



Case study of an ECBC Compliant, Energy Efficient Building: Aranya Bhawan, Jaipur

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Indo-Swiss Building Energy Efficiency Project (BEEP)

2nd REGIONAL WORKSHOP ON ECBC IMPLEMENTATION IN STATES

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Outline of the Presentation



- About Indo-Swiss Building Energy Efficiency Project (BEEP)
 - Overview of BEEP charrettes
- Case study: Aranya Bhawan, Jaipur
- Learnings

Indo-Swiss Building Energy Efficiency Project (BEEP)



Phase I: 2012-2016

Phase II: 2017-2021

To assist Government of India in mainstreaming thermally comfortable and energy efficient building design in India



Indo-Swiss Building Energy Efficiency Project (BEEP)



Building Design

Design support to large building projects

**Building
Technology**

Energy Efficient Building Envelope

**Building
Policy**

Design Guidelines for Residential & Public Buildings

**Training &
Information**

Trainings, Seminars , Web , ...

Energy Efficient Building Design



- Technical support to 18 building projects (IT buildings, hospital, offices, residential complexes, academic institutions,..)
- >1.4 million m² built-up area
- 25-40% estimated energy savings

Residential township



World Trade Centre

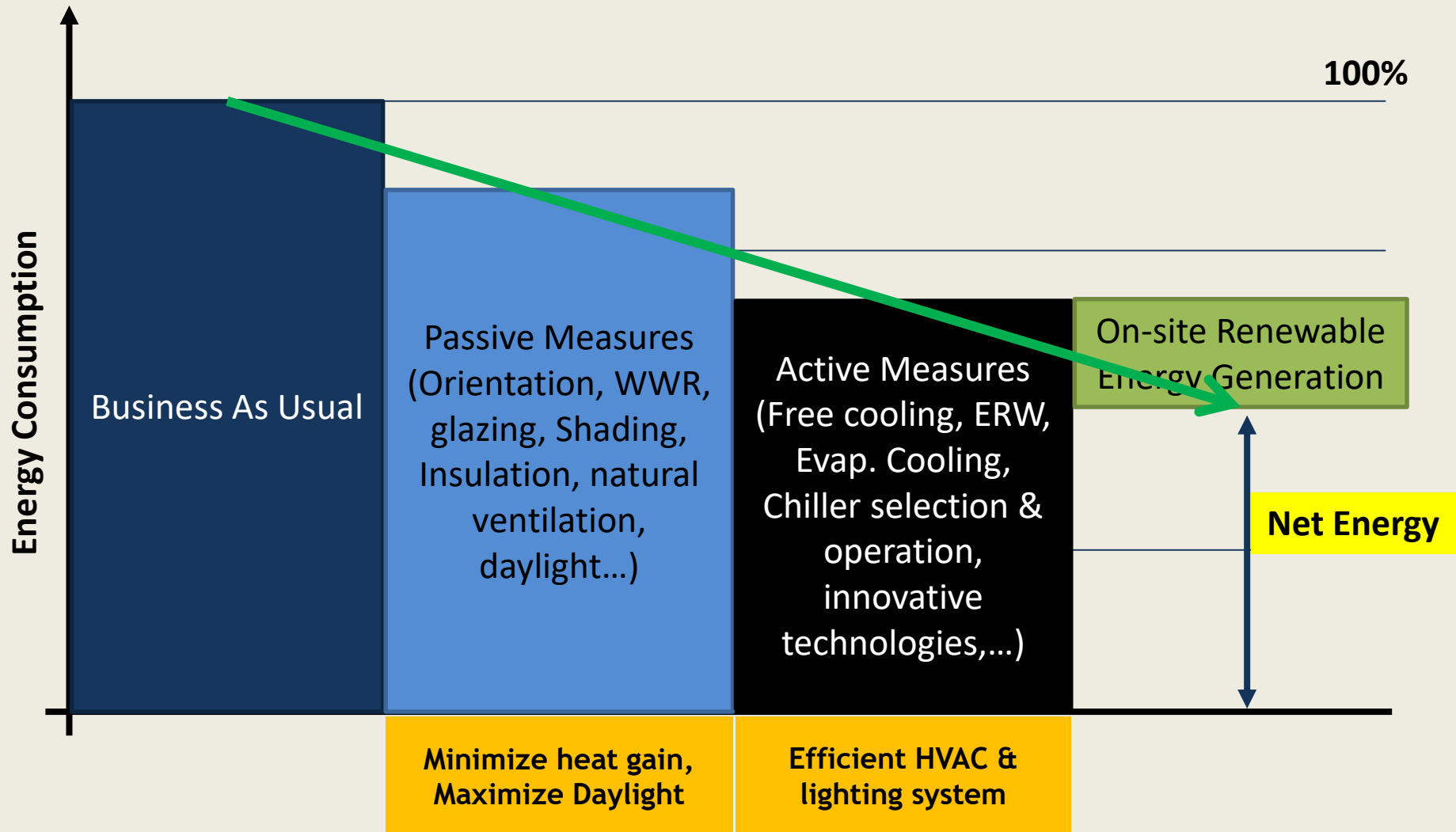


Office & Retail complex



Training institute & govt. office

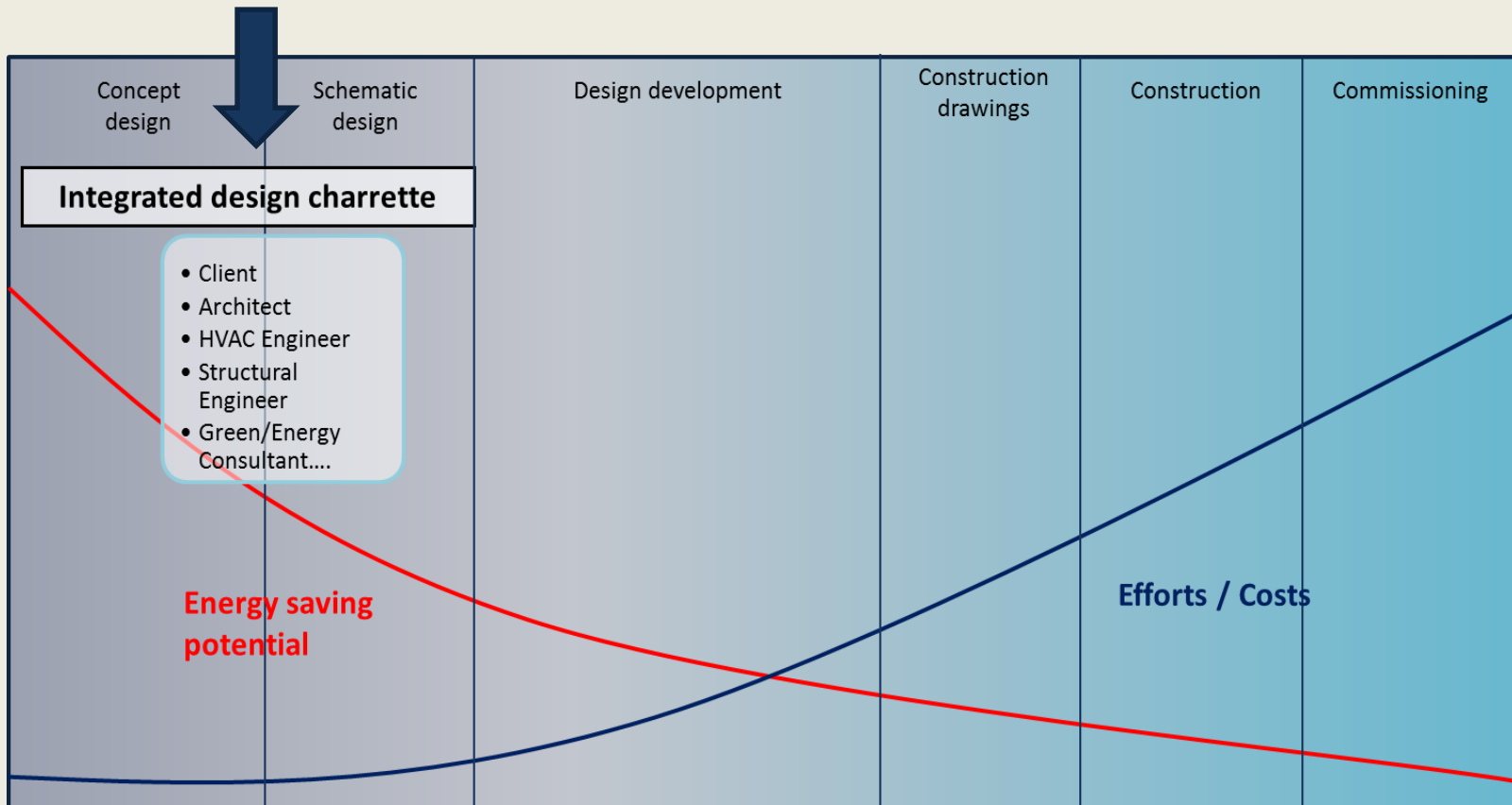
Integrated Design Charrette Approach for ECBC Compliance



