BEEP
BUILDING ENERGY EFFICIENCY PROJECT

Indo-Swiss Building Energy Efficiency Project

Case Study: Aranya Bhawan, Jaipur

Ministry of POWER
GOVERNMENT OF INDIA

ENERGY IS LIFE
BEE
CONSERVE IT

Schweizerische Eidgenossenschaft
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Swiss Agency for Development and Cooperation SDC

OVERVIEW

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 23rd March, 2015.

PROJECT DETAILS:

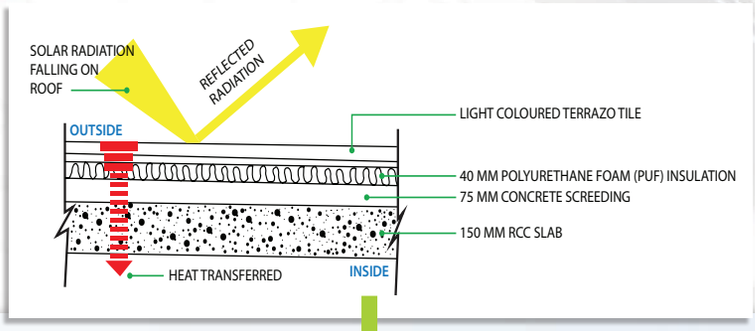
- Built-up area: ~10,000m^2 (excluding basement parking and service area)
- Number of floors: Five (G+4) + one basement level for parking and services
- Number of users: 344
- Types of spaces: Offices, museum, library, auditorium, guest rooms

During the charrette, energy performance of Aranya Bhawan was simulated, using energy simulation tool Design Builder/Energy Plus.

	BEFORE CHARRETTE (SIMULATED)	AFTER CHARRETTE (SIMULATED)	ACTUAL MONITORED PERFORMANCE
Energy Performance Index (EPI)	77 kWh/m^2.year	53 kWh/m^2.year	**43 kWh/m^2.year**
Cost of construction (not including the solar PV system)	Rs. 30 crores	Rs. 30.6 crores	
ANNUAL ELECTRICITY SAVINGS: 3,40,000 kWh PER YEAR **PAYBACK PERIOD: 2.5-3 YEARS**			
44% energy savings **2%** cost increase			

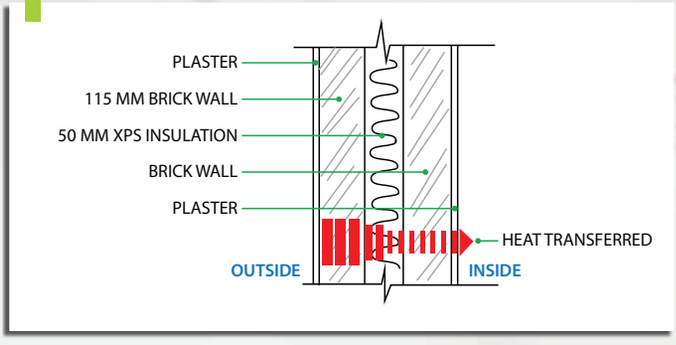
Aranya Bhawan qualifies for 5-star rating under the Bureau of Energy Efficiency (BEE) star rating programme for office buildings.

BUILDING ENVELOPE



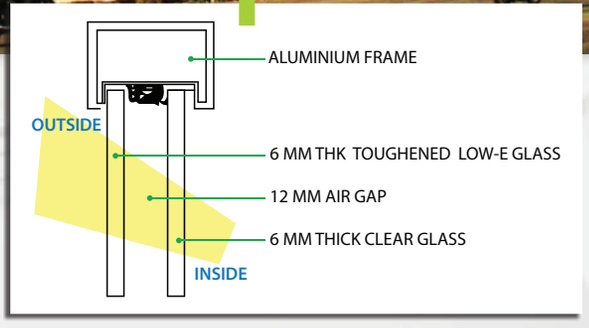
Roof: Insulation + Reflective finish

In Aranya Bhawan, 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.



