Infosys®
Navigate your next

PIONEERING NET ZERO BUILDINGS

THE INFOSYS JOURNEY

PIONEERING NET ZERO BUILDINGS

THE INFOSYS JOURNEY

September 2023

Suggested citation:

Infosys. 2023. Pioneering Net Zero Buildings: The Infosys Journey.

Compiled by:

Alliance for an Energy Efficient Economy

Dr Satish Kumar

Dr Bhaskar Natarajan

Shatakshi Suman

Akash Goenka

Meghaa Gangahar

Dharini Sridharan

Anandi Mishra

Saumya Swasti

Sanjay Chaurasia

Tanuj Joshi

भारत 2023 INDIA

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

ऊर्जा दक्षता ब्यूरो
(विद्युत मंत्रालय, भारत सरकार)
BUREAU OF ENERGY EFFICIENCY
(Ministry of Power, Government of India)

Foreword

India communicated an update to its first NDC submitted earlier on October 2, 2015, for the period up to 2030, to include: (a) Lifestyle for Environment as a key to combating climate change; (b) To reduce Emissions Intensity of its GDP by 45% by 2030, from 2005 levels; (c) To achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030. India also committed towards the long-term goal of reaching net zero by 2070.

Infosys institutionalized structured data-driven energy management at the enterprise level and reaped multi-fold benefits. Its sustainability journey began by making energy efficiency as a core pillar in new building design and construction. Infosys' in-house team developed, adopted, and implemented data-driven best practices for superior energy management for its entire portfolio. BEE, and indeed India, is proud to have a global leader paving the way for net-zero energy building to become the norm as part of India's net-zero commitments.

A holistic life cycle assessment gives a deeper understanding and perspective on how incremental costs for implementing such measures or solutions are perceived. Infosys case studies can sensitize policymakers and help them set minimum performance standards that are ambitious yet achievable for both new and existing buildings.

Infosys has achieved remarkable success in creating high-performing buildings that surpass industry benchmarks for energy efficiency. These buildings have consistently exceeded the performance standards set by the Super ECBC (Energy Conservation Building Code) and BEE (Bureau of Energy Efficiency) 5-star ratings, which are awarded to buildings that meet specific energy performance criteria.Infosys's high-performing buildings have showcased their ability to go beyond established standards and deliver exceptional energy efficiency at the corporate level.

We should use this report for benchmarking, tracking, mapping and strategizing on energy consumption by commercial use buildings in India. It will also help map India's Net Zero journey and SDG commitments.

I congratulate the Infosys team for their efforts.

Abhay Bakre 28/8

(Abhay Bakre)
Director General

Dt. 28.8.2023

Foreword

Amory B. Lovins

Cofounder and Chairman Emeritus, Rocky Mountain Institute

Adjunct Professor of Civil & Environmental Engineering, Stanford University

In early 2009, a young Infosys engineer named Rohan Parikh visited me at Rocky Mountain Institute's office in Boulder, Colorado. He earnestly told us how he thought he could save 40% of the energy used by the Infosys building fleet, which was adding about four big buildings each year. We patiently listened, then told him as gently as we could that while we were honored by his request to collaborate with India's flagship IT company, his ambition was too low: we only worked with clients seeking to save 70% or more, and we hadn't time to support incrementalism. Rohan went back dejected, but took it as a challenge, and with support from Infosys leadership, was able to initiate a reimagined approach to buildings design.

I had been developing for several decades a practice of "integrative design" that can save several times more energy than commonly supposed, yet cost less and work better, by designing buildings, factories, and vehicles as whole systems for multiple benefits, not as piles of isolated parts for single benefits.

Integrative design can typically save at least three-fourths of the energy used by big buildings—new or existing. This quadrupled efficiency, or better, can actually cost less to build (let alone to run) than smaller, incremental savings, because it uses fewer and simpler devices rather than more and fancier devices. It doesn't add complexity but designs things out. And typically the costly mechanical equipment, such as cooling and air-handling systems, becomes severalfold smaller. That shrinkage cuts construction cost by more than the efficiency gains (such as better lights, windows, and insulation) increase construction cost, so total up-front cost falls.

This approach is less about new technologies than about how familiar technologies are chosen, combined, timed, and sequenced. Its changes can be strikingly simple. For example, making pipes and ducts fat, short, and straight not thin, long, and crooked can reduce friction, and hence pump or fan power, by 80–90+%. This correspondingly shrinks the pumps and fans, the half of the world's motor torque that turns those pumps and fans, and the system supplying electricity of which more than half runs motors. Each unit of flow or friction saved in pipes and ducts avoids compounding losses upstream, saving roughly ten units of fuel, cost, air pollution, and "global weirding" at the thermal power plant. These simple design changes, if universally applied, could save a fifth of global electricity, or half the coal-fired electricity. The extra cost is typically repaid in less than a year in existing buildings and factories, or instantly in new ones.

Such novel design is difficult because it's so simple. It's also unfamiliar—not yet in any standard engineering textbook, government study, industry forecast, or climate model. Why not? Because it's not a technology; it's a *design* method. Few people yet think of design as a way to scale rapid change. And it's hard to rearrange people's mental furniture. To use big pipes and small pumps not small pipes and big pumps, to lay out the pipes first *then* the equipment, to lay out supply pipes as if they were drains, we must bend minds, not pipes. Not all minds are flexible.

Infosys team swiftly absorbed the principles and the practical examples I had learned from the Singaporean master LEE Eng Lock and his protégé Peter Rumsey PE FASHRAE (now the top US engineer for superefficient mechanical systems). The team encountered resistance from conventional designers, but when there wasn't consensus on which approach to use in a big new building, each was used in half the building. Their difference in performance was decisive. Infosys never looked back. Its visionary leaders and its talented buildings-efficiency team changed the firm's practices forever, driving innovation across India and worldwide.

These better designs, technologies, business models, metrics, reward systems, and corporate cultures are more than the sum of their parts. They don't just save energy, water, materials, and money. They create far greater value by making employees happier, healthier, and more productive. They apply as much to vehicle and factory design as to building design. Across the whole economy, they drive business and societal success at every level. They are indeed powerful new global tools for sustainable development, well-being, equity, security, and prosperity.

These well-honed tools were long scattered, untaught, unnoticed, and little-used. Some were held close as trade secrets or as specialists' folklore. But now they are neatly collected and shared in a masterfully terse, clear, and effective toolbox—this book you hold in your hands. It describes exactly how an impressive company has transformed the way its buildings are designed, made, and run. It provides the roadmap by which all others, step by step, can adopt, adapt, and further improve this proven practice. It's not handwaving; it's evidence-based and evidence-rich. It's not preaching; it's fact. It's not speculation; it's real. Whatever exists is possible.

For fifteen-plus years, Infosys experts have worked hard to produce the remarkable results described here. I'm immensely pleased that with the blessing and initiative of their firm's founding generation, they are now generously sharing this experience with all India and the whole world. We owe them all a debt of respectful gratitude. And we owe our shareholders, our stakeholders, and all beings our best efforts to spread and use this book's profound insights, keep improving, and keep the gift moving. So read, reflect, and do. Go forth, be fruitful, and *subtract.*

Preface

Climate change is undoubtedly the biggest challenge humanity is facing today. It is evident from the fact that with every passing year, new climate records such as highest temperatures, highest CO_2 levels, erratic rainfall pattern and such are becoming the norm. Climate change is primarily driven by various sectors, including energy production, transportation, industry, agriculture and buildings.

With rapid urbanisation, buildings sector is increasingly a significant contributor, currently responsible for over one third of global energy consumption and emissions. But within these numbers lies an opportunity—a chance to reimagine our cities as beacons of efficiency, comfort, and resilience. From passive solar design to cutting-edge materials, from intelligent HVAC systems to energy-efficient lighting, the solutions are as diverse as the buildings themselves. The need to transition to cleaner, more sustainable energy systems has never been more urgent. Energy efficiency emerges as the linchpin of this transition, a powerful tool to reduce energy consumption while maintaining or even enhancing the quality of our lives.

Significant improvements in energy efficiency can be achieved through a focused and data driven approach, questioning every assumption, redefining benchmarks and through continuous innovation. Success stories at Infosys show that reductions are achieved not only in the operating costs of a building, but a smart design process can also result in lower initial costs. The case studies illuminate the achievements that can be realized when architects, engineers, researchers, builders, and policymakers join forces in the spirit of innovation and sustainability.

This book is not just about success stories; it's about shared learning. While it provides performance benchmarks, it acknowledges that, in the complex puzzle of sustainability, there are no silver bullets. There is a need to learn from both triumphs and setbacks, to build a collective understanding among various stakeholders of what it means to create infrastructure with minimum environmental impact.

The right approach to Net Zero emissions and meeting global climate goals is only possible through collective efforts of all stakeholders. Let us embark on this journey together, with humility, curiosity and a shared commitment to collaboration and knowledge sharing. Our destination is a world where we leave a legacy of hope for generations yet to come.

Executive Summary

This book chronicles Infosys' remarkable transformation from a leading IT firm into a trailblazing carbon-neutral leader that has set global standards for sustainable building and campus practices.

The initial designs implied that it was possible to establish a modern infrastructure meeting global standards in India. Nevertheless, these designs were influenced by Western building models, which were designed for climates and needs that were notably distinct from those prevalent in India. Consequently, these so-called 'modern' buildings, characterised by their extensive use of glass in their facades, frequently caused discomfort for occupants and consumed significant amounts of energy. However, after achieving these external benchmarks through social comparison, Infosys underwent a profound internal transformation.

Recognising the impracticality of replicating Western-style buildings in the Indian context, Infosys embarked on an extraordinary journey that positioned sustainability as a cornerstone of its growth and development, embedding it in the corporate ethos. A dedicated Green Initiatives team was established, empowered to think boldly and creatively. This team was entrusted with piloting innovative designs, construction techniques, and untested technologies, all to revolutionise energy consumption at the enterprise level. Resources were allocated to enable this team to pioneer internal benchmarks for building energy efficiency, now widely adopted as the standard for demonstrating sustainability credentials.

Infosys achieved these innovations by embracing global best practices and collaborating with experts renowned for their transformative yet practical approaches to energy efficiency and carbon neutrality. This journey required Infosys to consistently challenge established norms, unlearn conventional practices, take calculated risks, and experiment with ideas rooted in fundamental principles, all with significant energy use reduction potential. Some ground-breaking ideas, implemented without incurring additional costs compared to traditional construction, included:

- Setting stringent limits on heat transfer across building envelopes and imposing penalties on non-compliance
- Incorporating daylighting as an integral part of every building to reduce reliance on artificial lighting
- Achieving remarkable cooling efficiency, cooling an area four to five times larger than typical floor space with one tonne of refrigeration cooling capacity
- Significantly reducing connected load and maximum demand to half the typical office building levels while maintaining performance and comfort standards

Infosys adopted a two-pronged strategy:

- **Deep Retrofits in Existing Buildings:** Infosys initiated a comprehensive retrofit program for its early-phase, inefficient buildings. This initiative, guided by extensive data collected from sensors and meters at both component and system levels, aimed to enhance the efficiency of lighting, HVAC, and UPS systems across Infosys campuses.
- **Integrative Building Design for New Buildings:** In 2008, Infosys embraced an integrative approach to new building design. This process prioritised building envelope performance to maximise natural light and minimise heat gain. Cutting-edge technologies such as LEDs, super-efficient chillers, VFDs, radiant cooling, and modular UPS systems were deployed. Renewable energy sources were used to meet reduced energy requirements, dispelling the myth that sustainable buildings come at additional costs.

Infosys assembled a world-class in-house team to realise its visionary goals, reshaping the roles and responsibilities of architects, engineers, consultants, and contractors. This multidisciplinary team was motivated and inspired to embrace a new mindset and push boundaries in green building practices. Suppliers were also encouraged to introduce advanced technologies and set up manufacturing plants in India, committing to stringent quality and performance targets. A disciplined and execution-oriented procurement team ensured swift and efficient procurement to support Infosys' rapid growth. Figure A captures the main cornerstones of Infosys' sustainability journey.

