THE BEEP JOURNEY

BEEP
BUILDING ENERGY
EFFICIENCY PROJECT

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Message

Dr. Jonathan Demenge
Head of Swiss Cooperation Office & Councellor
Embassy of Switzerland, New Delhi

It gives me immense pleasure to see that the Indo-Swiss Building Energy Efficiency Project (BEEP) has made such a significant contribution to the building and construction sector in India. In 2023, the BEEP project has ended. But looking back at its 14 year of existence, the achievements are impressive. Today the entire building-energy ecosystem in India is bubbling with energy to carry forward the legacy of BEEP further. It is only the start of new beginning.

During 14 years, BEEP has been a 'lighthouse' project for the Swiss Agency for Development and Cooperation (SDC), illuminating all critical aspects necessary for the development of a 'sustainable' building-energy sector in India. Whether among professionals, academics, and policymakers, the achievements of BEEP have been wide and numerous, concrete and durable. To name only a few:

- Bringing architects, engineers, planners, and other building professionals on one single platform, at the initial stages of building projects;
- Inspiring new building designs, and developing scalable energy efficiency solutions that have been demonstrated through direct involvement in various projects;
- Influencing policymakers in developing a sustainable building policy in India and in other relevant countries;
- Building capacities of planners, architects, engineers in both private and public institutions, and supporting educational institutions in incorporating building energy in engineering courses;
- Developing concrete and impactful knowledge products and guidelines on building energy efficiency to serve professionals over the years;
- Organizing national and international outreach events such as conferences, seminars, and charrettes for a varied audience;
- Building a great ecosystem within India, through knowledge transfer and learning, which has nurtured several 'champions' across the country.

Together, these achievements have contributed to the development of a vibrant ecosystem conducive to more sustainable and energy efficient buildings in India and beyond.

All this would not have been possible without the active partnership and support of the Government of India, through the Bureau of Energy Efficiency, Union Ministry of Power, and several States' governments. And I would also like to compliment and congratulate the many contributors who have worked on this document.

This publication documents the key learnings and essential processes of the BEEP journey. I am confident this will be a valuable tool for SDC and for organizations that plan to develop similar programmes in the future in various regions of the world, and who will carry the BEEP learnings towards new summits.

BEEP may have ended, but its impacts should last. May BEEP continue to inspire and make our buildings more energy efficient, thermally comfortable, and more sustainable!

About BEEP

The Indo-Swiss Building Energy Efficiency Project (BEEP) was a bilateral cooperation programme between the Ministry of Power (MoP), Government of India, and the Federal Department of Foreign Affairs (FDFA) of the Swiss Confederation. The Bureau of Energy Efficiency (BEE) was the implementing agency on behalf of the MoP while the Swiss Agency for Development and Cooperation (SDC) is the agency on behalf of the FDFA.

Phase I of the project was between 2008 and 2011. Upon successful completion of Phase I, the Phase II of the project commenced, which went on till 7 November 2016. The successful implementation of the project during 2011–2016 resulted in the two governments agreeing to extend the MoU for another 5 years, from 8 November 2016 to 7 November 2021. This Phase III of the project was, however, extended till 31 December 2022 due to the delays caused by the COVID-19 pandemic. The total project budget was a little over CHF 14 million.

The project was able to reduce 9 million tons of CO_2eq through direct interventions such as the integrated design charrettes (over the lifetime of the buildings of approx. 25 years), while 170 million tons CO_2eq per year* shall be reduced through indirect interventions such as the Eco-Niwas Samhita (ENS) and External Movable Shading Systems (EMSyS) .

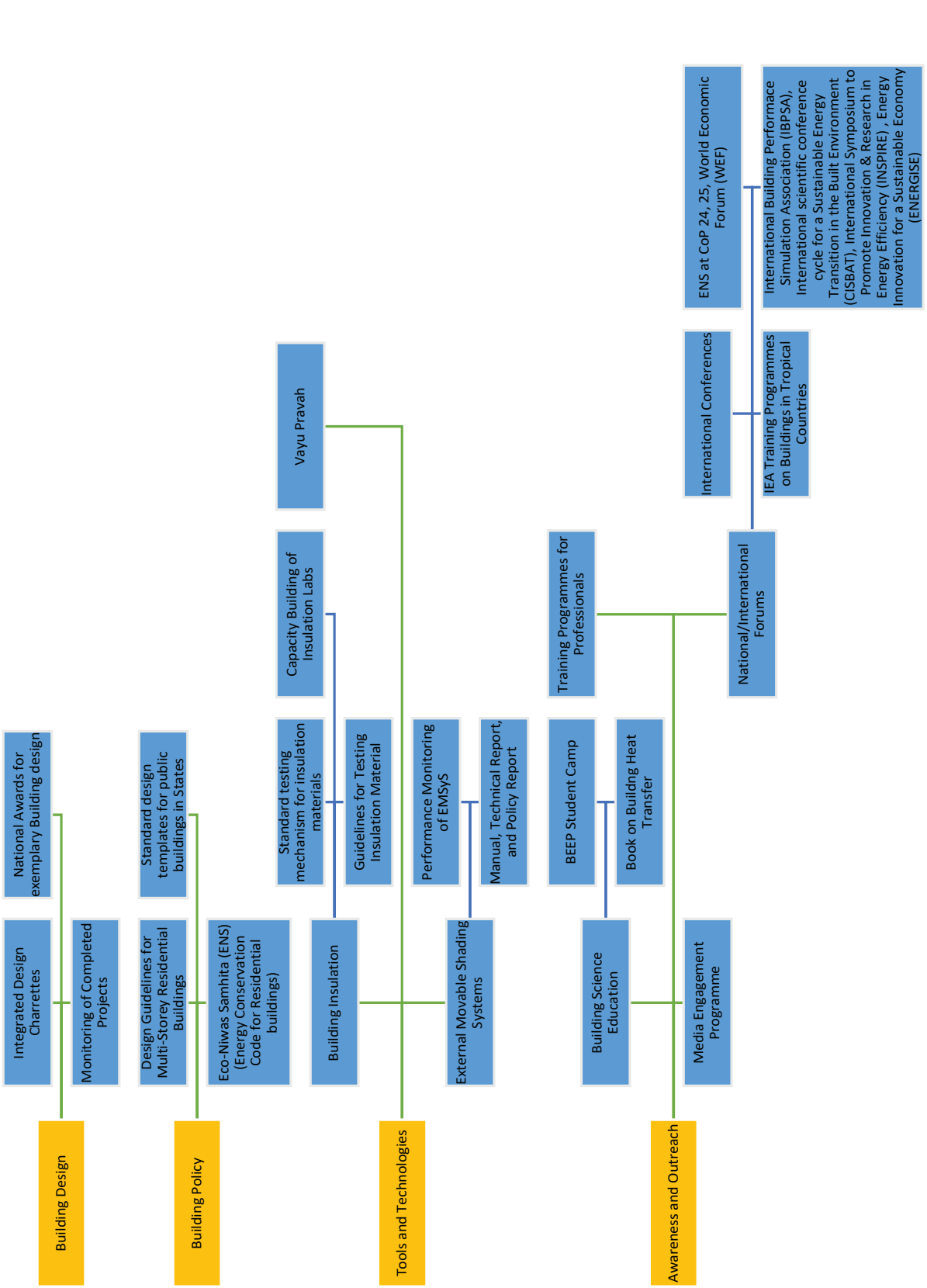


Figure 1: Thematic areas covered under BEEP

The overall goal of the project was to support the Government of India in the reduction of energy consumption in new commercial, public and residential buildings in India through energy-efficient and thermally comfortable (EETC) design. The project adopted a multi-pronged approach that could bring about change in policy, connects industry, and transforms the building sector.

With this in mind, the efforts were aimed at ensuring that multiple solutions are implemented simultaneously to trigger transformation at all levels. This was done by aligning and promoting a range of concepts, activities, policies, and technologies in a simple and accessible manner.

The Energy Conservation Building Code of India (ECBC), a voluntary code, was launched by the BEE in 2007. The code was applicable to commercial buildings that had a connected electricity load of at least 500 kW. This meant that only very large buildings, which were very few in India at the time, would come under the ambit of the code. Therefore, the applicability was revised in 2008 to include buildings with a minimum connected load of 100 kW.

The implementation of ECBC was a major area of focus of the BEE activities between 2012–2017. BEE had also launched a voluntary energy star rating programme for existing commercial buildings to spur the demand. During this period, BEE had actively engaged and collaborated with several international cooperation agencies/ programmes to develop its building energy efficiency programme.

After the signing and ratification of the Paris Agreement (in 2015) on climate change by India, reducing CO_2 emissions from the building sector also gained wider importance within the Government. It was recognised that the building sector will surpass industrial sector to become the largest electricity consuming sector in India aided by exponential increase in electricity use for cooling of buildings. The policy context evolved from energy conservation in commercial buildings to both energy conservation and GHG emission abatement. While in 2010, the focus was on energy conservation in new commercial buildings, the importance of energy conservation in residential buildings was also recognised around this time.

SPURT IN DEMAND FOR BUILDINGS AND ACS IN INDIA

With the rapid urbanization in India, it was envisaged that the demand for buildings will also increase exponentially. A report by McKinsey & Co. in 2009 had projected that the Indian building stock was expected to multiply five times during the period between 2005 and 2030.

Similar projections were made for the air-conditioning demand in Indian buildings. In 2008, the penetration of air-conditioners in Indian households was 13 million units, which was expected to rise to over 240 billion units by 2030.

A FEW PROMINENT INTERNATIONAL COOPERATION PROGRAMMES OF BEE

1. The Energy Conservation and Commercialization (ECO) Bilateral Project with the Government of the United States (2000–2010) contributed to the development of ECBC and in providing support to BEE to implement ECBC in selected states. Partnership to Advance Clean Energy - Deployment (PACE-D) (2012–2014) carried out pilot demonstration of 'Net Zero Energy Building' concept as one of its focus.
2. The UNDP-GEF project on 'Energy Efficiency Improvements in Commercial Buildings (2010–2016) focused on capacity building, undertaking pilot-projects to demonstrate ECBC-compliant buildings, and enforcement of building codes. The project was also instrumental in setting up ECBC cells in the states.
3. Shakti Sustainable Energy Foundation supported BEE in developing the implementation process for ECBC as well as a window labelling programme.
4. KfW Development Bank from Germany implemented a pilot promotional certification and financing programme with the National Housing Board (NHB) for new energy efficient residential buildings in India.

At that time, India had two voluntary green building rating systems: LEED-India implemented by Indian Green Building Council (IGBC) and GRIHA (Green Rating for Integrated Habitat Assessment) conceived by The Energy and Resource Institute (TERI) and developed jointly with the Ministry of New and Renewable Energy (MNRE), Government of India. These rating systems covered other sustainability aspects such as site, waste, and water, besides the energy efficiency bit. These rating systems had also made ECBC compliance a minimum energy criterion to receive the certification. While the number of green buildings was rising, it still remained a bleak fraction of the total new construction.

The Idea of BEEP

The Swiss Context

SDC had a long history of collaborating with the construction sector in India, particularly building materials such as bricks and cement-based materials. It was also supporting the building of houses in rural India and had developed a working relationship with the sector. Internationally, SDC had recognised climate change as a key problem for advanced developing economies such as India and China and Latin America. SDC had also pledged its support to these countries to adapt their policies to bring solutions related to climate change through the newly created Global Program for Climate Change (GPCC).

Switzerland's experience of promoting energy efficiency in the building sector began in 1979 as a response to the first oil crises of 1973. It started with the adoption of a standard for building insulation, followed by the first energy code addressing the building envelope in 1980. By 2008, the energy code had become far more stringent and lowered the benchmark specific energy consumption or energy performance index (EPI) by 60%.

A Project on Buildings

SDC seeded the idea of a programme on energy efficiency in buildings as it wanted to:

a) use its established network in the building sector and
b) use Swiss experience of lowering the energy consumption of buildings.

The overarching idea remained addressing the critical issue of mitigating climate change. The project conceptualization was initiated by a joint mission of Effin'Art Sarl (then Sorane SA) and Greentech Knowledge Solutions in July 2007. This mission was coordinated by the then Thematic Advisor, SDC, New Delhi. Mr Jaboyedoff and Sorane SA not only had more than two decades of experience in working on building energy efficiency in Switzerland but also had practical experience of working in India. Both experts were also involved in SDC's previous activities in the Indian construction sector as well.

The following areas of Swiss expertise were identified:

- Building Design & Policy: The Minergie label for energy-efficient buildings
- Tools & Technologies: Development of Sspecific highly energy-efficient technologies, e.g., in Combined Heat &and Power (CHP) and Heating, Ventilation, and Air Conditioning (HVAC). Testing of products building materials for their thermal performance

"For the SDC's Section Climate, DRR and Environment low-carbon development in the build environment is a priority since the building and construction sector is responsible for around 37 per cent of energy and process-related CO^2 emissions at the global level. In India, SDC has long-standing track record in improving the energy efficiency and carbon footprint of building materials (bricks and cement) and in promoting energy-efficient and thermally comfortable building design."

– Mr. André Daniel Mueller
Programme Officer, Federal Department of Foreign Affairs (FDFA) Swiss Agency for Development and Cooperation (SDC)

- Outreach & Awareness: Training of building sector professionals (aArchitects, Eengineers, etc.) in systemic design process for the design of energy-efficient buildings.
- Development of financing products from the banking sector for the financing of energy-efficient buildings

Equipped with this knowledge of Swiss expertise, the mission team had consultations with some key stakeholders. This included the two government ministries directly involved in energy conservation, i.e., BEE and MNRE, TERI (a research and green building rating organization), and DLF (one of the largest organized builders in India).