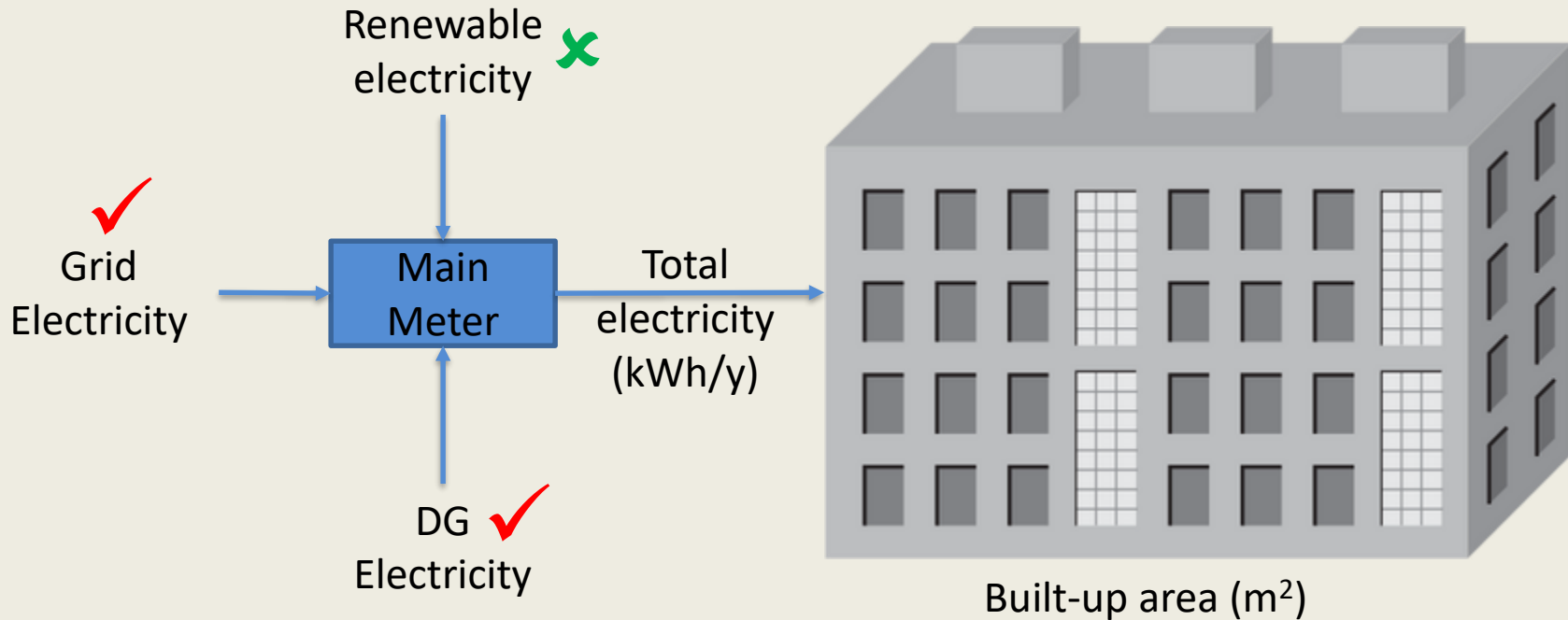
Integrated Design Charrette Approach for ECBC Compliance



Integrated Design during Early-Design Phase



What is Energy Performance Index (EPI)?



$$\text{Energy Performance Index (EPI) (kWh/m}^2\text{.y)} = \frac{\text{Annual Grid Electricity} + \text{Annual DG Electricity}}{\text{Built-up area}}$$

Built-up area: Total built-up area excluding the basements used for services and/or parking

Source: BEE Star rating for Office Building & BEE Star rating for BPO

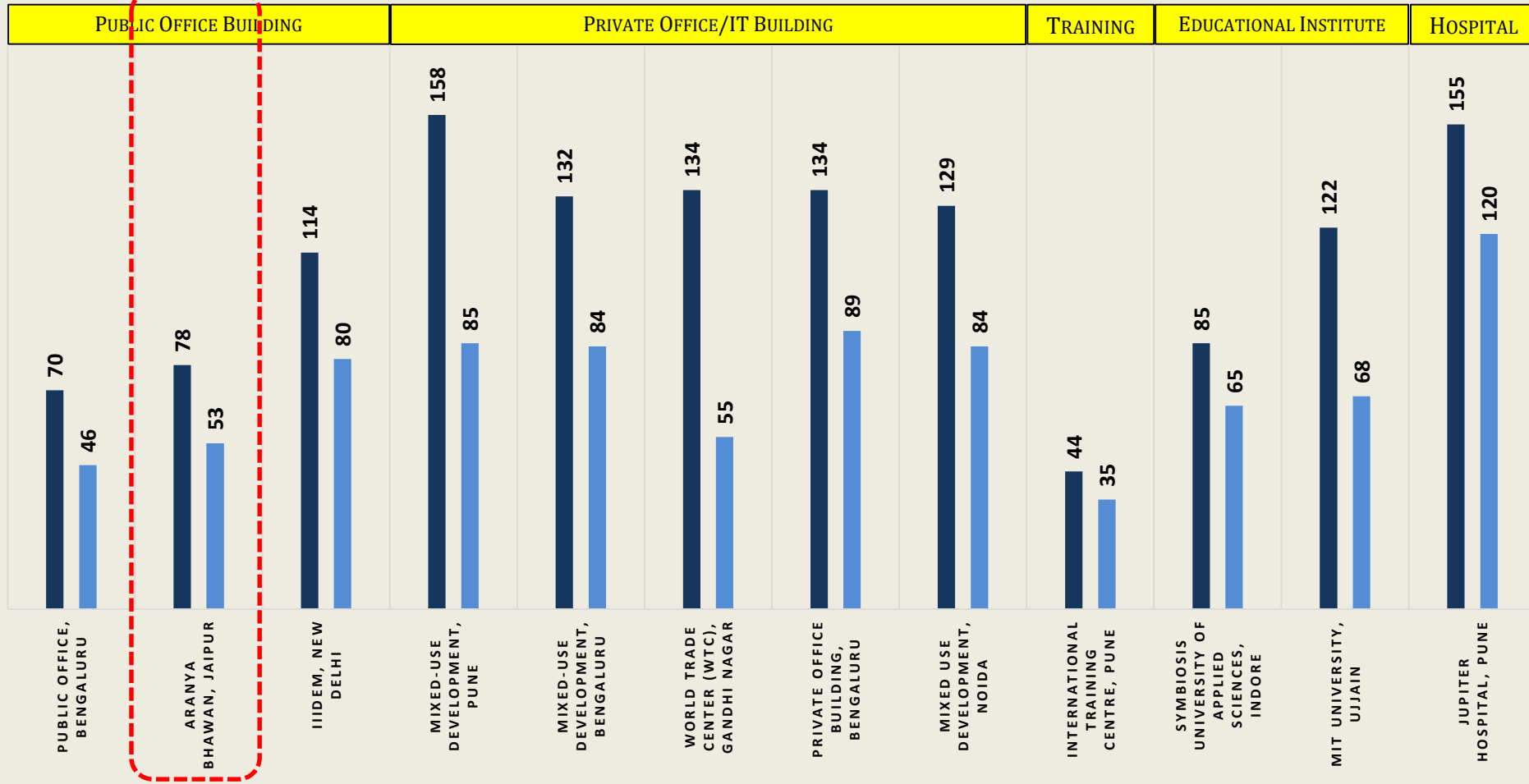
EPI of BEEP Charrette Projects: Commercial Buildings