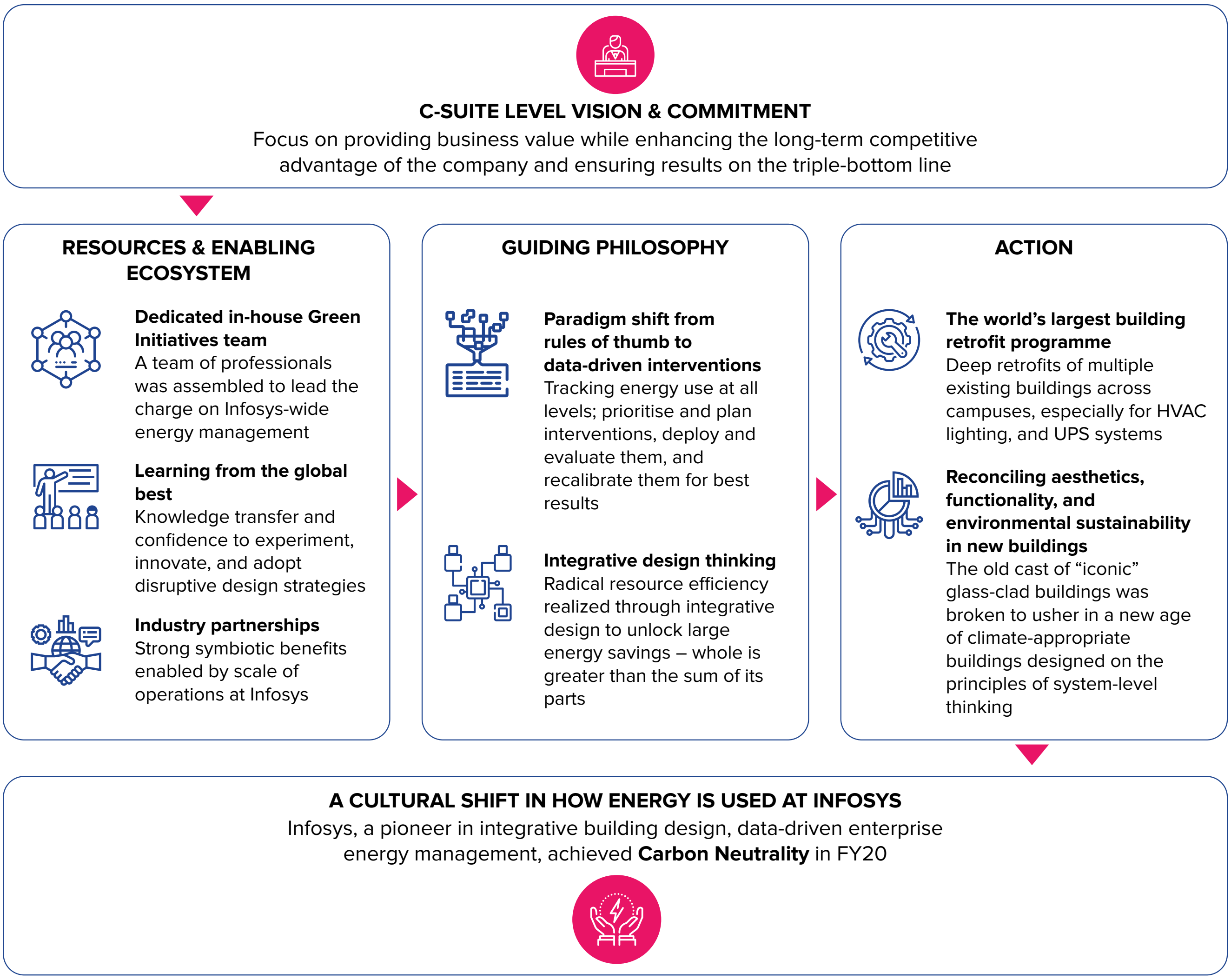


Figure A: The main cornerstones of Infosys' sustainability journey

Infosys achieved remarkable energy efficiency and sustainability gains despite a 166% increase in its workforce in India from FY2008-2020. Electricity consumption growth was limited to just 20%. This effort avoided 2.36 billion kWh of electricity consumption between FY2008 and FY2020. Infosys also achieved a cumulative 35 MW reduction in connected load in the same period through building retrofits. By FY2023, Infosys had in its portfolio about 28.9 million sq. ft. with the highest level of green building certification (IGBC/LEED/GRIHA).

This journey's significance lies in its potential impact on other companies' enterprise operations, particularly those grappling with commitments to achieve net-zero emissions. Infosys' template and detailed results offer encouragement and hope that businesses can become sustainability leaders while remaining cost-effective. As India sets ambitious targets for building sector decarbonisation, policymakers can draw inspiration from Infosys' accomplishments, recognising that stringent targets, data disclosures, and performance standards are crucial for achieving a net-zero economy.

> Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.
>
> —Margaret Mead

Content

Progress is often equal to the difference between mind and mindset.

—Narayana Murthy

1 A New Mindset

Infosys, founded by seven visionary engineers in 1981, has transformed from a modest venture into India's foremost enterprise in IT services. Its journey, rooted in strategic growth and relentless dedication, has expanded its presence globally, with offices and development centres spanning over 55 million sq.ft. across the world by 2023. Infosys has a revenue of $18.2 billion (FY 2023) and employs over 340,000 professionals, with offices in more than 50 countries, serving a diverse clientele of more than 1,850 clients. Its services play a vital role in digital transformation worldwide, shaping the global digital landscape.

Sustainability is at the core of Infosys' corporate governance, with Infosys senior management committed to taking action for the benefit of future generations. Within the erstwhile Predictability-Sustainability-Profitability-Derisking (PSPD) framework, environmental sustainability took precedence. In 2008, Infosys introduced its Sustainability Policy, firmly rooted in triple-bottom-line principles: the social contract, resource efficiency, and green innovation. This policy underscored Infosys' resolute commitment to reducing per capita electricity consumption and greenhouse gas emissions, with a long-term goal of achieving carbon neutrality.

Infosys became carbon neutral in FY2020, thirty years ahead of the Paris Agreement timeline. Infosys has effectively balanced its business pursuits while maintaining a strong focus on governance and responsiveness to environmental and societal needs. Infosys has actively integrated Environmental, Social, and Governance (ESG) factors into its operations. Today, Infosys' 2030 vision underscores the ongoing importance of ESG in the company's sustainable growth performance.

Infosys has emerged as a trailblazer in fostering a culture of environmental sustainability. The organisation strategically aligns its operations with three sustainability pillars: reducing greenhouse gas emissions through energy efficiency and renewable energy, minimising waste to landfills, and advancing water management. Implementing community-based projects to offset unavoidable emissions have contributed to carbon neutrality, positively impacting over 240,000 families and fostering socio economic development in rural India. Infosys' unparalleled achievements in environmental stewardship can be drawn back to three core principles:

- **Leadership's Commitment to Sustainable Progress:** Infosys' leadership embraces a forward-thinking ethos, understanding the symbiotic relationship between a company's enduring success and harmonious coexistence with the environment. Sustainability initiatives are driven by data-driven objectives, with C-Level leadership monitoring progress quarterly, fostering a profound sense of dedication, urgency, and innovation.
- **Cultivating a Culture of Data-driven Energy Efficiency:** Under this visionary guidance, the Infosys Green Initiatives Team embarked on a transformative journey, instilling a data-driven enterprise energy efficiency culture. Their systematic approach, supported by data-driven methodologies and feedback loop systems, promotes sustainable practices while optimising costs. It ventured beyond incremental changes, exploring paradigm shifts in the building portfolio, leveraging data-driven insights to enhance energy management, expedite decision-making, and continuously improve efficiency, ultimately reducing operational costs.
- **Mitigating Risks through Strategic Investments**: In mapping enterprise risks, Infosys conducted a comprehensive review at the board level committee, identifying critical risks like increased operating costs due to the non-adoption of energy-efficient technology and reputation risks related to sustainability and carbon neutrality targets. These risks influenced Infosys' investment strategy, incorporating environmental considerations, resulting in energy-efficient infrastructure and resource efficiency. Strategic budgets for highly efficient new offices and retrofitting existing ones aimed to reduce power demand, lower operating costs, and enhance cost-effectiveness.

Infosys' commitment to sustainability parallels the remarkable journey from humble beginnings to a global IT service giant. Sustainability is deeply ingrained in its corporate philosophy, focusing on environmental stewardship and carbon neutrality. Through visionary leadership, data-driven initiatives, and innovative design paradigms, Infosys continues to shape a greener and more sustainable future while leading the way in the IT industry.

> **Every once in a while, a new technology, an old problem, and a big idea turn into an innovation.**
>
> **—Dean Kamen**

2 Pioneering Change

In a world grappling with sustainability challenges, Infosys stands as a paragon of green innovation. Infosys has significantly improved its buildings' energy efficiency through a rigorous, repeatable, and well-defined process. To kick-start the journey, an energy consumption baseline was established and potential energy-saving opportunities were identified. The team worked diligently towards meeting Infosys' predefined targets by conducting in-depth research, drawing inspiration from proven vernacular design principles, fostering a culture of innovation, and integrating tested and validated technologies.

Infosys pursued two-pronged approach:

- Constructing ultra-efficient new buildings through an integrative design approach inset in holistic and sustainable campuses
- Retrofitting in existing buildings

2.1 Integrative Design Approach

Integrative design is a comprehensive, holistic approach combining different aspects of building design, typically considered separately. It examines all the factors and modalities necessary for decision-making. The integrative design process is highly collaborative, yields better results, and highlights potential challenges during the initial stages. Infosys adopted this approach in projects, leading to a gradual transformation towards holistically analysing the building, including all its systems and components.

The foundation of a high-performing building lies in its energy-efficient envelope—a principle that Infosys firmly stands by. According to the company, optimising the building envelope alone can account for over 50% of a building's energy efficiency. This assertion challenges conventional industry norms and sizing 'thumb rules that often fail to achieve desired outcomes. Why is this so crucial? An inefficient or oversized system not only drives up costs but also compromises operating efficiency and the comfort of the occupants. Infosys puts a premium on the early stages of design, focusing intently on crafting an efficient envelope first and then aligning other systems around it.

The company's design development process is comprehensive. It begins with reducing energy demand through a high-performing envelope. Next, it integrates high-efficiency systems specifically tailored to harmonize with the envelope. But the work doesn't stop at installation. Infosys monitors and verifies the operational efficiency post-construction, collecting crucial data to assess the effectiveness of the interventions. This data-driven approach validates the efficiency of existing structures and informs innovative strategies for future building designs.

The Green Initiatives Team set aspirational energy efficiency goals and targets for consultants and sub-contractors to encourage them to work beyond the industry standard thumb rules. This unique approach led to the successful implementation of energy efficiency initiatives at Infosys facilities.

At the Infosys Mysuru campus, the Integrative design approach involved re-evaluating the design process before placing an order for chillers. The initial design required 625 TR chillers. But upon closer examination of the building's envelope and other systems, significant changes were made in the building design. As a result, the chillers could be downsized to 400 TR chillers. Not just in Mysuru, HVAC improvements yielded substantial energy efficiency and operational performance gains across Infosys campuses. Redesigned chiller plant rooms achieved a remarkable 70% reduction in connected load, translating to energy savings exceeding 30%.

Understanding that a building is a complex system comprising various sub-systems and interrelated components that impact each other's performance proved to be a critical inflexion point. This led to Infosys bringing various system experts together to enable cross-team discussions, exchanging ideas, and voicing concerns to implement integrative solutions. Infosys helped identify and resolve many design issues and deviations, assisted the teams in better understanding the design process, and contributed more effectively to providing complete solutions and recommendations. Figure 2.1 depicts Infosys' model for collaboration and innovation in integrative building design.

Given the uncertainty of its yields, the transition from the conventional design and construction process to a brand new, hitherto unchartered approach was brave. Adopting integrated planning in design and construction was a novel concept and debatable in 2008 since what looked seamless involved multiple risks and challenges in its implementation. Pre-2008, Infosys buildings were known for their iconic designs and visual appeal. Therefore, shifting the emphasis to building energy performance, sustainability, and functionality could have been challenging. However, Infosys stood firm on performance criteria and showed zero relaxation in compromising its targets. As operational data showed promising results, the architects and consultants were motivated to follow Infosys' uncompromising vision. As a result, Infosys campuses continue to be iconic in design, visual feel, and appearance.

Multi-disciplinary kick off: From day one, a cross-functional team comprising architects, civil engineers, MEP (Mechanical, Electrical, and Plumbing) consultants, environmental design experts, specialists, and subject matter experts, commences the design process. They engage in 'design charrettes' and interdisciplinary meetings to ensure everyone aligns with the Infosys philosophy.

Setting targets: The design team articulates clear performance goals, regularly updating these as the project evolves.

Project facilitation: A project facilitator joins the team where needed to highlight performance issues and ensure seamless communication among all stakeholders.

Balancing priorities: Dialogues between the Infosys client team and designers determine the relative importance of varied performance metrics, helping establish a consensus for project objectives.

Data-driven validation: Energy simulations test various design assumptions, offering objective metrics on crucial performance aspects.

Iterative design: The team generates multiple concept design alternatives—each tested through energy simulations—to arrive at the most promising design for final development.

Figure 2.1: Infosys' model for collaboration and innovation

Global Inspirations

Infosys embraced global collaboration to advance its sustainability goals by forming partnerships with experts and esteemed institutions worldwide, unlocking valuable insights and innovative concepts. Notable collaborators included Rocky Mountain Institute (RMI), Lawrence Berkeley National Laboratory (LBNL), the Centre for the Built Environment (CBE) at the University of California, Berkeley, Mr Peter Rumsey from Stanford University, and engineer Mr Lee Eng Lock from Singapore.

Inspired by Dr Amory Lovins and RMI's innovative concepts like 10x engineering, Infosys revolutionised resource efficiency through integrative design, achieving substantial energy savings. Infosys prioritised employee comfort by addressing energy-intensive all-glass buildings and consistently met exceptional efficiency standards. Infosys successfully debunked the myth that large-scale, efficient buildings adapted to Indian climates incur extra costs compared to traditional ones.

Mr Rumsey's expertise from Stanford University optimised HVAC systems for energy efficiency and comfort, while Mr Lee Eng Lock set high efficiency standards for Infosys' Green Initiatives team.

These collaborative efforts strengthened Infosys' commitment to sustainability, effectively translating global expertise into practical Indian initiatives.