The meeting with BEE, the prospective government partner, was the most important as it resulted in the identification of possible collaboration areas. The authorities in charge of buildings program laid out their requirements and expectations clearly, which expedited the development process of the project.

Another important milestone in the project formulation was the organisation of a joint SDC–BEE–TERI special event titled 'Energy Efficient Buildings – Today and Tomorrow' in February 2008 on the side-lines of the Delhi Sustainable Development Summit. This was a high-level event attended by the then IPCC Chair and Director General of TERI, senior officials of the MoP, then Director General of SDC, senior Swiss academicians, Indian practitioners, Members of Effin'Art Sarl and Greentech Knowledge Solutions. The meeting articulated the need for a potential multi-stakeholder Swiss–India programme on energy efficiency in buildings to address issues of capacity building, developing design guidelines for residential buildings and development of an Indian building energy label'.

BEEP takes shape

An outline of a 3-year project started evolving during the first half of the year 2008. The project document – along with the identification of potential Swiss Experts – was done in the summer of the same year.

While the initial discussions with BEE had identified Minergie-like building rating as a priority, due to Minergie's reluctance to introduce an adapted rating version for India, the work could not be taken further. The project at that point of time had three main components:

- Building capacities of private developers and design teams in energy-efficient building design through organising a series of Design Charrettes to implement Energy Conservation Building Codes (ECBC)
- Knowledge exchange (through study tours, workshops, training of trainers, etc.) to promote new approaches for building energy conservation and to promote collaboration between public and private sector institutions of the two countries.
- Development of design guidelines for energy-efficient residential buildings for India.

Phase I kickstarted with the first Swiss Mission to India in November 2008, which included the organisation of a pilot charrette with Infosys and also a key meeting with BEE on 26 November 2008.

An MoU gets signed

Having identified the broad themes on which the project would focus on, the team then developed a list of detailed activities to be carried out under the project. While both SDC and BEE were in agreement with the project outline, a formal Memorandum of Understanding (MoU) between the two organisations to be approved by the Union Cabinet of India was necessary. [1]

[1] Cabinet Approval: The Union Cabinet is the supreme decision-making body in India; it is a subset of the Union Council of Ministers (Chaired by the Prime Minister) who hold important portfolios and ministries of the government.

The time period of 2 years for receiving the cabinet approval was utilised to carry out preparatory activities, such as pilot testing of the integrated Design Charrette Module, awareness workshops and consultations, energy survey of households, exposure visits and development of a network of professionals.

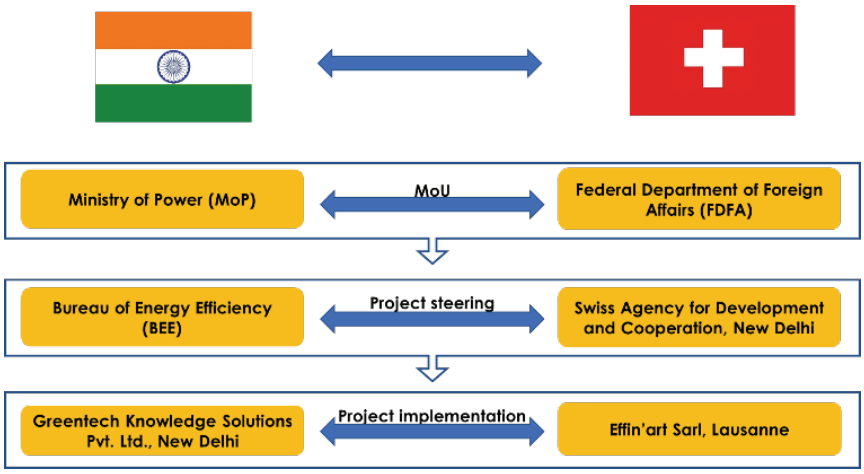


Figure 2: Institutional arrangement of the project

Steering the Project

The project team and the steering structure were developed in 2008 during the consultation phase with BEE during the first Swiss experts mission to India. In order to ensure that the project receives necessary guidance during its course and maintains accountability, a two-step steering structure for the project was decided upon. While the Joint Apex Committee (JAC) was formulated to give overall guidence to the project and maintain accountability, the Joint Implementation Group (JIG) was aimed at ensuring smooth implementation. and dealing with day-today issues.

1. A Joint Apex Committee (JAC) was proposed to steer the project. The first meeting of JAC to be organised during February/March 2009.

Joint Apex Committee (JAC)

Co- Chairs

- Joint Secretary, MoP
- Counsellor and Head of Climate Change and Developmen t, Embassy of Switzerland in India

Conveners

- Secretary, BEE
- Senior Advisor, Energy, Embassy of Switzerland in India

Other Members

- Director-General, BEE (First Special invitee)
- Director, BEE
- Joint Secretary, Ministry of Urban Development
- Director (MoP) in charge of Energy Conservation, Co-Chair of JIG
- Director, Ministry of New and Renewable Energy (MNRE)
- Energy Economist, BEE
- Head of Energy and Environment Unit at UNDP (Second Special Invitee)
- Indian practitioner on sustainable buildings/construction (Mr Ashok Lall, Architect)
- Swiss practitioner on sustainable buildings/construction (Dr Heinrich Gugerli, Head of Sustainable Buildings, City of Zurich)
- Effin'Art Sàrl (Swiss PMTU) team leader
- Greentech Knowledge Solutions Pvt. Ltd. (Indian PMTU) team leader
- Representative of Indian private sector (NAREDCO)

Figure 3: Composition of the Joint Apex Committee (JAC)

2. A Joint Implementation Group (JIG) was formed to oversee the implementation of the project.

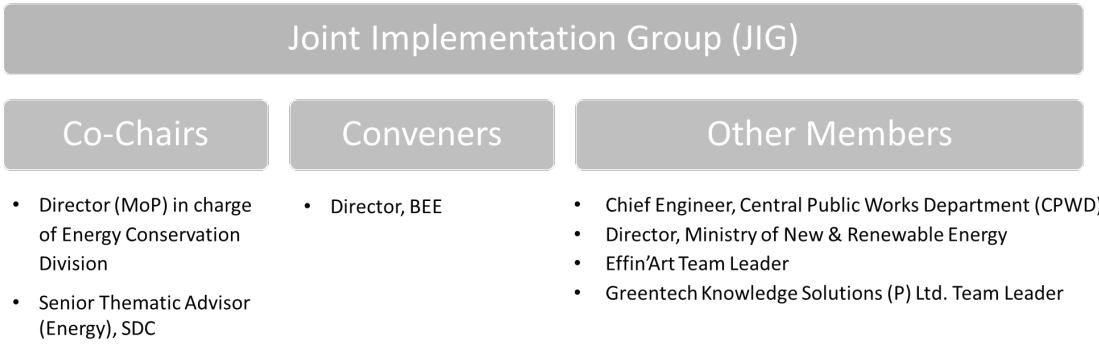


Figure 4: Composition of Joint Implementation Group (JIG)

Project Management Technical Unit

Simultaneously, the two Project Management and Technical Units (PMTUs) were set up: one in Switzerland and the other in India. This was the same team that had conceptualised the project and was now responsible for its implementation and management. It was also decided early on that the PMTU's shall work with a range of partners both from Switzerland and in India to bring in different perspectives and enable knowledge exchange. A detailed member list of the PMTU's and the project partners is given in Annex 2.

Project Evolution

The Assistant Director General of SDC visited India in 2015 and participated in site visits to completed charrette projects as well as in stakeholder consultations. Project made a strong case for developing a follow-up phase (2016–2021) to scale up the activities of Phase II. The proposition was presented to JAC for approval following which the MoU was exchanged between the two governments in November 2016 during the BEEP International Conference. SDC also commissioned an independent review of the project in 2017, which was instrumental in the formulation of activities in Phase III. 2017 was considered as a transition year and consultations were carried out with most existing partners and a few new ones to formulate the project document for Phase III. The formal project activities for this phase were initiated in October 2017.

Figure 5: MoU exchange for BEEP Phase III during BEEP International Conference 2016

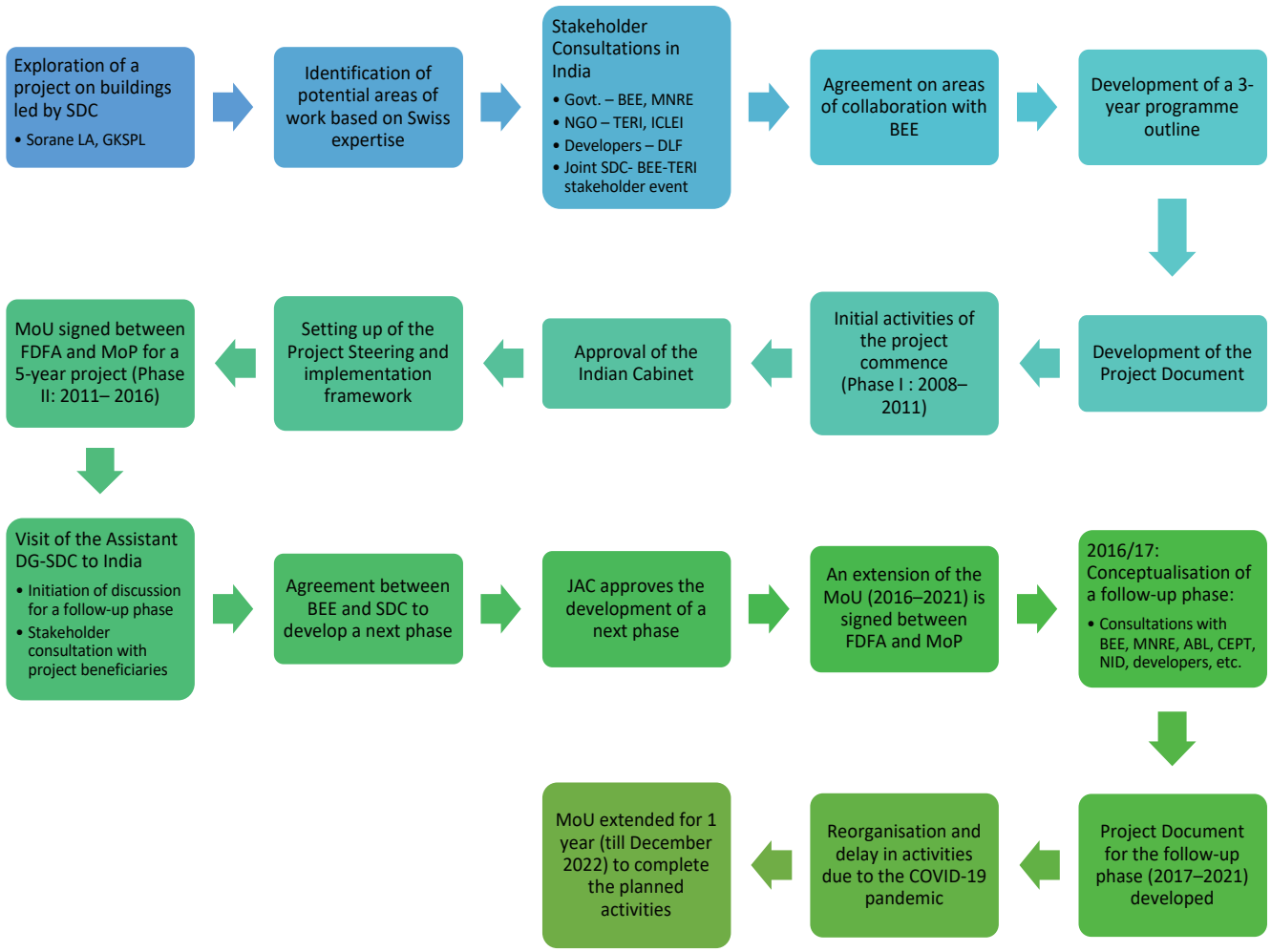


Figure 6: Project evolution

BEEP was conceptualised with the idea to support the GoI to reduce the energy consumption in new commercial buildings and that best practices for the construction of low-energy residential and public buildings are broadly known and recognised in India. The project adopted a multi-pronged approach, which promoted application of new techniques, tools, processes, materials, and labels for designing energy-efficient buildings. This was supplemented with a strong capacity building and knowledge transfer drive. The project from the very beginning was focused on developing solutions through research, which were suitable for implementation in real-life projects.

The core technical concept behind BEEP was the Integrated Design of buildings in which the architecture team and the engineering team work together from the early design stage of a project. The approach gives equal importance to good passive design and design of efficient space conditioning systems.

The core principle: the Integrated Design Process (IDP)

During the conceptualisation of BEEP, one of the meetings with a leading Indian developer, DLF India, prompted BEEP Team to apply the concept of the integrated Design process in India in the form of Integrated Design Charrettes. The conventional design process is sequential where different specialist design consultants/stakeholders are brought in separately after much of the architectural design has been fixed to give their respective technical inputs. The figures given below explain the difference between a conventional and Integrated Design Process and the corresponding energy saving potential.