ESTIMATED ENERGY PERFORMANCE INDEXES OF CHARRETTE PROJECTS

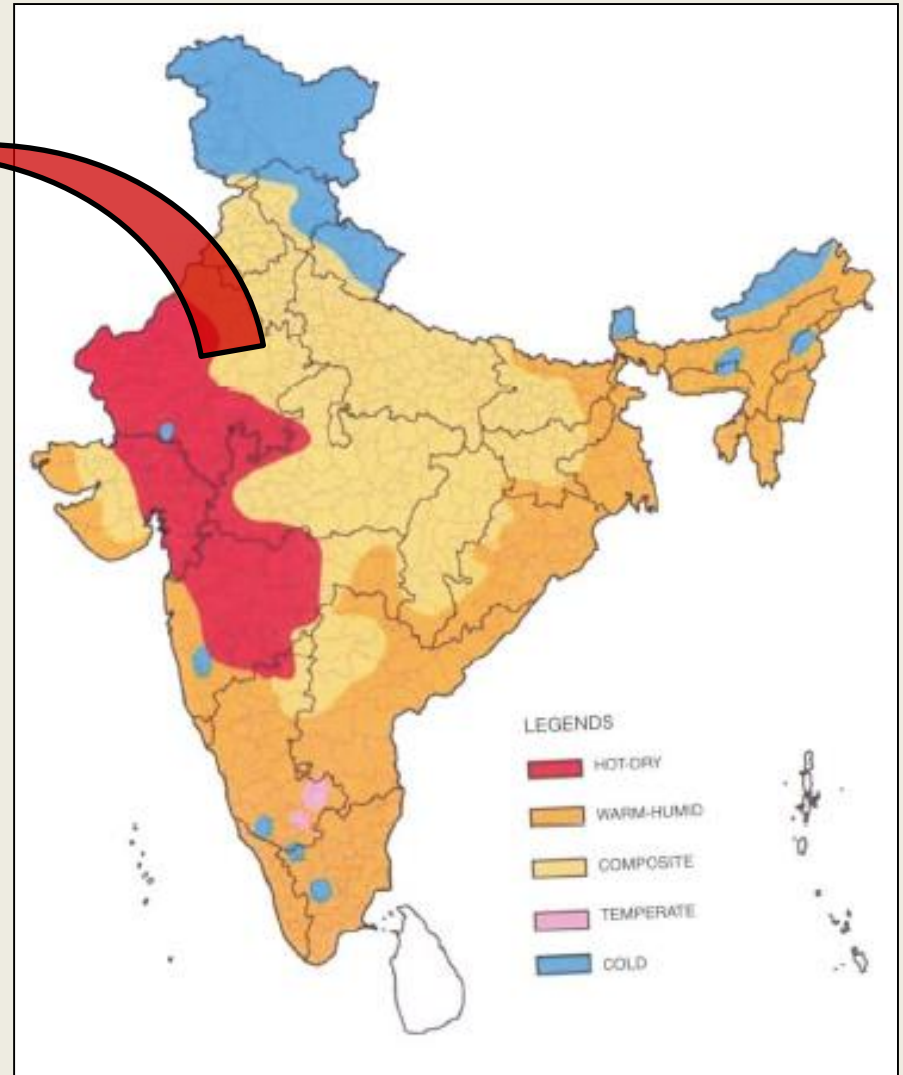
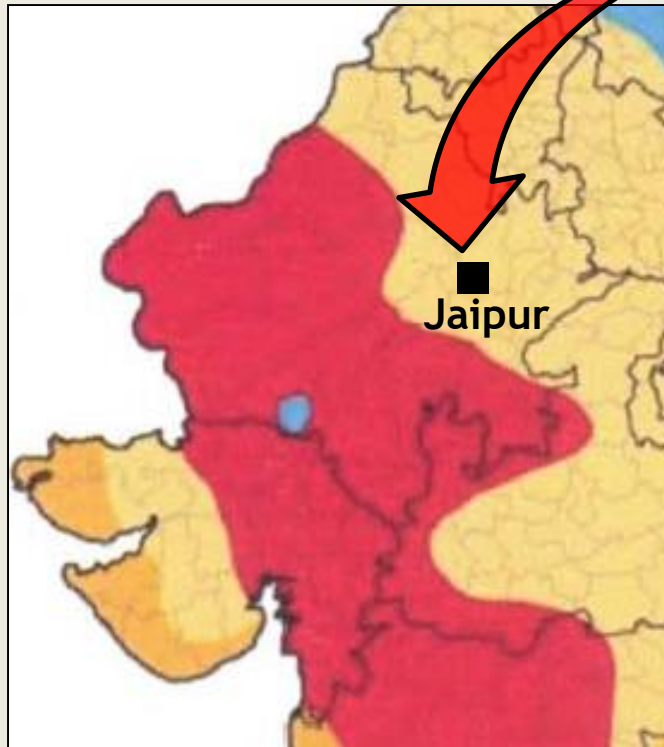
■ Energy Performance Index (EPI) - kWh/m2.y
Before Charrette

