With projections of a 66 percent increase in the built sector by 2030, an expected corollary is a significant increase in energy requirements. Even though newer technologies have greater economic viability today, and are readily available, resource management is definitely an immediate first step toward achieving sustainability.

The global IT giant Infosys, with 13 large campuses pan-India and 11.29 million sq ft of green buildings with the highest level of certification, leads the way toward sustainable growth. Infosys's commitment to resource management through energy efficiency is not new. In 2008, it set up a dedicated green team and published its first sustainability report. In the same year, Infosys announced an ambitious goal of halving its per capita energy consumption by 2018. This target has been achieved a year in advance, thanks to the incorporation of several energy-efficient measures that pertain to Heating Ventilation and Air Conditioning (HVAC) systems, lighting, building envelope, wastewater management and the use of renewable energy.

Infosys was successful in demonstrating that with the technology available it is possible to design buildings that require a third of the energy needed by conventional buildings at no additional cost. Rather than using the rule of thumb, an internal set of building-specific standards was defined for Infosys buildings. These focus on design stage intervention for new buildings, smart building systems, and retrofits for achieving super-efficient buildings. All Infosys new buildings are designed with an efficient envelope. This includes right orientation, insulated walls and roofs, window-wall ratios of less than 30 percent, and high-performance glazing with shading to enable the maximum penetration of daylight into the building and that too, without glare. All of this goes toward ensuring a pleasant and productive work environment for the employees. All new buildings have LED light fixtures with occupancy sensors and daylight controls. This has led to a significant reduction in the total lighting energy consumption.

Radiant Cooling is one such example. A beginning was made at Infosys SDB 1 in Hyderabad in 2009. This Infosys building is the first radiant cooled commercial building in India. It is a live lab split into two symmetric halves, one with conventional air conditioning and the other with radiant cooling. Data over the last five years shows that radiant cooling technology is 30 percent more efficient than conventional cooling. The En-

ergy Performance Index (EPI) of the radiant cooled building is about 75 kWh/sqm/year. This is among the lowest in the world for a hot and dry climate like Hyderabad's. Realizing that the available radiant panel based cooling solutions in the market today may not be cost effective in India, Infosys developed Radiflux Panels in-house. These panels are twice as efficient as other products available in the market, take less time to install, and are economically viable. Following the success at Hyderabad, the system has been installed in all new Infosys buildings.

Infosys has set up the first-of-its-kind central command center in Bengaluru. This enables remote monitoring and optimization of operations of all Infosys buildings across India. The command center manages 91 buildings, covering about 20 million sq ft of built-up area. A single place manages all these different campuses with Integrated Building management systems. Data from various systems are analyzed and used to review and optimize operations, drive resource conservation, perform fault detection and diagnostics, and ensure a high level of comfort and indoor air quality to the employees.

In order to identify the energy saving potential in its existing buildings, Infosys undertook a massive green retrofit program. It started metering and monitoring each piece of equipment and system to identify energy savings opportunities. These retrofits were undertaken in most of the energy-intensive areas, the critical ones being the chiller plant room, Uninterrupted Power Supply (UPS), and lighting systems. Moreover, these are financially viable for implementation as the payback period is less than three years.

Infosys was the first Indian corporate to join the RE100 campaign that commits the world's most influential companies to 100 percent renewable power. Infosys has voluntarily taken up the goal to become carbon neutral. In order to achieve this, Infosys is investing in onsite renewables. It also purchases green power. Currently, a total capacity of 15.2 MW of rooftop and ground-mounted solar photovoltaics is installed across campuses, equaling about 44.6 percent of the total electricity requirement. What is most interesting to observe is that the eventual cost of the solar energy is equal to that from the power grid, proving it to be a viable option.

Infosys's buildings are also water wise and have a very low water demand, about 25 liters/person per day. This is a result of low-flow fixtures, dual flush toilets, waterless urinals, etc.100 percent of the wastewater is recycled by the Sewage Treatment Plant and the recycled water is used for flushing, irrigation, and cooling tower make up requirements. Rooftop rainwater is harvested and reused.

Its buildings with cutting-edge designs are not only resource efficient, but also focus on employee productivity and well-being by creating a comfortable environment for its occupants. "Our green campuses with numerous facilities are an example of that," we say. The bigger picture of this initiative is bringing transformation to the energy market in India. Along with making internal changes, Infosys has also enhanced the expertise of consultants and vendors involved in the projects, by pushing boundaries, questioning assumptions, and eventually setting new global benchmarks for high performance buildings.

Infosys has indisputably developed a successful business model that industry peers can also invest in. And, not just those in India, but also those across the globe!

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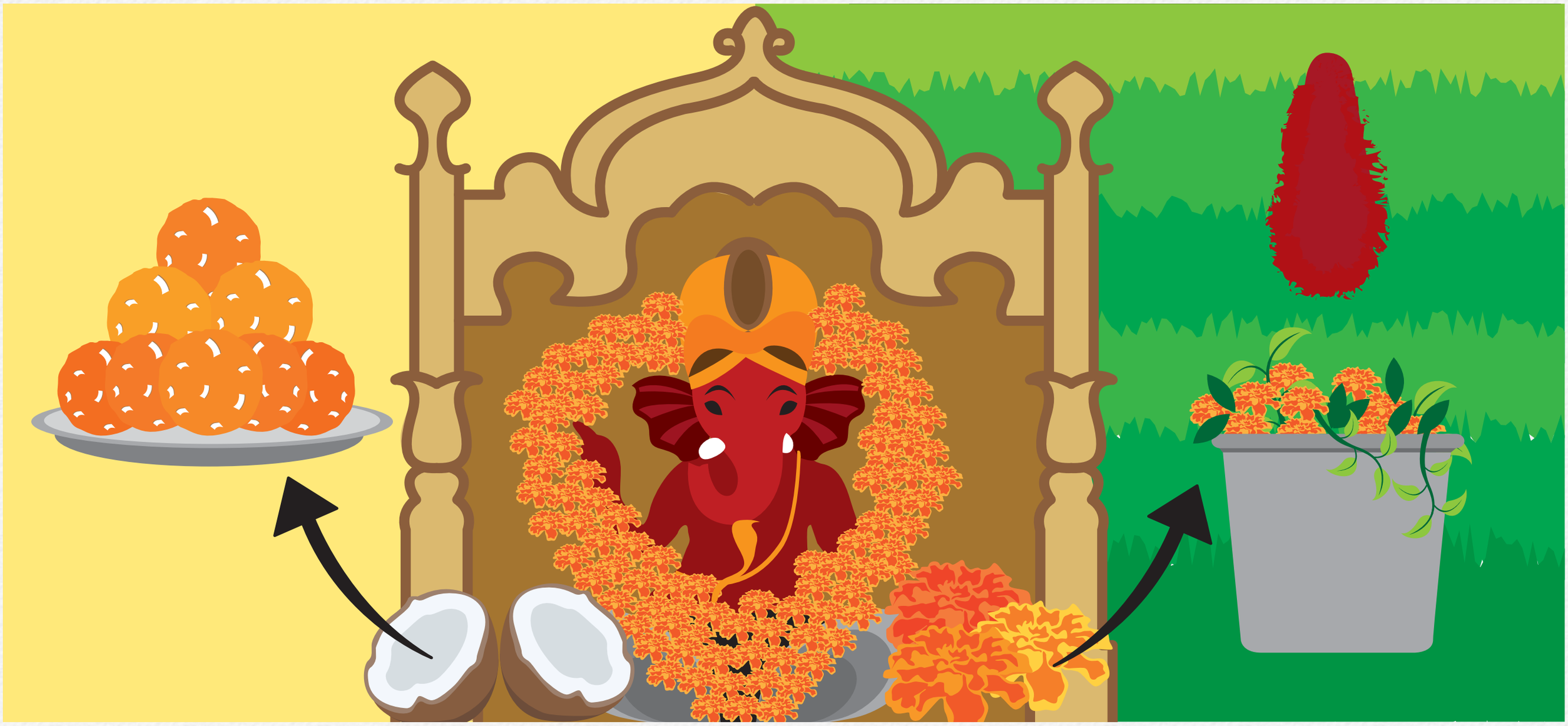
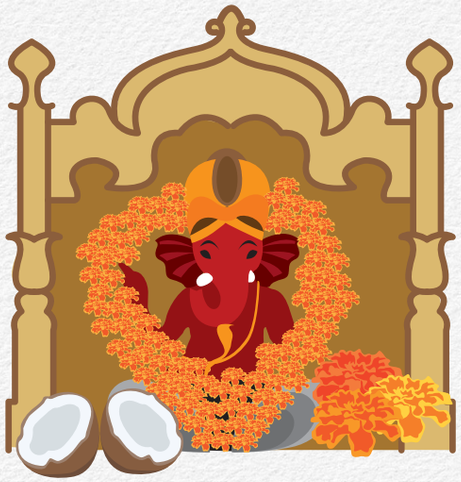
India's First Green Temple





India's First Green Temple

Busy as we are today in our worldly lives, how many of us remember what most religious scriptures say? That it is our principal duty to live in harmony with nature. However, there is a unique religious structure that has installed green technologies in order to ensure that nature is not misused, but rather sustained. It joins the prestigious list of spaces awarded the Indian Green Building Council's Platinum award. This is the 210-year-old, much revered Siddhivinayak Temple in Mumbai that is proud to be recognized as India's first green temple.

Members of the Shree Siddhivinayak Ganapati Mandir Nyas Trust diligently work to ensure systems are in place so that green practices are adopted and maintained in the temple's precincts. Solar panels generate 100 percent of the required energy demand of 20 kW. There are plans to upgrade the capacity to 100 kW. The management has set a target for zero-garbage. This is no mean feat as over 30,000 devotees daily visit the temple, with footfalls on Tuesdays (the day of the deity) running into the millions. Several strategies are adopted to attain this. The flowers, garlands and coconut offering are diligently segregated and converted into useful items. Pigment is extracted to produce a natural colour from the mounds of marigolds offered by devotees. It is then used to produce the material for "tilaks", (religious symbols anointed on foreheads), and the "sindoor" used in religious ceremonies. These are far better than similar colours available in the market, some of which are known to cause headaches and stain the skin. The natural colour is also used in making "laddoos" (sacramental sweets) thus saving the devotees from ingesting artificial ingredients. Coconut offerings are grated and included in the recipe. The production process is fully automated and hygienic. This is an example that other religious sites can also adopt.

Any remaining waste is collected in the garden adjoining the temple and then treated and converted into manure. A majority of this end product is used for the upkeep of the garden. Any excess is handed over to a lady who makes small packets of it to sell at a nominal cost outside the temple's gates. To encourage devotees to follow this practice in their homes as well, the entire method is clearly illustrated and displayed within the temple precincts.

There are also arrangements to harvest rainwater while a Sewage Treatment Plant converts the 25,000 liters of waste water regularly used. A Premium Cool Roof System is installed. Just as wearing light-coloured clothing can help keep one cooler on a sunny day, the Cool Roof System helps reduce heat generation by reflecting the infrared radiation of the sun. It stops it at the surface, preventing it from being absorbed, thus preventing it from getting converted into heat. A standard roof is not able to do this. In the case of the Siddhivinayak Temple, the surface temperature of its roof has been greatly reduced by as much as 12˚C. The under deck

temperature in the temple shows a reduction of nearly 5-7˚C. What an achievement and such a relief to visitors to the temple as the weather in Mumbai is sultry throughout the year with temperatures ranging from 20-30˚C. The Cool Roof also helps save by 25-35 percent, energy requirements as well as funds to run air-conditioning. As the Cool Roof is applied using TranSeal, it makes the surface water and dust resistant, both very necessary in a city that sees heavy rains during the monsoon, and where the Particulate Matter is far above recommended levels.