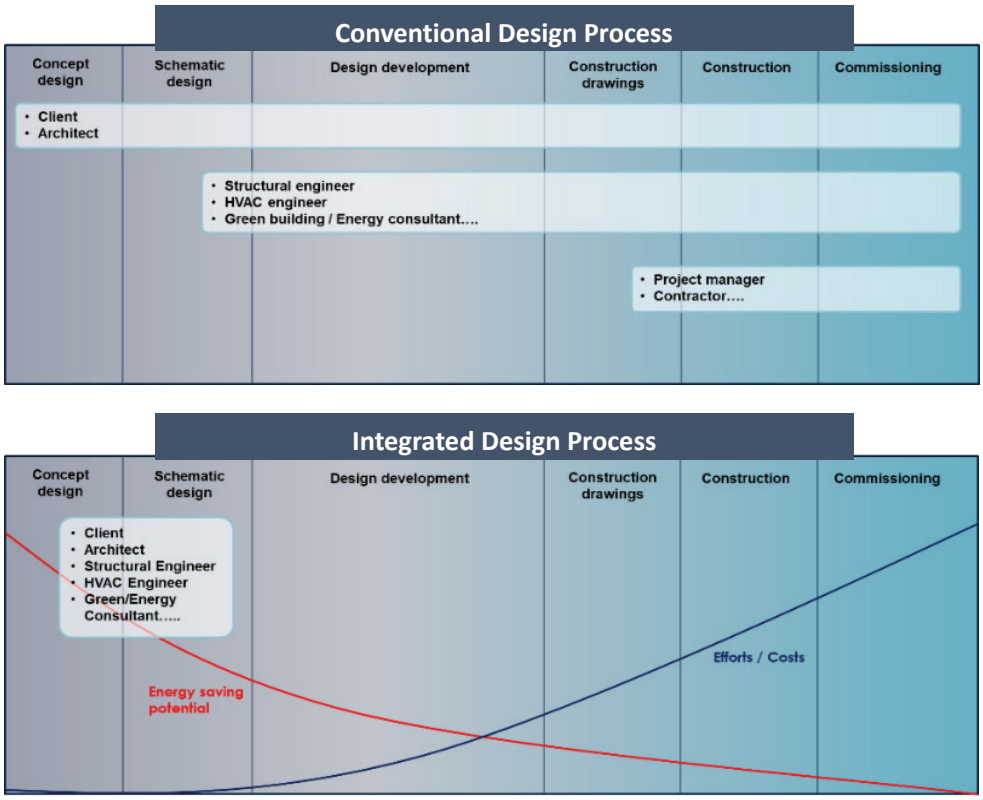


Figure 7: Explain the difference between a conventional and Integrated Design Process and the corresponding energy saving potential.

BEEP has been able to demystify thermal comfort and energy efficiency in buildings. The fact that it has narrowed down the innumerable complex energy efficiency measures to simply saying that we need to address the wall, window, roof makes it more understandable and relatable to people at large.

– Ashok Lall, AB Lall Architects

The module of the Integrated Design Charrette was developed where it was proposed that a 4–5-day workshop be conducted where most of the stakeholders, like the architects, owners, MEP consultants, etc. if not all, start working on the project together right from the beginning, based on the design brief. Doing this allowed BEEP to tap the largest energy saving potential with minimum effort and cost. This also meant that energy goals were to be set at the very outset and shared with the whole team. The charrette also enabled the team to reduce its overall duration of the design period and laid out common goals for the whole team to achieve. It resulted in buildings with 25-45% improvement energy performance at minimal to no increase in cost.

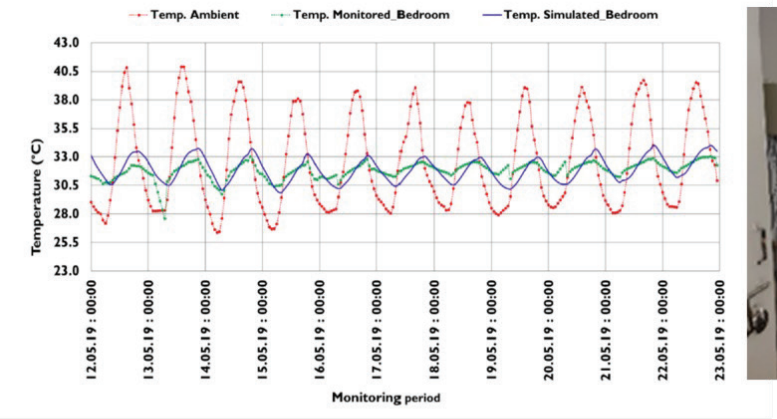
Having conducted the charrettes for buildings, BEEP continued to stay in touch with the respective project teams and offered additional support during the tendering and construction process to ensure that the charrette recommendations are seen through and incorporated in the constructed building. It was also realised during this period that there was very little data available on the actual performance of buildings in India. To cover this gap, BEEP introduced a new activity component, which was to carry out performance monitoring for charrette projects that were completed and occupied.

It also became a strong means to validate whether the design recommendations given during the charrette based on simulations were effective in the real-life scenario. The case studies and the technical papers developed post this process for three specific cases (Aranya Bhawan, Jupiter Hospital and Smart Ghar III) included (a) the base case design, (b) improved design with design recommendations; and (c) the implemented design along a comparison of the energy consumption. A snapshot of the energy efficiency measures adopted in these buildings and the corresponding energy savings is given in Annex 1. All these studies were the proof of concept as these were the first of their kind developed for buildings in India. These documents have been the most downloaded resources from BEEP in India but internationally as well.

Integrated Design Charrettes can greatly facilitate the adoption of the energy conservation codes, enabling people to embrace it more easily and expedite the process of implementation.

– Ajay Mathur, Ex-Director General, BEE

Having made an impact on individual buildings, the BEEP Phase III (2017–2022) aimed at developing long-term relationships with developers to embed



During hot summer in Rajkot the daily ambient peak temperature is ~ 40°C; Indoor peak room temperature is ~32°C → 8°C below ambient temperature without any cooling

Figure 8: Performance monitoring of Smart Ghar III, Rajkot

the IDP into their standard practices. While the idea was appealing, it was an extremely challenging task for its actual implementation. The project in its last 4–5 years was able to develop a working relationship with the sustainability team of Mahindra Lifespace Developers Ltd (MLDL). It was able to work with them on around 6 projects, which ranged from some that were being conceptualised, some just about to begin construction, and some mid-way into construction. In all cases, some aspects of thermal comfort and energy efficiency were incorporated into these buildings. The highlight of this relationship though was the Mahindra Eden project in Bengaluru, which is set to become the first Net-Zero residential building in India. BEEP also got an opportunity to collaborate with SDC's project (Integration of renewables in buildings in India, BEEP-RE) for this building.

The design and the expert opinion of the BEEP team has clearly impacted the energy consumption, which is showcasing significant reductions.
- Neelesh Shinde, Group Chief Technical Officer, Jupiter Hospitals

We were able to have a continued relation with not just Rajkot Municipal Corporation, but also the project manager & contractor of the project during construction and later, with the Resident Welfare Association there. This project gave us the unique opportunity to see a building through design, construction and occupancy, as well as validate our recommendations through performance monitoring.

- Saswati Chetia, Indian PMTU

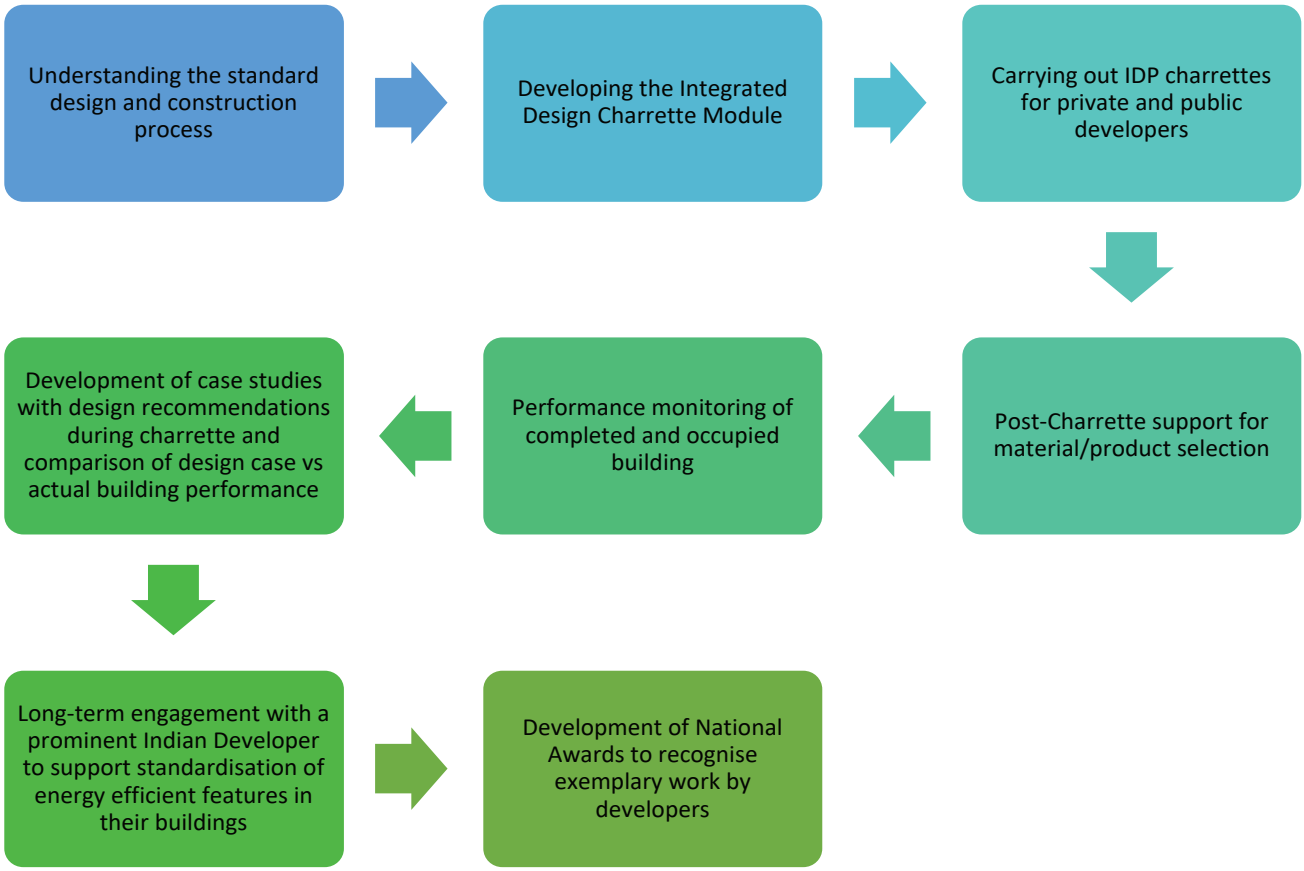


Figure 9: Integrated Design – Work with developers

The success stories

During the course of the project, technical assistance was provided to about 70 building projects covering over 9.5 million square metres of built-up space. A snapshot of a few completed projects is given in Annex 1.

Figures 10: SDC team visiting the Smart Ghar Project in Rajkot and Mahindra Eden (Kanakpura) in Bengaluru

Figure 11: Visit of the Minister, Shri Hardeep Singh Puri of Ministry of Housing and Urban Affairs (MoHUA) to Smart Ghar, Rajkot

Figure 12: Aranya Bhawan being inaugurated by the then Chief Minister of Rajasthan, Smt. Vasundhara Raje

Bring back the wisdom!

As part of the strategies to improve the thermal performance of the building envelop, BEEP worked on promoting certain technologies that are helpful in achieving the same in India. These include building insulation, dynamic shading of windows and harnessing the natural ventilation potential. All these passive design technologies have been traditionally used in India and have proved to be effective in blocking the heat. However, with the passage of time these techniques were forgotten. BEEP promoted the use of the same techniques in their modern avatars for contemporary buildings learning from the Swiss experience. Through this, BEEP tried to uphold the importance of the design principle 'Shade, Insulate, Ventilate' to make any building thermally comfortable.

Various activities were undertaken to promote the use of each of these technologies.

Vayu Pravah – The air flow

While working on the design solutions during the IDP charrettes, especially for the residential buildings, one of the key strategies was to design the window openings to harness the best natural ventilation potential. In typical dense mid- and high-rise buildings, the first building is often facing the wind receiving the maximum wind while the ones behind it do not get adequate wind. Strategies to overcome this problem were suggested and implemented in the Smart GHAR III project in Rajkot, which being an affordable housing project had a very tight budget. BEEP also designed and implemented an assisted ventilation system in one of the towers, which was monitored for its contribution to the flat's thermal performance post occupancy and showed promising results.

The simulations for the same were done using sophisticated Computational fluid dynamics (CFD) analysis software such as FloVENT [2] and Fluent [3]. However, most architects and consultants in India did not have access to such software primarily due to its high cost. To address this gap, Vayu Pravah, a free software based on openFOAM [4] a free, open source CFD software, was developed in partnership with the University of Applied Science of Sion (HES-SO), which can be used to assess the natural ventilation of the building. Further to its development, training programmes were organised for various stakeholders, including academia, green building consultants, architects, etc. to demonstrate the utility of this software. As part of the design problems during the 5th BEEP Student Camp, participants were urged to use the tool to assess the natural ventilation potential of the building.

Shade the windows

Another design principle that has been a key solution to excessive heat gains in building is the external movable shading systems (EMSyS). This design feature was quintessential to the indigenous building design in India and its many variations based on regional relevance can be seen in the old buildings throughout the country. However, in the wake of modern buildings, both fixed and dynamic shading were the first of many elements to be eliminated to give way to flashy buildings with glass facades.