Wall: Insulation

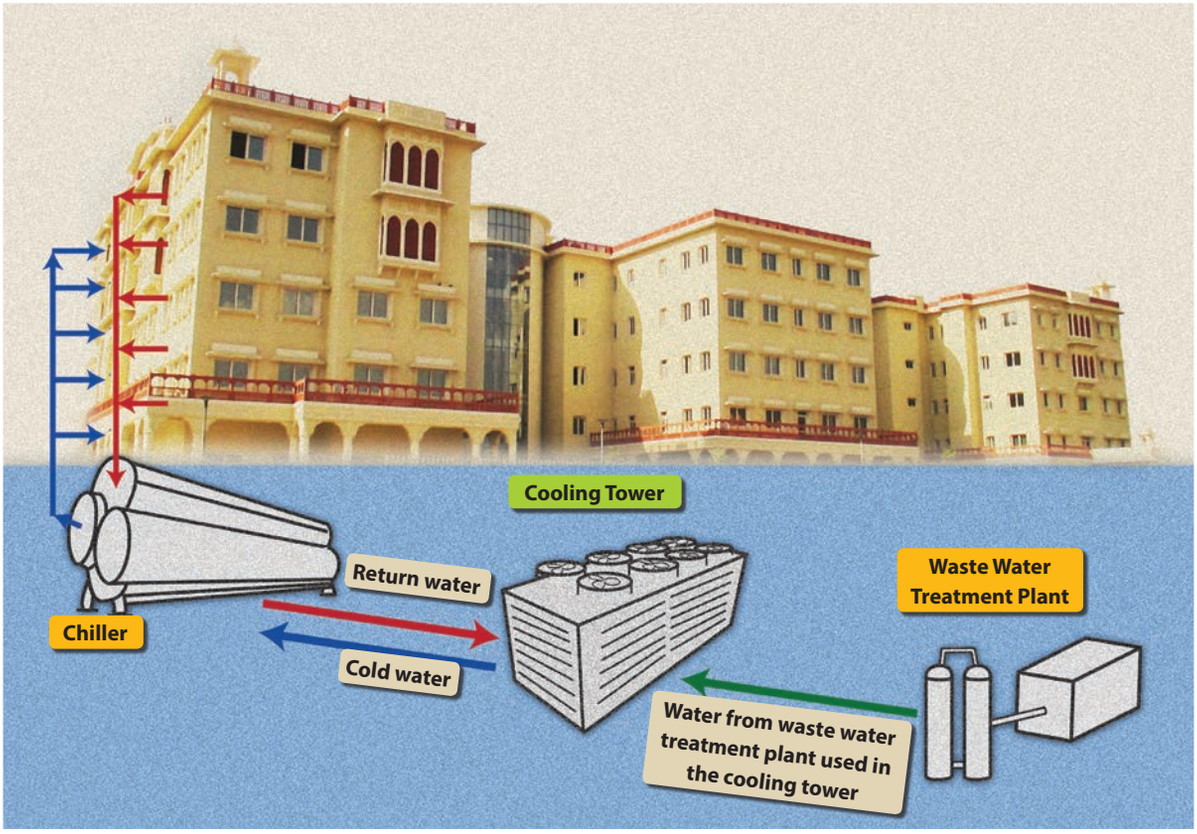
In Aranya Bhawan, Extruded Polystyrene (XPS) insulation is used in the cavity walls to reduce heat transfer.



Window: Double Glazed Unit (DGU)

The windows of Aranya Bhawan use two panes of glass with an air gap in between. This air gap acts as insulation. The low-e outer pane also reflects heat back to the outside.

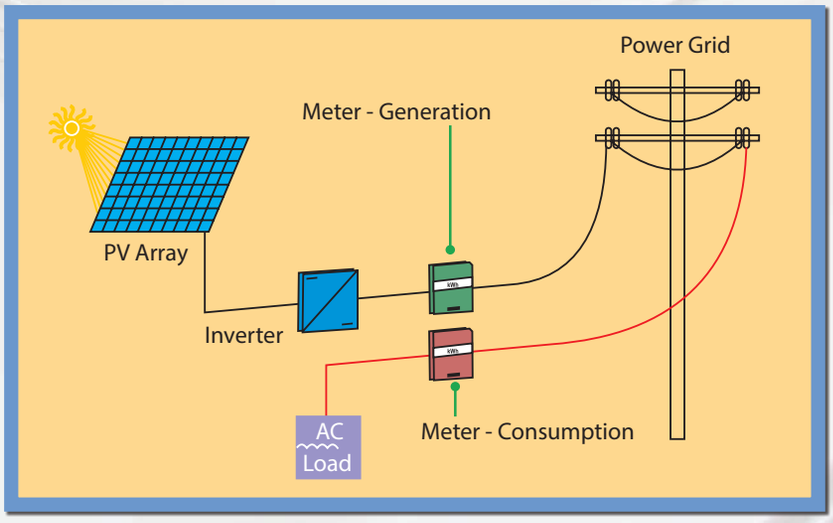
COOLING SYSTEM



- A centralised high-efficiency water-cooled chiller was implemented for air-conditioning the building. It uses lesser energy compared to an air-cooled system.
- Given the water scarcity in Jaipur, treated waste water is used in this system.