Siddhivinayak is dedicated to Lord Ganesh, the Hindu deity to be worshipped first before embarking upon any new venture as HE is “Vighnaharta”, the destroyer of obstacles. What an impressive example of green practices HIS temple presents. As the Siddhivinayak temple is thronged by devotees in their thousands (influential personalities from all spheres included), it is in a unique position to bring about widespread change. We hope that many other religious sites also consider adopting green strategies. Given that India has countless temples, mosques, gurudwaras, viharas, churches, and other sacred spaces, doing so would indeed make for a greener and cleaner land.

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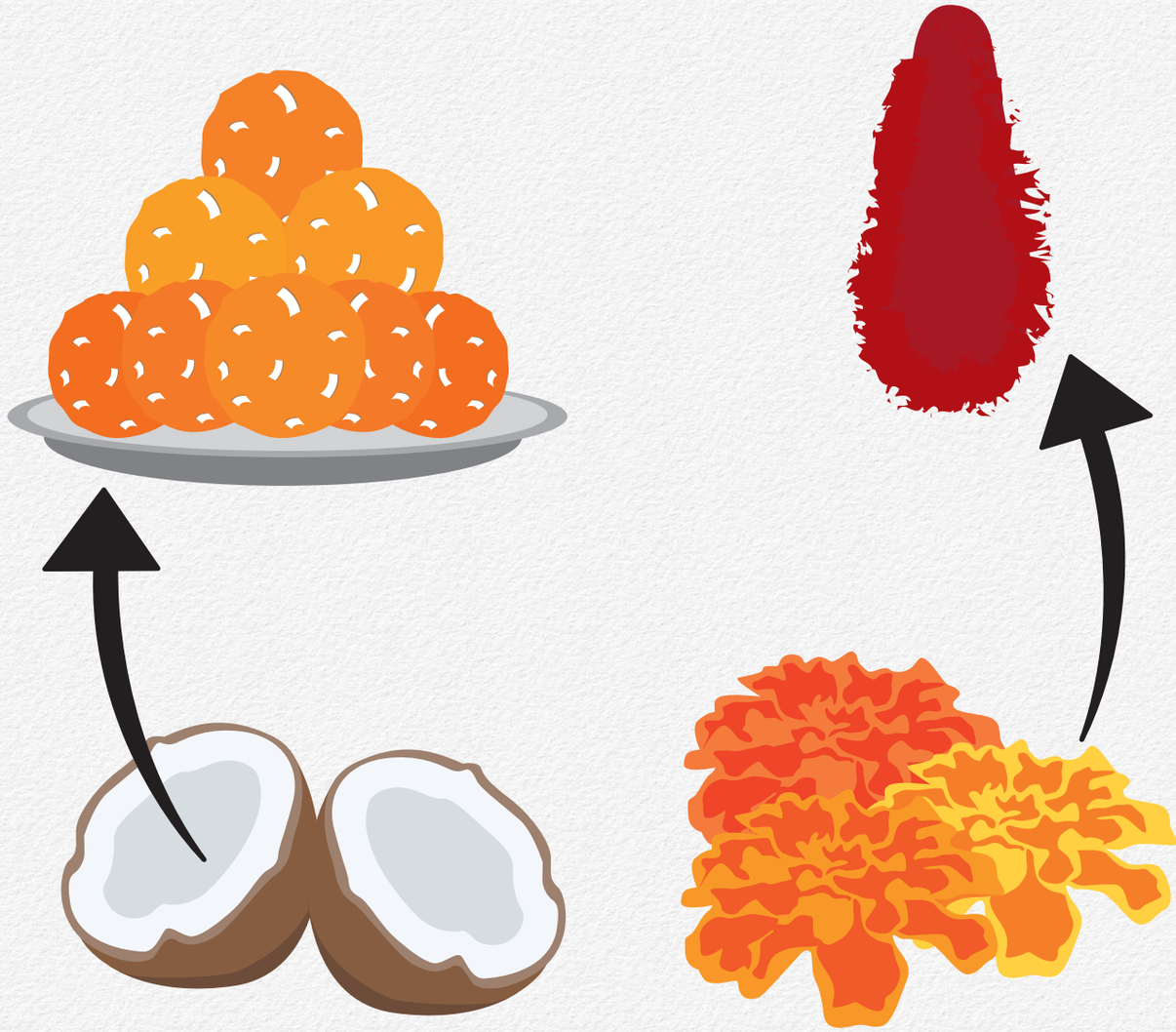
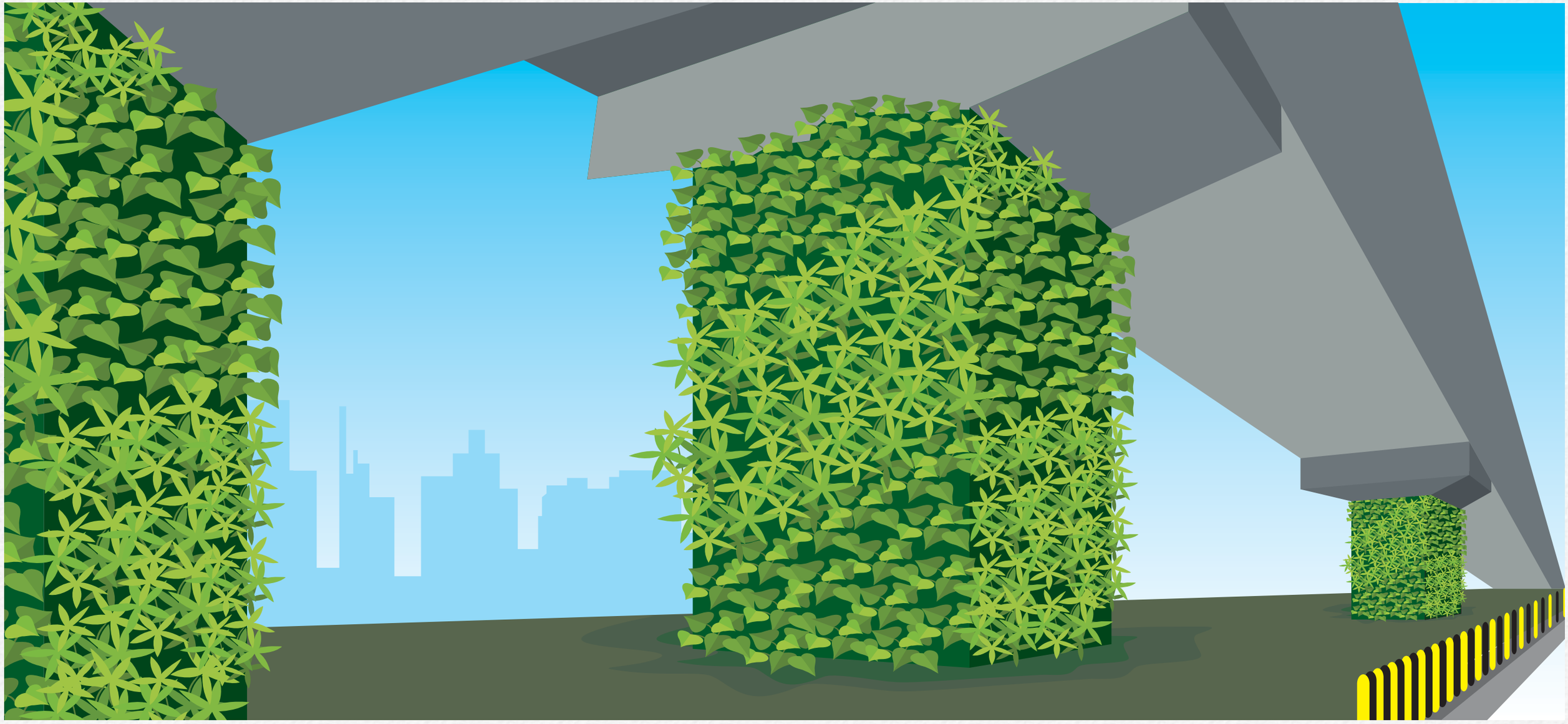
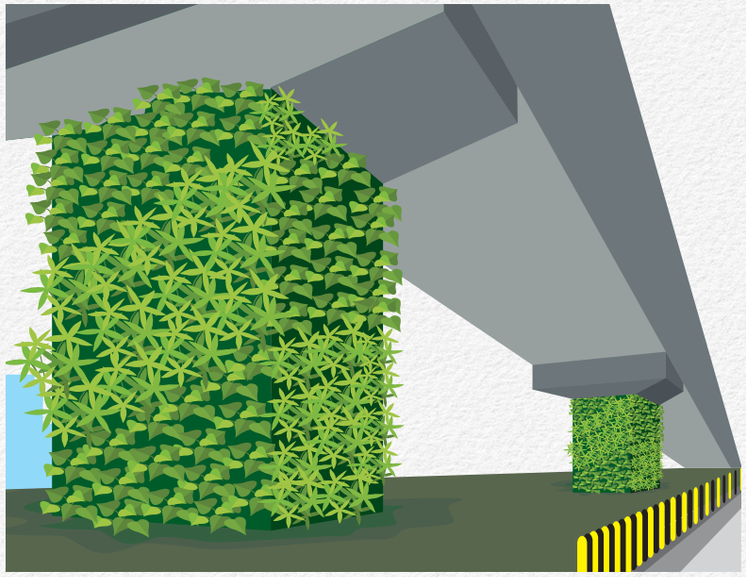


In the Business of Bringing Joy





In the Business of Bringing Joy

Much before “environment” became a buzzword, the vision of the Kirloskar forefathers had the Group base its societal initiatives on three fundamental themes, one of which was the environment. The other two were equally important: health and education.

Step into any Kirloskar industrial unit and you will immediately sense this as all Kirloskar companies are certified by Environmental Standards. Energy conservation and the use of non-conventional methods for energy generation, water treatment, conservation, and recycling techniques are all implemented at their units. When structures are built, it is with environment-friendly materials. LEED Platinum-rated units and 5-star products are but the norm for the Kirloskar Group. This strong consciousness about good environmental practices percolates down and is ingrained in its employees who take it beyond the workspace to their homes.

Below we describe just a few of the many examples that showcase the Kirloskar concern for the well-being of our planet. These are apart from what are the usual features of their workspaces: rainwater harvesting, use of renewable energies, etc.

Kirloskar Oil Engines Limited (KOEL) runs a state-of-the-art manufacturing facility in the Kolhapur District of Maharashtra State. For its employees, there is a central kitchen facility that caters meals for the 1,500 people that work at KOEL. As can be expected, wherever food is cooked and eaten, waste is generated. In the case of the KOEL facility, it amounted to around 300kg/day. Food takes a long time to decompose and till such time, produces a foul smell. Unregulated, the greenhouse gas, methane that emanates from decomposing food waste, would contribute to global warming. It could also turn into a fertile breeding ground for disease-carrying pests.

A solution had to be found, and scientific methods were used to do that. In 2015, a biogas plant was installed to generate bio-methane from waste food. Systems in place properly store the methane and use it as fuel for cooking and to generate electricity for the street lights in the premises. The plant processes upto 400–500 kg/day of food waste, thereby generating biogas up to 25–30 m3/day. The residue from the biogas plant is utilized as manure for plantations.

This method has had excellent results. 100 percent of the food waste is processed internally with no disposal outside the premises. On an average, 550 m3 of biogas is generated per month and 500 kWh/month electricity generated. The factory premises remain clean and free from bad odour and pests. The release of methane in the atmosphere is elimnated.

2,000 kg of manure per month is available for use to grow organic vegetables for the kitchens, and for sprinkling in flower beds and lawns.