External movable shading is also a design feature that is mandatory by law in Switzerland. This results in multiple products being available for different usages. When BEEP started working on external shading in 2013, not many products were available in the market. To address this gap, a National Design Competition was organised, which invited entries from designers/manufacturers for external shading devices. Of the 30 entries received, five winning entries (3 for residential and 2 for commercial buildings) were awarded a cash prize to develop prototypes, which

[2] FloVENT® is a powerful Computational Fluid Dynamics (CFD) software that predicts 3D airflow, heat transfer, contamination distribution and comfort indices in and around buildings of all types and sizes.

[3] Ansys Fluent is the industry-leading fluid simulation software known for its advanced physics modeling capabilities and industry leading accuracy.

[4] OpenFOAM, released by OpenCFD Ltd., is the leading open source software for Computational Fluid Dynamics.

were tested for their thermal performance at the laboratory of CEPT University. The initial idea was to support the incubation of the winning designs for mass-scale production. However, a tepid response from the winners nudged the project to re-think its strategy.

Figure 13: Winners of the National Design Competition on EMSyS

By this time (around 2017), the market matured a bit and a few EMSyS products were available. To understand the market status, the project carried out market surveys in Ahmedabad, Mumbai, and Chennai regions to assess the product availability. The outcome of these surveys was two-fold:

1. The market offered either very low-cost local products, which were being used primarily in the residential sector or highly sophisticated systems, which were extremely expensive and were useful only for large commercial buildings. It lacked a mid-segment in terms of affordability and quality, which could be used in the residential sector.
2. While low-cost materials like the bamboo chicks (blinds made of thin bamboo slivers/ grass) were used primarily to block heat, the high-end products from an organised sector were not marketed for their thermal performance but as façade treatments.

The project developed a manual on the types of EMSyS available in the Indian market and their key features. It was developed with the objective of giving an overview to architects and users on the features of each product and enabling them to make an informed choice for their building.

There was no scientific data available in India to demonstrate the impact that EMSyS can have on thermal comfort and hence an exercise of measuring its impact both on thermal comfort as well as on the cooling requirement was done. The performance monitoring was carried out in a real apartment building in the National Capital Region

(NCR) with two variations of a mid-segment product available in the market. A difference of ~3.5 °C was observed in the peak inside operative temperature for the naturally ventilated case (lower temperatures in the room fitted with EMSYS), while a difference of ~32% (savings in the room fitted with EMSyS) was observed in cumulative cooling demand (thermal) for the air-conditioned case. This was followed by publishing a technical paper as well as a policy paper to quantify the cumulative impact EMSyS could have on thermal comfort and energy consumptions in the Indian residential sector. It is expected that these documents will give a much-needed nudge to policy makers and to the EMSyS manufacturing industry for its market development in India.

Figure 14: Performance monitoring of EMSyS

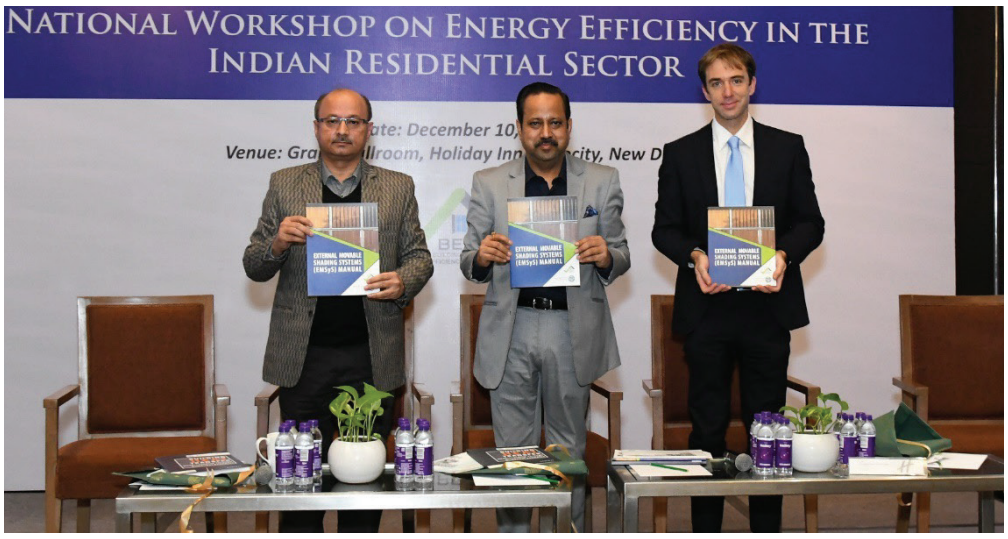


Figure 15: Launch of EMSyS Manual by , Mr R K Rai, Secretary, BEE (centre), Dr Jonathan Demenge, Head of Swiss Cooperation Office, India (right), and Dr Anand Shukla, Senior Thematic Advisor-SDC (left)

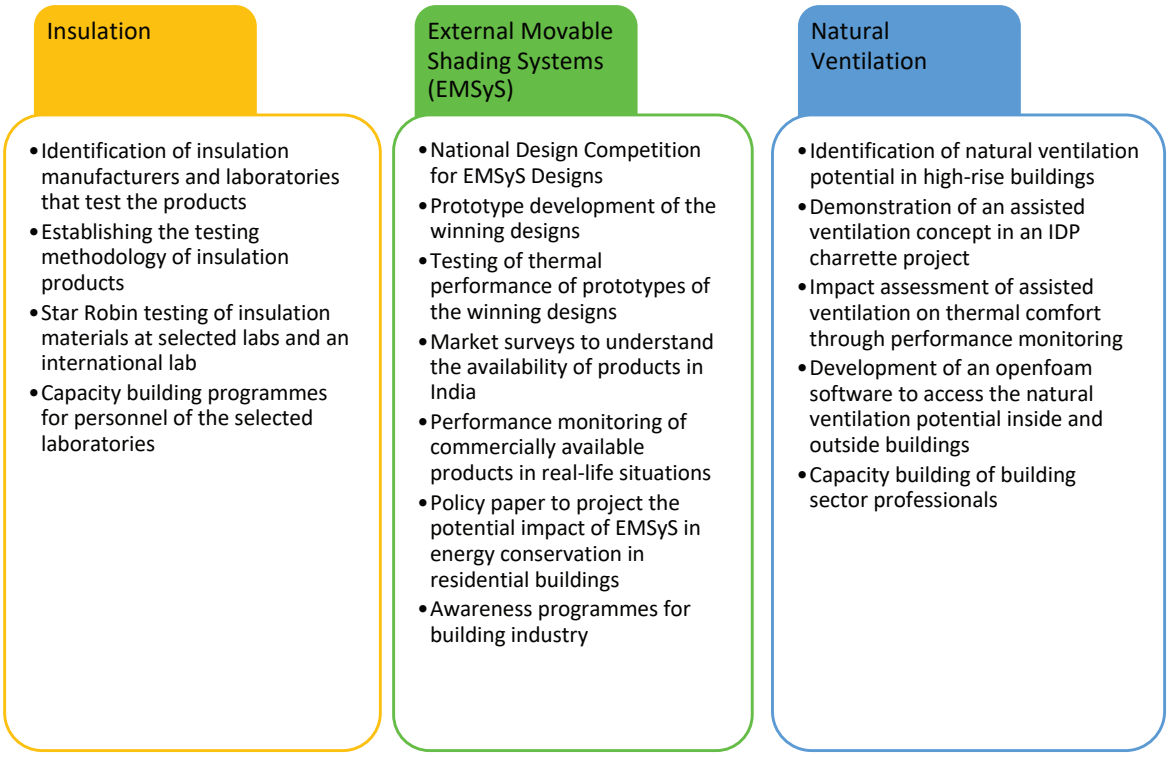
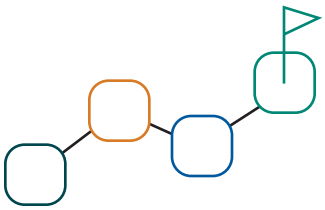


Figure 16: Technologies for energy efficient envelope



The BIG Policy Shift

While BEE was working on the Standards and Labelling programme for household appliances, the design of energy efficient residential buildings was not a priority area in 2008. As part of the BEEP conceptualisation process, a joint event titled 'Energy Efficient Buildings - Today and Tomorrow' was organised by SDC and BEE on the sidelines of the Delhi Sustainable Development Summit – 2008, an annual event organised by TERI. The event was attended by high-level officials of the MoP, BEE, Embassy of Switzerland in India, TERI, etc. During the event, Ar. Ashok Lall made strong pitch to address the issue of energy efficiency in residential buildings as BEE's energy efficiency programme on buildings at that time was mainly focused on commercial buildings. As an outcome, it was decided that the project shall start off by conducting a survey of around 1200 households (in standard multi-storeyed apartment buildings) to assess the building consumption pattern of residential buildings followed by the development of design guidelines for multi-storeyed residential buildings.

Get Data

The baseline survey of residential buildings was a gamechanger in many ways and set off a series of events in the residential sector, which continues till this date. A few important conclusions of the survey were as follows:

Understanding of the baseline Energy performance index in middle class multi-storey housing located in two different climate zone Delhi (composite climate) and Chennai (warm and humid climate).

Space conditioning (primarily air-conditioning during the summer months) is a key factor, which influences the EPI. Homes having larger area under air-conditioning showed significantly large EPIs.

At the time (2009–2012), projections were also being made on the potential increase in the sale of air-conditioners in the coming decades. However, the fact remained that over 90% of Indian households did not have access to air-conditioning and hence the issue of occupant thermal comfort was crucial for this segment. This figure still holds good as of 2023.

BEEP'S PASSIVE MEASURES BECOME MORE ACTIVE!

In 2015, the Government of India launched the Pradhan Mantri Awas Yojana (PMAY) to address the shortage in housing, particularly for the low-income group (LIG) and economically weaker section (EWS) of the society.

BEEP had also extended the IDP charrettes for residential buildings. The Smart Ghar III, Rajkot, was one of the first projects to receive technical assistance. Being an affordable housing project, there was no scope or leeway to include strategies that had an additional cost or make an assumption that the occupants would use air-conditioners in the harsh climate.

It was also a validation for BEEP's approach to address the issue of thermal comfort in housing through passive measures and lower the Degree Discomfort Hours (DDH) rather than focus on the Energy Performance Index (EPI, the approach being followed for commercial buildings) of the building.

Design Guidelines

Efforts were made to first address the issue of thermal comfort through passive design features, followed by intervention in the active cooling strategies. The Design Guidelines became the first comprehensive document by the GoI on designing of residential buildings and were officially published by BEE in 2014. It later found mention in India's INDC submitted for the Paris Agreement in CoP 21 (held in 2015) and nudged the GoI to start thinking about a code for residential buildings.

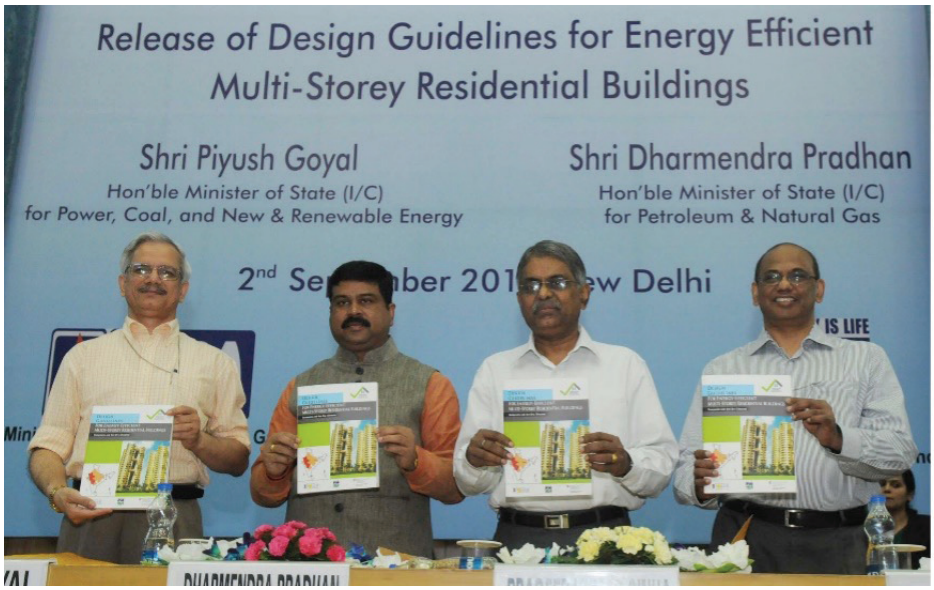


Figure 17: Launch of Design Guidelines by the then Minister of Petroleum and Natural Gas, Shri Dharmendra Pradhan

A Code is developed

This was also the same time when SDC was contemplating of a 3rd phase for BEEP in which the Residential Code would be a key outcome. However, in 2017, during the launch of ECBC-2017, the then Minister of Power directed BEE to develop the residential code in the next 6 months. As BEEP has already worked with BEE in developing the design guidelines for energy efficient residential buildings, this provided an opportunity to carry forward that collaboration and work together on the residential code. SDC's proactive leadership during this juncture helped in finalising the arrangement resulting in BEEP providing technical support to BEE for the development of the code.

Figure 18: Launch of ENS 2018

There was a consensus between the BEE and the BEEP PMTU that the residential code (now called Eco-Niwas Samhita – ENS) had to be developed as a simple and practical code for implementation, with a focus on the quality of building envelope, i.e., improving the thermal comfort and, in turn, reducing the demand for space heating and cooling. This approach of having a Residential Envelope Transmittance Value (RETV) as the key parameter was influenced by the energy conservation code of Singapore and was also accepted by highly experienced technical and steering committees. SDC also facilitated exchange visits for PMTU and BEE to Singapore for consultations with various stakeholders involved in the development and implementation of the Singapore code. During one of these visits, the SDC–PMTU–BEE delegation also participated in an IEA Task 40 event, where the team was able to make a strong case for addressing the issue of thermal comfort of buildings in tropical countries like India.