2.1.1 Integrative Design from a Financial Perspective

Infosys offset the incremental capital expenditure of an ultra-efficient building envelope by downsizing the end-use systems and reducing operational energy consumption. Table 2.1 compares the end-use capacities and operational energy use for 1 million sq.ft. infrastructure under two different approaches: conventional and integrative design.

Table 2.1: Financial comparison of the integrative design approach with the conventional approach for a 1 million sq.ft. infrastructure

	Conventional approach	Integrative design approach	Cost savings under the integrative design approach (crore INR)	Cost savings under the integrative design approach (INR/sq.ft.)
Total electric load	8 MW	3.5 MW	10	100
Transformer capacity	10 MVA	4.5 MVA	1	10
DG set capacity	12 + 2 MVA	4.5 + 1.5 MVA	12	120
HVAC capacity	2850 TR	1350 TR	3	30
Lighting system	1.2 MW	0.45 MW	1.5	15
Annual energy consumption	25 million kWh	8 million kWh	10	100

2.2 Retrofitting in Existing Buildings

Infosys utilised metering and energy audit data to identify and prioritise energy-saving opportunities. This included the following key initiatives:

- Sub-metering key energy end-uses across existing campuses
- Monitoring the operational schedules of different buildings and systems
- Utilising extensive energy audits to assess the energy performance of building envelope and air-conditioning systems, lighting levels and lighting power density (LPD), UPS systems, etc.
- Identifying energy-saving opportunities across different systems and equipment such as pumps, chillers, fans, etc.

Infosys went on to implement retrofits in a phased manner through three stages with increasing capital investments, as shown in Figure 2.2.

Stage 1: No-cost measures

"Low-hanging fruits" that delivered impressive energy savings without any capital investment and helped gain the confidence of the senior management to make investments in future stages

Examples: Improving the operational sequencing of HVAC systems, setting temperatures at 24°C.

Stage 2: Low-cost measures

Ensured higher level of energy savings in buildings with moderate level of investments

Examples: Replacing pumps and installing thermostats and timers for electrical panels to schedule the major equipment on/off, etc.

Stage 3: Capital-intensive retrofits with a payback period of 3 years

Highest capital allocation through budgetary approvals for major retrofits with a payback of up to three years with highest level of energy savings

Reduced the connected HVAC load by over 10 MW across campuses

Examples: Redesigning, re-engineering and upgrading the chiller plant and replacing inefficient UPS systems with high-efficiency modular systems

Figure 2.2: Infosys' phased retrofitting programme

The retrofit process commenced in 2008 and was implemented across campuses with an annual spend of INR 25-35 crores ($3,900,000-5,500,000)[1] annually over eight years. Infosys completed over 300 retrofit programmes, covering HVAC, electrical systems, building envelopes, and UPS. Through deep retrofits in air-conditioning, UPS, and lighting, Infosys successfully reduced the connected load by over 35 MW across its campuses. These retrofits improved thermal and visual comfort for building occupants and positively impacted their productivity. Many of these retrofits demonstrated a payback period of less than three years for comprehensive system upgrades, making them financially viable and environmentally sensible.

1. 1 $ = 64 INR, based on considerations of consistency, the period of 2010-2020, and year-ending exchange rates

2.3 Salubrious Campuses

At Infosys, employee satisfaction isn't just a catchphrase—it's a design principle. The company's approach to campus development, illustrated in Figure 2.3, places a premium on creating workspaces that promote productivity, comfort, and, most importantly, sustainability.

The trifecta of comfort: Infosys ensures that its buildings offer thermal, visual, and acoustic comfort—all without sacrificing energy efficiency. In simple terms, occupants feel good in these spaces, both physically and ethically.

A breath of fresh air: Infosys' new radiant-cooled buildings have 100% fresh air without any recirculation. Fresh air supply in other buildings exceed ASHRAE benchmarks and WHO guidelines. Carbon dioxide sensors are strategically installed to continuously monitor indoor air quality (IAQ), ensuring a healthier work environment.

In harmony with nature: Infosys campuses are lush with native flora, contributing to local biodiversity and creating a soothing microclimate. Through meticulous landscaping, including the presence of trees and water bodies, the outdoor spaces offer a tranquil setting for employees.

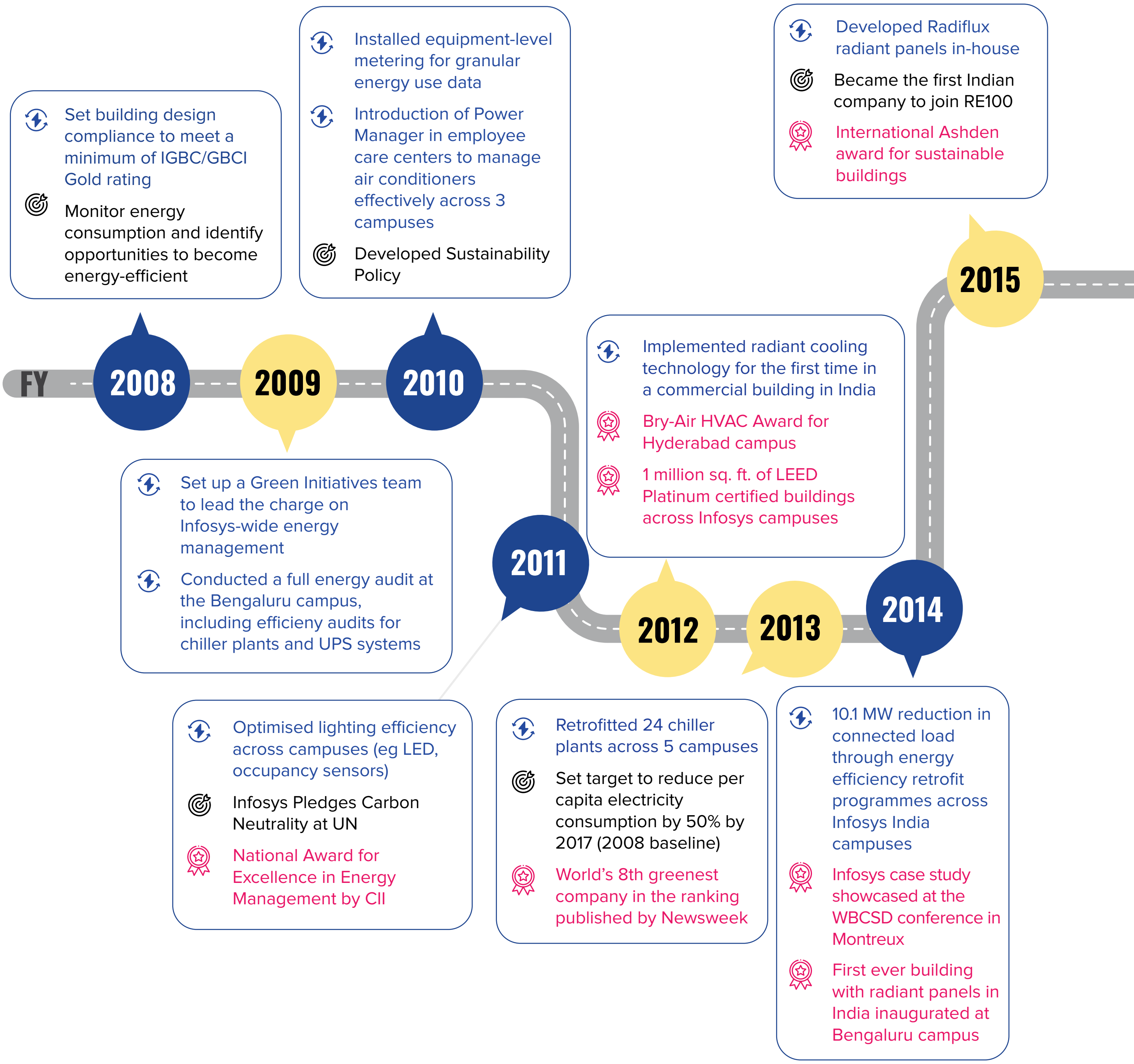
Smart zoning and massing: Careful planning includes creating landscapes and breakout spaces that encourage good wind flow and natural irradiation, minimizing the urban heat island effect. Even the food courts employ natural ventilation, complemented by mechanical ventilation like ceiling fans, for optimum comfort.

Beyond buildings: While substantial investment has been made in construction and maintenance, Infosys also focuses on the larger ecological footprint. It has initiated programmes encouraging mass/public transport and carpooling. This eases commuting and substantially reduces the company's operational carbon footprint.

Figure 2.3: Infosys' focus on employee well-being and holistic sustainability

3 The Journey in Numbers

The vision for sustainability at Infosys materialised into concrete actions, which resulted in measurable outcomes. The journey began with a baselining exercise in FY2008, following which several data-driven energy efficiency initiatives were taken. This eventually evolved into the world's largest building retrofitting programme. Figure 3.1 illustrates Infosys' transformative journey from vision to reality.



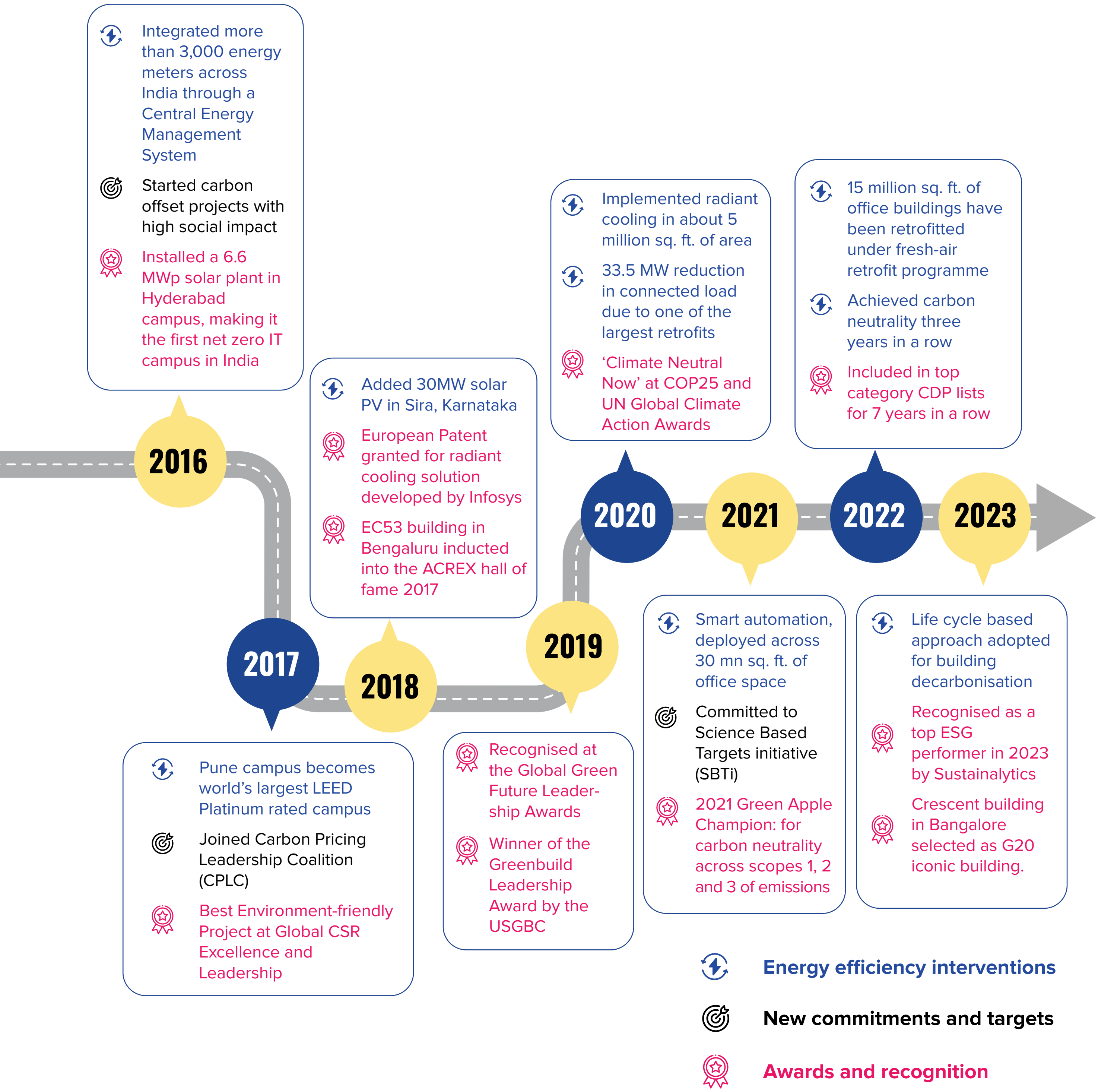


Figure 3.1: Key milestones in Infosys' sustainability journey

3.1 Enterprise-wide KPIs

Infosys' enterprise-wide sustainability drive resulted in quantitative improvements across several aspects of building energy performance. This section highlights key achievements measured in high-level KPIs related to electricity consumption, connected load, greenhouse gas emissions, and the role of energy efficiency in securing significant enterprise-wide improvements.

The data presented in this chapter have been sourced from Infosys' past and present Sustainability Reports, ESG Reports, and associated ESG Databooks.

3.1.1 Electricity Consumption

Despite a 166% increase in the number of employees in India in FY2008-20, Infosys limited the absolute increase in electricity consumption to 20%.

