

Building Sector Case Study

High energy performance in an office building in Rajasthan:

The Aranya Bhavan Project



The challenge

The building sector accounts for almost 40% of global greenhouse gas emissions. India with its booming economy and high population growth has a strong need for construction of office space. Official projections indicate that energy consumption in the commercial and institutional building sector may exceed the 2012 level by as much as 13 times by 2047. This growth contributes to climate change. The air conditioning and lighting typically installed in large office buildings are intensive electricity users. In India, production of 1kWh of electricity results in nearly 1kg of CO₂ emissions. This 1:1 ratio is almost six times greater than the ratio of production to emissions in Switzerland.

With the Aranya Bhavan project in Jaipur, the Rajasthan Forest Department aimed for a new day-use head office building that has a substantially smaller climate footprint than standard projects, that is fully compliant with the new Energy Conservation Building Code and that achieves the highest performance class (5 Stars) in the labelling scheme of the Indian Bureau of Energy Efficiency. With a total built-up area of 10,000 square metres, Aranya Bhavan comprises high quality work places for over 340 users, an auditorium, an exhibition area, a library and guest rooms.

Optimised design for energy-efficient and climate-friendly solutions

The Indo-Swiss Building Energy Efficiency Project (BEEP), supported by the Swiss Agency for Development and Cooperation, provided technical assistance to the developers during the conceptualisation and design phase. The process included a three-day integrated design workshop organised early in the design phase of the project. Workshop participants came up with the following optimisation strategies:

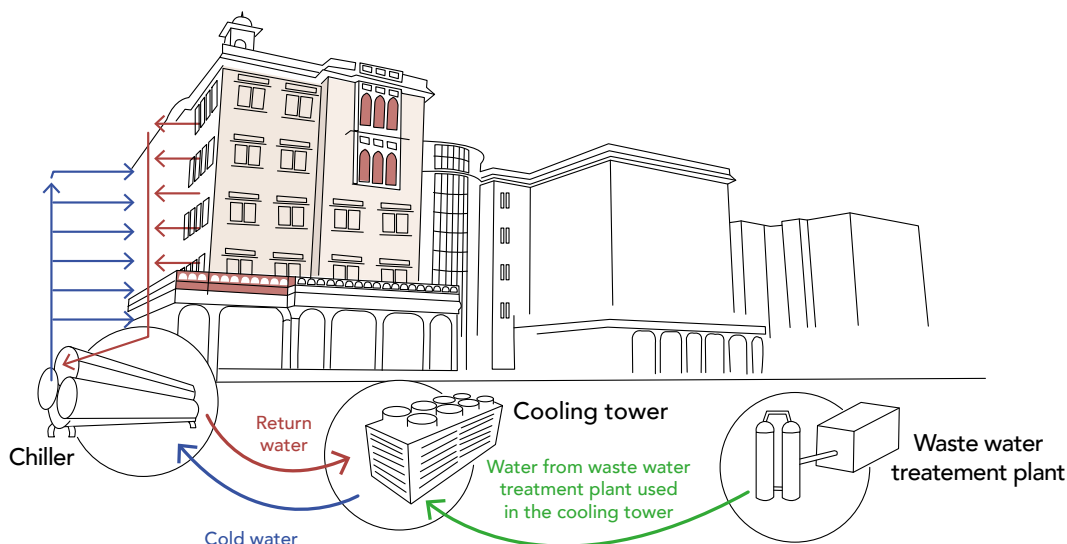
- Insulated high reflectivity roof with polyurethane foam insulation and light-coloured terrazzo tiles to reduce heat gain
- Cavity walls with extruded polystyrene insulation in the cavity to reduce heat transfer
- Double pane windows with low emissivity coating on the outer pane to reduce cooling load
- Centralised high-efficiency water-cooled chiller for air conditioning of the building (using treated waste water in light of chronic water scarcity in Jaipur)
- Grid-connected rooftop photovoltaic system with 45 kWh capacity and net metering.



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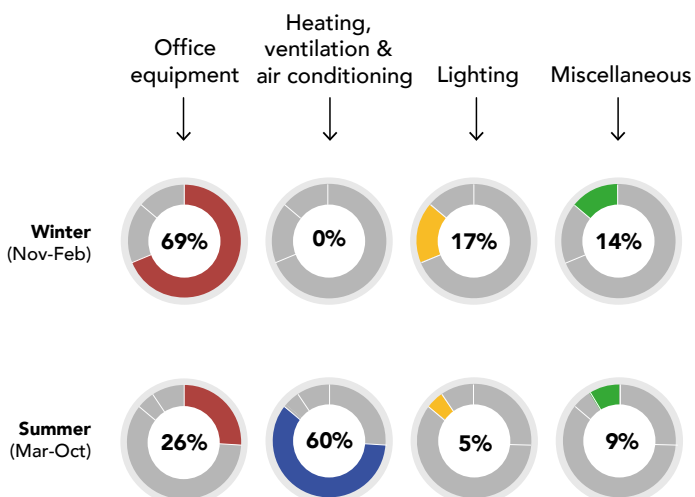
Schematic drawing of high-efficiency water-cooled chiller AC system.



Energy performance and climate impact

The computational modelling of the initial design as proposed by the developer resulted in an energy performance index (EPI) of 77 kWh of electricity per square metre of built-up area per year. This was already well below the 90 kWh per square metre limit for 5-Star buildings under the Indian scheme. In a joint optimisation process with support from the BEEP team, the energy performance was again dramatically improved, achieving a modelled EPI of 53 kWh per square metre (excluding solar photovoltaic production). Long-term monitoring of actual building performance demonstrated an even lower value of 43 kWh per square metre, which is about 45% lower than the estimated EPI of the initial design.

Breakdown of energy consumption in winter and summer periods as taken from monitoring.



Lessons for other projects

Focused design strategies using widely available technologies enabled the project to exceed the performance levels of the best available building standards in the Indian and international markets, and to reduce electricity consumption and climate impact by almost 45% compared to conventional design in India. The insulated building envelope with a small window to wall ratio in combination with other simple measures allowed for a reduction of the cooling plant capacity by about 28% compared to the baseline design. The extra costs attributable to the high-performance design resulted in overall construction costs that were 2% higher than they would have been otherwise (not including the photovoltaic system). The building users benefit from better thermal comfort and improved daylight. Using water that comes partly from waste water treatment for the cooling towers allows the use of high-efficiency water-cooled chillers even in water-scarce areas.

Main partners in the Building Energy Efficiency project

- Bureau of Energy Efficiency, Ministry of Power, Government of India
- Swiss Agency for Development and Cooperation on behalf of the Swiss Government
- Effin'Art Sarl, Lausanne
- Greentech Knowledge Solutions Pvt. Ltd., New Delhi
- Rajasthan State Road Development & Construction Corporation Ltd.
- Forest Department Head Office, Jaipur, Rajasthan