The Ripple Effect

The Eco-Niwas Samhita (Part 1: Building Envelope) became the stepping stone for BEE to catalyse further action. Part II of the code on electromechanical systems was developed under the BEE-GIZ programme on buildings followed by type designs for ENS compliance and a star rating scheme. Standard solution sets for building envelope were developed under BEEP, which were further customised for the state of Rajasthan. The project also supported BEE in the implementation of the code through IDP charrettes, development of a compliance tool, training programmes, etc. The project also supported BEE in the conceptualisation and implementation of NEERMAN awards aimed at recognising buildings complying with ECBC and ENS and encouraging energy efficient building design. The first cycle of the awards was implemented in partnership with Environmental Design Solutions and over 15 buildings and 3 state nodal agencies (SDAs) were awarded. The awards showed participation from large developers such as DLF and Infosys.

It is gratifying to see that BEEP approach on focus on building envelope, thermal comfort and need for simple and practical building energy codes has found support and resonance both within India as well as in other international initiatives and developing countries.

– Sameer Maithel, Indian PMTU (2008-2021)

The development of ENS has been a key highlight of Indo-Swiss BEEP and also my career. The challenge was to do all these things in a short time and to get everything approved through a highly experienced technical and steering committee. It was a good learning experience.

– Prashant Bhanware, Head - Indian PMTU

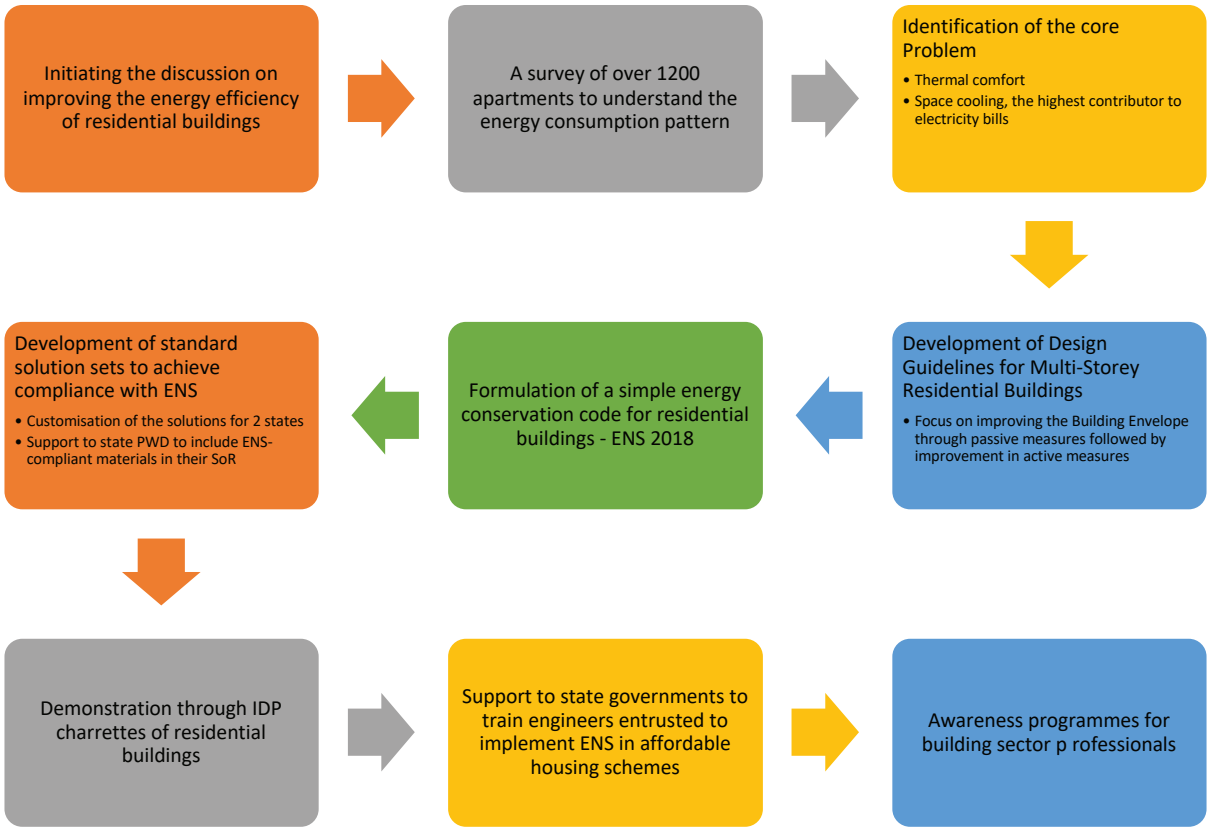


Figure 19: Work on thermal comfort in residential buildings in India

Figure 20: The winners of the NEERMAN Awards 2022

The project also partnered with four states –Karnataka, Rajasthan, Gujarat, and Andhra Pradesh – to support the implementation of ENS and adoption of EETC design in their public buildings. The work was carried out through local partners and varied in different states based on their requirements. While a guideline for template public buildings was developed for Karnataka, materials helping ENS compliance were incorporated in the Schedule of Rates in Rajasthan.

The Andhra Pradesh (AP) Government launched its flagship affordable housing BLC (Beneficiary Led Construction) scheme 'Pedalandariki Illu' in 2020 under the PMAY, which was aimed at supporting the construction of about 13 lakh (1.3 million) houses and approached BEEP to support them for ENS compliance. A template of the house design that would be shared with beneficiaries is equipped to comply with the minimum RETV requirement of ENS. In order to ensure that these designs get implemented, the AP government also wanted to ensure that the 13,000 ward-level engineers entrusted for implementation are also trained on ENS. BEEP, in partnership with the Administrative Staff College of India (ASCI), developed a special training programme for the same and trained a batch of 50 as trainers, who would train the other engineers; BEEP and ASCI also conducted pilot trainings for the first 500 of them.

Figure 21: Support to Andhra Pradesh for ENS implementation

Figure 22: ENS dissemination seminars at various locations

The EC Act 2001 covered only commercial buildings under its ambit for the longest time. However, the amendment to the act was recently passed by both houses of the Indian Parliament in 2022 and shall now cover residential buildings as well. This means that the ENS, which was launched as a voluntary code now, has the possibility of becoming a mandatory code by law. BEE has also initiated a process to increase the scope of ENS to cover other sustainability aspects. Thus, one of the most significant contributions made by BEEP was to initiate the work on design of energy efficient residential buildings in India, which has resulted in this major policy shift.

Spreading the Word

The project from the very beginning focused on capacity building of various stakeholders and members of the building industry through training and awareness programmes.

Phase II (2011–2016) of BEEP focused on conducting short training programmes for building sector professionals on topics such as conducting integrated design charrettes, advanced simulations, and the use of technologies such as radiant cooling and earth air tunnels. The goal of this phase was to provide a foundation of knowledge and skills for professionals to incorporate energy-efficient design practices into their work.

Phase III (2017–2022) of BEEP had a more focused approach on designing long-term specialised training programmes. These programmes included the BEEP Student Camp, which aimed to train the next generation of building professionals on energy-efficient design practices, and the BEEP Media Engagement Programme, which aimed to raise awareness of energy-efficient buildings through the media. The (ENS) training programmes were also launched to provide specialised training for ground-level engineers and other building professionals.

The objective of the capacity building initiatives of Phase III was to have a long-term impact on key audiences and promote the adoption of energy-efficient building practices in India. Through its training and awareness programmes, BEEP aimed to develop a skilled workforce capable of designing and constructing energy-efficient buildings that can contribute to thermally comfortable and energy efficient buildings.

The project carried out over 55 trainings, workshops, international conferences, trained over 6000 students and professionals and reached out to over 1 million persons through its web outreach. Over 55 knowledge products

were developed out of which technical papers were published in leading journals and presented in international conferences. All knowledge products can be accessed on the BEEP website.

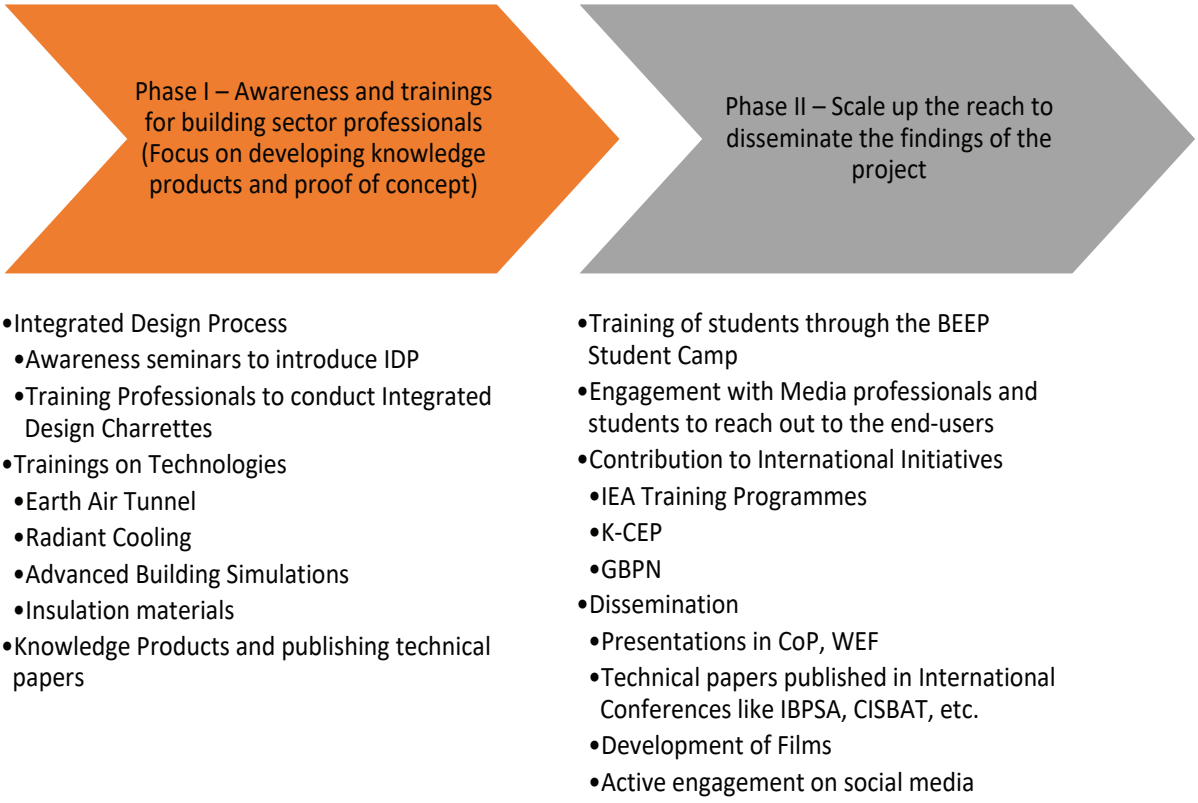


Figure 23: Awareness and outreach

The Young Professionals

While Phase II focused on training building sector professionals, Phase III shifted its approach to train the upcoming generation of architects and engineers who will join the industry. While architectural courses cover relevant engineering components of a building, they do not teach these concepts in an application-based way. Similarly, in engineering curriculum, the basic science of HVAC is clear, but the building context is absent. BEEP identified the importance of training young professionals to bridge this gap in the building science education and to develop competencies required to design energy efficient buildings. This was done using the integrated design process through initiatives like the BEEP Student Camp, development of a book on "Understanding heat transfer in buildings through numerical problems" and the Building Energy Performance Simulation (BEPS) course.

Beyond the educational content, BEEP Camp offered a unique and inclusive environment where engineers, researchers, teachers, professionals, and participants from diverse backgrounds came together.

- Vartika Sharma, BEEP Camp Alumni

BEEP Camp offers the opportunity to both spacial design and systems design professionals to learn each other's languages. This is important to bridge the gap between the two fields which are intrinsically related to develop efficient buildings.

– Ulrike Passe (BEEP Camp Faculty), Associate Professor, Architecture & Director, Centre for Building Energy Research, Iowa State University

BEEP Student Camp was designed as an immersive training programme for undergraduate and post-graduate students in the streams of architecture and engineering, as well as young professionals. The annual 8-day immersive residential camp was designed to provide a mix of technical learning sessions, interpersonal skill sessions, and group design exercises to develop competencies required for designing energy-efficient buildings using integrated design process. The faculty members for the programme were eminent national and international practitioners who are experts in their fields. The setting for delivering the course was chosen carefully to ensure that participants get the best learning experience. While the first two editions of the camp in 2018 and 2019 were housed at the CEPT University, the third and fourth editions had to be converted into an online program due to the COVID-19 pandemic. A fifth camp was also organised in 2022, which was again an in-person programme at the CEPT University campus. The BEEP Student Camp was awarded the CIBSE Award in 2022 under the Learning and Development category and is likely to be continued as an annual activity by BEE.

Figure 24: Participants of the BEEP Student Camp 2019 with the then Ambassador of Switzerland to India and Bhutan, HE Dr Andreas Baum

The book on Understanding Heat Transfer in Buildings through Numerical Examples was developed for engineering students, to make them understand the application of heat transfer in buildings. The book was authored by Dr Udayraj from the Indian Institute of Technology (IIT) – Bhilai and was also circulated among faculty members from other premier engineering institutes.