Per capita monthly electricity consumption decreased by 55% in FY2020 with respect to the FY2008 baseline, as shown in Figure 3.2. Although impressive, this KPI is no longer tracked since Infosys has adopted a hybrid mode of working post the pandemic. Infosys embarked on workplace transformation to enable its employees to adapt and excel in the new normal entailing flexible working options between office and home.

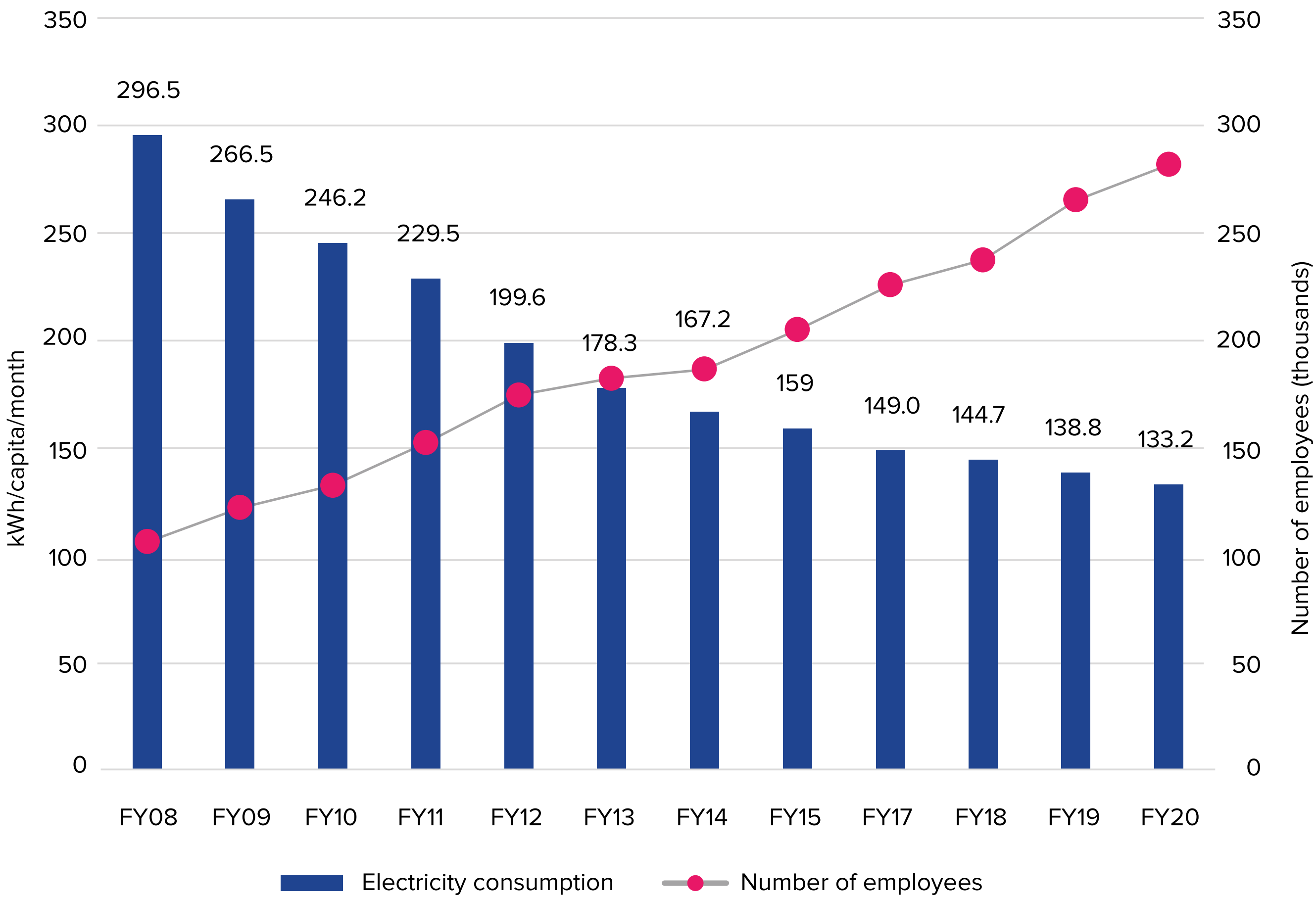


Figure 3.2: Monthly per capita electricity consumption

In FY2021, with most employees working from home, the metric for energy intensity was revised from per capita to per $ revenue. Between FY2008 and FY2020, prior to the pandemic, Infosys achieved a substantial improvement of over 50% in its annual electricity intensity (Figure 3.3).

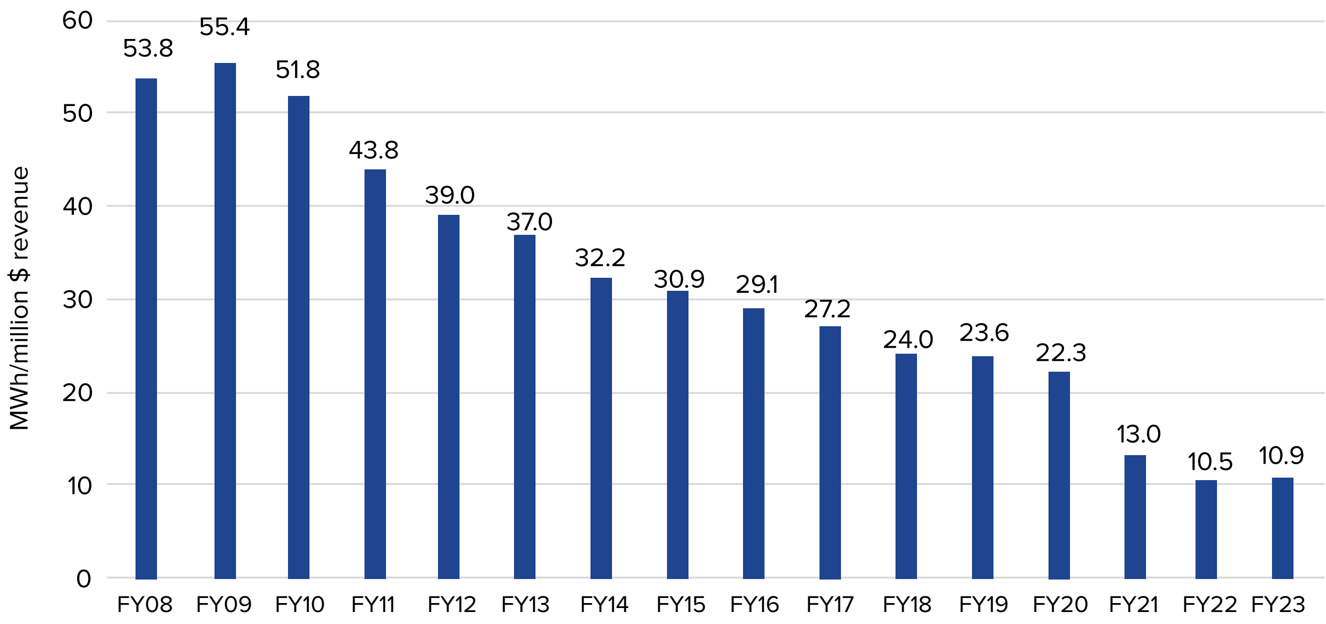


Figure 3.3: Annual electricity intensity

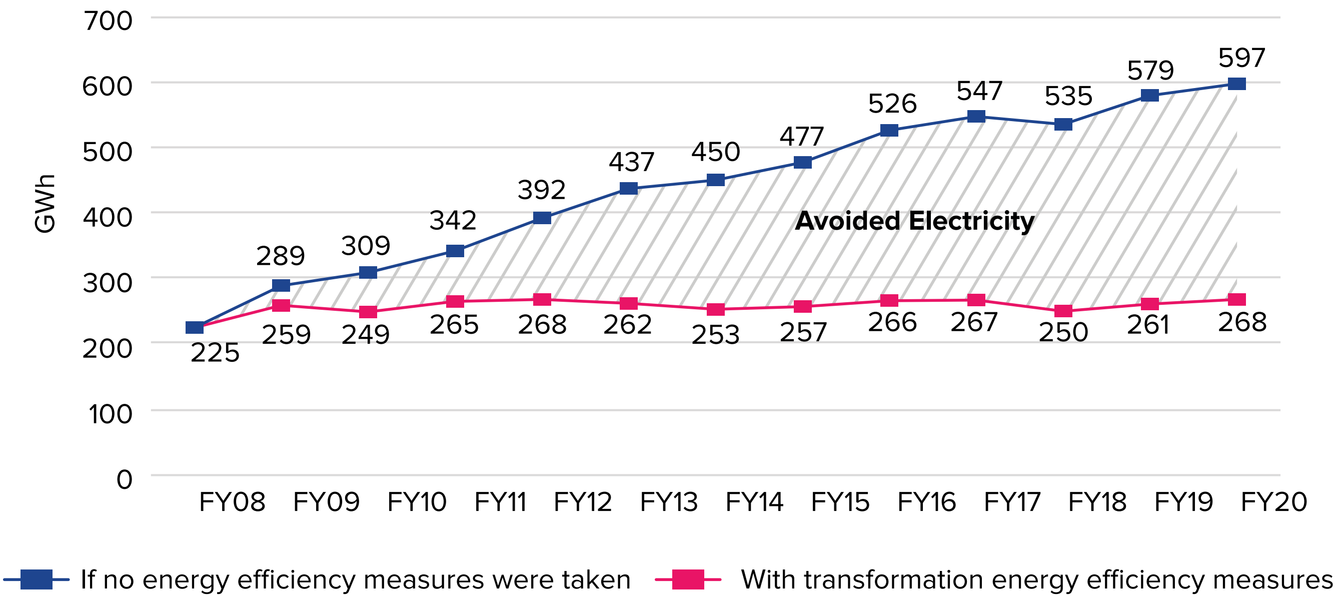


Figure 3.4: Electricity avoided due to transformational energy efficiency measures taken by Infosys

As shown in Figure 3.4[2], energy efficiency helped avoid an estimated 2.36 billion kWh cumulatively from FY2008 and FY2020 as compared to a scenario in which no energy efficiency interventions were taken, and electricity intensities experienced in FY2008 were experienced through FY2020. This roughly translates to nearly 2 million tonnes of CO_2e of avoided GHG emissions. In other words, Infosys avoided nearly 50% of its Scope 2 GHG emissions compared to a scenario in which no energy efficiency interventions were taken.

2 This graph was presented by Infosys at the Forum for Energy Efficiency and Decarbonisation organised by AEEE in February 2022.

3.1.2 Connected Load

Infosys has successfully reduced its connected load through retrofitting existing buildings. Figure 3.5 illustrates the connected load reduction across years, amounting to 35 MW cumulative reduction in FY2020. Notably, deep retrofits in HVAC, UPS systems, and lighting contributed significantly to the cumulative connected load reduction.

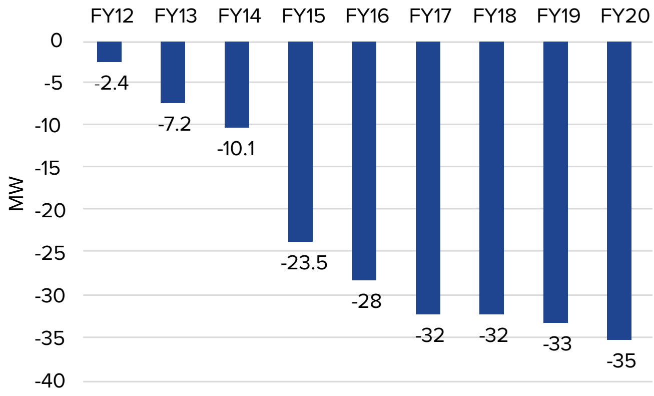


Figure 3.5: Cumulative reduction in connected load

3.1.3 Scope 1 & 2 Greenhouse Gas Emissions

As shown in Figure 3.6, between FY2008 and FY2020 (pre-pandemic) Infosys' annual GHG emissions (Scope 1 & 2) intensity reduced by nearly 75%.