At the Kirloskar Institute of Advanced Management Studies (KIAMS), in Pune, the sludge generated from the Sewage Treatment Plant is converted into manure for plantations. For use in the summer months KIAMS has a water pond of 3.5 million liters capacity, to collect rain water. This does away with the need to bring in tankers to cater to the needs for water. The vacant land is used by KIAMS for organic farming. The produce harvested makes its way to the kitchens where it is cooked into nutritious and healthy meals for the students. Pathways around the area that were earlier dark are now illuminated by solar lights.

Kirloskar Pneumatic Company Limited (KPCL) is another interesting case study. It goes beyond the Company's official premises to create a green environment outside. Close to the KPCL Pune plant is a massive flyover. The offices in KPCL's administrative building face it and all those who work there had no option but to have the huge, concrete wall of the flyover stare them in the face. Nothing pretty, just blocks of concrete. This was unusual for Kirloskar employees who are used to beautiful vistas of green spaces around them. As a way out, the Company created a vertical garden on the flyover wall. What was earlier a drab view is today one that is a pleasure to see. What an achievement indeed! The beautiful greenery that vertically covers a space of about 21,000 sq ft provides nesting to more than 3,000 birds of various species. It also helps lower ambient temperatures that had risen because of the mammoth construction.

While on the theme of building green cover, another miracle has taken place at KPCL's plant at Saswad. The issue here was not one of over construction, but of barren land. It was a challenge to create an environment that allowed people to celebrate nature in a stark, unplanted space. Planting trees was the method adopted over a 7-year period. The result today is a grove of greenery that is aesthetically pleasing and one that provides a healthier environ for the people around. The area also attracts plenty of fauna that is happy to exist in the natural surroundings.

At KPCL's plant in Pune, a thicket of trees now covers what was once a hill of debris. Earlier, the dust particles around the rubble raised air pollution levels. But with trees filtering these out, the air is much cleaner. To encourage an increase in the green cover, there is a unique initiative that KPCL has begun. This is a "Memory Garden" where any employee approaching retirement is invited to plant local varieties of trees. What a wonderful way to be remembered!

Even beyond work spaces, the environmental movement is supported by the Kirloskar belief that sustainable green initiatives are a key to "Enriching Lives". One of these is the "Kirloskar Vasundhara International Film Festival." It showcases the Group's strong commitment to "leave behind a better Vasundhara (Earth) than the one we inherited." Kirloskar is proud that this festival, the only one of its kind in India, combines film screenings with allied activities related to the environment, wildlife, energy, air, and water.

So much and more! It is no wonder that the company says it is "In the Business of Bringing Joy." This is not just for the people that form a part of the Kirloskar family, but for the planet itself, as the many green initiatives Kirloskar runs help in sustaining Earth.

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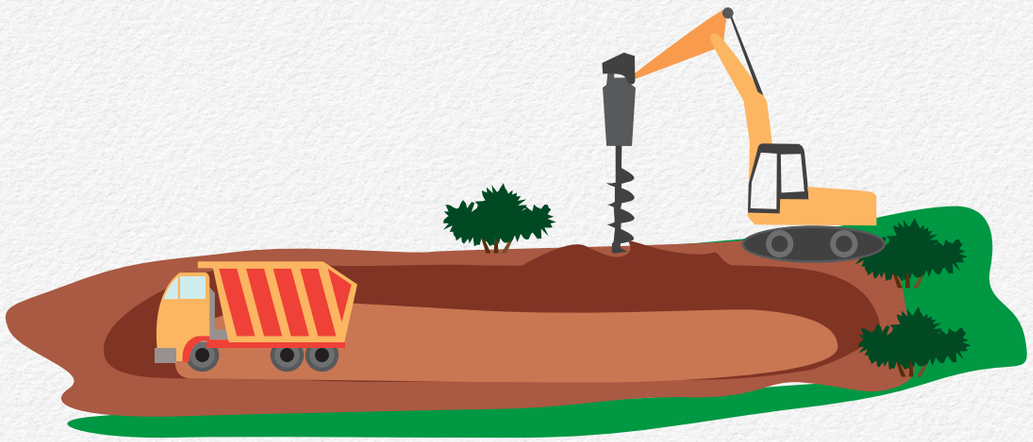
Katamati



Katamati

Since its inception, the Tata Steel Group's core values include a focus on sustainability. The Group ensures that responsible practices are in place to minimize the impacts of its operations on the environment. Optimal resource utilization for sustainable development is another of its aims. The Group is also recognized for going beyond immediate areas of work to improve the quality of life of those that live around its areas of operation.

The Ministry of Mines, Government of India, has recognized the sustainable practices of many of Tata Steel's mines by awarding them 5-Star rating. The evaluation procedure for the selection has built-in compliance mechanisms that include environment and forest safeguards via scientific and systematic mining that mitigate environmental impacts.

In 2017, the Tata Katamati Iron Mine at Keonjhar in the state of Odisha was conferred the Best Green Organization of the Year Award at the Global Green Future Leadership Awards ceremony that marked World Corporate Social Responsibility Day. The Katamati mine was recognized as an organization that ensures all its processes, products, and manufacturing activities adequately address environmental concerns. It has been engaged in environmental protection efforts for years and has successfully implemented the requirements of ISO 14001:2004 Environment Management Systems. Katamati's management aims to achieve "Green Productivity" and thus implements strategies that simultaneously enhance productivity and environmental performance, ensuring overall socio-economic development. The mine was earlier operated by a manual opencast method. In 2003, the mining operations were mechanized by a series of 12 meter high benches. It demonstrated best practices to improve and enhance environmental conditions and avoid, reduce and mitigate the impact on surrounding communities with a vision of Zero Harm to People and Environment.

What are the environment-friendly preventive measures taken in and around the mine's various facilities to conserve natural resources and control pollution that won the award for the Katamati mine? First, electronic detonators used for blasting are programmed with precision to control the fly rocks and ground vibration during the blast—something that is not possible with normal blasting. Moreover, there is zero discharge outside the mine of any industrial effluent as all surface runoffs are channelized. A network of retaining "toe" (low embankment) walls and "garland" (shallow trench) drains carry the discharge to settling pits and slime dams. Furthermore, check dams improve the quality of the water seams, and help capture suspended solids (particularly present during the monsoons) from surface runoffs. Wastewater produced by mining activities is

made viable for reuse as a result of which the ratio of wastewater disposed of to water recovered is close to zero. Cabins are rendered dust-proof with the use of an internal ventilation system featuring air intake of staged filtering. The cabins are mounted with vibration dampers and dust seals. The glass in the cabins is fitted with rubber seals to insulate the spaces. Lastly, installed rubber grommets act as dust sealants in all cable openings.

Above the ground as well, water table mining operations ensure that there is no intersection of the groundwater table, nor are natural watercourse or water resources obstructed. The implementation of scientific rainwater harvesting and artificial recharge of groundwater systems further enhances the quantity of this precious natural resource.

To ensure that environment-friendly parameters continue to meet standards, there is regular monitoring of the Ambient Air Quality (in both the core and buffer zones), the quality of drinking and surface water, noise pollution levels, as well as the amount and composition of dust fall, among other parameters.

Around the mine, Tata Steel ensures a green world through reclamation and rehabilitation of the mined land. Vetiver grass, good for soil and water conservation, is planted. The topsoil is used for greening slopes of dump yards to help stabilize them. Reclaimed land is seeded with vegetation after it is contoured and topsoil placed on it. The developed green zones help in reducing fugitive dust getting dispersed. This is important because, during the mining process, large quantities of dust is released into the air that often contains small airborne particles with the potential to adversely affect human health and the environment. Water sprinklers reduce dust levels by spraying haul roads. In addition, at the loading, unloading and transfer points. At the mobile crushing and screening plant, there is the effective operation of a dry fog system. About 45–55 percent of the iron ore is stored separately and the dump slopes are stabilized gradually for future use. All these efforts translate into visible achievements. Statistics indicate that PM10, PM2.5 and SOx levels of 46.24 μg/m3 (one-millionth of a microgram per cubic meter air), 28.46μg/m3 and 8.63μg/m3 during 2014–15 were reduced to levels of 44.46μg/m3, 25.99μg/m3& 6.09μg/m3 respectively during 2015–16.

The Company is not resting on its laurels. It has chalked out an enhanced strategy of additional projects and plans for the next five years that will implement further environment-related initiatives in the mines.

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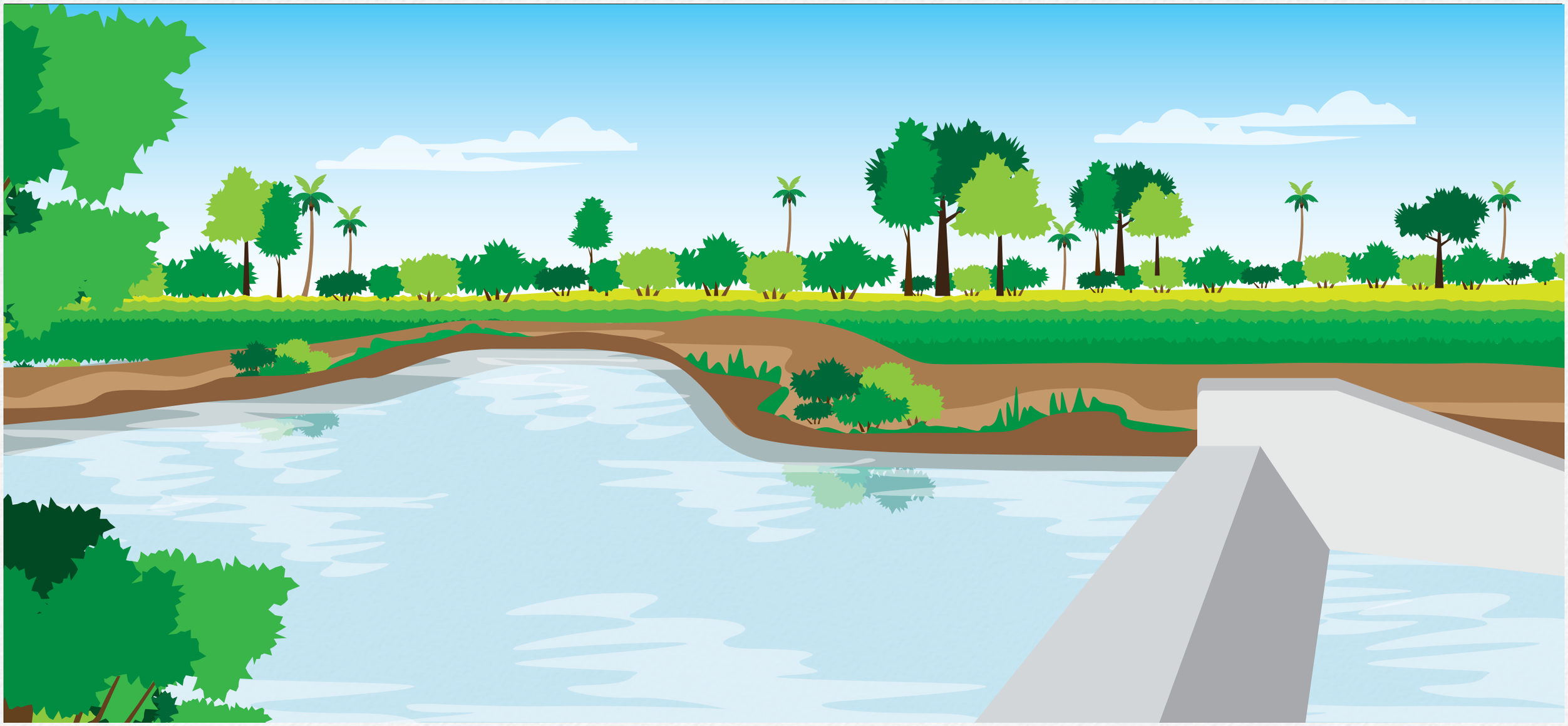
Putting India First



Putting India First

Sustainability is embedded in the heart of ITC's business model. ITC's abiding vision to create larger societal value has powered a multi-pronged strategy that fosters innovative interventions that support sustainable livelihood creation while enriching the environment at the same time. The Company measures its performance along the triple bottom line that builds and enriches the country's economic, environmental and social capital. ITC has been carbon, water and solid waste recycling positive for the last 12, 15 and 10 years, respectively—the sole company in the world to have achieved these milestones. Moreover, it has created sustainable livelihoods for over 6 million people.