■ Energy Performance Index (EPI) - kWh/m2.y
After Charrette



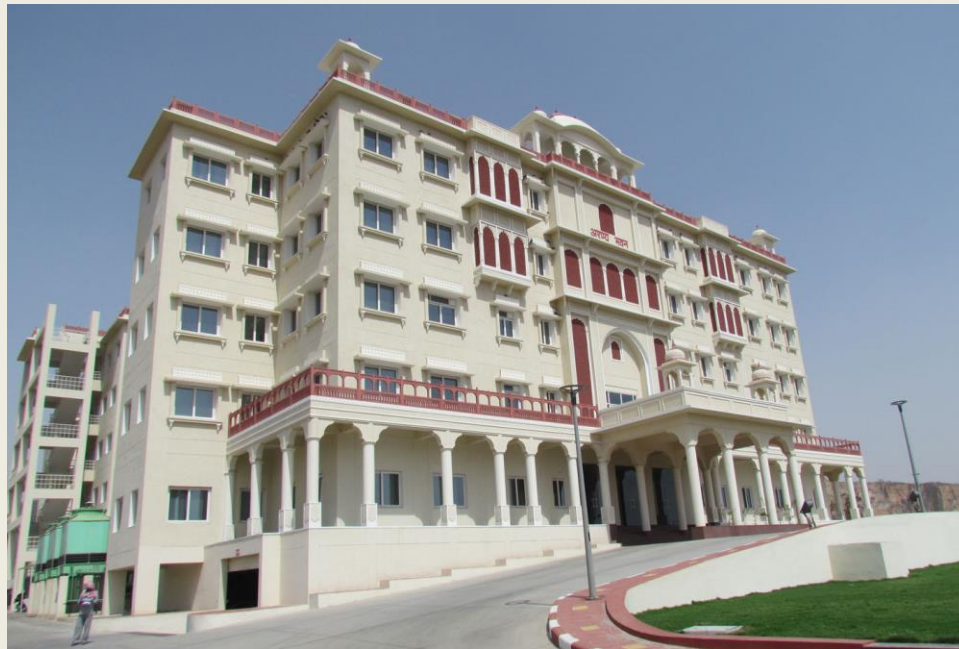
CASE STUDY: ARANYA BHAWAN, JAIPUR

Jaipur: Climate



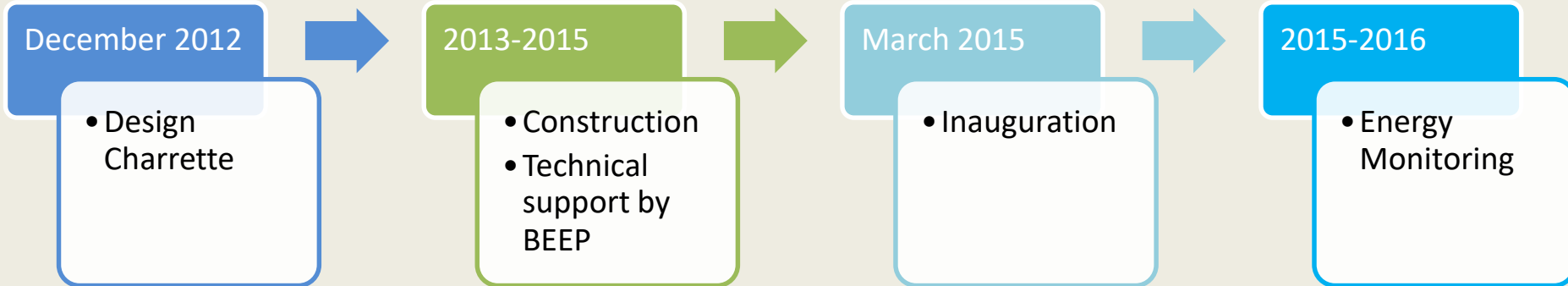
Aranya Bhawan

Aranya Bhawan is the new office building of the Rajasthan Forest Department in Jaipur, inaugurated in March 2015.



- Built-up area: ~10,000 m² (excluding basement parking and service area)
- Number of floors: Five (G+4) + one basement for parking and services
- Number of users: ~350
- Types of spaces: Offices, museum, library, auditorium, guest rooms

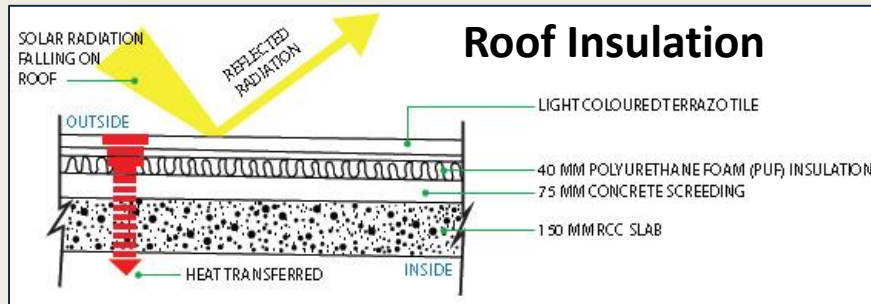
Aranya Bhawan: Project Timeline



- **Client:** Rajasthan Forest Department
- **Executing Agency:** Rajasthan State Road Development and Construction Corporation Ltd. (RSRDC)
- **Architects:** Mathur, Ugam and Associates