Figure 25: Launch of the Book on Building Heat Transfer by the then Secretary of Power, Shri Alok Kumar

Figure 26: The BEPS course at the Sri Sri University, Cuttak

Similarly, an elective course was developed for 6th semester B.Arch students of Sri-Sri University on how to use building energy simulation to improve a building's performance and not just to demonstrate compliance with green building rating systems.

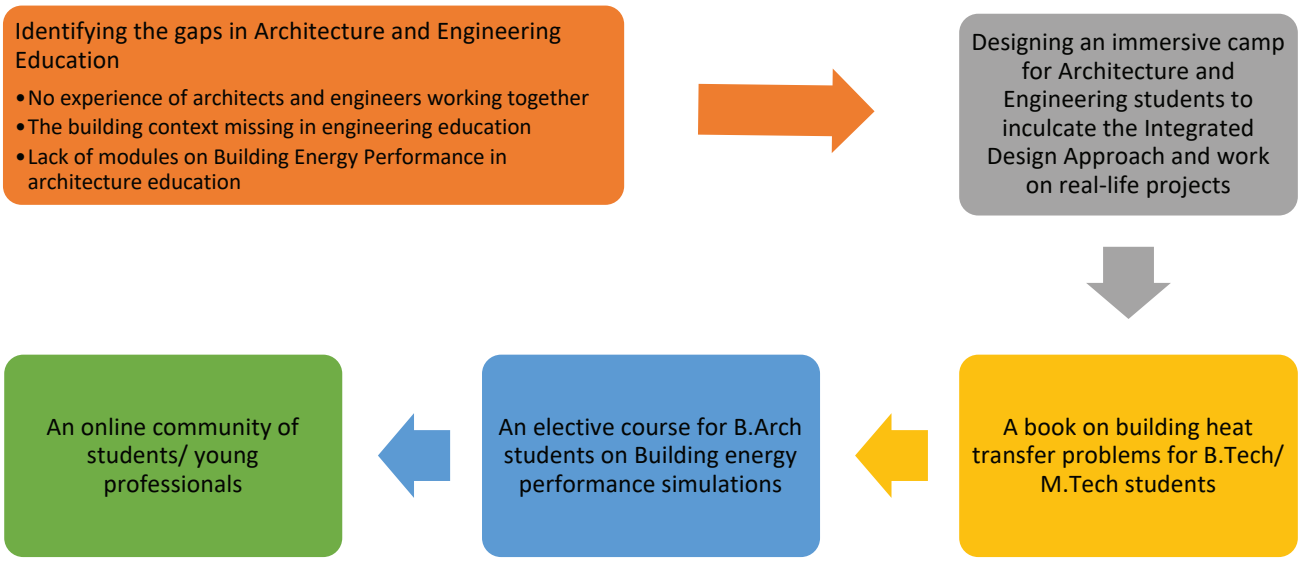


Figure 27: Building science education

BEEP's Media engagement Program on building energy efficiency is important to raise awareness of the public on the subject. It is an add on to BEE's existing Media campaigns on energy efficiency.

– R K Rai, Secretary, BEE

Media Engagement

One of the objectives of BEEP Phase III was to scale up the outreach and reach out to larger audiences to disseminate the knowledge generated under BEEP Phase II. On SDC's recommendation (based on their experience in the IHCAP project), a Media Engagement programme was conceptualised. It was a pilot programme carried out in partnership with the Centre for Media Studies (CMS) as no member of the team had any experience of working on training for media professionals. The idea was to conduct 2–3-day workshops that included lecture sessions from practitioners, panel discussions with government representatives, field visits to energy efficient buildings and hands-on sessions for writing/ conceptualising story ideas on the subject. This was to be followed by floating media fellowships where the selected fellows would publish stories on building energy efficiency in their respective publications.

The plan, however, had to be altered due to the COVID-19 pandemic. While the initial workshops were conducted in-person as per the original plan, the later ones had to be shifted to an online mode. The workshops communicated the broad idea to the media

professionals, however, the lack of field visits resulted in less exposure to the participants. The challenge also arose in the fellowships as suddenly there was no print/visual/digital space available to cover any other subjects besides the pandemic. However, it gave the project an opportunity to modulate the story based on the current narrative. At the time, advisories were issued by senior health-care professionals from the All-India Institute of Medical Sciences (AIIMS) to ensure that people have adequate sunlight and natural ventilation to keep the virus at bay. The project used the opportunity to award a set of fellowships to cover how buildings with adequate daylight and ventilation are not only thermally comfortable for occupants, reduce energy bills but are also crucial for the occupants' health. The response of journalists was overwhelming and so the number of fellowships was doubled.

Figure 28: Launch of Media Manuals during Energy Conservation Day 2022

Figure 29: Launch of Media Engagement Programme in ANGAN 2019

While I do write extensively on environment and climate change, I had not written and considered to write on this important sector (Construction and energy) in past, even though it is so critical for our climate goals. I am happy that the BEEP fellowship gave me an opportunity to cover this crucial aspect and especially thank the mentors who patiently responded to all my queries.

- Kumkum Dasgupta (BEEP Media Fellow) - Associate Editor, Hindustan Times New Delhi

Through the fellowships, over 60 news items were published in mainstream media both at the national and regional levels. It was the first time ever that media persons were exposed to the importance of buildings both for healthy living as well as for climate change mitigation. The articles published with their online links can be accessed on the BEEP website. A 2-week-long training programme for post-graduate level mass communication students was also developed and conducted as an additional activity as it was realised that mid-level and senior professionals may be too caught up with regular beats and may not be able to devote time for covering a topic like buildings and hence the upcoming generation of professionals should be trained to do so. A 4-credit elective course for mass communication students was also developed and submitted to over 40 media colleges as well as the UGC.

Figure 30: Journalists who received the BEEP-CMS Media Fellowships

International Outreach

The project in its third phase worked on disseminating the knowledge generated under BEEP at an international stage also. It was also due to the fact that many international initiatives on building energy efficiency were developing. This exchange was also facilitated by BEE and SDC. A few key events that BEEP participated and engaged with are International Energy Agency (IEA), Sustainable Energy for All (SEforAll), Kigali Cooling Efficiency Program (K-CEP), Annex-80 ECB-IEA, CoP, WEF, International Building Performance Simulation Association (IBPSA), 2000 Watt Symbiosis, Central Public Works Department (CPWD), *Alliance for an Energy Efficient Economy* (AEEE), SSSCC, GHTC-India, Augmenting Nature by Green Affordable New-habitat (ANGAN) 2019, etc.

Figures 31: Presentation at the India Pavilion in CoP 24 at Katowice, Poland, CoP 25 in Madrid, Spain, and World Economic Forum 2020, Switzerland, on the Eco Niwas Samhita 2018.

Figure 32: IEA India training week (E4) from 10 to 14 December 2018

Figure 33: Paper on 'Simulation methodology for the development of the residential building code' presented in International Building Performance Simulation Association (IBPSA), 2019

The Intangibles

On one hand where the project team carefully scanned the building sector for gaps and assessed the needs of BEE and other stakeholders to develop potential technical solutions which were useful, one the other hand, it also worked hard on the intangible aspects, which also equally contributed to the project's success. Some of the key aspects are discussed below.

Teamwork and Collaboration

From the very start, the project was focused on building a strong team and a partner network. This can be broken down to healthy working relationships at different levels.

- Interpersonal relationship of team members: All along efforts were made to identify, select, and induct the right team members and have processes, which help in facilitating teamwork. High degree of competence and commitment of individual team members, premium on high quality outputs, mutual respect and trust, were some of the main qualities that were given importance while developing and nurturing the team. The teamwork helped the team to not only meet several of the project objectives but also getting over challenging situations, be it major illness and non-availability of key members, meeting tight deadlines or carrying out field work under challenging conditions.
- The Swiss–Indian relationship: The Indian and Swiss PMTUs shared a healthy relationship from the start. One of the key reasons for this was the Swiss PMTU's insistence of separate contracts with SDC so that the two teams treat each other as equals. This was also reflected in the roles defined for both teams and the compensation received by them. Both teams played on each other's strengths; while senior members of the Swiss team were not just very experienced professionals, they also had a deep understanding of the Indian context, which was reflected in the technical solutions that they developed. The Indian team on the other hand was strong in the implementation.
- The BEEP Network: The project started with a small team consisting of SDC, BEE, and the PMTUs,

One of the key reasons for the success of BEEP was its strong implementation team both on the Swiss as well as the Indian sides. Both teams played on each other's strengths; while senior members of the Swiss team were not just very experienced professionals, they also had a deep understanding of the Indian context which was reflected in the technical solutions that they developed. The Indian team on the hand was very strong in the implementation.

– Anand Shukla, Senior Thematic Advisor – SDC

A strong Indian Partner that implements the project on ground has been a major strength of the project. As international experts, it is the only way to ensure that the technical solutions offered by us are relevant to the local context and are implemented properly.

– Pierre Jaboyedoff, Head, Swiss PMTU

Being the project's interface at the BEE was quite a challenging task. It entailed having the latest update on all project activities at ALL times, responding to any urgent requests and ensuring effective communication between team members. We were able to build a sustained relationship with officials across MoP and BEE who considered us as dependable project partners.

- Vernica Prakash, Indian PMTU

The collaboration with SDC was a very fruitful longstanding project for BEE. A highly skilled and stable team delivered some very high quality and unique outputs like the Eco-Niwas Samhita, demonstration projects like Aranya Bhawan and Smart Ghar III, BEEP Student Camp and the Media Engagement Program. Most of the initiatives under the project have been great value addition to BEE's Building Energy Program.

- Saurabh Diddi, Director-BEE

but it always aimed to work with a network of professionals and organisations. While during the first two phases, the focus was on getting Swiss/European experts to India for knowledge transfer, the third phase of the project focused on expanding the network in India for implementation purposes.

- SDC–PMTU relationship: SDC through its office in Delhi always maintained a close relationship with the project. While there was a formal process of reporting and interaction during the JAC–JIG meetings, annual reports, etc., SDC always ensured participation in significant project activities, key meetings with BEE, partners, etc. as well as de-briefing meetings at the end of missions. This led to an excellent understanding and coordination between the SDC and the PMTUs.
- SDC–BEE–PMTU relationship: BEE midway through Phase II had raised a special request to station a team member at their office to handle the day-to-day issues and urgent requests. This helped the project greatly as the team member stationed was the project's interface with the Government of India who not only ensured streamlined communication between and among BEE/MoP, SDC, and the PMTUs, but also ensured that all requests were responded to in time for the smooth functioning of the project.

Identifying Challenges and Converting Them into Opportunities

Doing work that has high relevance in the Indian context was one of the mantras of the project. This meant that the project had to continuously scan the emerging scenario, analyse the situation, identify challenges, and, if possible, convert them into opportunities. A few examples where the project was able to do so as listed below.

- Integrated Design Charrette was proposed as a solution when it was found that tight project deadlines are a barrier for adopting energy-efficient design by large developers. Hence the 3–4-day module of the BEEP ID charrette was proposed.
- Development of Eco-Niwas Samhita, Part I: While the original plan was to develop the code during a period of 3–4 years in Phase III of the project,

the sudden request by the then Union Minister of Power to develop a residential building energy code in six-months timeframe resulted in not just the successful development of the code but also extending support to BEE for its awareness and implementation in the states.

- Development of Vayu Pravah emanated with the realisation that the available CFD software were too expensive and complex for an average Indian building design professional, which is also a reason why simulations for natural ventilation potential are not carried out during building design in India.

Reflective approach to project management

BEEP was one of those projects in which the team that designed the project also had the task of implementing it. This gave an opportunity to the project for adopting a reflective approach to project management, which involved periodic reflection during missions and team meetings, which to certain extent helped in refining the activities of the project.

The redefining of activities was based on the evolving situation on ground, which included the changing needs of beneficiaries, change in market dynamics, alignment with GoI's/international organisations' priority areas, interventions through other developmental programmes, global emergencies such as the COVID-19 pandemic, etc.

This evolution of activities was possible only because SDC acknowledged the dynamic situation on ground and was open to discussing possible solutions with the PMTUs. This is in contrast to some other bilateral and multilateral agencies where there is very little scope to make adjustments in the project documents. The flexible approach helped the project to capitalise on the opportunities such as the development of the Eco-Niwas Samhita as well as in addressing challenges as in the case of the work on External Movable Shading Systems.

Looking Forward

The Prime Minister of India announced in CoP 27 that India aims to achieve Net-Zero Carbon emissions by 2070. For the building industry, it converts into focusing on the embodied carbon of buildings as much as it does on operational carbon. While BEEP and other initiatives have worked significantly in the area of operational carbon, it is time that the embodied carbon of buildings is also addressed. In line with this thought, BEEP had supported BEE in organising its flagship biennial international conference, ANGAN 2022, which deliberated on the theme of 'Making the zero-carbon transition in buildings'. A few key action points emerged from this deliberation, which are as listed below.