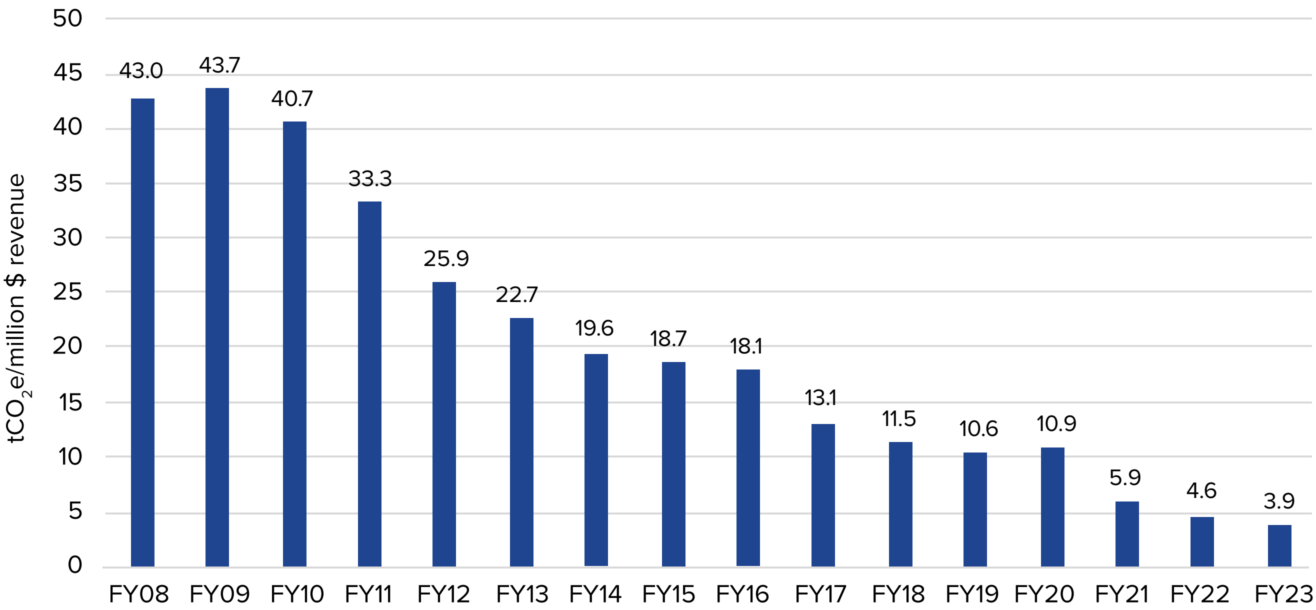


Figure 3.6: Annual Scope 1 and 2 emissions intensity

3.2 Building Energy Performance

3.2.1 Green Building

Since 2008, all Infosys buildings have been designed to meet the highest ratings of IGBC/GBCI/GRIHA. By FY2023, Infosys achieved green building certifications for 28.9 million sq. ft. of built-up area, most of which was added between FY2012-22. Figure 3.7 showcases the growing built-up area with the highest LEED/GRIHA certification over the years.

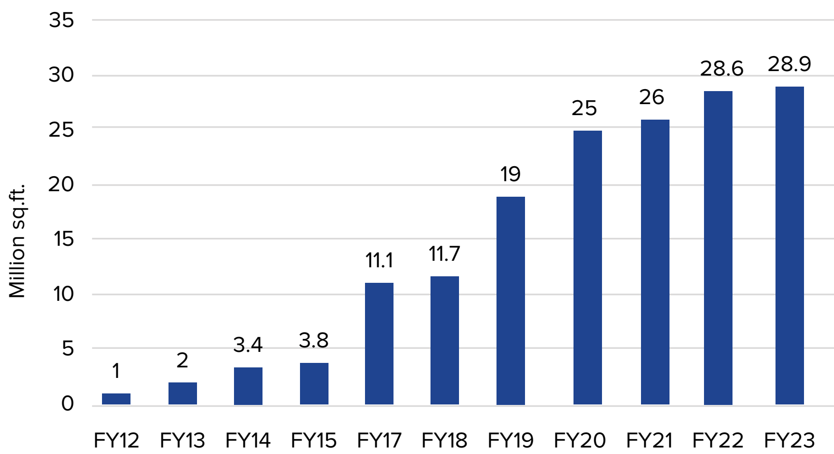


Figure 3.7: Built-up area with the highest IGBC/GBCI/GRIHA rating

3.2.2 Building & End-use Benchmarking

Infosys aimed to continuously improve building performance by aligning with industry standards and benchmarks. This included adopting best practices guidelines such as ASHRAE Standard 62.1 for HVAC and indoor air quality, BEE Star Labelling for building EPI, and building energy code 'SuperECBC' for essential end-use design and performance parameters. Infosys also developed an internal benchmarking system based on these standards, guiding its retrofitting and new design strategies to achieve higher efficiency levels. As a result of these measures, Infosys successfully improved building performance, surpassing industry benchmarks and continuously striving for better results in its energy efficiency parameters, as shown in Figure 3.8.

	2008	2020	Reference standards and benchmarks
Lighting Design	1.2 W/sq.ft.	0.45 W/sq.ft.	Super ECBC: 0.46 W/sq.ft.
HVAC Design	350 sq.ft./TR	750 sq.ft./TR	Regular building: 300-500 sq.ft./TR
Electrical Design	6.5 W/sq.ft.	3.3 W/sq.ft.	Regular building: 5-10 W/sq.ft.
Chiller Plant Efficiency	0.9 to 1.0 kW/TR	0.55 kW/TR	Super ECBC: 0.7 kW/TR
Building EPI	200 kWh/m²/year	70 kWh/m²/year	BEE 5-star rated building: 90 kWh/m²/year

Figure 3.8: Comparison of Infosys' building-level and end-use-level energy performance with national and international standards and benchmarks

The EPI of Infosys high-performing buildings has improved by around 65% over the years as shown in Figure 3.9.

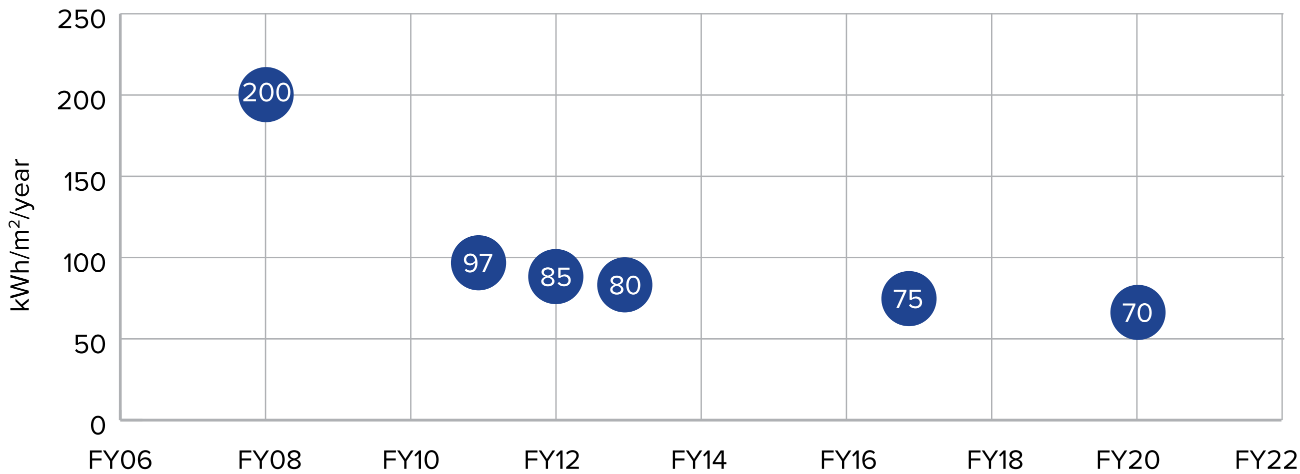


Figure 3.9: EPI of Infosys' high-performing buildings over time

By surpassing the standards and benchmarks shown in Figure 3.8, Infosys' high-performing buildings have showcased exceptional energy efficiency. The energy performance of high-performing Infosys buildings is not only ahead of Indian standards and benchmarks but also comparable to high-performing office buildings worldwide, as detailed in Annexe, and shown in Figure 3.10. Comparing energy performance across countries with varying climatic and geographical conditions can be challenging. However, it's worth noting that Infosys often implemented climate adaptive building design strategies and advanced technologies to optimise energy efficiency leading to remarkable results.

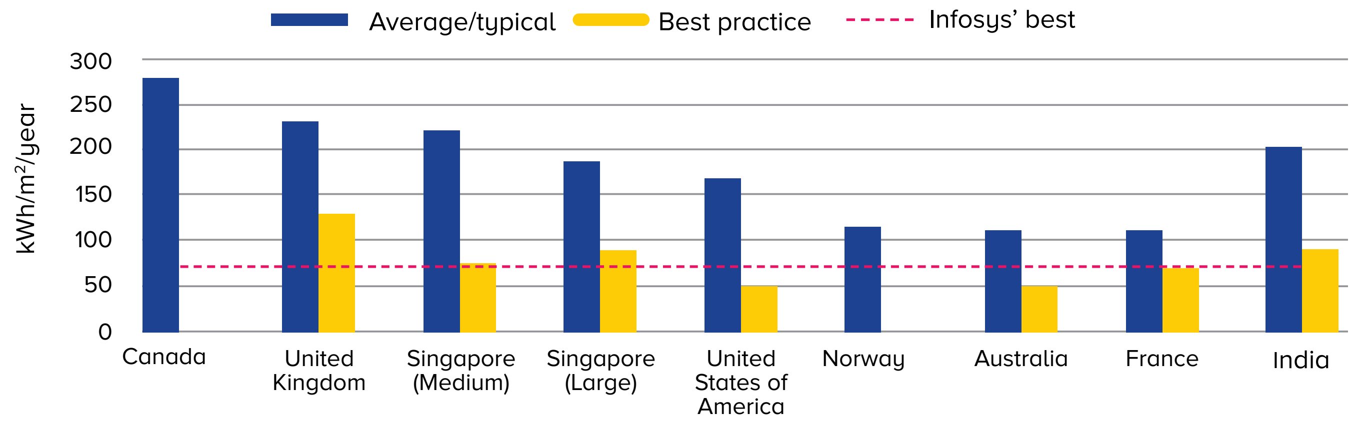


Figure 3.10: Comparison of Infosys' best building EPI and the standards and benchmarks for office buildings in other countries

3.3 The Untapped Potential of National Electricity Savings in IT & ITeS Buildings

Infosys serves as a remarkable example of how IT companies can achieve substantial medium-to-long-term energy savings through integrative building design and proactive energy management. The company successfully limited its electricity consumption increase to 20% while expanding its workforce by 166% between FY08 and FY20.

IT & ITeS buildings are a significant segment of India's commercial infrastructure, constituting about 10% of all commercial built-up area and one-third of all office spaces. As of 2017, these buildings covered 73.8-110 million m^2, and the projections suggest that this figure could grow to exceed 170 million m^2 by 2030. This represents an enormous opportunity to incorporate energy-efficient design and construction practices, akin to Infosys, in approximately 55 million m^2 of new construction planned till 2030.

Based on the influence of Infosys' energy-efficient practices, three future scenarios for energy consumption in IT & ITeS buildings are outlined. Annexe contains the complete set of inputs and assumptions.

- **Business as usual (BAU) scenario**: Assumes that all new construction in 2023-2030 will continue to operate at 100-150 kWh/m^2/year
- **Moderate effort scenario**: Assumes that most new construction in 2023-2030 will continue to operate at 100-150 kWh/m^2/year; assumes a gradual adoption of Infosys' best-in-class EPI of 70 kWh/m^2/year during 2023-2030
- **Aggressive effort scenario**: Assumes rapid adoption of Best of Infosys EPI (70 kWh/m^2/year), led by large IT companies with strong ESG commitments, and potential adoption by smaller IT firms during 2023-2030

The adoption of more energy-efficient practices in line with Infosys' achievements could lead to significant electricity savings as shown in Figure 3.11:

- **Moderate effort scenario**: Could yield a cumulative electricity saving of 1900 GWh by 2030 (6% savings compared to the BAU scenario)
- **Aggressive effort scenario**: Could yield an even greater saving of 4000 GWh (13% savings compared to the BAU scenario)

This analysis shows that nearly 3 million tonnes of CO_2e can be avoided cumulatively until 2030 from class A IT & ITeS buildings alone through aggressive energy efficiency interventions.

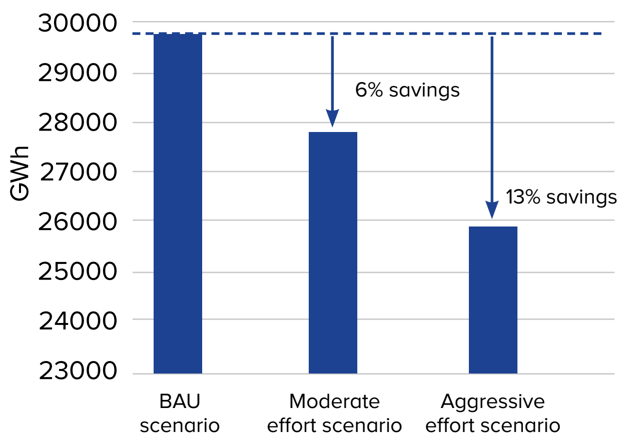


Figure 3.11: Cumulative energy saving potential for IT & ITeS buildings to be built in 2023-2030

> When we are no longer able to change a situation - we are challenged to change ourselves.
>
> —Viktor E. Frankl

4 Vision to Execution

4.1 Building the Right Team

The transformation of Infosys' infrastructure practices towards sustainability relied on a skilled and dedicated team, particularly the Infosys Green Initiatives Team. This team was pivotal in driving and reshaping Infosys' infrastructure practices to support sustainability goals.

Infosys' journey towards sustainable infrastructure development began by challenging conventional beliefs with robust empirical evidence. This process led to the Infosys Green Initiatives Team, a dedicated in-house group comprising architects, engineers, MEP consultants, and energy experts. This team has been instrumental in working with stakeholders and clients to question existing practices, set energy efficiency targets, establish KPIs, and provide research support for experimentation.

The approach involved strategic planning, data-driven decision-making, and constructive feedback loops. This collaborative effort engaged the Infosys Green Initiatives Team, strategic research partners, and external consultants. This ensured that all stakeholders remained aligned with Infosys' sustainability agenda. Additionally, external consultants and contractors underwent regular evaluations by a specialised panel of experts to ensure their adherence to Infosys' vision of sustainable infrastructure development.