ITC's commitment to creating larger societal value is manifest in its innovative interventions, which are aimed at providing livelihood security and ensuring environmental replenishment. These large-scale efforts encompass agricultural and rural communities residing near ITC's agri-sourcing operations or near its production units. Agriculture, which forms a major share of India's economy, remains to a large extent dependent upon natural resources, in particular, water. With almost half of India reeling under severe water stress for decades, agriculture continues to be in the grip of a crisis.

Recognizing the critical role that water resources play in ensuring sustainable development and inclusive growth, especially for the farming community, ITC set itself a target in the late 1990s to be water positive by 2003. The Company achieved this target and has maintained its water positive status for many years since then.

A two-pronged strategy was adopted to achieve this. At one level, ITC focused on reducing the net water consumption at all its manufacturing units. Technology upgrades improved water efficiency. The intake of fresh water was reduced. Practices were implemented to increase water reuse and recycling. ITC spearheaded rainwater harvesting systems and worked toward zero effluent discharge.

The second prong had ITC implement large-scale watershed development programs in its catchment areas. In 2001, ITC launched its Integrated Watershed Development Program, which revives, builds and maintains water-harvesting structures so that land degradation is reversed, critical irrigation is extended, and agricultural productivity is raised. ITC facilitates community-based participation in planning and executing projects. Currently, the total water harvesting potential created by ITC is over three times the net water consumption by ITC's operations.

ITC works with NGOs to mobilize local people to form Water User Groups, trained to carry out the entire spectrum of activities: from planning to execution and maintenance of water harvesting structures. Ways to formulate regulations and fix water user charges are additional skills

imparted to the members. The funds are used to maintain existing structures and build new ones.

The model is highly replicable and scalable as traditional methods and modern techniques combine to build location-specific, low-cost water harvesting structures, relying on simple technologies and locally-available materials. The participation and contribution of local communities, both in terms of finance and labor, along with the creation of a maintenance fund from user charges, generate high levels of ownership. This is crucial to long-term sustainability of the projects.

The benefits of the program are both multiple and multidimensional. Employment is generated by the requirement of civil work for the structures, and by increased availability of water for farming activities. This helps benefit the marginal/landless, a key factor in reducing seasonal out-migration. The areas see improvements in both quality and quantity of natural resources, enhanced green cover and restored soil health. The availability of water resources also contributes to farmer incomes through increased productivity.

Take, for example, ITC's Social Investment Program, Mission SunehraKal (Mission Golden Tomorrow) in the Sehore district of Madhya Pradesh. Launched in 2003–04, the objective was to enhance land productivity and thus farm incomes as well as augment non-farm incomes through the creation of alternative livelihood opportunities. A beginning was made with Integrated Watershed Development and Livestock Development programs. The project was later scaled up to include Sustainable Agriculture Practices and Climate Smart Agriculture, as well as Community Development initiatives such as the Empowerment of Ultra Poor Women, Vocational Training, Health and Sanitation.

At present, four soil and moisture conservation projects cover 55,280 acres in 66 villages in Sehore. Altogether, 70 stop dams, 161 irrigation tanks, 11 check dams, 495 farm ponds, 141 group wells, and 99 well recharge units have been constructed as part of the projects. To date, the program has benefitted 2,500 families by treating 19,148 acres of land. These activities have generated over 170,000 person days of employment.

According to a third-party impact assessment study, ITC's interventions in Sehore have had a significant impact on major economic indicators in the area, namely, improvement in the yield of crops, improvement in net income from agriculture, and improvement in net income from non-agriculture sources. The report further indicates that other than village development, the biophysical condition of the villages has shown improvement—groundwater levels have improved and so has soil quality. Soil erosion has been reduced; there is an improved supply of water and irrigation facilities that in turn have contributed to increased income and more productivity. Social harmony has also increased and along with it, the awareness of the benefits of the program. Simultaneously, the health and hygiene, education and the overall living conditions of the people have also shown considerable improvement.

ITC's Integrated Watershed Development Program currently covers over 822,000 acres in 12 states with over 11,000 rainwater harvesting structures. It has benefitted over 26,100 households and created over 5,600,000 person days of employment. The program has received several awards and accolades, the latest being the Best Practices Award for Sustainable Development Goal (SDG) 15—Life on Land, for ITC's Integrated Natural Resource Management Program, which covers its initia-

tives in Watershed Development and Afforestation by United Nations Global Compact Network India (UN-GCNI).

The Company proves that aims can be achieved. And in the case of ITC, it lives by its credo of ”Putting India First”.

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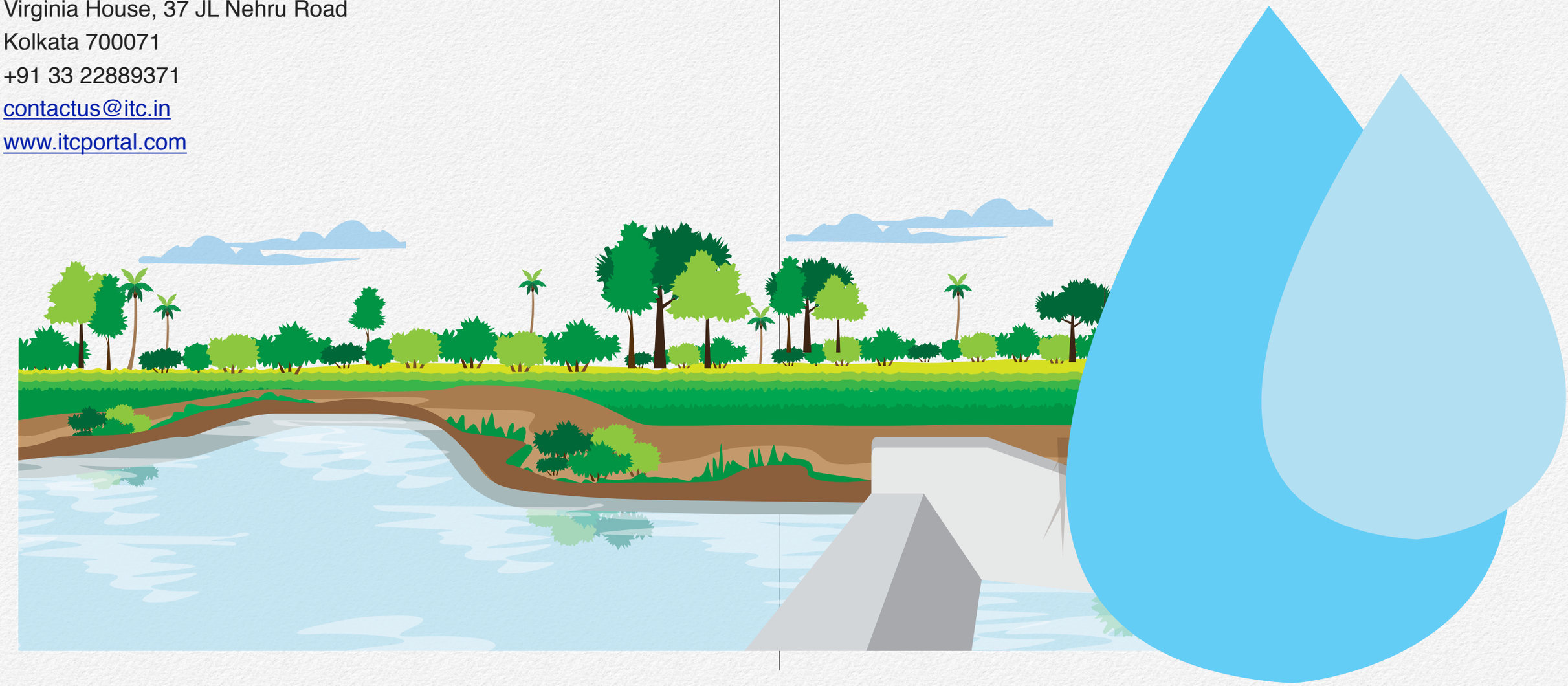

Sacred Earth

Sacred Earth

The Sacred Earth Trust (SET) works in Bodh Gaya, a town in Bihar of profound historical, spiritual and cultural significance, where thousands of years ago Lord Buddha attained enlightenment.

Pilgrims in their multitudes regularly visit Bodh Gaya to offer prayers at the Mahabodhi Temple, and pay obeisance to the Bodhi Tree under which, centuries ago, Lord Buddha sat. Imagine the huge garbage disposal system needed to deal with the mounds of waste these visits generate as well as the need for widespread sanitary facilities! This is a difficult task for any one organization to handle single-handedly. With this in mind, the NGO SET developed an innovative way to both recycle plastic and produce low-cost bricks for constructing toilets. This worked as an eco-friendly way of supplementing the ongoing work by the municipal corporation.

SET researchers first analysed the waste in Bodh Gaya and identified plastic bags, paper, flowers, and vegetable peels as its major components. While most of the items were quick to get fully bio-degraded (for example, vegetable peels took about a month) the discarded plastic was a scourge. It could exist on earth for centuries and centuries before it got broken down into organic matter. How could this plastic pollution be contained? There was need to find an innovative way to keep the plastic from choking up landfills. “Perhaps it could be converted into something useful”, was a thought.

All this could be accomplished, SET demonstrated. The NGO developed an innovative design that effectively converted discarded plastic into material for construction that costs a fraction of the price of traditional bricks. With a design in hand, SET employed ragpickers to collect plastic waste. This is then cleaned and compressed by machines. Next, the compacted plastic is converted into plastic block bricks of 9”x9”x18” dimensions. Each weighs around 2.5 kg.

SET uses these plastic blocks for setting up the much-needed toilets. Approximately 90 plastic blocks are required for a 4’x5’ structure. Walls using plastic bricks are made up to a height of 7’x10’. The wall designs integrate the use of soil, sand and discarded bottles of colored glass. The light passing through the bottles creates a soothing effect. The outside surface of the structure is fortified with a mixture of clay and cement while the roof is of bamboo allowing for cross ventilation to keep the structure cool even at the height of summer. Masons working on these toilets easily learn the building method and can replicate them anywhere. The resulting structures are extremely sturdy and can withstand low magnitude tremors of 4.9 on the Richter scale. In Bodh Gaya, the structures have been tested to withstand earthquakes of up to 8.3 on the Richter scale.

Sacred Earth's amazing green initiatives don't stop with just the construction of walls. The unique design of their toilets has many other green features as well. Each toilet has the option of a separate collection point for waste-water filtration and one for collection of solid waste. A four-chamber filtration system works on the liquid waste and turns it into fluid bio-fertilizer that is diverted into the bio-remediation garden. The solid waste is collected in drums and a bio-culture (enzyme) is mixed with it to help break down the odor. Over the months, this solid dump turns into manure. SET even prepares the organic enzymes. This is achieved by mixing waste raw vegetable and fruits, jaggery and water. After three months, the fermented culture (enzyme) is ready for use. Other eco solutions include solar power for lighting and a rainwater harvesting system.