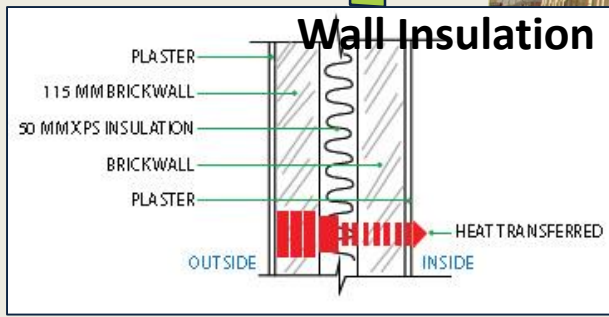
Aranya Bhawan: Passive Measures



U-value: 0.6 W/m².K

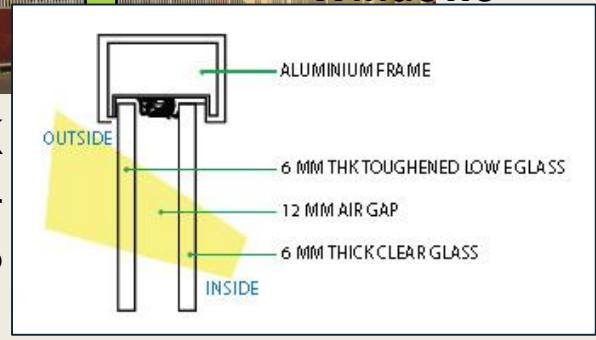


Reduction in Glazed Area
Double-Glazed Windows



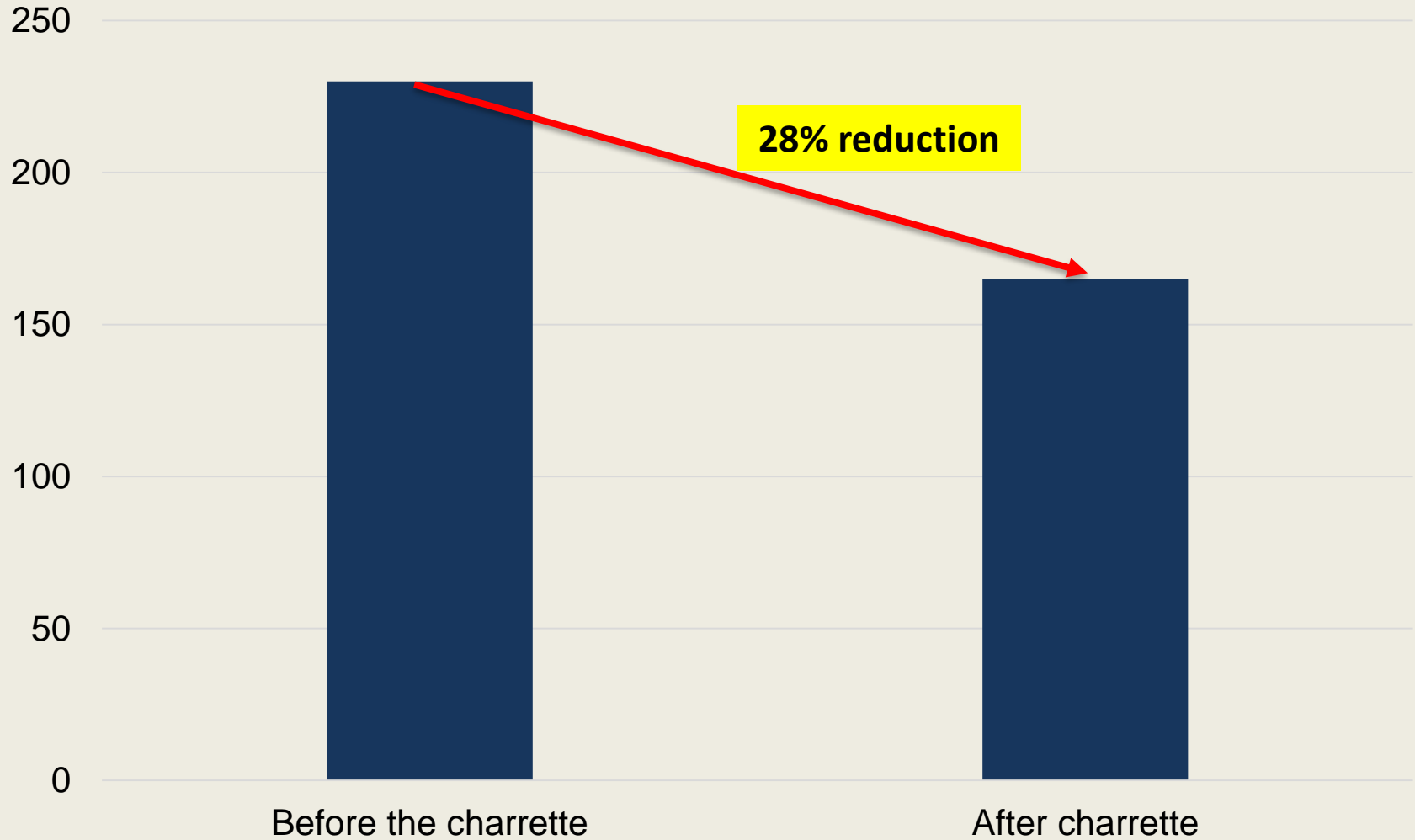
U-value*: 0.5 W/m².K

U-value: 1.8 W/m².K
SHGC: 0.24
VLT: 36%



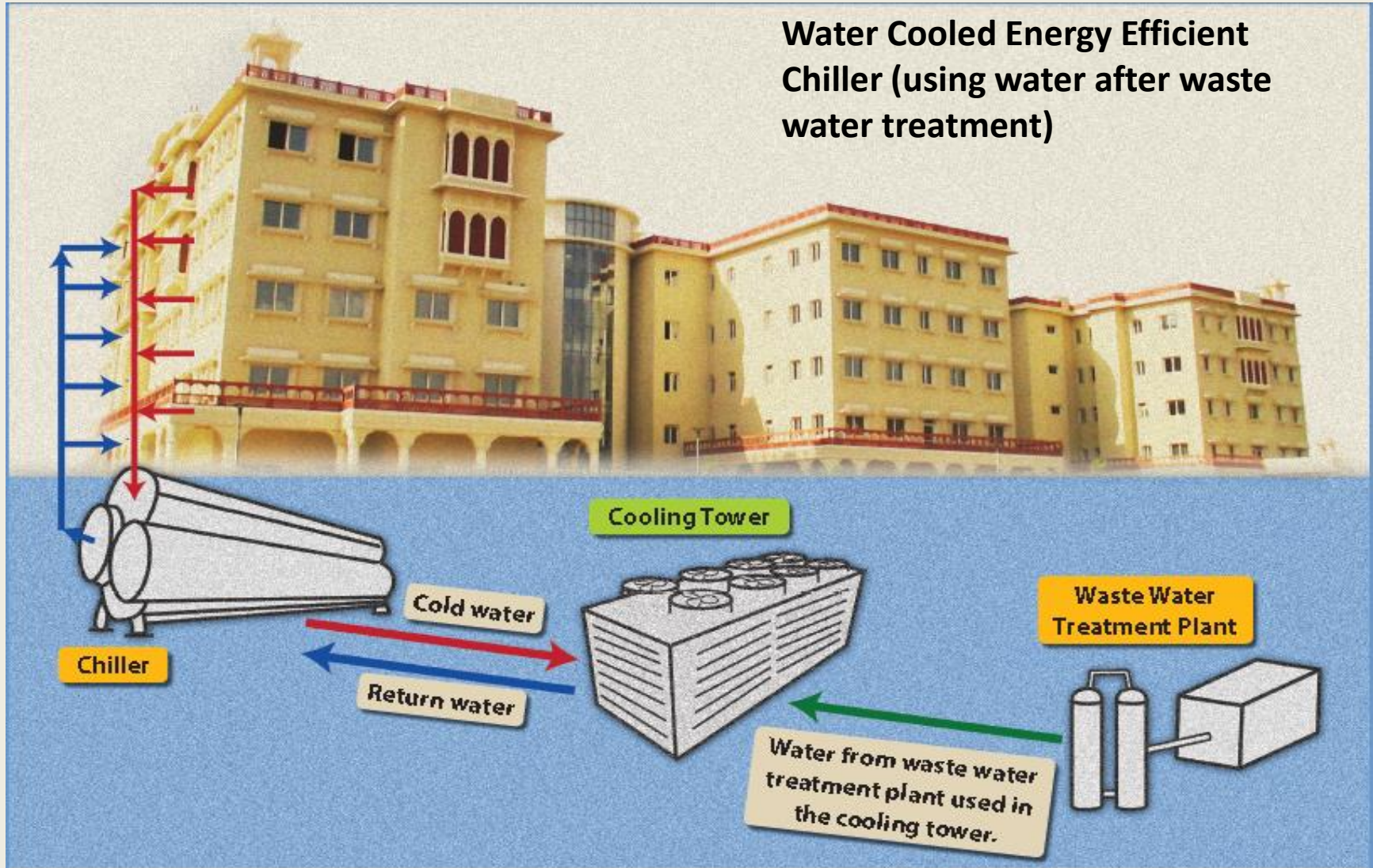
Reduction in Cooling System Size

Cooling system size (TR)