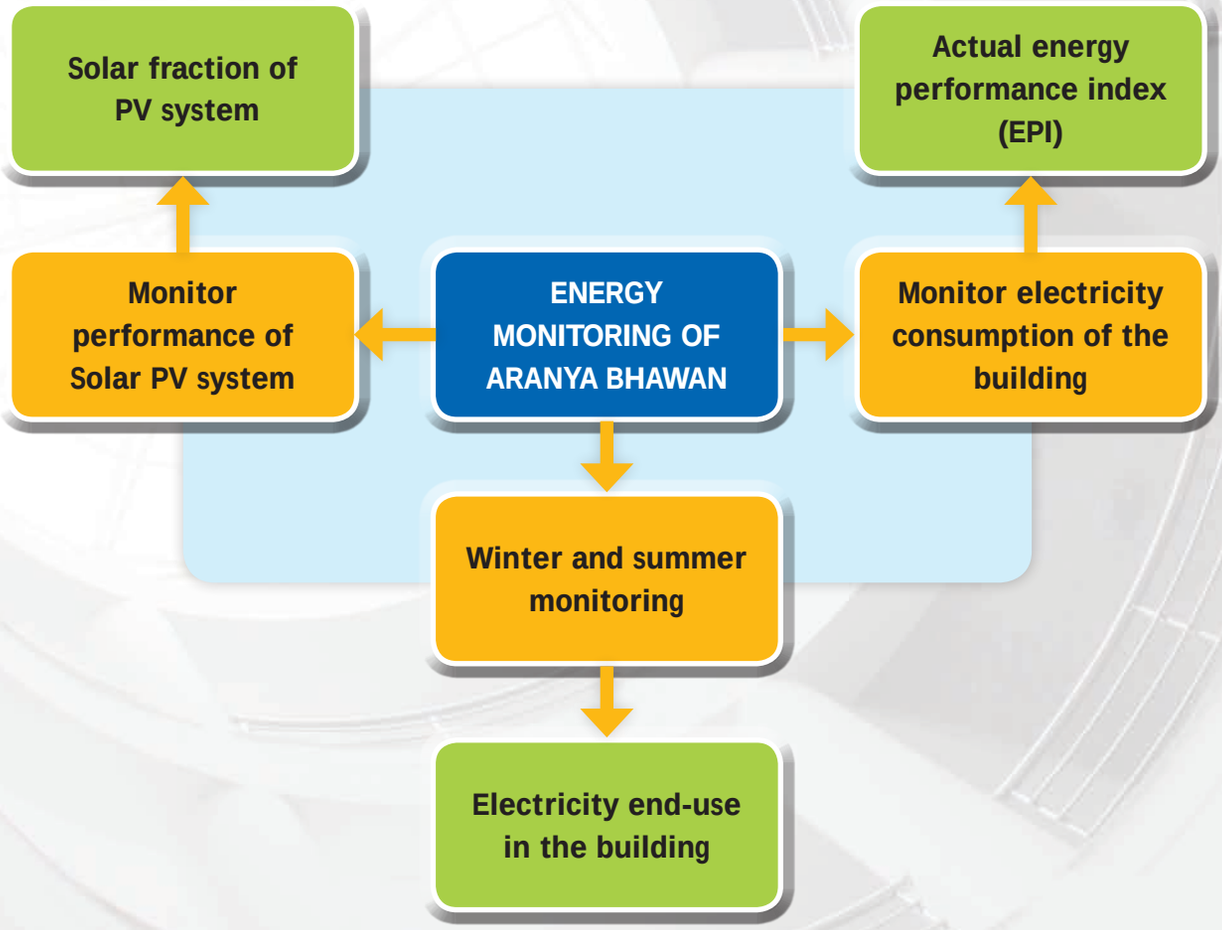
SOLAR PHOTOVOLTAIC (SPV) SYSTEM

Aranya Bhawan has installed a grid-connected roof-top solar PV system with net metering. The system size is 45kWp with an estimated annual electricity generation of around 60,000 kWh. An additional 100 kWp system will be installed on the grounds of the building.