SET proposes to build similar toilets in six slums around Bodh Gaya and potentially benefit 1,800+ households. Their aim is to recycle 446 metric tons of plastic waste and convert it into 162,000 plastic blocks over a period of two years. That figure is based on the calculation that each block will recycle approximately 2.5 kg of plastic. The blocks will replace the need for 1,944,000 earthen bricks (1 plastic block= 12 bricks), the making of which would have possibly released 5,357 of clay or 1,307 metric tons of carbon dioxide into the atmosphere. Plastic waste choking landfills will be reduced. Just as importantly, there will be less noxious fumes in the atmosphere that result from the burning of plastic. So far, besides the eco-training and plastic upcycling centre, 13 women's toilet blocks have been completed in the slum villages surrounding Bodh Gaya.

To ensure that the science behind these green initiatives is understood and adopted, SET has constructed an eco-training and plastic upcycling centre to hold training courses for women, many of whom come from marginalized sections of society. At the workshop, the women learn about organic-culture, eco-solutions, plastic block making, ways to construct eco-friendly toilets, ways to turn used plastic into usable bags and folders for sale and much more.

Those who attend the leadership training workshops are encouraged to widen awareness by taking on the role of trainers who disseminate information on the eco-friendly and zero waste methods learned among the communities around Bodh Gaya. This helps open up employment and income-generation opportunities. SET further assists by helping the women link eco-friendly products for the consumer markets. Women from surrounding villages have been trained in adopting environment-friendly technologies and effective, low-cost solutions.

SET's small-scale methods provide a closed loop system with many benefits to people and the environment. The beauty of their strategies is that they are not complicated, but rather easy to implement.

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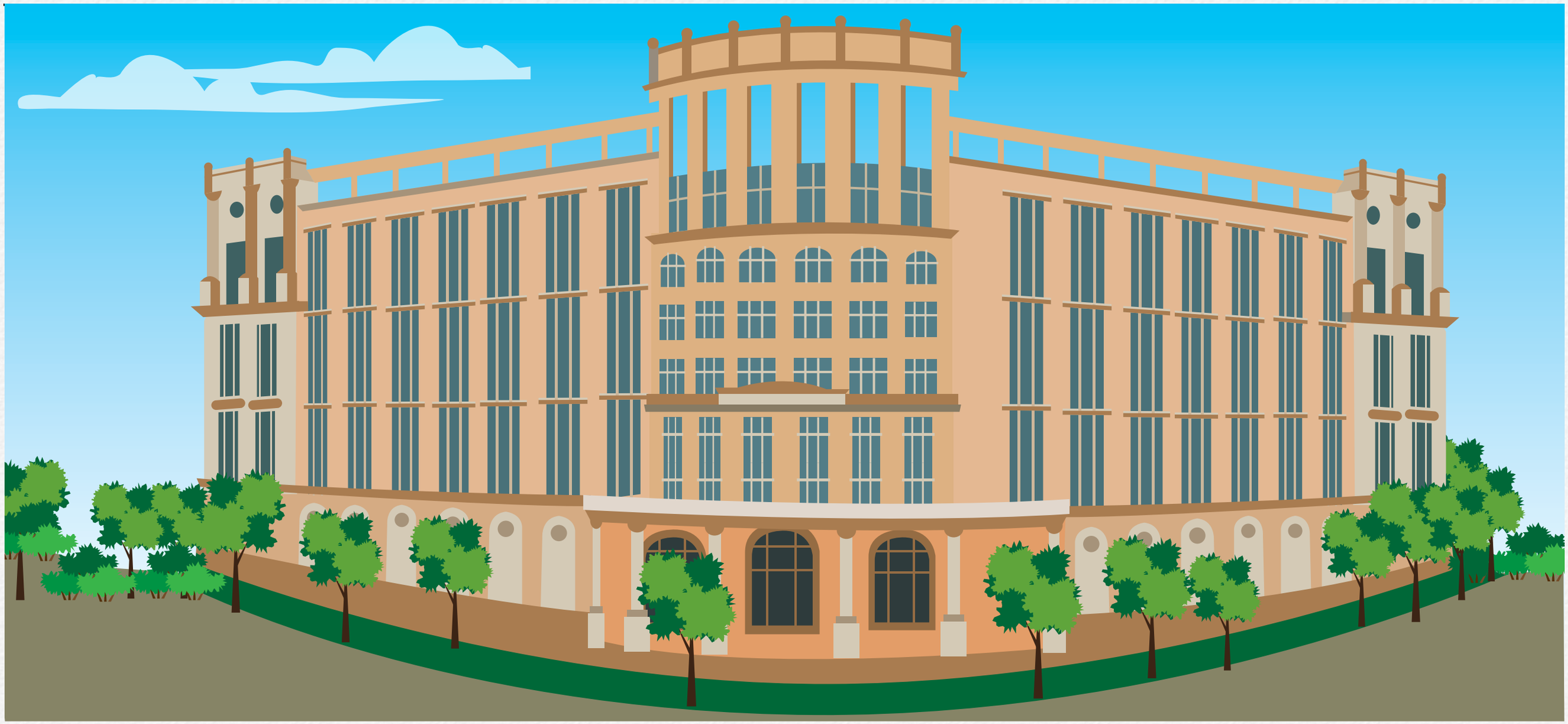
Sustainability Resides in its Soul



Sustainability Resides in its Soul

CRISIL is an innovative, global analytics company driven by its mission of making markets function better. Recognized as India's leading ratings agency, it is a provider of ratings, data, high-end research, analytics and solutions to some of the world's foremost banks and corporations. An environmentally-conscious organization, CRISIL is deeply committed to minimizing its carbon footprint.

In 2009, CRISIL consolidated all its Mumbai operations, spread across more than ten different locations in the city and shifted these to a single building at CRISIL House, Hiranandani, Powai. CRISIL House is a 210,000 sqft aesthetically designed, environment-friendly building. It has installed, the latest equipment that ensures comfortable and efficient operations for its employees. Situated in a bustling part of Mumbai, CRISIL House has earned the credential of being a top-rated green building. Featuring global green practices, it has been awarded the Platinum Rating by the Indian Green Building Council.

While many offices are known to turn environment-savvy after completion, what is truly exemplary in the case of CRISIL is that, environmental concerns were at the forefront while developing this state-of-the-art space.

Let's start at the very beginning—the site selection and method of construction—in which concerns to ensure minimum harm to nature played a pivotal role. To control erosion and reduce the negative impacts on water and air quality, the top soil excavated was used to build flower beds. The site selected ensured that most of the basic services that employees could require were within walking distance—grocers, banks, ATMs, chemists, restaurants, hardware stores, etc. The use of mechanized transport (which data from India's Central Pollution Control Board confirms is a leading polluter), was minimized thus keeping the carbon footprint minimal.

Recyclable, renewable and locally available materials were used in the construction of CRISIL House. The upcycling of old material and furniture during construction made for a judicious use of natural resources and resulted in reduced need for fresh supplies.

CRISIL House is energy-efficient, with a design that allows ample amounts of sunlight to filter in. Workstations are placed at a maximum of 40 feet from the windows. Zoning allows air conditioners to be switched off in spaces that are unoccupied. Reflective paint on the roof and other green efforts keep the heat out, thereby reducing energy demand. Special light fixtures are installed for exterior lighting. This helps reduce a negative impact on nocturnal environments. Light pollution reduction minimizes light trespass from the building and site, reducing the sky's glow and increasing night sky access. The management believes that the build-

ing's design improves employee wellness and efficiency as 80 percent of their employees get natural light at their workstations.

To combat the atmospheric Heat Island Effect caused by an intense movement of traffic and a high density of construction, there are 14 gardens outside and step gardens on different floors in CRISIL House. A 10,000 sq ft central atrium connects the building's nine floors. It also has a beautiful terrace garden that is insulated against heat and absorbs emissions. While all these green spaces are effective in keeping the building cool, they also provide a visually pleasing environment where employees can sit and have a cup of coffee, interact with colleagues and enjoy the rarely seen greenery in an over-populated and over constructed metropolis such as Mumbai. CRISIL says these features have been included to make CRISIL House a place that their employees look forward to coming to every morning.

The design makes the best use of scarce water and energy resources, among other green practices. Through a mix of innovation and cutting-edge technologies, the building promotes energy efficiency. Solar water heaters provide the building's heating requirements. In addition, by managing storm water runoffs and digging boreholes, the disruption to the natural flow of water is limited. There are energy and water metering facilities at all load centers. Building Management Systems to monitor carbon dioxide levels are also in place.

To ensure a healthy and eco-friendly atmosphere, the employees have also adopted green practices to ensure a low carbon footprint. For example, the printers and reprographic machines are placed in printing centers so that emissions are better managed. To ensure segregation between dry and wet garbage as per LEED rules, employees cannot carry their teas or coffees to their desks but must enjoy these in the common areas that serve the beverages. The building has recently installed a vermicompost pit to convert wet waste into compost for gardening. The building also uses recycled wastewater for gardening purposes.

The CRISIL Headquarter is a unique green building in every sense. In the words of its renowned architect, Hafeez Contractor, "Sustainability resides in the soul of CRISIL House."

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The Green Mosque

The Green Mosque

Badriya Juma Masjid in Kodi, Karnataka is a place of worship that welcomes people of all faiths. In popular parlance, it is referred to as the “Green Mosque”. The word “green” here signifies how environment-friendly the mosque is.

The mosque is located on a picturesque beach with the waters of the Arabian Sea lapping close by to remind people about nature’s beauty and the magnificence of its creator. Lateritic pathways, lush greenery and ample seating with an open ceremonial entry along the beach road, formalize the connection between the beach and the Mosque. This allows the locals as well as visitors an opportunity to enjoy the green space and be a part of the experience that encompasses the land, the community, and its culture.

Recipient of Platinum Rating from the Indian Green Building Council, the Mosque is a combination of the traditional practices of Islamic architecture, combined with modern principles that typify green buildings. The present Mosque stands on a site where an earlier one stood. As per Islamic principles, the entire demolition waste was segregated and re-used in the new mosque. Any additional requirements were fulfilled with local materials. All residue construction waste was sold to scrap dealers. The ‘Reduce-Reuse-Recycle-Regenerate’ principles adopted resulted in a site that remained pristine, even after extensive work had taken place there.

The structure stands tall to showcase the immense faith, commitment and dedication of those who constructed it. Built into its design is the clear message to society at large that rooftops can be put to use to generate renewable energy and that eco-friendly development is both economical and sustainable.

It is a unique place of worship (perhaps the world’s first “Zero Energy” Mosque) that meets its entire power requirement through a combination of wind and solar energies. Through the months of May to September, the strong winds that blow turn the turbines effectively and wind energy is produced. During this time, limited availability of sunshine minimizes the capture of solar energy. For the remaining months, the reverse is true. This wonderful blend ensures the Badriya Juma Masjid a regular supply of renewable energy throughout the year.

There were several issues to resolve before the Green Mosque’s first brick was laid. First, it was an onerous task to create a consensus among members of the mosque in adopting a blueprint that included elements of modern sustainable design as against going 100 percent with traditional forms. Costs had to be considered. Minimizing capital costs and recurring expenditures was a challenge. Climatic conditions were another stum-

bling block since the place remains hot and humid for a large part of the year. The weather is further compounded by the respiration of large numbers of worshippers and others that constantly flow into the prayer hall, which can accommodate about 2,000 persons. The design thus had to optimize ways to cool the building on the one hand and naturally evacuate heat from the prayer hall on the other.