Aranya Bhawan: Cooling System

**Water Cooled Energy Efficient
Chiller (using water after waste
water treatment)**



Aranya Bhawan: Solar Energy Generation

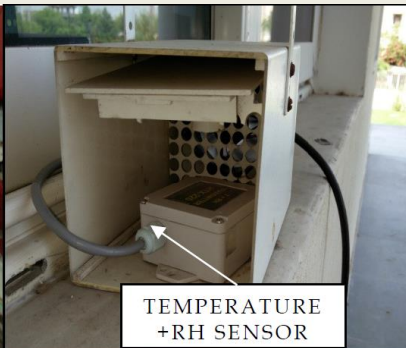
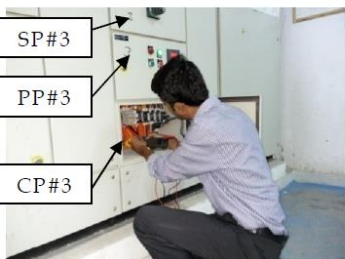
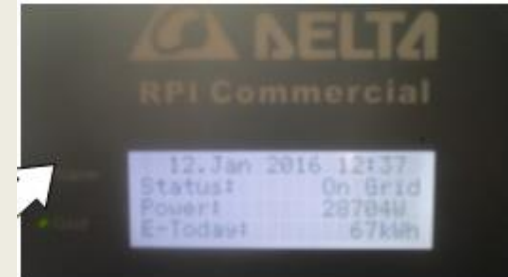
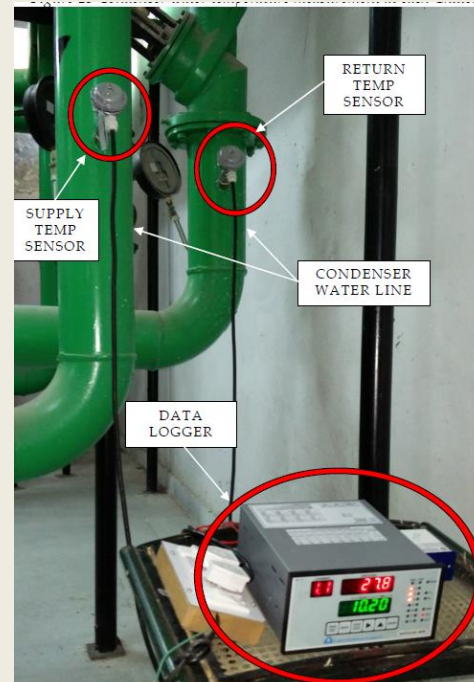
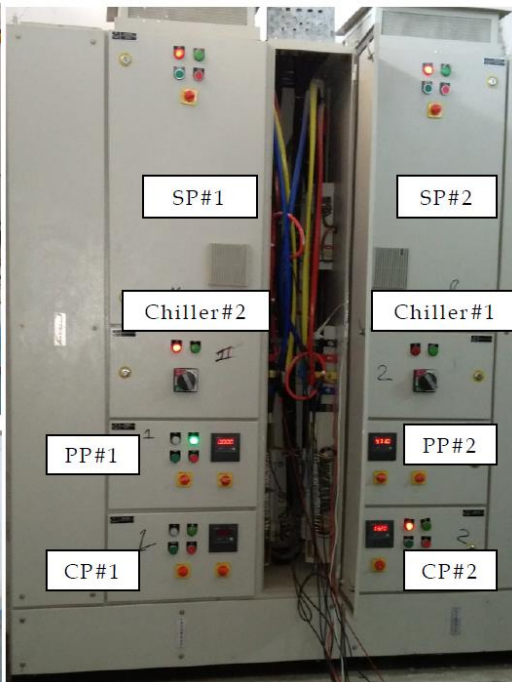


Grid connected rooftop solar PV

- Capacity: 45 kWp (annual production: ~60,000 kWh)

Aranya Bhawan – Energy Monitoring

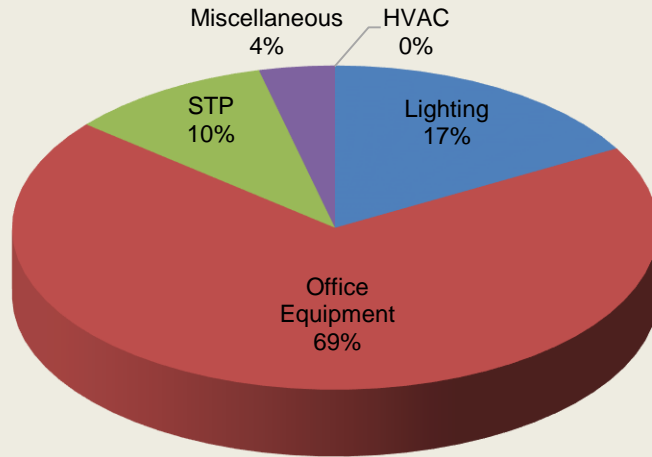
- Detailed monitoring of 2 weeks in Winter (Jan.16) & 2 weeks in Summer (May.16) + Monthly electricity bills for 1 year



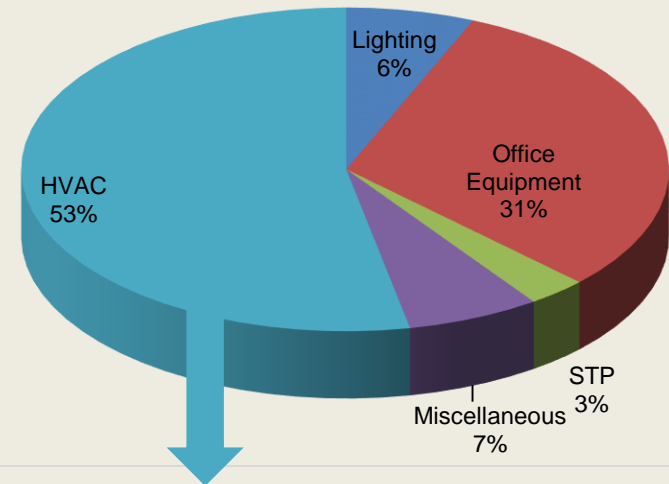
Monitoring results Aranya Bhawan



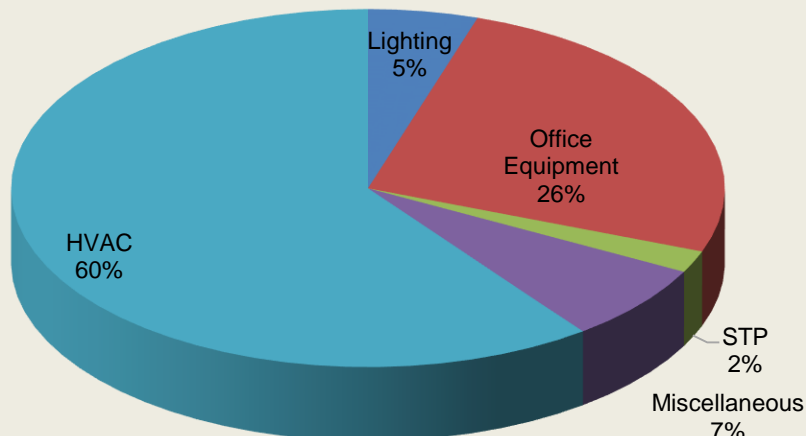
Winter (Nov-Feb)



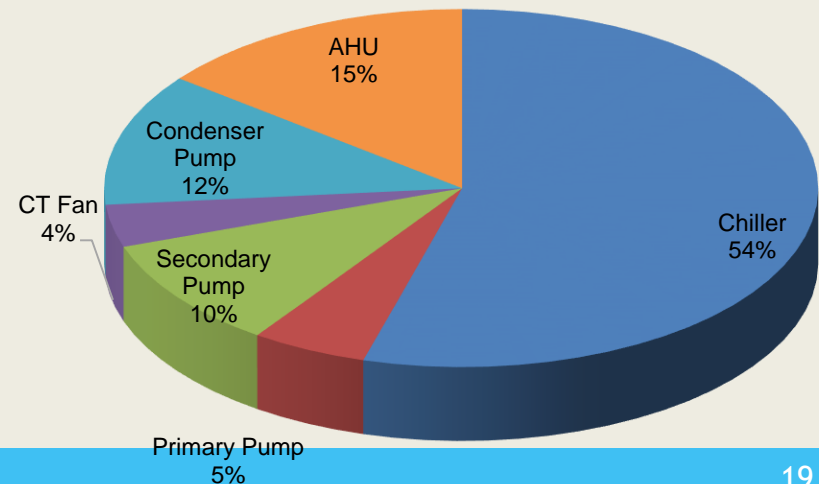
Annual Energy Consumption



Summer (Mar-Oct)