The strategic planning process encompassed three tiers of expertise:

- The Infosys Green Initiatives Team, consisting of in-house professionals at Infosys, focused on designing Infosys campuses across India and developing in-house green solutions.
- Strategic research partnerships were forged to bring specialised knowledge and insights.
- Strategic collaborations with dedicated consultants involved identifying and engaging national and international consultants, sub-contractors, and stakeholders with expertise in architecture, green building consulting, contracting, development, and HVAC systems.

The Infosys Green Initiatives Team took a performance-driven approach, introducing KPIs for consultants, contractors, and in-house employees. It implemented performance-linked contracts, which encouraged integrative design practices across project teams. These contracts outlined time-bound targets and included penalty clauses for falling short of goals. A percentage of the total fee was released upon evaluation to motivate successful target achievement.

In addition, Infosys nurtured a culture of innovation and encouraged its in-house team to think creatively. The performance appraisal of the in-house team was based on the number of successfully implemented ideas sourced from a pool of suggestions provided by Infosys employees. This approach fostered a sustainable thinking culture and generated a continuous flow of ideas for exploration and implementation.

4.2 Procurement & Partnerships

The green building movement began in India in 2008-09. Infosys recognised the need for sustainable and efficient buildings and initiated efforts to expand the available options. By offering significant business opportunities to vendors, Infosys encouraged innovation to reduce energy consumption. This pioneering approach reshaped the sustainability product and technology market, generating early demand and driving manufacturers to invest in R&D and establish production lines.

Infosys' unwavering commitment to climate-conscious practices and ambitious energy efficiency targets fostered a culture of innovation and research. It attracted leading experts in building design and technologies, promoting a collaborative environment for knowledge exchange. Through partnerships and research collaborations, Infosys actively sought novel techniques and solutions for cutting-edge buildings, instrumental in implementing innovative ideas.

Leveraging its expansive reach and influence, Infosys persuaded manufacturers and vendors to provide customised sustainable products, even if it required establishing new production lines. This proactive approach promoted affordability and expanded the national market for sustainable products, significantly impacting the industry.

Infosys established partnerships with vendors and R&D teams in various ecosystems to foster innovation, enhancing design, systems, and operational efficiency. This collaborative approach facilitated knowledge sharing between the vendors and Infosys' design teams, integrating technological advancements into mainstream processes.

Infosys relied on data-driven decision-making for procurement, using performance-based metrics to assess the feasibility and overall impact of adopting new technologies. This calculation considered the broader effects on various systems and total savings, allowing Infosys to comprehensively evaluate the benefits and costs of new technologies and make decisions based on overall system efficiency and savings.

Infosys orchestrated major innovations in walling materials, shading devices, glazing, lighting, HVAC systems, metering and energy management systems, and UPS by setting industry-leading performance specifications. It coordinated its quest for high-performance green and net-zero buildings by working with various industry partners, providing test beds for the best-in-class energy-efficient products and solutions, monitoring their performance, and communicating the test results for further tweaking and refining by the companies. Once these products and solutions passed the performance benchmarks set by the Infosys Green Initiatives team, they became part of the approved products and solutions toolkit, helping Infosys go to the next stage and the companies to market those products and solutions to a wider community, contributing to the broader green building movement in the wake of the trailblazing building performance achieved by Infosys.

Any sufficiently advanced technology is indistinguishable from magic.

—Arthur C. Clark

5 Harnessing Integrative Effects

Infosys' integrative building design strategy for new buildings focuses on:

- Optimising the building envelope for diffused daylighting and heat rejection, minimising cooling loads
- Using super-efficient lighting (e.g., LEDs) to reduce artificial lighting loads by 70%
- Incorporating appropriately selected, right-sized, and super-efficient HVAC systems not just in buildings but also in critical IT infrastructure such as data centres to cut HVAC energy use by 50%
- Modular UPS

Infosys achieved this balance through computational simulations, sun path analysis, irradiation mapping, and real-world testing. The envelope design resulted in 35% lower heat transmittance than Energy Conservation Building Code, reducing indoor heat build-up. These strategies have set new benchmarks for energy-efficient building design.

5.1 Optimised Building Envelope

Infosys prioritises energy-efficient design in its new buildings through a strategic approach that optimises heat management and maximises natural daylight. Here's how:

- **Orientation:** New Infosys buildings are strategically oriented, with their longer sides facing North-South. This minimises direct exposure to intense solar radiation from the East and West, ensuring excellent thermal performance and ideal daylight conditions.
- **Floor Plate Depth:** The depth of floor plates in these buildings is generally limited to about 20 meters. This limitation ensures that natural daylight can penetrate deeper into the floor plate, reducing the reliance on artificial lighting.
- **Light Shelves:** Light shelves are integrated into the fenestration design to enhance daylight penetration further. These internal features redirect and diffuse natural light, maximising its reach within the building and reducing the need for artificial lighting.
- **Window Proportions:** The proportion of windows on all façades of new Infosys buildings is intentionally kept below 35%. This balanced distribution minimises heat gain and glare from direct sunlight. Larger fenestrations are strategically placed in northern and southern orientations to effectively manage glare and heat through optimised shading techniques.
- **Shading Strategies:** Infosys recognises the importance of shading in building envelope performance. Extensive shading strategies are tested for each façade to assess their impact on daylight availability and cooling loads. This iterative approach effectively ensures that buildings balance daylighting and cooling needs while maximising overall energy efficiency.
- **Glass Selection:** Infosys selects glass designed to achieve a light-to-heat ratio of 2:1 or higher to minimise heat gain from direct and indirect solar radiation while maximising daylighting. This often involves double-glazed units (DGUs) and low-emissivity (low-e) coated glass. The selection process considers parameters such as High Visible Light Transmittance (VLT), Low Solar Heat Gain Coefficient (SHGC), and U Value to optimise performance.

In summary, Infosys' building design strategy integrates a range of measures to enhance energy efficiency, comfort, and sustainability. By combining thoughtful orientation, effective shading, daylight optimisation, and careful glass selection, Infosys aims to create environmentally responsible buildings that set new standards for energy-efficient design.

5.2 Super-efficient Lighting

Infosys has made substantial strides in enhancing the efficiency of artificial lighting across its buildings, employing various strategies and interventions. These include:

- **Daylight Integration:** Through simulations, Infosys assesses the availability of natural daylight resulting from building envelope improvements, influencing the design of electric lighting systems and controls.

Figure 5.1: (a) Components of façade design, (b) Daylit interiors due to daylight panels and light shelves

- **Lighting Design:** Lighting design consultants use simulations to determine optimal illuminance levels, considering factors like fixture placement, fixture selection, integration with natural daylight, and control systems. Occupancy and daylight sensors and astronomical timers for external lighting enhance control.
- **LED Lighting Fixtures:** In new buildings, Infosys incorporates energy-efficient LED lighting fixtures, significantly reducing energy consumption compared to conventional lighting sources. LED fixtures also replace metal halide lamps for exterior lighting, improving illuminance and uniformity while reducing light pollution.
- **Integration with Building Management System (BMS):** Lighting systems and controls are integrated into the BMS for centralised monitoring and control. Intelligent lighting fixtures with sensors and dimmers adjust lighting levels and sequences. Daylight sensors regulate artificial lighting based on available daylight, while occupancy sensors manage lighting based on movement.
- **Energy Monitoring and Alerts:** End-use energy metering allows analysis of lighting energy consumption, with the command centre issuing alerts for energy consumption outside regular operating hours, enabling corrective actions.

- **Retrofit Strategies:** Existing buildings with conventional lighting fixtures undergo retrofitting by replacing CFL lamps with energy-efficient LEDs. Lighting management plans, sensor-based controls, fixture positioning, and group lighting upgrades with individual controls are implemented.

These interventions have yielded significant results, including a 60% reduction in lighting energy consumption compared to 2008. Replacing CFLs with LEDs led to a 37% reduction in lighting load and improved visual comfort. Lighting upgrades also contributed to a 2.45 MW reduction in connected load, surpassing ASHRAE standards by achieving 30% higher efficiency.

5.3 Super-efficient HVAC

Infosys recognised that HVAC systems were the most energy-intensive end-use in its buildings. Infosys implemented a comprehensive approach to optimise HVAC system sizing and efficiency during the building design stage to address this. This approach led to a significant reduction of 40-50% in cooling demand compared to conventional practices.

The key steps in this approach included:

- **Assessment of Cooling Requirement:** The MEP teams and sustainability consultants conducted a thorough evaluation of each building›s cooling needs, considering climate conditions, building envelope, and internal heat gains from occupancy, lighting, and equipment.
- **System Sizing Optimisation:** HVAC systems were designed and sized optimally based on the cooling requirement assessment, avoiding oversized systems that waste energy and operate inefficiently.
- **Selection of Efficient HVAC Systems:** Infosys invested in the most energy-efficient HVAC systems and controls, including chillers, fans, and pumps with variable frequency drives (VFDs). An integrated building control system, operated by well-trained technicians, further enhanced energy performance.

Infosys implemented interventions for other end-uses in the building to achieve efficient system sizing through calculations and simulations. These interventions included:

- **Envelope Heat Gain Reduction:** Measures like efficient glazing, insulation, shading, and envelope design strategies were employed to limit heat gain through the building envelope, reducing the cooling load on the HVAC system.
- **Cooling Efficiency Goal:** Infosys set a target cooling efficiency of 700-800 square feet per tonne of refrigeration (TR), nearly double the efficiency in the old buildings. This measure assesses cooling capacity relative to floor area, achieved through optimised system size and performance.
- **Temperature and Humidity Control:** The HVAC system was designed to maintain a temperature of 24°C and a relative humidity of 55%, ensuring occupant comfort while minimising energy consumption.
- Infosys aimed to achieve efficient HVAC system sizing through these interventions while enhancing thermal comfort and minimising energy consumption and operational costs for building occupants.

Infosys has been at the forefront of adopting radiant cooling as an energy-efficient cooling technology in its buildings. This innovative approach was relatively unexplored in India despite its historical use in ancient heritage structures in Jaipur and elsewhere. The knowledge of passive cooling techniques has not been widely passed down through generations, resulting in a gap in its adoption across the country.

Radiant Cooling Technology

Principles of Radiant Cooling: Radiant cooling is a highly efficient HVAC technique compared to traditional variable air volume (VAV) systems. It cools the human body through radiation via chilled water pipes embedded in ceiling slabs/floors, which is more efficient than convection, which relies on moving large volumes of air. In radiant cooling systems, cold water pipes are embedded in concrete or in ceiling panels, maintaining a surface temperature of around 20°C. This cooled slab absorbs heat radiated by occupants, computers, lighting, and equipment in contact with it, effectively cooling the entire structure. A dedicated outdoor air system (DOAS) supplies fresh air to ensure indoor air quality and moisture control, while the cooled slab handles sensible heat load, and the DOAS addresses the latent heat load. Infosys leverages radiant cooling to enhance energy efficiency and comfort in indoor environments.

Turning the Pocharam, Hyderabad Campus, into a Test Bed: Infosys achieved a significant milestone by implementing radiant cooling technology at the Pocharam campus in Hyderabad. This initiative was one of the company's most successful innovations in air conditioning. The campus was divided into two wings, East and West, identical in terms of area, occupancy, orientation, envelope, and lighting. One wing used a conventional yet highly efficient air conditioning system, while the other employed radiant cooling. This side-by-side comparison allowed Infosys to directly assess the performance and energy efficiency of radiant cooling, providing valuable insights and data to refine the approach to building cooling.

Transferable Learnings: Infosys' successful implementation of radiant cooling led to further innovation, specifically the development of in-house-produced Radiflux radiant panels. These panels use chilled water for cooling and have demonstrated superior performance compared to other products. They offer twice the efficiency at a lower cost, and a 50% reduction in installation time compared to conventional air-conditioning. Infosys has deployed radiant cooling in 5 million sq.ft., and another 3 million sq.ft. is under construction.

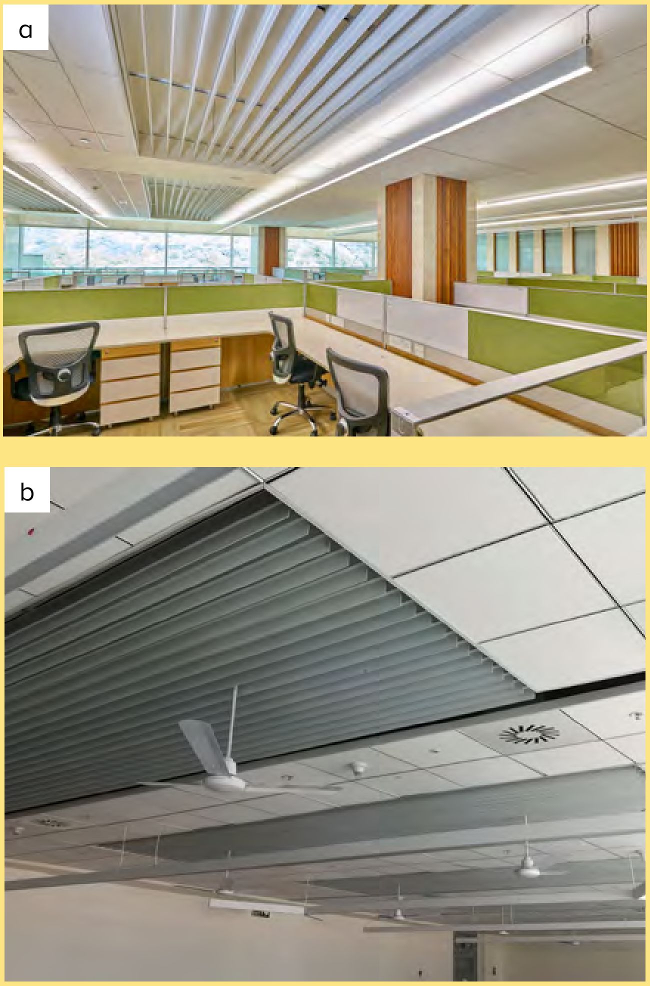


Figure 5.2: (a) Early radiant panels, (b) New radiant panels

Integrative design doesn't primarily focus on introducing novel technologies but emphasises the selection, combination, timing, and arrangement of familiar technologies. Its impact can be surprisingly straightforward. For instance, optimising the dimensions of pipes and ducts by making them wider, shorter, and straighter, as opposed to narrow, long, and convoluted, can significantly reduce friction. This, in turn, leads to an 80%-90% reduction in the power required for pumps or fans, consequently reducing the size of these components. The additional upfront cost is typically recouped in less than a year for existing buildings or immediately for new construction projects.