1. **A period of urgent action: 2022–2030:** It is imperative that the building energy codes are made mandatory supported by availability of a trained workforce, availability of suitable building materials, and ease of implementation. This coupled with green financing options and a simple compliance mechanism at the urban local body (ULB) level with necessary resources can drive up the number of energy efficient buildings.
2. **Addressing embodied carbon:** Decarbonising the building sector means addressing lifecycle carbon emissions, i.e., both embodied and operational carbon. As India's buildings sector transformation is a story about new construction, embodied carbon of buildings and building materials will majorly drive sector emissions between now and 2050. Although the aspect of operational carbon has seen some improvement in the last decade, developing an understanding and having reliable embodied carbon data is critical for transformative action towards net-zero carbon buildings and built environment.
3. **Thermally comfortable climate-resilient housing:** Climate resilience and thermal comfort have to be at the forefront of housing (particularly for the affordable housing segment) in India and not be treated as additional features. Solutions have to be found at the urban planning level to address the 'Urban Heat Island Effect' coupled with affordable sustainable cooling solutions.
4. **Making energy efficiency in buildings a mass and inclusive movement:** Implementation of energy efficiency and a low-carbon built environment cannot be achieved solely by top-down approach, nor by influencing selected stakeholders. It requires influencing stakeholders through an intensive awareness programme at all levels – across gender, region, governance levels, and sectors – and achieving a concerted effort by all.
4. **Preparing for the future:** Being technology-ready, building capacities of young professionals and driving the global narrative on action for energy efficiency and decarbonisation of buildings is necessary to be future-proof and adapt ourselves.

BEEP initiatives such as the Eco-Niwas Samhita, NEERMAN Awards, and BEEP Student Camp are embedded in BEE's Building's Programme and shall be continued post 2022.

SDC supported the BEEP project for almost 14 years and considers it a high-impact international cooperation project. It wants to further explore and work on the topic of space cooling in buildings while considering that India has launched the India Cooling Action Plan (ICAP) in 2019. This may come with a holistic approach of working on other topics of urban heat mapping, nature-based solution at the neighbourhood/city level, decarbonisation of the real estate sector etc., and continue expanding the use of various tools and methods developed under BEEP at the same time.

The Swiss and Indian PMTUs also plan to take forward the work done under BEEP in their individual capacities. While the Swiss PMTU is working as expert energy consultants for a factory project in India and a Net Zero Energy Building, the Indian PMTU, on the other hand, has initiated work on a project similar to BEEP for the Nepal region. While the work done under BEEP was focused on the operational energy, the Indian PMTU plans to now work on the embodied energy of building materials as well.

Aranya Bhawan, Jaipur

Aranya Bhawan, the office building of the Rajasthan Forest Department in Jaipur, was one of the first projects selected for the BEEP Integrated Design Charrette and the charrette was held in December 2012. The project was implemented by the Rajasthan State Road Development Corporation Limited (RSRDC) and was inaugurated on 23 March 2015.

Project details

- Built-up area: ~10,000 m^2 (excluding basement parking and service area)
- Number of floors: Five (G+4) + one basement level for parking and services
- Number of users: 344
- Types of spaces: Offices, museum, library, auditorium, guest rooms
- Operation: Day-use, air-conditioned
- Climate zone: Composite

Charrette goals

- ECBC compliance
- BEE 5-star rating, i.e., EPI less than 90 kWh/m^2/annum.

Recommended strategies

- Polyurethane Foam (PUF) insulation is used over the roof slab to reduce heat transfer. Light-coloured terrazo tile finish reflects some of the solar radiation falling on the roof.
- Extruded Polystyrene (XPS) insulation is used in the cavity walls to reduce heat transfer.
- Double Glazed Unit in windows with low-e outer pane.
- A centralised high-efficiency water-cooled chiller was implemented for air conditioning the building instead of an air-cooled system. Given the water scarcity in Jaipur, treated waste water is used in this system.
- A 45-kWp grid-connected roof-top solar PV system with net metering. The estimated annual electricity generation is about 60,000 kWh.

Impact

- Base case EPI (pre-charrette): 77 kWh/m^2.year
- EPI estimated with the strategies during the charrette: 53 kWh/m^2.year
- EPI measured after 1 year of operation: 43 kWh/m^2.year
- 44% annual electricity savings
- 2% increase in the overall project cost

Smart GHAR III, Rajkot

Smart GHAR III (Green Homes at Affordable Rate), now known as Lakshman Township, is an affordable housing project in Rajkot under the Pradhan Mantri Awas Yojana (PMAY). The project was executed by the Rajkot Municipal Corporation (RMC). The charrette for this project was held in September 2016 and it was the 18th BEEP charrette. The project was completed in 2019.

Project details

- Built-up area: 57,408 m^2
- Number of floors: Stilt+7
- Number of dwelling units (DU): 1176 (all 1 BHK)
- Built-up area per DU: 33.6 m^2
- Carpet area per DU: 28 m^2
- 11 residential towers
- The project had already planned to use Autoclaved Aerated Concrete (AAC) blocks as the walling material

Charrette goals

- Provide acceptable comfort by reducing the duration of time when indoor temperatures are above 30 °C
- Reduce heat gains through the building envelope
- Utilise and improve potential of natural ventilation for better cooling

Recommended strategies

- Polyurethane Foam (PUF) insulation on the roof slab. However, this was not used.
- China-mosaic finish on the roof
- Taller, partially glazed and casement windows instead of fully glazed sliding windows
- Assisted ventilation shafts with low-energy fans on top of the existing common shafts. This feature would create negative pressure in the shaft (with / without ambient wind) improving air-change through the flats. This concept was tested in one of the shafts.

Impact

- Reduction of peak summer room temperature by >5 °C. A reduction from 39 °C to 33 °C was estimated in the simulations. Actual monitoring in May 2019 showed an average maximum temperature of 32 °C.
- Estimated increase in the number of hours below 30 °C from ~2600 hours to ~6300 hours.
- No increase in the overall project cost

Ela Green School, Chennai

Ela Green School is a private, co-ed independent school with students from play school to Class VIII, with plans to expand to Class XII. It has been conceived as a green school and aspires to help students imbibe the concepts of sustainable living. The charrette for this project was held in July 2017 and this was the 20th BEEP charrette.

Project details

- Built-up area: ~7900 m^2
- Number of floors: G+3
- Occupancy period: 8 am to 3 pm
- Types of spaces: One administrative block, and seven interconnected blocks with classrooms, labs, seminar rooms, halls, auditorium, etc.
- Operation: Day-use, mixed-mode
- Climate zone: Warm-humid
- The project had already planned to use pre-fab insulated wall panels, roof insulation, and double-glazed windows before the charrette.

Charrette goals

- Increase comfortable hours through passive strategies and ventilation, i.e., without the use of air-conditioning
- Improve the efficiency of the air-conditioning system
- Improve daylight in the classrooms

Recommended strategies

- Increased openable area of windows
- Increase roof insulation, decreasing the U-value of the roof from 0.74 W/m^2.K to 0.5 W/m^2.K
- Assisted ventilation shafts with turbo ventilators on top to improve ventilation potential. In air-conditioning mode, these shafts can serve the purpose of fresh air distribution ducts
- Use of enthalpy recovery wheel
- Increasing air-conditioning set-point to 28 °C, with the use of ceiling fans

Impact

- Number of comfortable hours during occupancy period doubled from the base case through passive measures and assisted ventilation (increased from 22% to 44%)
- 24% reduction in air-conditioning load
- 27% reduction in EPI, if the building is air-conditioned throughout the year

Jupiter Hospital, Pune

Jupiter Hospital in Pune is a 350-bed multi-specialty hospital in Pune. This BEEP charrette for this project was held in February 2014 and it was the 8th BEEP charrette. The project was completed in December 2016.

Project details

- Built-up area: 26,580 m^2 (excluding parking and service floor)
- Number of floors: G+8, 3 underground floors, and 1 service floor
- Types of spaces: Technical areas like MRI, ICUs, Cath lab, OTs; patient indoor rooms and recovery rooms; restaurants, emergency rooms, etc.

Charrette goals

- Propose energy efficiency measures to save energy and reduce pollution, while maintaining the footprint and general layout of the buildings as the architectural design was finalised
- Keep balance between initial capital cost and maintenance cost

Recommended strategies

- Use of 100-mm extruded polystyrene (XPS) insulation on the roof (0.31 $W/m^2.K$)
- Use of 150-mm Autoclaved Aertaed Concrete (AAC) blocks as the walling material. (0.9 $W/m^2.K$)
- Double-glazed units with U-value of 2.8 $W/m^2.K$
- Use of dynamic energy simulation software for chiller plant sizing instead of simplified calculation based on static design conditions. Installed chiller capacity is 560 TR (280 × 3 nos., 2 working + 1 standby).
- Enthalpy recovery wheel (75% effectiveness) for both latent and sensible heat recovery was integrated in the fresh air Air Handling Units AHUs.
- Condenser water is used for reheating the air in AHUs for maintaining the relative humidity. Back-up hot water is provided by a heat pump system with a COP of 2.81.
- Patient floors have the provision of free cooling.

Impact

- Base case EPI (pre-charrette): 154 $kWh/m^2.year$
- EPI estimated with the strategies during the charrette: 130 $kWh/m^2.year$ (excluding sewage treatment plant, outdoor lighting, and basement ventilation)
- EPI measured after 1 year of operation: 136 $kWh/m^2.year$ (all inclusive)
- 12% annual electricity savings

Annex 2: The Team

Swiss PMTU

Pierre Jaboyedoff

Partner in Effin'Art Sarl

Association with BEEP: Since Inception (2008)

Pierre has over 35 years of experience and has been involved in BEEP's conceptualisation, overall planning and management. He is also actively involved in simulation and performance monitoring, CFD Tool, innovative technological solution and supporting the IEA trainings on buildings.

Education: EPF-Lausanne, Masters - Mechanical Engineering

Dario Aiulfi

Partner in Effin'Art Sarl

Association with BEEP: Since Inception (2008)

Dario carries over 25 years of experience in Fluid dynamics; HVAC, building dynamic energy simulation for low-energy and high-performance buildings. He has been involved as a technical expert in IDP Charrettes and analysis of building design.

Education: EPF-Lausanne, Masters in Mechanical Engineering / ETH-Zurich PHD in Energy Systems, CFD and Combustion Models

Chinar Sharma

Assistant Project Manager in Effin'Art Sarl

Association with BEEP: Since 2018

Chinar has experience largely in corporate strategy, business planning, and project management. She is involved in EMSYS market survey and development and project management.

Education: Electronics and Communication Engineering - Rajasthan Technical University and MBA - Indian Institute of Management, Lucknow

Kira Cusack

Partner in Effin'Art Sarl

Association with BEEP: 2011 to 2014

Kira was involved in the overall project management activities and was was instrumental in the preparation of the Karnataka guidelines.

Education: B.Sc. (Political Science) - School of Oriental and African Studies, University of London, and Masters in Sustainable Buildings - Arts et Métiers Paristech, Paris.

Dominique Chuard

Partner in Effin'Art Sarl

Association with BEEP: 2008 to 2014

Dominique has over 30 years of experience in the field of energy efficiency in buildings. He is also a federal expert in building physics for new and existing buildings, particularly historical monuments. He was involved in passive design analysis in IDP charrettes.

Education: ETH-Zurich, Masters in Architecture

Indian PMTU

Sameer Maithel

Founder and Director, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since Inception (2008)

Sameer has over 30 years of experience in industry (ONGC), research, and consulting (TERI). He has been involved in BEEP's conceptualisation, overall planning and management of the project and BEEP network.

Education: BE (Mechanical) - NIT, Jaipur; M.Tech and Ph.D. (Energy Systems) - IIT, Bombay

Prashant Bhanware

Principal Consultant, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since Inception (2008)

Prashant specializes in Building energy simulation, Energy monitoring and Renewable energy systems and has been instrumental in the development of Eco-Niwas Samhita, Building energy simulations for Charrettes, activities in Rajasthan, Performance monitoring activities and Project Management.

Education: B.Tech (Mechanical) - NIT, Raipur and M.Tech. (Energy Systems) - IIT, Bombay

Saswati Chetia

Senior Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since 2012

Saswati specialises in climate-responsive building design and has been involved in the BEEP Student Camp and Educator Network, IPD Charrettes, Activities in Gujarat and Project Management.

Education: B.Arch - NIT, Bhopal and M.Plan - SPA, Delhi.

Vernica Prakash

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since 2014

Vernica specializes in climate-responsive building design and web-based outreach. She was stationed as BEEP's representative to BEE and was involved in BEEP's Media Engagement Programme, web outreach activities, External Movable Shading market development, Project Management, Coordination and Reporting to BEE.

Education: B.Arch - U.P. Technical University, Lucknow and MA (Public Policy and Sustainable Development) - TERI University, New Delhi.

Vasudha Sunger

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since 2018

Vasudha specialises in Building energy simulation, Energy efficient building design, and Daylighting analysis and is involved in RETV calculation and daylight analysis in buildings, BEEP Student Camp, and BEEP Youth Forum.

Education: B.Arch - KR Mangalam SAP, New Delhi and M.Tech (Building Energy Performance) - CEPT University, Ahmedabad.

Mohit Jain

Consultant, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: Since 2019

Mohit specialises in Computational Fluid Dynamics, Energy analysis of systems and Technical training. He is involved in BEEP's Simulation and Performance monitoring activities.

Education: BE (Mechanical) – MITM, Indore and M.Tech (Material Manufacturing Modelling) – IIT Bombay, Mumbai.

Kanagraj Ganesan

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: 2009 to 2015

Kanagaraj was closely involved in the development of residential building guidelines and survey of residential buildings, as well as the BEEP website development and project management activities.

Education: B.Arch - T.V.B School of Habitat Studies, MS (Building Energy Efficiency) - IIT Madras.

Pallav Singh

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: 2012 to 2015

Pallav was instrumental in carrying out the National Design Competition on External Moveable Shading Systems.

Education: B.Tech (Mechanical) from IIT, Bombay.

Bharat Reddy Tripuram

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: 2015 to 2017

Bharat was involved in building energy simulation for IDP charrettes and activities in Andhra Pradesh.