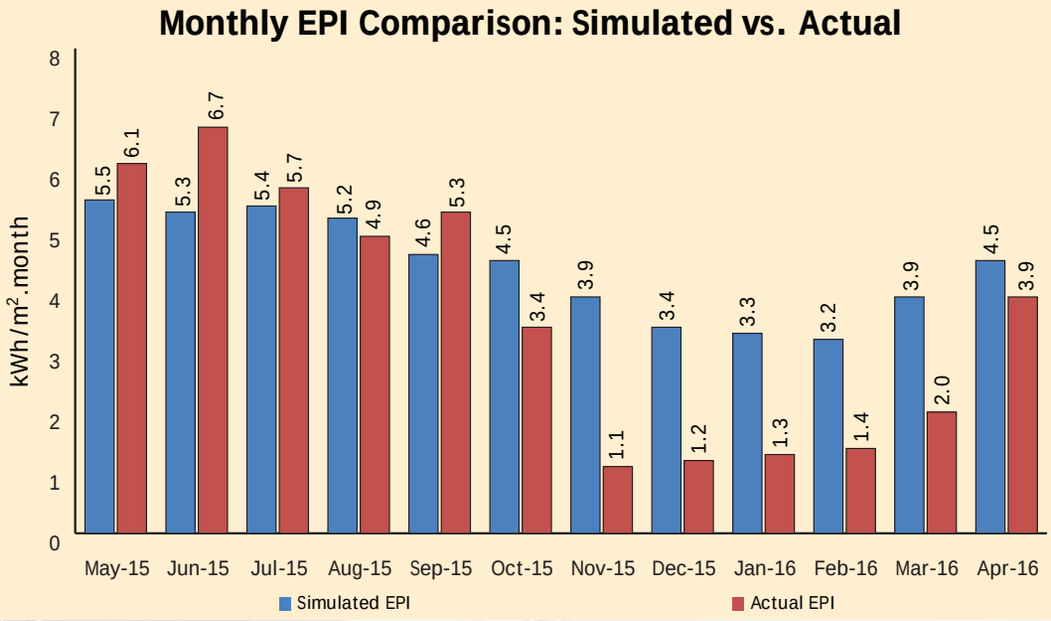
POST-OCCUPANCY ENERGY MONITORING

The actual energy and thermal performance monitoring of Aranya Bhawan was carried out by Energetic Consulting Pvt. Ltd. (ECPL). This was primarily done in 2 stages: winter monitoring was done from 11th January to 25th January, 2016 and summer monitoring was done from 5th May to 19th May, 2016.

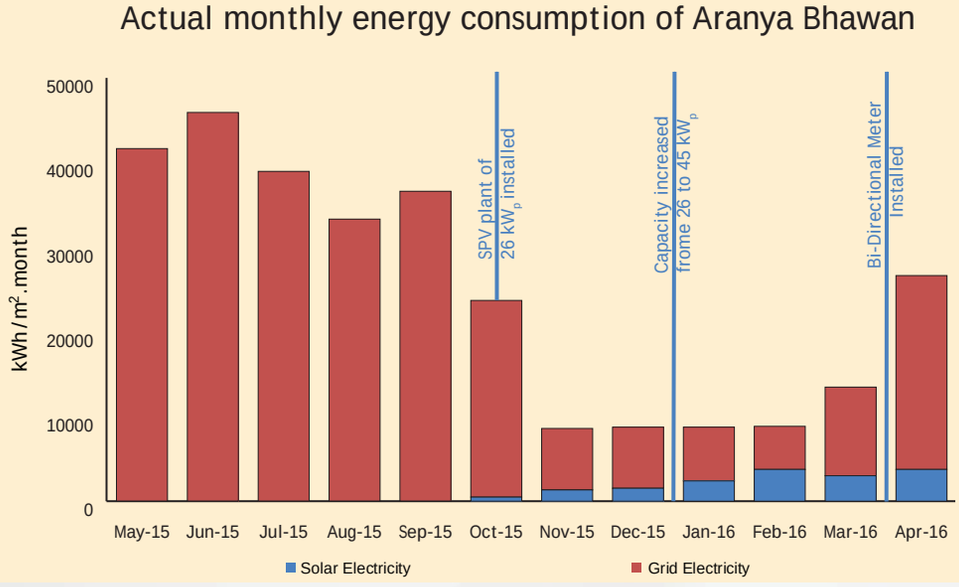


COMPARISON OF ENERGY PERFORMANCE INDEX (EPI): Simulated vs. Actual

The simulated EPI during the charrette was 53 kWh/m^2.yr as compared to the actual EPI of 43 kWh/m^2.yr. The difference is in the winter (Nov-Mar) months when the HVAC system remains off. In the simulation done during the charrette, it was considered operational. The artificial lighting energy consumed in winter was also less than that estimated in the charrette due to better use of daylight.