This was a major challenge. How was it overcome? To a large extent, it was achieved by employing natural elements. The building's east-west orientation minimizes solar heat gain. The L-shaped building plan has an elevated prayer hall that is raised 10 feet above ground to improve natural airflow. The hall has a ceiling height of 30 feet. Venturi-type, large turbo vents help evacuate heat from the prayer hall, while a network pattern of Glass Reinforced Concrete(GRC) window exteriors helps in reducing heat gain. A thick canopy of tall coconut trees and green vegetation around the building both help to cool the structure as do the non-conducting GRC screens with over 60 percent openings to maximize natural ventilation. The terrace is laid with solar heat reflecting white China mosaics. Roof gutters retain shallow water to additionally cool the roof's concrete through evaporation. As is done in ancient monuments, evaporation from the ablution water tanks and the wells cools the structure's base. The west wall is made of local laterite bricks that block the ingress of heat. The overflowing vines on the wall further help cool the space.

Natural cooling of the prayer hall is accentuated with the construction of a 70 foot high multifunctional minaret, from where the "Azan" (call to prayer) is delivered. The top of the minaret is open on the west and south sides. It is designed to act as a wind scoop that rushes a downdraft of cool breeze into the prayer hall.

The "Green Mosque" is a shining example of the incorporation of futuristic thought processes with contemporary Islamic designs. Its architectural exquisiteness is breathtaking. The trustees opine that "In the course of time, we envision our example being emulated and a trail of such Zero Energy Buildings coming up to reduce millions of tons of CO_2 emitted annually."

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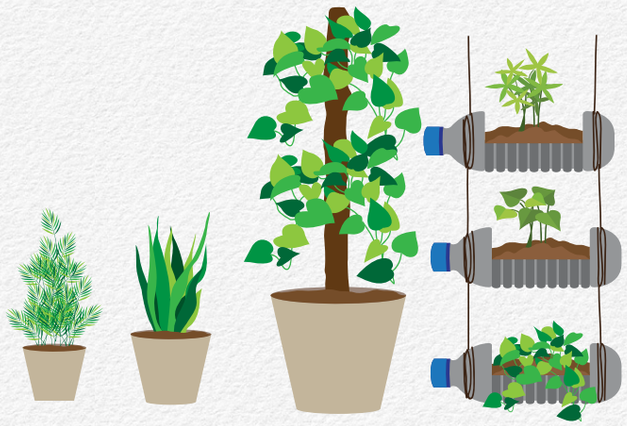
The Mountains Reach the Plains



The Mountains Reach the Plains

Kamal Meattle, the Chairperson of the Paharpur Business Centre (PBC) is a resident of Delhi. Some 20 years ago he began to suffer from respiratory distress. His lung capacity had dropped significantly causing chest congestion and breathing problems. All the doctors he consulted made the same diagnosis—his breathlessness was owing to the high levels of pollutants in the air, in particular benzene. Doctors were unanimous in zeroing-in on one possible remedy, “Leave Delhi” they all advised.

However, Mr Meattle is not one to abandon ship so quickly. He had read about the Clean Air Study led by the National Aeronautics and Space Administration (NASA) and wondered if that could provide a solution. The NASA scientists researched for years to find evidence that confirms that plants could serve the need for biological life support systems aboard orbiting space stations. How could biological processes help solve environmental problems, both on earth and in space habitats, they wondered? The results were a revelation. Data that emerged from the study concluded that common plants had the capacity to purify and revitalise closed spaces, as the tiny openings in their leaves act as filters that absorb contaminants present in the air. Could these findings help Mr Meattle improve the air quality around him?

Armed with this information, he worked with experts at the Indian Institute of Technology and The Energy Research Institute in Delhi to identify locally available plants that can naturally remove toxic agents such as benzene, formaldehyde and trichloroethylene from indoor air and also help neutralize the effects of the sick building syndrome so that there is improved Indoor Air Quality (IAQ). Three plants were shortlisted: Money Plant (Epipremnum aureum), Mother-in-law’s Tongue (Sansevieria laurentii) and Areca Palm (Dypsis lupescens). All three help remove chemical toxins from indoor air and also oxygenate it. Each converts carbon dioxide (CO_2) into oxygen (O_2). Money Plant and Areca Palm perform the conversion during the day, while Mother-in-law’s Tongue (also known as the Bedroom Plant) does it at night.

The “miracle workers”, as Mr Meattle calls them, have helped create mountain-like fresh air for the occupants of PBC offices in Delhi. This, despite the fact that PBC is located in the heart of a bustling commercial hub that sees a footfall of 100,000 people every day! High counts of Particulate Matter levels (2.5 and 10), sulphur oxides, nitrogen oxides, volatile organic compounds, ozone and more are expected. However, the PBC team has still managed to create a healthy micro-climate inside and outside the building that brings about good Indoor Air Quality.

By placing over 7,000 air-purifying plants all over the building, the decades old PBC sees a significant reduction in the quantum of air pollutants

such as carbon dioxide, in levels of fungus and bacteria, and also of particulate matter. To ensure the continuous availability of plants, PBC has a rooftop green house with vertical green walls of plants. All this helps PBC grow fresh air.

The brilliant outcome of plant use has earned for PBC the distinction of receiving the National Australian Built Environment Rating System certification for good Indoor Environment Quality—the only building outside Australia to receive this.

PBC's Management adheres to the thought that better offices make for better thinking. The Central Pollution Control Board, Ministry of Environment Forest and Climate Change, Government of India and the Chittaranjan National Cancer Institute, Kolkata, tested the air quality at PBC over a two-year period. Their conclusions were that the good IAQ has brought about a reduction of 52 percent in incidences of eye irritation, 34 percent in respiratory problems, 24 percent in headaches, 12 percent in impaired lung functions, and 9 percent in asthmatic attacks. The improved health parameters have brought about a 20 percent increase in productivity of those who work in PBC. This matches studies by Harvard Centre for Health & Environment and others that conclude that lowered CO_2 levels coupled with lower pollutants in buildings raise cognitive scores when compared to conventional buildings.

PBC is today a model of Health and Wellness at Work. It, along with its 27 support services, is certified with ISO:9001, 14001, 22000; SA 8000; OHSAS 18001; and Food Safety and Standards Authority of India. It is also a signatory to the United Nations Global Compact (UNGC) and Women's Empowerment Principles (WEP), and the only one from the Micro Small and Medium Enterprise category among the six signatories to WEP from India. It also became India's first Healthy and Sustainable Operational building to get CETEC 5-Palm Rating.

Research is ongoing to identify other plants to add so that the air quality improves even more. While each plant comes with its own health benefits, each also needs special care to grow. In order to help other spaces also get mountain-quality air, PBC has incubated Breathe Easy, (www.breatheeasylabs.com). The Company offers a wide range of products and services as solutions to purify air.

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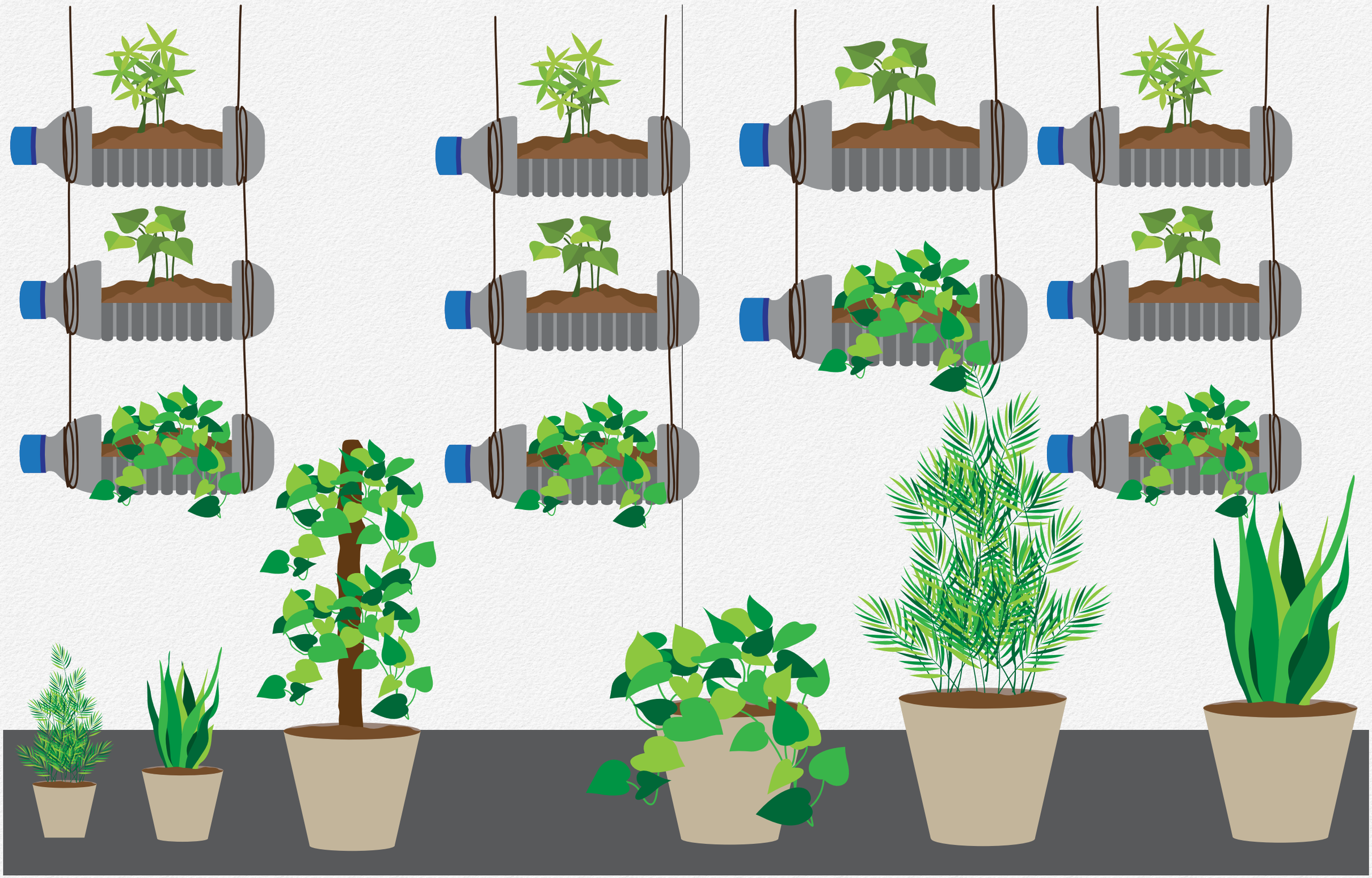
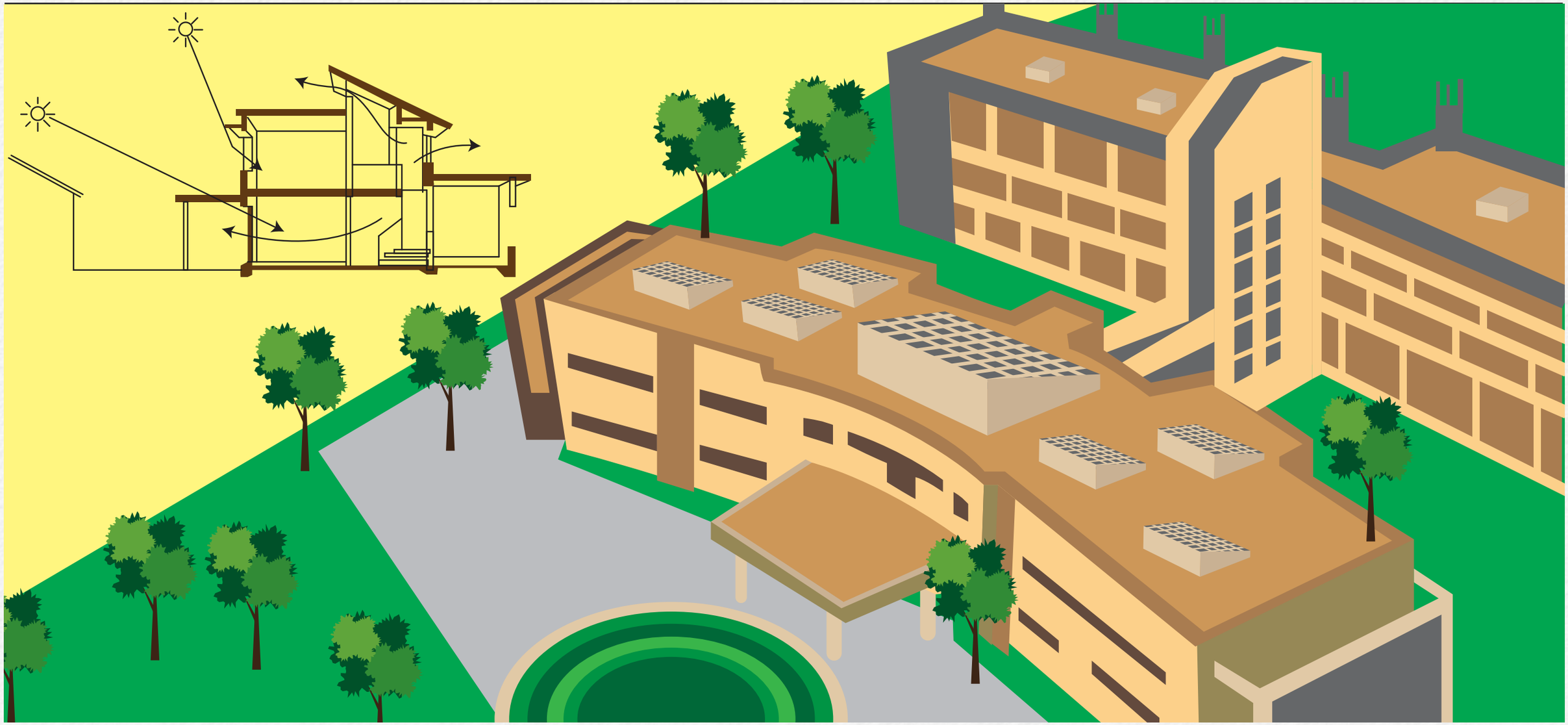
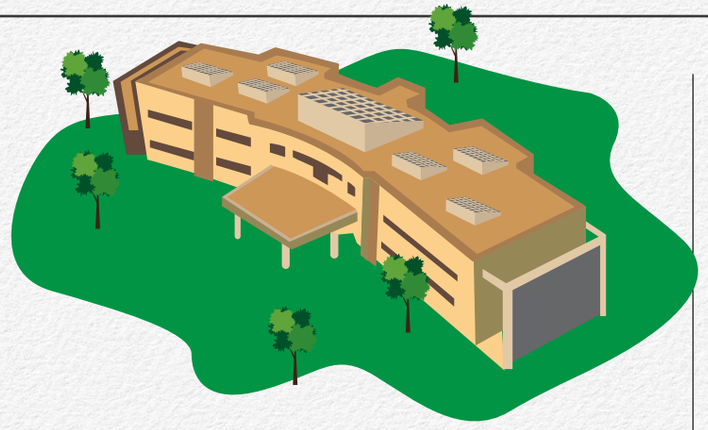