Education: B.Tech (Mechanical) - Nalla Malla Reddy Engineering College, Hyderabad and M.E. in Energy Engineering from Anna University, Guindy, Chennai.

Anandh S Krishna

Programme Officer, Greentech Knowledge Solutions Pvt. Ltd

Association with BEEP: 2019 to 2021

Anandh specialises in Green building certification and sustainability disclosures. He has been involved in the implementation of ENS in Andhra Pradesh, BEEP Youth Forum, building industry network and web outreach.

Education: B.Tech (Mechanical) - CUSAT, Kochi and MBA (Energy and Environment) - Symbiosis International University, Pune

Education: Ph.D. in Physics: Air Pollution, Indian Institute of Technology

Saurabh Diddi

Director, Bureau of Energy Efficiency

Association with BEEP: Since 2015

Saurabh is currently overlooking the Building's Programme at BEE and in-charge of BEEP. He has previously been managing BEE's standards and labelling programme.

Education: B.Tech (Mechanical) – Punjab Technical University, MBA (Finance) – FMS, University of Delhi

Sanjay Seth

Director, Bureau of Energy Efficiency

Association with BEEP: 2008 to 2015

Sanjay has over 25 years of experience and was in charge of the Buildings Programme at BEE. He was instrumental in the formalisation of BEEP.

Education: B.E. – Civil Engineering, BMS College of Engineering

Government Partners

Anand Shukla

Senior Thematic Advisor, Swiss Agency for Development and Cooperation

Association with BEEP: Since 2014

Anand has a Ph.D. and over 25 years of experience. He overlooks climate change mitigation projects on energy efficiency, renewable energy and clean air and is in-charge of BEEP at SDC.

Veena Joshi

Senior Thematic Advisor, Swiss Agency for Development and Cooperation

Association with BEEP: 2008 to 2014

Veena worked with SDC for over 30 years on energy related projects and was instrumental in conceptualising BEEP.

Swiss Partners

Heinrich Gugerli

Former Head, Department of Sustainable Buildings, City of Zurich

Association with BEEP: Since 2011

Heinrich is a structural engineer and a researcher in energy efficiency, ecology in building design, and facility management. He coordinated the task on municipal buildings of the City Council's goal 'Sustainable City of Zurich'. He is a member of the JAC and is involved in BEEP's work in the Indian States.

Stefan Kessler

Associate Partner at Infras

Association with BEEP: Since 2018

Stefan has extensive experience in climate protection, energy technology, energy concepts and energy policy programmes, impact analyses, implementation issues,

development cooperation and technology transfer. He has been involved in ENS implementation in the partner states.

Jean Decaix

Senior Researcher at HES-SO

Association with BEEP: Since 2019

Jean has a Ph.D. in fluid mechanics and has been instrumental in the development of the CFD tool.

François Garde

Professor, Laboratory of Physics and Mathematical Engineering for Energy and the Environment (PIMENT)

Association with BEEP: Since 2018

François is a world recognized specialist in thermal comfort in tropical climate, NZEB and green buildings. He has been involved as a key faculty of the BEEP Student Camp.

Ulrike Passe

Director - ISU Centre for Building Energy Research

Association with BEEP: 2018

Ulrike has been the Past-President of the Society for Building Science Educators and was involved as faculty with the first BEEP Student Camp.

Thomas Jusselme

Professor at HES-SO

Association with BEEP: 2018

Thomas works on data-driven methods for low-carbon building design and was involved as a faculty in the first BEEP Student Camp.

Andreas Binkert

Architect & Partner in Nüesch Development AG

Association with BEEP: 2011 to 2016

Andreas is an architect and has over 30 years of architectural and teaching experience in Switzerland, USA, and Canada. He has been involved as a technical expert in IDP Charrettes.

Armin Binz

Senior Consultant, Minergie

Association with BEEP: 2011 to 2013

Armin is an architect and runs a consulting firm for applied building physics. He has been involved as a technical expert in the IDP Charrettes.

Claude Alain Roulet

Professor Emeritus, Institute of Technology of Lausanne, EPFL

Association with BEEP: 2014 to 2017

Claude Alain is a building physicist with over 50 years of experience in materials and energy. He is a researcher and professor at the Institute of Technology in Lausanne and has been instrumental in carrying out the star robin testing and training programmes for building insulation laboratories.

Christoph Ospelt

Director, EnergyKonzepte SA

Association with BEEP: 2011 to 2013

Christoph specializes in the sustainability of built environments, energy efficiency, and renewable energy. He has been involved as a technical expert in IDP Charrettes.

Pierre Hollmuller

Senior Researcher, University of Geneva, Energy Group

Association with BEEP: 2011 to 2013

Pierre is a senior research scientist at the Energy Group, Institute of Environmental Science, University of Geneva. His research has focused on the design and implementation of earth air tunnels for heating and cooling purposes. He has been involved with BEEP in carrying out training programmes on Earth Air Tunnels.

Willi Frei

Partner, Bauart

Willi has over 40 years of experience in architectural practice in Switzerland and internationally. He has been involved as an architectural expert in IDP charrettes.

Indian Partners

Ashok B. Lall

Ashok B Lall Architects

Association with BEEP: Since 2013

Ashok has been a key technical partner supporting multiple activities under BEEP such as IDP Charrettes, development of Eco-Niwas Samhita, BEEP Student Camp, EMSYS design competition and studies, etc. He is also a member of the JAC.

Centre for Media Studies

Association with BEEP: Since 2019

CMS is the key implementation partner for BEEP's Media Engagement Programme on Energy Efficient Buildings.

Centre for Advanced Research in Building Science & Energy, CEPT University

Association with BEEP: 2015, 2018 to 2019

CARBSE has been the institutional partner for the BEEP Student Camps 2018 and 2019. It was also the lead academic partner institution and partner insulation lab for the testing of EMSYS prototypes for EMSYS design competition.

Conserve Consultants Private Limited (CCPL)

Association with BEEP: 2013- to 2014, 2018 to Present

CCPL is involved with BEEP as a regional partner in Chennai and Bengaluru.

Smita Chandiwala

Energe-se Research and Consulting

Association with BEEP: Since 2019

Smita is involved with BEEP in the development and implementation of the Eco-Niwas Samhita implementation strategy in selected states.

Environmental Design Solutions Pvt. Ltd

Association with BEEP: Since 2019

Environmental Design Solutions Pvt. Ltd is involved with BEEP in development and implementation of the BEE - ECBC National Awards for Energy-Efficient Building Design.

Ram Bhat

Options & Solutions, Bengaluru

Association with BEEP: Since 2014

Ram has been involved with BEEP for the development and execution of the e soft skills sessions for the BEEP Student Camp and was the moderator for the charrette conductors training programmes.

Deependra Prashad Architects & Planners (DPAP)

Association with BEEP: 2016

Deependra was involved with BEEP as a technical expert for IDP Charrettes

Energetic Consultants

Association with BEEP: 2015 to 2019

Energetic Consultants assisted BEEP activities in Mumbai and Pune regions as regional partner. It was also involved in the energy performance and thermal performance monitoring and assessment of Aranya Bhawan, Jaipur.

Integrative Design Solutions Pvt. Ltd. (IDSPL)

Association with BEEP: 2016

IDSPL contributed in the development of baseline standards for energy performance of residential buildings in the cold climatic zone.

Global Evolutionary Energy Design (GEED)

Association with BEEP: 2017 to 2019

GEED contributed to the development of cost assessment tool for building energy efficiency measures and the development of compliance tool for Eco-Niwas Samhita.

Kanwarjit Nagi

Association with BEEP: 2015

Kanwarjit developed case studies demonstrating best practices for energy efficiency in residential building of India for the Design Guidelines for Energy Efficient Multi-Storey Residential Buildings.

M.C Modgil

Sterling India

Association with BEEP: 2013 to 2016

M C Modgil was involved as a technical expert in IDP charrettes.

Meenal Sutaria

Green Angle

Association with BEEP: 2015

Meenal was a trainer for Charrette Conductors' Trainings and an expert for charrettes.

Platypus Design Pvt Ltd

Association with BEEP: 2015

Platypus Design was a jury member for the design competition of External Moveable Shading System design.

P G Ganapathy

Association with BEEP: 2015

Ganapathy was a jury member for the National Design Competition on External Moveable Shading System design.

Praveen Nahar

National Institute of Design, Ahmedabad

Association with BEEP: 2014 to 2015

Praveen Nahar was a jury member for the National Design Competition on External Moveable Shading System design.

Lawyers Transcontinental

Association with BEEP: 2014 to 2015

Lawyers Transcontinental drafted the non-disclosure agreement and design competition rules for design competition for external moveable shading system.

Ram Krishna Sharma

Association with BEEP: 2018

Ram supported BEEP in initiating the development of the BEEP builder network.

Ravi K Kapoor

Association with BEEP: 2014 to 2017

Ravi was involved in BEEP for carrying out the trainings on building insulation material for partner laboratories and was also instrumental in developing a draft label for building insulation.

Shailesh Modi

Fourth Vision

Association with BEEP: 2013 to 2014

Shailesh was a key member in carrying out the Minergie market study.

Shruthi Narayan

Association with BEEP: 2013 to 2014

Shruthi was involved in BEEP for developing the public building template design in states.

Academic and Development Communications Services (ADCS)

Association with BEEP: Since 2013

ADCS is instrumental in editing and preparing most of the BEEP publications.

Ebizon NetInfo Pvt. Ltd

Noida

Association with BEEP: Since 2013

Ebizon oversees the design, development, and maintenance of BEEP official website.

Genesis Media Pvt. Ltd

Association with BEEP: Since 2013

Genesis Media has been involved with BEEP in creating videos and short films for BEEP

Remya Sasindran

Association with BEEP: Since 2018

Remya has been involved with BEEP in developing and implementing the communication strategy.

The Banyan Tree

Association with BEEP: Since 2013

The Banyan Tree has been one of the key partners involved in designing outreach material for BEEP to be disseminated and presented at various platforms and events.

Innobella Marketing & Entertainment Solutions Pvt. Ltd

Association with BEEP: 2016

Innobella helped plan and organise the BEEP International Conference on Energy Efficient Building Design.

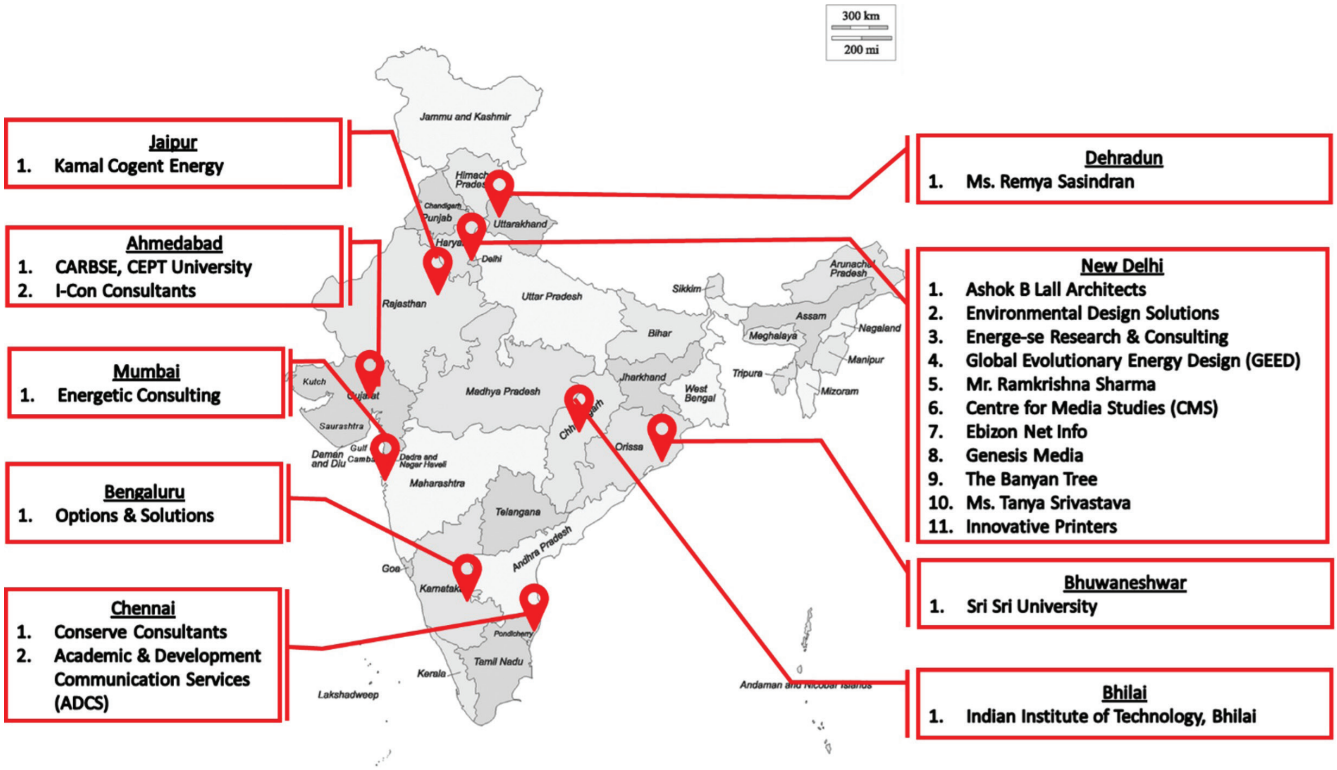


Figure 34: Geographical spread of BEEP partners in India


BEEP
BUILDING ENERGY
EFFICIENCY PROJECT