ENERGY GENERATED AND USED FROM THE SOLAR PV SYSTEM

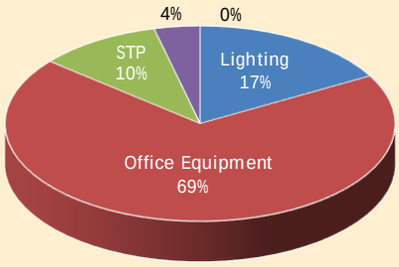


The solar photovoltaic system was commissioned in the month of October 2015. Thus, till the end of the monitoring period (April 2016), the solar fraction was 5% of the total electricity consumed in the building. It is expected that the annual solar fraction for Jan-Dec 2016 would be nearly 20%.

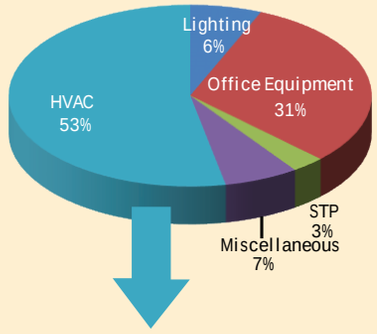
ELECTRICITY END-USE IN ARANYA BHAWAN

In the summer months (Mar-Oct) 60% of the electricity is consumed by HVAC. Annually, this accounts for 53% of the electricity consumed. Office equipment consumes 30% of the annual electricity with artificial lighting consuming 6%.

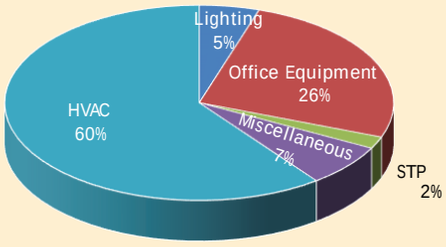
Winter (Nov Feb)
Miscellaneous HVAC



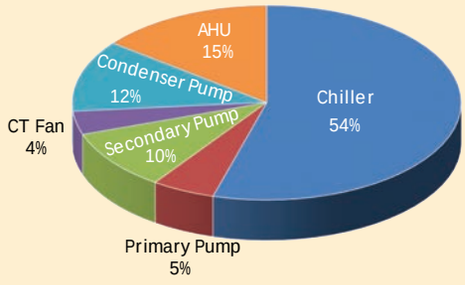
Annual Energy Consumption Scenario



Summer (Mar-Oct)



Break-up of HVAC energy consumption



Of the electricity consumed in HVAC, the chillers consume 54%, pumps consume 27% and the AHU and cooling tower fans consume 19%.

The study also showed that of the 2 operational chillers, one was operating at a better COP (7.5) than the other (5.5). This could be attributed to fouled tubes of the under-performing chiller.

RECOMMENDATIONS OF THE ENERGY MONITORING STUDY

- Reduction of contract demand from 500 kVA to 400 kVA as the recorded demand did not exceed 300 kVA.
- Improve condenser approach for under-performing chiller by cleaning the condenser tubes and maintaining water quality.
- Improve cooling tower efficiency.
- Replace condenser water pumps & primary chilled water pump with revised capacity (pressure & flow).

Indo-Swiss Building Energy Efficiency Project (BEEP)

The Indo-Swiss Building Energy Efficiency Project (BEEP) is a bilateral cooperation project 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) is the implementing agency on behalf of the MoP while the Swiss Agency for Development and Cooperation (SDC) is the agency in charge on behalf of the FDFA.

The overall objective of the project is to reduce energy consumption in new commercial buildings and to disseminate best practices for the construction of low energy residential and public buildings.

The project contributes to strengthening and broadening the Bureau of Energy Efficiency's (BEE) building energy conservation programme. It has the following components:

- **Component 1:** Design workshops (charrettes) with public / private builders
- **Component 2:** Technical assistance in developing building material testing infrastructure
- **Component 3:** Developing design guidelines and tools for the design of energy-efficient residential buildings
- **Component 4:** Production and dissemination of knowledge products

Builders, developers and other interested agencies can apply for charrettes on: http://www.beepindia.org/content/apply-integrated-design-charrette

PMTU India
Greentech Knowledge Solutions Pvt. Ltd.
Regd. office: 342, Abhiyan Apartments,
Plot 15, Sector 12, Dwarka, New Delhi -110078.
Telefax: +91 11 45535574
E Mail: sameer@gskpl.in
(Dr. Sameer Maithel, Head – PMTU India)

PMTU Switzerland
Effin'Art Sàrl
The Art of Energy Efficiency
Rue du Petit-Chene 38, CH-1003 Lausanne
Tel: +41 21 616 11 00
E-mail: pierre.jaboyedoff@effinart.ch
(Pierre Jaboyedoff, Head – PMTU Switzerland)