The Resource Efficient Retreat





The Resource Efficient Retreat

The Energy and Resources Institute conducts research work in the fields of energy, environment and sustainable development. Commonly referred to as TERI, it has developed an innovative, environment-friendly complex named RETREAT. The name is an acronym for “Resource Efficient TERI Retreat for Environmental Awareness and Training.”

RETREAT is located amidst 36 hectares of beautifully landscaped environs at Gual Pahari, Gurugram in Haryana State. When TERI bought the land, it was rocky and devoid of any vegetation. With the help of scientists and researchers, intense plantation activities were undertaken to improve the fertility of the land. Today, the area is lush—covered with green forests and gardens full of beautiful flowers. Surrounded by this greenery and beauty, RETREAT proudly stands as a model sustainable habitat, a campus of the future.

The brainchild of architect Sanjay Prakash, this architectural wonder has features that result in near-total energy autonomy and minimal resource depletion while continuing to provide a comfortable lifestyle. Its buildings utilize an array of techniques based on both modern science and traditional knowledge such as solar chimneys and earth air tunnels, fully integrated solar photovoltaic systems, a bed of Phragmites (reed plants) to recycle wastewater using the root zone technique, a biomass gasifier fed by firewood, twigs, branches, and crop stubble from the campus itself. All this and more help the RETREAT achieve considerable savings in energy consumption and a reduction in its carbon footprint with an estimated saving of CO_2 emission of about 570 tons per year.

The complex has two semicircular blocks arranged one behind the other. The structures showcase how orientation plays an important role in “solar architecture”. Built as these are with longer façades on the east-west axis, the design allows maximum south-north exposure so that the warmth of the sun streams in from the south during the chilly winter months and the harsh heat of the sun gets blocked out in the hot summer with the help of shading devices. The north block is slightly concave toward the front, while the south forms a hybrid convex surface facing the winter sun. The installation of innovatively designed skylights helps capture maximum daylight year round. Insulated walls and roofs finished with broken tiles further reduce the demand for heating. Shading and fenestration such as “jallies” (a construction design popular in the Mughal era) incorporated in the built infrastructure provide the RETREAT shade in the summer. A grove of deciduous trees planted in the south further cools the building in summer by acting as a sunscreen; in winter, the bare branches of the trees allow the sun’s rays a free run to the building. The load bearing structure of reduced steel results in lower embodied energy.

What is particularly unique to the RETREAT is the use of the underground earth-air tunnel system. Four tunnels, each 70 meters long and with a diameter of 70 cm, laid at a depth of 4 meters below the ground ensure that even without the use of air conditioning, the temperature indoors is kept within the comfortable range of 20–30°C throughout the

year. The novel system takes advantage of the relative constancy of the earth's temperature to provide the rooms with subterranean airflows that maintain the temperatures in those ranges. Temperatures recorded at roughly 4 meters below the surface in Gurugram reflect a stable average annual measure of 26°C, regardless of the fact that with the change of seasons, surface temperatures in the area are known to fluctuate anywhere between 10°C to over 40°C. The RETREAT takes advantage of the fact that because underground structures are not exposed to the sun, they do not heat up as much. In addition, the insulation provided by the surrounding earth helps in maintaining more or less constant temperature. This is something known and incorporated in structures centuries ago as evidenced in historical buildings such as the 17th century Red Fort in Delhi.

To circulate the air, rooms have solar chimneys through which warm air rises and escapes by creating an air current. Blowers fitted in the tunnels push cool air up to replace the vacuums created by the escaped warm air. The system is augmented by ammonia-based, chlorofluorocarbon-free chillers for dehumidification and additional cooling during the monsoon season keeping in mind that there is a drop in efficiency during humid conditions as the tunnels cannot remove the excess humidity from the air.

It is no wonder that the amount of energy needed for heating, ventilation and air-conditioning is reduced to 96 kW when in the normal course the demand would have been around 280 kW.

The RETREAT proves that sustainable habitats are not a Utopian ideal but a reality cast in brick and mortar. However, the RETREAT is an evolving experiment. TERI has systems in place to constantly monitor the performance of the buildings. Elaborate, extensive, and sensitive networks of sensors linked to a central station provide data 24 hours a day, 365 days a year to research, analyze, and find answers to the question "How well does the RETREAT perform under varying ambient conditions—in winter, summer, on bright days, cloudy days, at varying levels of occupancy etc?" The findings help TERI pinpoint successes and identify areas for improvement so that future buildings incorporate upgraded designs and more effective systems of operation.

Amit Kumar
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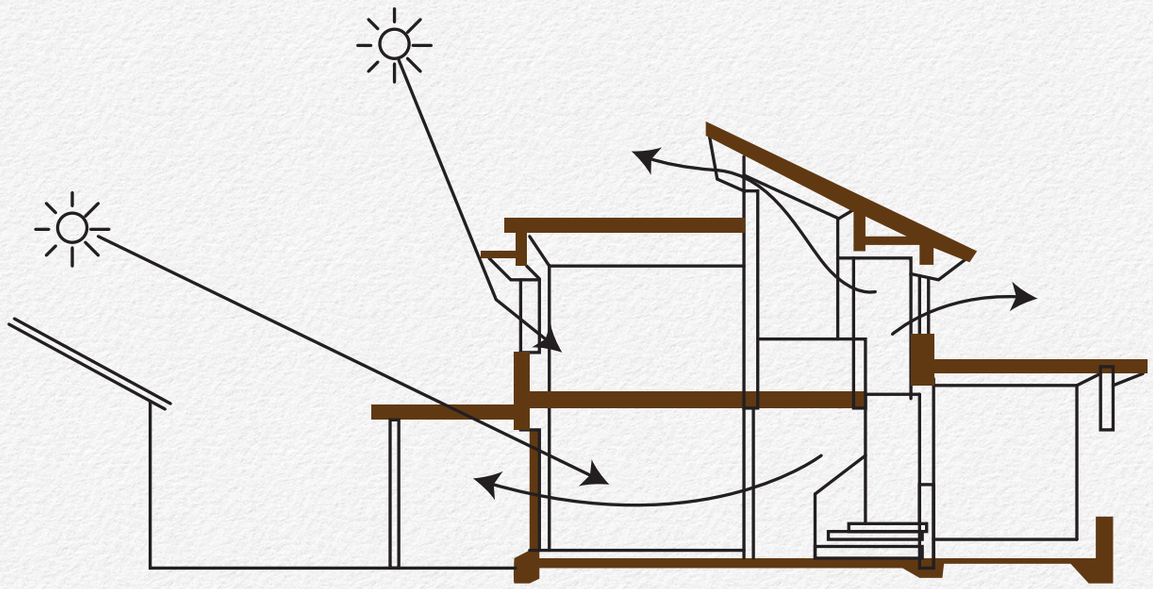
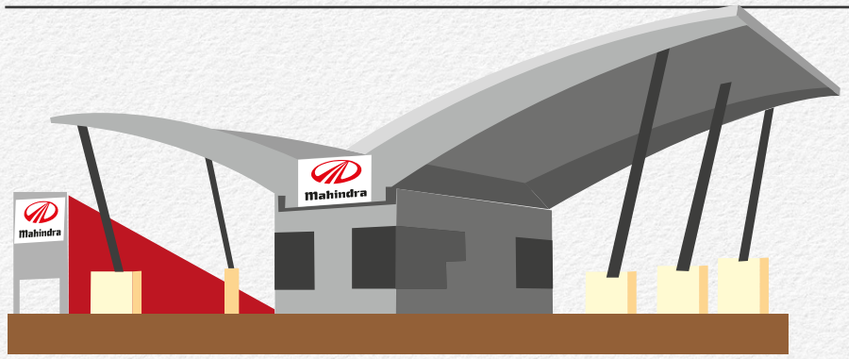


They Rise
To Do Good



They Rise To Do Good

The Mahindra Group is a $19 billion multinational group headquartered in Mumbai, India, with a presence in more than 100 countries and over 200,000 employees. Its operations span 20 key industries. Its chairman, Mr Anand Mahindra, the head of the conglomerate, is committed toward making every aspect of the business sustainable. He is globally recognized as a staunch advocate for the environment and was chosen to represent India Inc at the “Paris Agreement on Climate Change” on Earth Day 2016, at the UN Headquarters in New York.