Figure 5.3: (a) Smooth and obtuse angle bends in chilled water piping, (b) Piping and ducting at AHU with minimum bends

Figure 5.4: (a) Central plant layout, Infosys, Bengaluru, (b) Tube cleaning system on the condenser line

5.3.1 Energy Use Reductions through HVAC Interventions

New Buildings: HVAC interventions have made remarkable strides in enhancing energy efficiency and operational performance in new buildings. The redesigned plant room and improved system design have led to an impressive 70% reduction in connected load, translating into energy savings of over 30%. The simplified plant layout with fewer valves, pumps, and optimised pipe and duct layouts to minimise frictional losses contributed to energy savings and simplified maintenance and operation.

Existing Buildings: Retrofitting HVAC systems in existing buildings has proven highly cost-effective, with quick returns on investment. Key retrofit impacts include:

- **Operational Chiller Efficiency:** Chiller plants have achieved up to a 60% improvement in efficiency, resulting in substantial energy savings.
- **Internal Benchmarking:** Weekly benchmarking of all chiller plants across Infosys ensures efficient operation and identifies areas for improvement.
- **EC Fan Systems:** Replacing belt-driven systems with electronically commutated (EC) fan systems in air handling units (AHUs) reduced energy consumption by 40%, with a payback period of less than three years.
- **R22 Phase-out:** Infosys is gradually phasing out R22-based systems across its Indian campuses in favour of more environmentally friendly alternatives.

HVAC accounted for roughly 40% of Infosys' annual electricity consumption. Deep green retrofits of 50 chiller plants with an aggregate cooling capacity of around 60,000 TR across diverse campuses resulted in significant savings in electricity consumption.

Infosys achieved these results through best practices in building envelope design, HVAC system sizing optimisation, selection of efficient HVAC components, innovative cooling techniques, and the establishment of standard operating procedures for maintenance. These deliberate and strategic interventions yielded cost savings, improved occupant comfort, and other intangible benefits. Infosys demonstrated its commitment to energy efficiency and sustainability in HVAC systems, aiming for optimal performance while minimising energy consumption and maximising benefits for occupants and the organisation.

5.4 UPS Systems

UPS systems are integral to a data centre's electrical distribution system, which includes power supply from utilities or generators, building switchgear, transformers, and Power Distribution Units (PDUs). These electrical distribution system components can account for 10% to 12% of a data centre's energy consumption. Often, lightly loaded UPS systems operate inefficiently. Infosys replaced conventional UPS systems in older buildings to boost UPS system efficiency with modular ones.

The new modular UPS systems require fewer batteries and less physical space. Their modular design allows Infosys to add capacity incrementally, in proportion to the growth of IT load, ensuring high UPS load factors. This unique feature significantly improves efficiency and reduces operation and maintenance costs. The modular UPS systems achieve over 94% efficiency. Implementing the UPS retrofitting project across all Infosys buildings in India substantially reduced the connected load to 14.7 MW. This demonstrates the energy savings by replacing inefficient UPS systems with more efficient and modular alternatives.

Figure 5.5: Modular UPS battery bank

5.5 Data Centre Design

Infosys envisioned data centre design to incorporate energy-efficient practices. Cooling coils were positioned in one of the data centres to remove heat immediately as servers produced it. This innovative design allowed free cooling from cooling towers, reducing energy consumption compared to traditional cooling methods.

Additionally, Infosys aimed to improve the data centres' Power Usage Effectiveness (PUE). PUE is a metric that measures data centre energy efficiency, with lower values indicating higher efficiency. While the global average PUE for data centres is 1.8, Infosys' newly designed data centre is operating at a PUE of 1.33, underscoring its commitment to enhancing energy efficiency in IT infrastructure.

These interventions in UPS systems and data centre design have yielded significant energy savings, reduced connected load, and enhanced overall efficiency in Infosys' IT operations.

Case Study: Infosys, Mysuru

Integrative design approach is a method that enhances energy savings through successive improvements, illustrated by the building envelope elements' impact on comfort and energy use. For instance, optimising daylight reduces lighting energy. Table 5.1 demonstrates how Infosys reduced the cooling capacity, annual electricity consumption, and maximum connected load by 35%, 45%, and 43%, respectively, in its Mysuru campus using the integrative design approach.

Table 5.1: Integrative design approach at Infosys, Mysuru

Energy efficiency measures	Cooling capacity required (TR)	Annual energy consumption (kWh)	Maximum electrical load (kW)
Conventional building envelope	**622**	**3,244,284**	**1,052**
Efficient building envelope	530	3,030,908	968
Efficient lighting design	510	2,713,390	882
Efficient computers	486	2,358,776	778
Variable Air Volume system for AC	486	2,080,462	754
Heat Recovery Wheels for AC	400	2,015,430	662
Ultra high efficiency chiller	400	1,992,156	650
Efficient chilled water system design	400	1,960,898	640
High efficiency cooling tower	400	1,946,532	632
Lighting controls	**400**	**1,775,706**	**600**

> In God we trust. All others must bring data.
>
> —W. Edwards Deming

6 Culture of Data-driven Progress

6.1 Critical Role of M&V

Embodying the axiom "If it cannot be measured, it cannot be managed" Infosys adopted a rigorous approach to Measurement & Verification (M&V) practices that set new standards for sustainability, energy efficiency, and operational excellence. This chapter delves into the intricacies of Infosys' state-of-the-art M&V framework, focusing on how it contributes to the company's broader goals of becoming a global leader in green practices and energy conservation.

The top management at Infosys recognised that M&V practices are indispensable for managing and optimizing energy use in both newly constructed and existing buildings. An advanced Building Management System (BMS) facilitates robust measurement and monitoring schemes, enhancing the effectiveness of resource conservation measures across their campuses.

Infosys equips its campuses with 19,500 sensors, 10,000 energy meters, and 1,650 flow meters. These intelligent technologies feed real-time operational data into the BMS, which incorporates advanced algorithms to manage demand dynamically. The algorithms enable systems to scale their performance according to real-time demands, eliminating wasteful energy consumption while enabling early fault detection.

This round-the-clock monitoring and real-time analysis provides helps achieve continuous operational excellence, and provides valuable insights for new designs.

6.2 Central Command Centre

Located at the Bengaluru campus, the Central Command Centre serves as the nerve center to remote monitor all campus buildings across India. Utilizing a hierarchical, hyper-converged infrastructure (HCI), it seamlessly integrates the BMS, energy management systems, solar photovoltaic (PV) systems, data centers, sewage treatment plants (STP), battery management systems and other components. This comprehensive integration allows Infosys to manage operational data from these systems efficiently, significantly contributing to energy conservation, fault detection, and improved Indoor Air Quality (IAQ). Figure 6.1 depicts the salient features of the command centre and its capabilities.

Extensive R&D has gone into developing the system's dashboard and user interface (UI). The dashboard provides detailed information on energy distribution inside the building, allowing users to monitor the performance of systems, sub-systems, and components. This includes HVAC, UPS, lighting systems, fans, auxiliary equipment, water systems, plug loads, etc.

By monitoring real-time data at a granular level, Infosys can ensure the efficiency of building operations. This approach helps identify improvement areas and enables proactive measures to optimise building performance across multiple parameters. Overall, Infosys leverages its command centre and data monitoring processes to maintain efficient building operations, address issues promptly, and continuously improve building performance.

24×7 Real-time Monitoring

The command centre enables real-time monitoring of parameters across Infosys buildings. It employs SMS alerts to notify relevant personnel promptly about potential wastage or deviations from predefined parameters, allowing immediate action and improvement.

Proactive Management of KPIs

KPIs such as energy consumption per square foot, carbon footprint, and water usage are actively managed to ensure that assets operate at higher efficiencies.

Artificial Intelligence (AI) in Action

The use of AI specifically for chiller operations leads to optimised cooling with minimal energy consumption, thereby achieving significant cost and energy savings. The command centre compares the actual performance of chiller plants with their design performance in real-time, which allows to identify and correct inefficiencies, resulting in improved chiller plant performance.

Enhanced Occupant Comfort

The command centre connects employees through mobile apps, enabling them to provide feedback on comfort levels. This feedback helps automate responses and further enhances occupant comfort.

Improved Indoor Air Quality (IAQ)

PM 2.5 sensors are deployed to monitor indoor spaces, ensuring improved IAQ. This capability enables the command centre to identify and address IAQ issues based on real-time data.

Enhanced Building and Equipment Performance

The command centre uses an advanced analytics platform to diagnose faults in real time, improving building and equipment performance. By identifying and resolving issues in real-time, the command centre ensures superior performance of building systems.

Water Leakage Detection

The command centre has identified over 1,000 kilolitres of water leakage across campuses through smart water metering. This capability aids in water conservation efforts while reducing wastage.

Utilisation of Real-time Weather Data

The command centre incorporates real-time weather data to maintain equipment performance and optimises the operation of building systems for energy efficiency and comfort.

Figure 6.1: Salient features of the Infosys Central Command Centre

Figure 6.2: Flow meter

6.3 Troubleshooting and Performance Improvement Protocol

A comprehensive set of reporting tools complements the command centre's functionalities. Weekly campus-wide reviews and monthly consolidated reports help identify underperforming systems and prioritize remedial actions. The Green Initiatives Team at Infosys regularly scrutinizes this data to identify key areas for improvement. Figure 6.3 captures the entire protocol in a schematic form.

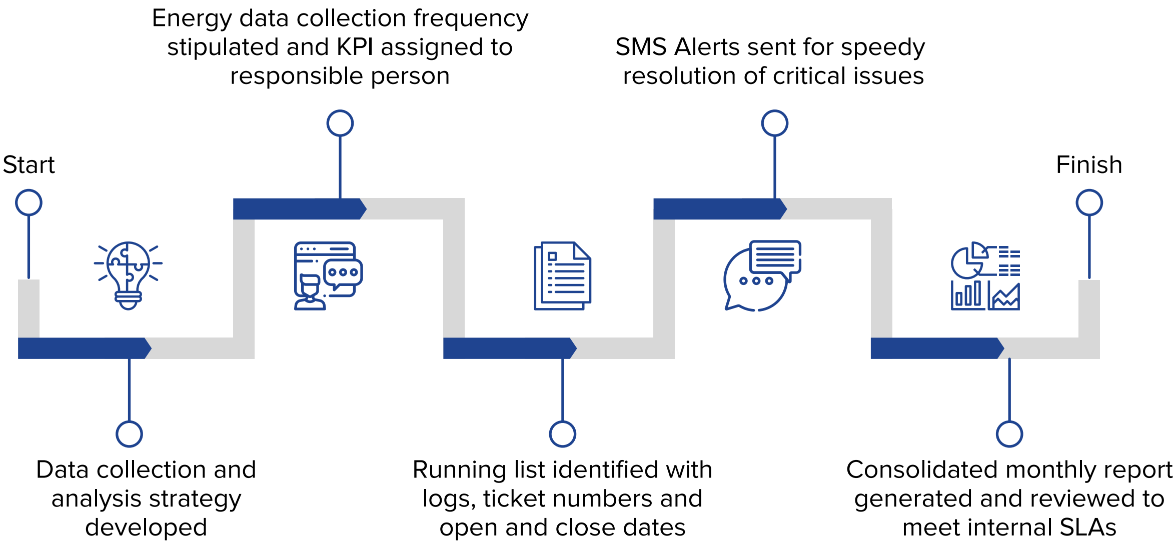


Figure 6.3: Troubleshooting and performance improvement protocol

> **Be the change you want to see in the world.**
>
> —Mahatma Gandhi

7 Learnings for Tomorrow

7.1 Insights for Enterprises

In the modern era, marked by the wake of the COVID-19 pandemic and India's renewed National Determined Contributions (NDCs) for 2030, the corporate landscape is undergoing a significant transformation. Environmental performance has moved from being a boiler room to a board room issue. Herein lies a vital crossroad for the private sector, teeming with both responsibilities and unparalleled opportunities.