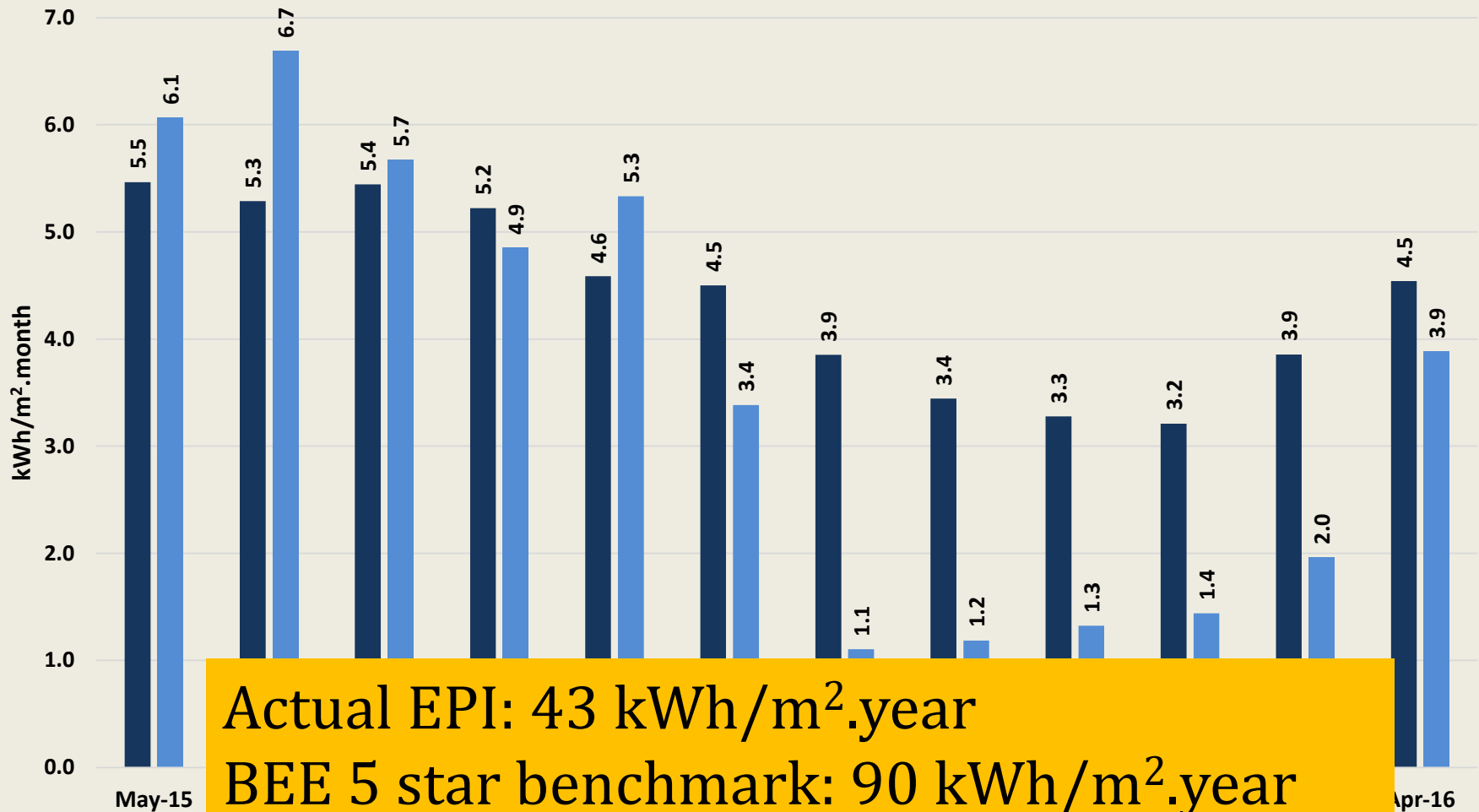
Break-up of HVAC energy consumption



Electricity Consumption: Simulation & Actual (EPI)

Monthly EPI Comparison: Simulated vs. Actual

■ Simulated EPI ■ Actual EPI



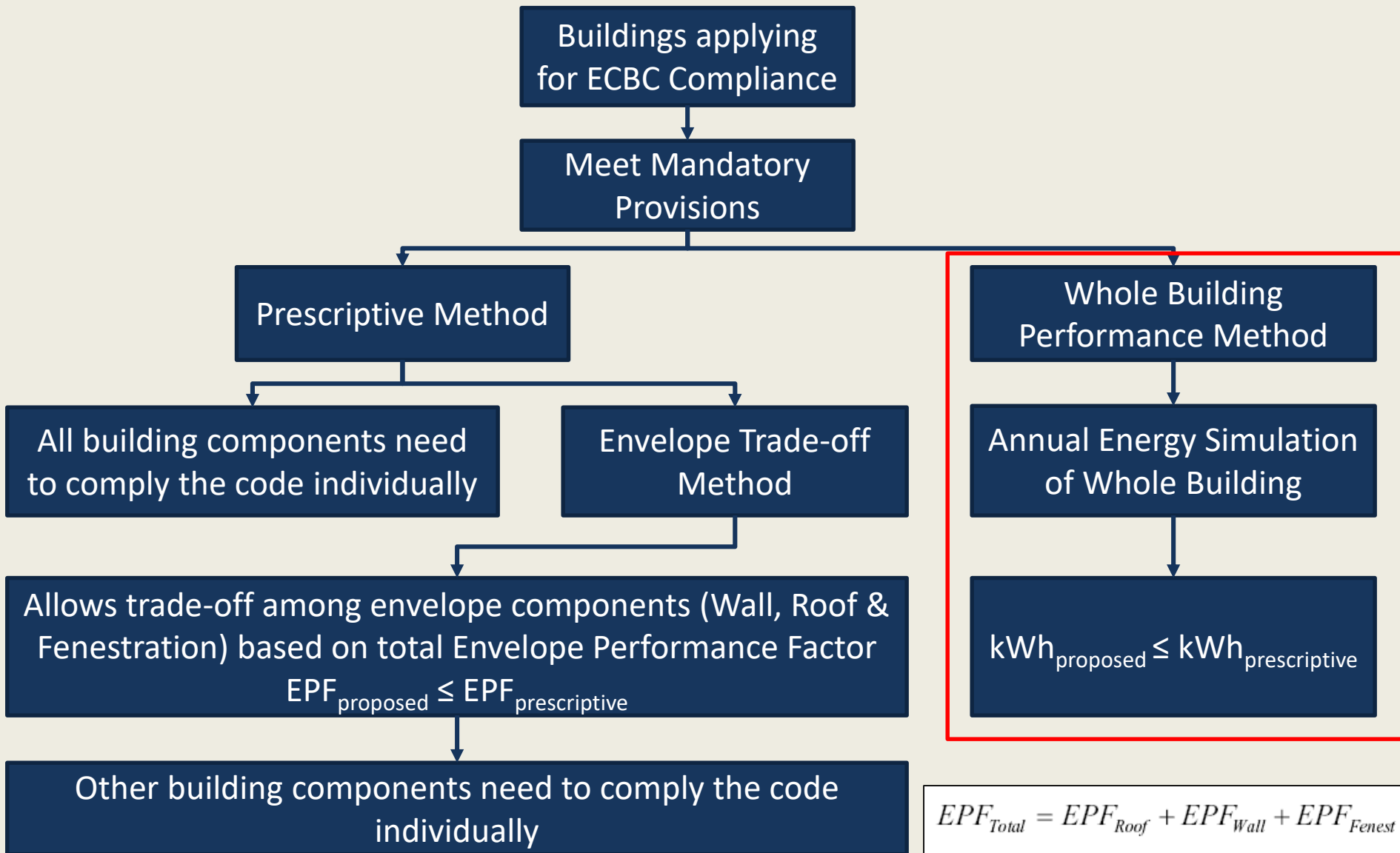
Aranya Bhawan: Overall Cost and Performance Summary



	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.