In everything they do, the Mahindra Group’s aim is to “Rise To Do Good.” The conservation of the environment included. Ensuring that all buildings are environment-friendly is usual practice at the Mahindra Group. From the blueprint of the structure to its creation and then right through its lifetime, environmentally responsible and resource-efficient processes are put in place. Carbon neutral, energy efficient, buildings incorporate systems that make a greater use of solar and wind energies. The essential natural resource, water, or “Blue Gold” as they refer to it, is conserved and recycled. Zero waste management is a goal. These and other green initiatives are an integral part of the Mahindra Group’s philosophy and are practiced in each of their units. It is no wonder that many of the Mahindra Group’s buildings are certified by the Indian Green Building Council. The Mahindra Group’s office at Igatpuri is recognized as the 2nd best green building in all of India.

The Mahindra Group believes that working toward sustainability is not the sole responsibility of the administration. It ensures that sensitization and awareness is also created among all its employees and even external stakeholders, such as dealers and suppliers, so that the sustainability is integrated into everyone’s social conscience. Publicity campaigns, quizzes and other contests are run that showcase ways employees can play their part in sustainability. Online training modules are also created for associates.

While the Mahindra Group has in place a plethora of strategies for a greener environment, this article focuses on their working toward a Circular Economy, in particular by employing waste management techniques in their factories and residential complexes. Currently, the dominant mode in our economy is to manufacture products using resources, and to send to landfills waste that results from the process. In some cases, it is recycled. This is often referred to as the “take-make-dispose” economy, and is said to recover only 20 percent of the waste. The circular economy on the other hand, works to address resource losses. How does it do that? This model of industrial production incorporates processes that minimize waste to landfills and where products are designed so that components and materials can be reused many times over.

With this in mind, the Group strives to ensure Zero Waste to Landfills. In sync with the spirit of the circular economy, the Mahindra Group keeps resources in use for as long as possible, extracts the maximum value from these whilst in use, and recovers and regenerates products and ma-

terials at the end of each service life. The Mahindra units ensure that waste is drawn out not just from the manufacturing process, but throughout the lifecycle and use of products and their components. This enables them to create synergies with other industries to utilize waste as a valuable resource.

The zero waste policy they follow has the Mahindra Group manage waste at every stage in the hierarchy—right from prevention to minimization, to reuse, recycling, energy recovery and disposal. At Mahindra World City, for instance, buses, tractors and streetlights are powered by organic waste that is converted into Compressed Natural Gas (CNG). The Group has installed Global System for Mobile Communications (GSM) enabled solar-powered garbage compaction bins that not only call for a pick-up when full, but also optimize the route of the waste collection vehicle.

In 2016, the Mahindra Group's plant at Igatpuri achieved a status of near zero waste to landfill with a diversion rate of 98 percent. The Igatpuri plant facility is now zero waste to landfill and a Platinum rated green building in the existing buildings category. The plant recovers primer paints, metal powder, fuel oil and carbon from grinding mud and paint sludge—all items that would otherwise form part of hazardous waste. Biogas plants convert food and kitchen waste into energy and fertilizer. To fight the plastic monster, the Igatpuri plant has eliminated plastic bottles across its works. The management has taken the initiative wider to the community level as well. How did the team achieve this? A beginning was made by building awareness about the ill effects of plastic on health and on marine life among employees and members of the immediate communities. Next, the team started a collection drive in both office spaces and public places. 1,500+employees were joined by over 100,000 citizens, resulting in one of the largest ever cleanliness drives in the area. 100,300 plastic bottles were collected. With these, the Igatpuri team built a 20.4 meter high Plastic Bottle Monster—the largest of its sort in the world. The Monster symbolically demonstrates the damage to marine life caused by plastic pollution. To spread the message globally, the team applied and received recognition from the Guinness Book of World Records. The Igatpuri team plans to strengthen the fight against plastic pollution by identifying plastic recycling agencies that can convert the waste plastic into worthy wealth and thus adopt the regenerative and restorative principles of a circular economy.

The Mahindra Group officials say that while they are proud of the progress made and the accolades received, they are aware that there is still a long way to go. "The journey from constraints to abundance will be a long and complex one, but it is a journey we are proud to embark upon," they say. The Group is confident that, "With increased awareness, enthusiasm and dedication, our teams will rise to the challenge."

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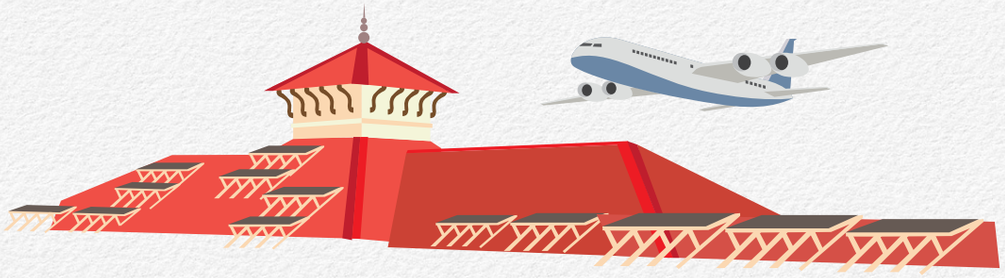
World's First Solar Powered Airport



World's First Solar Powered Airport

Headline news stated "The World's First Entirely Solar-Powered Airport Has Been Unveiled." Any guesses for where on the globe this airport is located? The answer is in Kochi, Kerala. The Cochin International Airport is declared the first international airport in the world to be entirely powered by solar energy.

To achieve this distinction, the Cochin International Airport Limited (CIAL) made a beginning in 2013 with the commissioning of its first solar plant. This was set up to generate 100 kWp. Over the next four years, the installed capacity rapidly grew to reach 23.2 mWp. Approximately 47 million units of green power were generated, thus avoiding carbon dioxide emissions of over 25,000 metric tons.

The expansion hasn't stopped. Plans are already in place to increase the solar capacity to 29.1 mWp by the end of 2017. A power potential of 43 million units per annum is visualized, that will bring about a substantial cost saving of approximately ₹300,000,000 per year. This will also avoid carbon dioxide emissions by over 720,000 metric tons over the next 25 years, equivalent to planting 7,000,000 trees or not driving 1,800 million miles. Toward this end, work is in progress for a 6 mWp canal-top solar photovoltaic plant. This is projected over a 2 km long canal on airport land that is outside the operational zone. For the plant, cost effective reinforced concrete mounting structures will be used in lieu of steel.

What triggered Cochin Airport's shift to solar. VJ Kurian, the Founder Managing Director of Cochin International Airport Ltd, the first Public Private Partnership model airport in India says, "In the beginning it was an economic initiative rather than an environmental one." In 2012, the Kerala State Electricity Board increased the power tariff of Cochin Airport from ` ₹4 per unit to ₹7 per unit. The annual expenditure toward electricity charges thus almost doubled and compelled the Cochin International Airport Limited (CIAL) to look for alternative avenues to source power.

In 2013, a pilot project to generate 100 kWp solar power was initiated on the roof of the international terminal. The plant had 400 solar modules with a capacity to generate 400 units per day on an average. This was less than 1 percent of the daily requirement. Happy with the outcome, in the same year, a bigger photovoltaic solar plant with a capacity of 1,000 kWp was commissioned. The latter plant had 4,000 solar modules with a capacity to generate 4,000 units per day on an average. This was installed partly on the rooftop and also on the ground. As both plants performed well for more than a year, it was decided to implement units to enable Cochin Airport to function totally on solar power. The new 12 mWp generating plant together with the existing 1.1 mWp plant would produce an average of 52,000 units a day resulting in a surplus as the daily requirement was only about 48,000 units a day.

This larger plant required approximately 45 acres of land. It was decided to make use of the vacant land that was earmarked for the expansion of the Cargo Terminal, after leaving enough area to accommodate the next

five year's expansion plans. Even if any buildings needed to be later constructed on this land, it was thought possible that the solar modules could be dismantled from the ground and reinstalled on top of the buildings that would come up on it.

With the commissioning of the 12 mWp photovoltaic solar plant in 2015, Cochin International Airport became the first airport in the world to be fully powered by solar energy. The entire power required by the airport for 24 hours was generated during the daytime when solar power is available. After consumption of the required power during the day, the remaining energy was exported to the State Electricity Grid and equivalent power was withdrawn when solar power was not available.

Keeping in mind that as the airport grew, additional power would be needed, it was decided to progressively build additional solar capacity to meet the growing demand and also to ensure that Cochin Airport did not lose its status as "A fully solar-powered airport." Thus, another ground-mounted photovoltaic solar plant of 3 mWp capacity was commissioned and installed in the vacant area earmarked for the future expansion of the aircraft maintenance facilities.

A buffer zone of a 40 metre-wide strip of land parallel to the runway outside the operational area belonging to the airport was lying vacant for the last 18 years which could not be utilized for any useful purpose. A 21,500,000 sqft solar carport photovoltaic solar plant was installed in front of the new international terminal building to provide a solar roof to approximately 1,400 cars. This is the biggest carport solar plant in India and the second biggest solar carport in the world (Weeze Airport in Germany is the first).

What began as an economic-driven need has now paid rich dividends. It not only saves money for the CIAL, but also reduces carbon emissions. This is a really well-thought out plan that has resulted in a complete win-win venture.

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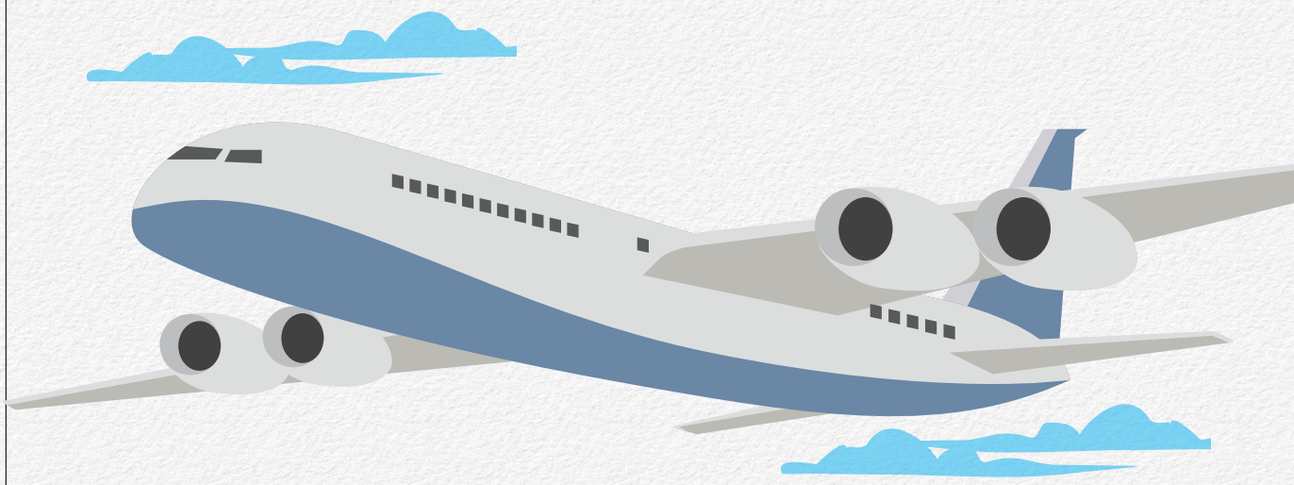

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This volume is part of our continuing endeavor to make available tried and tested techniques for sustainable development.

Our previous volumes include *Pathways to Green Cities: Innovative Ideas from Urban India, Volume I*, *Pathways to Green Cities: Innovative Ideas from Urban India, Volume II* and *Pathways to Green India: Innovative Ideas From Students, Volume I*.

As with our previous volumes, all are available on the internet free of cost.

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