As of August 2023, 202 Indian companies[3] have signed up for Science-Based Targets, which helps corporations

Growing Responsibilities

The integration of Environmental, Social, and Governance (ESG) considerations into business strategy has necessitated a multi-faceted approach to corporate responsibility. It's not just about setting near-term and long-term emission targets anymore. Companies are now expected to:

- Assess and integrate climate-related risks into corporate risk management frameworks, contemplating both physical and transition risks.
- Determine and allocate capital that will be required for the transition towards a more sustainable business model. This includes investments in clean energy, green infrastructure, and workforce re-skilling.
- Implement sophisticated tracking and reporting systems to regularly monitor ESG performance indicators and the effectiveness of implemented sustainability measures.

Unlocked Opportunities

Navigating the complex web of responsibilities can unlock a plethora of opportunities that can create a competitive advantage in the long term.

- Infosys is a case in point that shows profitability, social responsibility, and environmental stewardship can go hand-in-hand, creating a synergy that enhances overall business value.
- A strong sustainability profile attracts not just customers but also quality talent and socially responsible investors, giving companies an edge in a crowded marketplace.

Sustainable practices often encourage innovation, leading to the development of new products, services, and even revenue streams that are aligned with a more sustainable and circular economy. Enterprises can translate corporate climate pledges into profitable plans, emulating Infosys, by shifting from a myopic model of achieving energy efficiency through isolated interventions to high-performance building design and deep-retrofit model and institutionalising energy and emissions management practices. These practices should be based on tracking energy use at the campus, building, and end-use system levels. Key learnings from the Infosys experience for small, medium, and large enterprises are described as follows:

3 Science Based Targets. "Companies Taking Action - Science Based Targets," n.d. https://sciencebasedtargets.org/companies-taking-action.

The Critical Role of Senior Leadership and Public Commitment: A transformative sustainability journey starts at the top. A public pledge by senior leadership to optimize enterprise-wide energy consumption is a cornerstone for success. Such a commitment should spell out short-, medium-, and long-term targets. It should not exist in isolation but be intricately woven into the company's broader sustainability policy and climate action plans. Here, the focus is not just on mitigating environmental impacts but also on enhancing business value and achieving a triple-bottom-line of social, economic, and environmental benefits. Tools like the Science-Based Targets initiative (SBTi) can be leveraged to further bolster these commitments.

Building an In-House Sustainability Team: Implementing a sustainability vision requires a dedicated team that shares the senior leadership's goals. This in-house team must maintain exceptional project planning and delivery standards while continuously striving for improvement. Supported by strategically chosen consultants and contractors, this team is responsible for designing and executing increasingly ambitious energy efficiency projects. Innovative performance incentives, tied to the actual ideas generated and implemented by the team, can serve to keep the innovation pipeline flowing.

Performance Metrics for External Partnerships: Just as the in-house team is held to stringent standards, external consultants and contractors must also be accountable for their performance. Clear key performance indicators (KPIs) should be defined in performance-based contracts. These KPIs should include explicit incentives for meeting ambitious targets and penalties for falling short. It sets the benchmark for high performance, aligning external contributions with the company's overarching sustainability goals.

Data-Driven Decision Making: The Power of Sub-Metering and Continuous Tracking: Infosys' journey underscores the power of data-driven design and operations. While many enterprises operate in the dark regarding their energy use, this should not be the norm. The myth that strategic energy management is expensive and redundant needs to be dispelled. Investments in campus-wide energy use sub-metering can provide the granular data necessary to make informed decisions. A dedicated team must track this data against global benchmarks to identify areas for energy-efficiency interventions. Starting with low-cost measures can build confidence among senior management, eventually securing funding for more capital-intensive projects with demonstrable ROI. Continuous tracking helps evaluate the performance of deployed solutions and informs future initiatives, be it in retrofitting existing buildings or in the design of new construction projects.

7.2 Insights for Policymakers

India has recently revised its 2030 Nationally Determined Contributions (NDCs), setting more ambitious goals that align with the nation's long-term objective of reaching net-zero emissions by 2070.

Infosys has pioneered a structured, data-driven approach to energy management at the enterprise scale, resulting in substantial benefits across multiple dimensions. The company initiated its sustainability efforts by complying with green building standards in new constructions. Over time, its dedicated in-house team has evolved, adopting and enacting data-guided best practices for exceptional energy management, especially as the number of buildings under its portfolio expanded. Comprehensive life cycle assessments offer nuanced perspectives on the apparent incremental costs of adopting these sustainable measures.

Case studies from Infosys serve as a valuable resource for policymakers:

Mandating End-Use Metering: Being a first mover in the deployment of end-use metering in commercial buildings should be formalised through policies and regulations. The data collected serves a dual purpose: it not only enables real-time energy monitoring but also informs broader policy decisions. Such data can be instrumental in formulating comprehensive guidelines for commercial building design, construction, operation, and maintenance.

Data Disclosure for Benchmarking: In a data-rich environment, transparency is key. Mandating the public disclosure of operational energy use data for buildings will help in establishing realistic benchmarks and targets for the commercial building sector. This benchmarking will inform the periodic revision of building energy codes, monitor operational efficiency, and help develop building rating programmes based on quantifiable energy performance parameters.

Data-Driven Behavioral Change: Converting data into relatable terms has the power to shape individual behaviors. Infosys is a prime example, having successfully ingrained environmental consciousness among its employees through data-backed awareness campaigns. This not only shows the potential for company-wide change but also serves as a scalable model for national-level programmes focused on behavioral transformation.

Building Energy Codes: In the context of India's rapidly growing building construction sector, the adoption of energy codes is not a luxury but a necessity. However, having codes on paper is not enough; their successful implementation is what counts. Validation and acknowledgement of compliance in existing buildings create a body of evidence and learnings that can be transferred across projects. It will engender confidence in the industry, catalysing widespread acceptance and realisation of the benefits that come with code compliance.

Pioneers in any field often encounter various challenges, obstacles, and setbacks. As an early adopter of the carbon neutrality objective across its enterprise, Infosys has amassed a wealth of insights. By assimilating these insights into public policy, governments can set the stage for other enterprises to follow in Infosys' footsteps, accelerating national goals and turning environmental challenges into societal and economic opportunities.

Epilogue

Our honourable PM set a long-term goal for India to reach net zero by 2070. This cannot be achieved unless our buildings become net zero carbon much before that date. But are we on track, as a nation to achieve that?

The pioneering efforts of Infosys not only gives me hope but a lot of confidence that as difficult as the journey may be, it can be achieved. While the majority of building developers are struggling to meet an envelope heat transmittance value of 12 W/m^2 or even 15 W/m^2, Infosys has proved that by having an insulated envelope and high-performance glazing, the heat transmittance value can be slashed in half at speed and at scale. The significance of innovations such as pre-fabricated insulated panels and novel construction practices has far reaching ramifications for net-zero and "Thermal Comfort for All" encapsulated in Ministry of Environment Forest and Climate Change's seminal India Cooling Action Plan. Quite astonishingly, Infosys went on to air-condition 750 sq.ft. of indoor space with one tonne of refrigeration (TR) while many conventional office buildings still use the thumb rule to air-condition 150 sq.ft./TR. While the world focuses on providing "Cooling for All", Infosys' trailblazing achievement in passive solar design coupled with super-efficient HVAC system design and operation cut both the first cost and the life cycle cost of achieving net zero carbon buildings significantly and make them affordable by dispelling the widespread myth that green buildings cost more than conventional buildings. This is not proven through one pilot building but by constructing nearly 30 million sq.ft. of highest certified green buildings.

India is on the verge of launching Energy Conservation Sustainability Building Code - an ambitious effort to fast-track its journey to achieve net zero. And yet, we are struggling to adopt and enforce commercial and residential building energy codes. Can we achieve a net zero built environment without ensuring that all buildings in India must comply with the building energy codes?

Perhaps the most significant contribution, or I dare say disruption, that can be unleashed in the Indian building sector is how India chooses to enforce its building energy codes, moving forward. It is common knowledge that design-based approval, followed by site inspections, followed by compliance certificate is considered a very costly, resource-intensive, and imperfect implementation model. No country globally has cracked the formula for effective code compliance. Global Building Performance Network gives failing marks to all the countries around the world (at or below 50%)[4]. Infosys developed a template where it met the highest level of energy performance levels through energy-efficient design, and it followed with strict quality control on site during construction and then by wiring the buildings with a network of sensors and meters to continuously monitor performance - no building inspectors, no code compliance officials. All this is done voluntarily and the results are published for everyone to see.

As a public policy wonk, I dream of a national building energy code compliance digital platform where all buildings will receive design-based compliance within a week of submitting the required documents; the developers and building owners would then be responsible for translating the design intent and specifications submitted through self-regulating high quality construction, and then disclosing the building performance data by uploading the requested information onto the digital platform to maintain the integrity of the national building energy code. Building on the idea of frugal innovation that is at the heart of Unified Payment Interface (UPI) platform that India pioneered, the sustainable building design and the energy efficiency policy making community, this can address an extremely wicked problem that has defied a practical solution around the world. Am I daydreaming or visualising a future that I see unfolding in front of my eyes because Infosys has exposed us to the mind-boggling possibilities. India is a land of mouth-watering opportunities and eye-watering challenges. It is for us to decide to which camp we belong. Thank you, Infosys, for allowing us to dream!

Satish Kumar
Executive Director and President
Alliance for an Energy Efficient Economy

4 GBPN. "New Buildings | Global Buildings Performance Network," n.d. https://library.gbpn.org/library/purpose-policy-tool-new-buildings.

Annexe

Standards and Benchmarks in other Countries (Section 3.2.2)

Australia: According to the 2019 review conducted by the Australian government for the Commercial Building Disclosure (CBD) program, the average energy use for offices in Australia was 111 kWh/m²/year in 2019.

Canada: As stated by the Energy Star's Portfolio Manager for Canada, the national median reference value for site energy use intensity in office buildings is approximately 275 kWh/m²/year.[5]

France: Based on data from 2018, the implementation of the Energy Performance of Buildings Directive (EPBD) resulted in average energy performance requirements for office buildings of 110 kWh/m²/year.[6] This indicates the desired energy efficiency level that office buildings should strive to achieve to meet the directive's standards.

Norway: According to the Norwegian building code TEK17, compliant office buildings are required to have a total net energy requirement below 115 kWh/m²/year.[7] This energy requirement sets a maximum limit for the energy consumed by office buildings in Norway.

Singapore: According to Singapore's Building and Construction Authority, the average EPI for large office buildings in Singapore was 185 kWh/m²/year in 2020. The top 10% of buildings achieved an impressive EPI of 90kWh/m²/year.[8] Drawing a parallel between Infosys' high-performing buildings and exemplary commercial buildings in Singapore suggests that Infosys has been successful in achieving exceptional energy efficiency since Singapore is known for its sustainable building practices and stringent energy efficiency standards.

United Kingdom: The Chartered Institution of Building Services Engineers (CIBSE) Energy Benchmarking Tool specifies best practices and typical benchmarks. For standard airconditioned offices, the good practice electricity performance value is 128 kWh/m²/year (treated floor area), while the typical practice value is 226 kWh/m²/year.[9]

United States: As per Energy Star's Portfolio Manager, the national median reference value for site energy use intensity for office buildings is around 167 kWh/m²/year.[10]

5 Energy Star Portfolio Manager (2021): https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf
6 France EPBD: https://epbd-ca.eu/wp-content/uploads/2018/08/CA-EPBD-IV-France-2018.pdf
7 TEK17 building code for Norway (2017): https://dibk.no/globalassets/byggeregler/regulation-on-technical-requirements-for-construction-works--technical-regulations.pdf
8 Singapore BCA benchmarking report (2021): https://www.bca.gov.sg/bess/benchmarkingreport/benchmarkingreport.aspx
Note: As electricity is the main source of energy used in Singapore's buildings, other energy sources were excluded from the EUI computation. EUI is based on the total electricity used within a building in a year, expressed as kWh per gross floor area (m²).
9 CIBSE's Energy Benchmarking Tool (2021): https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/benchmarking-registration
10 Energy Star Portfolio Manager (2021): https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

Inputs and assumptions (Section 3.3)

- Built-up area of IT & ITeS buildings in 2017 = 73.8-110 million m^2 [11]
- Growth rate for IT & ITeS buildings = 5.5%-6% CAGR[12] except for 0% CAGR in 2020-2021 due to COVID-19
- EPI of regular IT & ITeS buildings built in 2023-2030 will improve by 3% p.a. from 150 to 100 kWh/m^2/year (assumption)
- EPI of best-in-class Infosys-type IT & ITeS buildings built in 2023-2030 = 70 kWh/m^2/year (assumption)
- Share of regular and best-in-class Infosys-type IT & ITeS buildings built in 2023-2030

	BAU		Moderate		Aggressive	
	Regular	Infosys-type	Regular	Infosys-type	Regular	Infosys-type
2023	100%	0%	95%	5%	90%	10%
2024	100%	0%	90%	10%	80%	20%
2025	100%	0%	85%	15%	70%	30%
2026	100%	0%	80%	20%	60%	40%
2027	100%	0%	75%	25%	50%	50%
2028	100%	0%	70%	30%	40%	60%
2029	100%	0%	65%	35%	30%	70%
2030	100%	0%	60%	40%	20%	80%

11 Kumar, S., Yadav, N., Singh, M. and Kachhawa, S. (2018). Estimating India's commercial building stock to address the energy data challenge. Building Research & Information.

12 Ibid.

For more information, contact askus@infosys.com

Infosys®
Navigate your next