ECBC Compliance



ECBC Compliance of Aranya Bhawan: Whole Building Performance Method



	ECBC Prescriptive*	Proposed#
Opaque Wall U-value (W/m ² .K)	0.44	0.5
Roof U-value (W/m ² .K)	0.409	0.6
Fenestration		
- SHGC	0.25	0.24
- VLT	0.27	0.36
- U-value (W/m ² .K)	3.3	1.8
LPD ("building area method") (W/m ²)	10.8	7
HVAC: Centralised system		
- Water cooled screw chiller (COP)	4.7	5.8
- AHU	Constant volume	Constant volume AHUs + FCUs

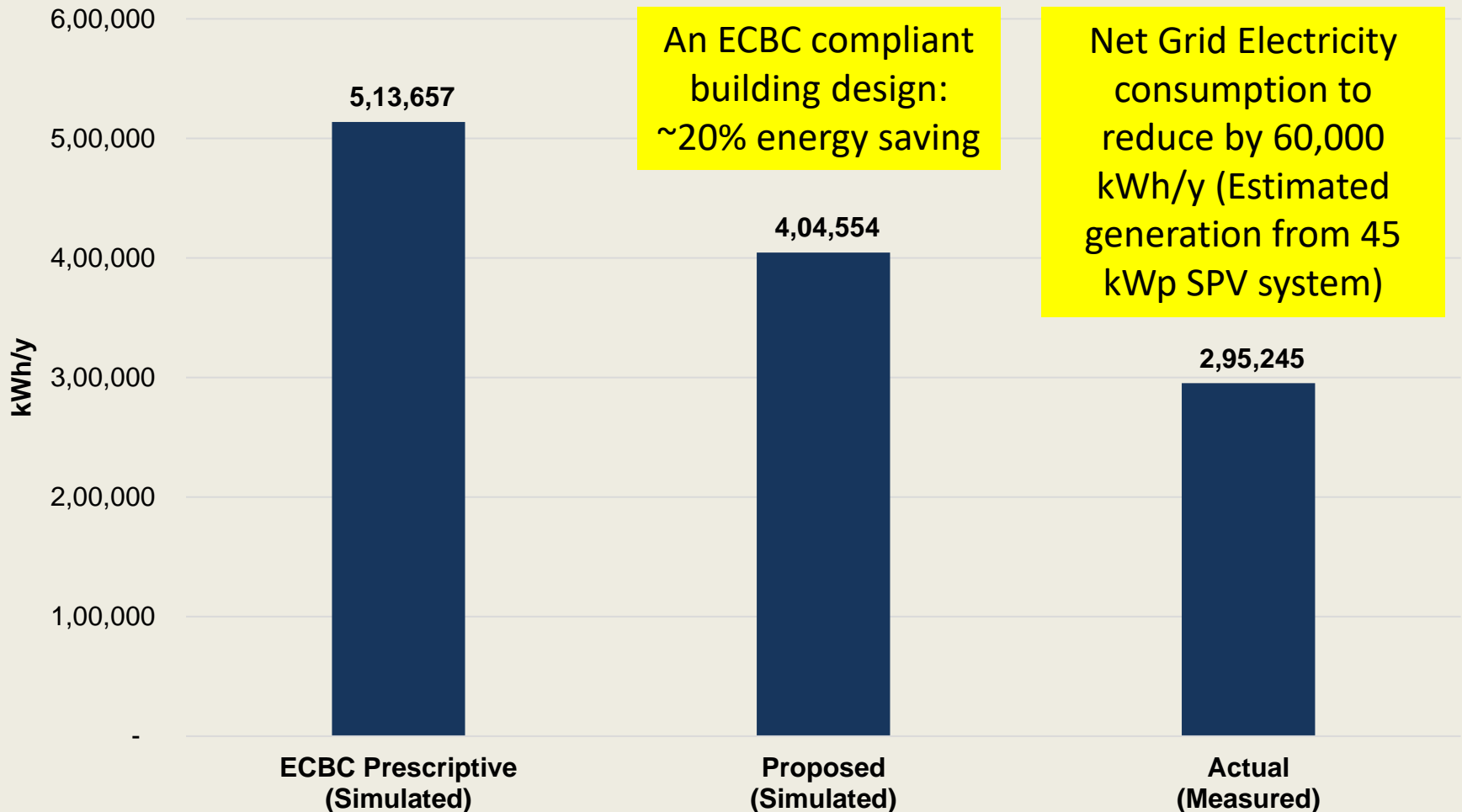
*Day use office building in Composite climate; Glazing distributed in all 4 sides equally; Baseline model simulated for 0, 90, 180 & 270 degree orientation and average value taken

#Same building operation assumptions (thermostat setpoints, schedules, internal gains, occupant loads, etc.); Finalized based on calibrated energy simulation model

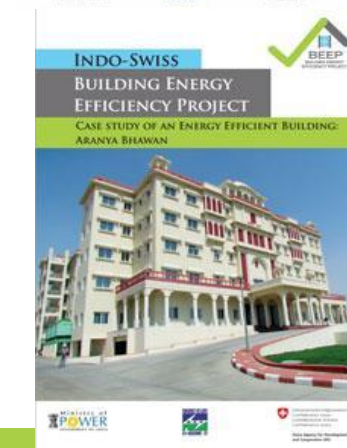
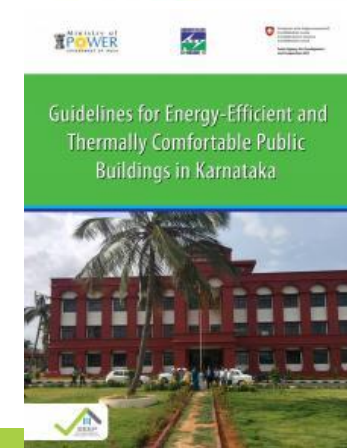
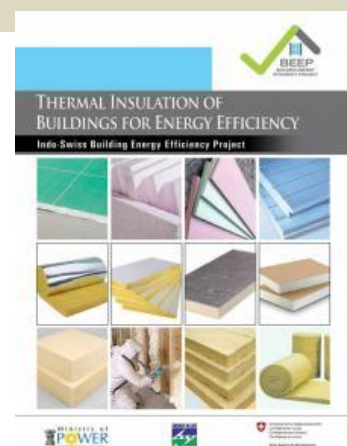
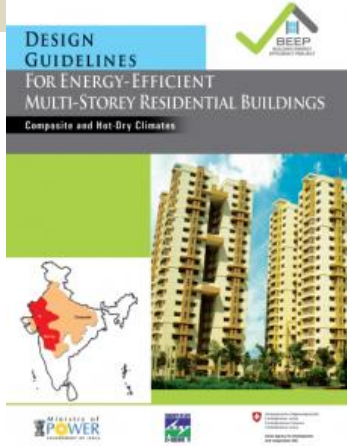
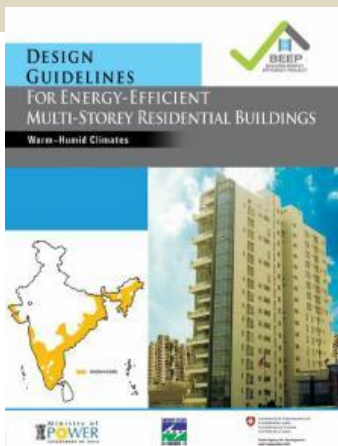
ECBC Compliance of Aranya Bhawan



Annual Energy Consumption



- The approach for energy efficiency/ECBC compliance should always be reducing the demand first through passive measures, use efficient systems with controls and then integrate renewable energy system.
- Integrated approach at early design stage for energy efficiency results in 20-40% energy savings. Charrettes help in estimating the techno-economics of energy efficiency measures; helping in decision making and identifying acceptable measures for implementation; thus help in achieving ECBC compliance.



To download BEEP publications, know about BEEP charrettes and to apply for a charrette, please visit www.beepindia.org

THANK YOU !!!

