Energy Conservation Building Code-2017

19th July 2021

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ECBC Master Trainer

Technical Session 2

01 Lighting and Controls

02 Electrical and Renewable Energy System

03 Whole building Simulation Method

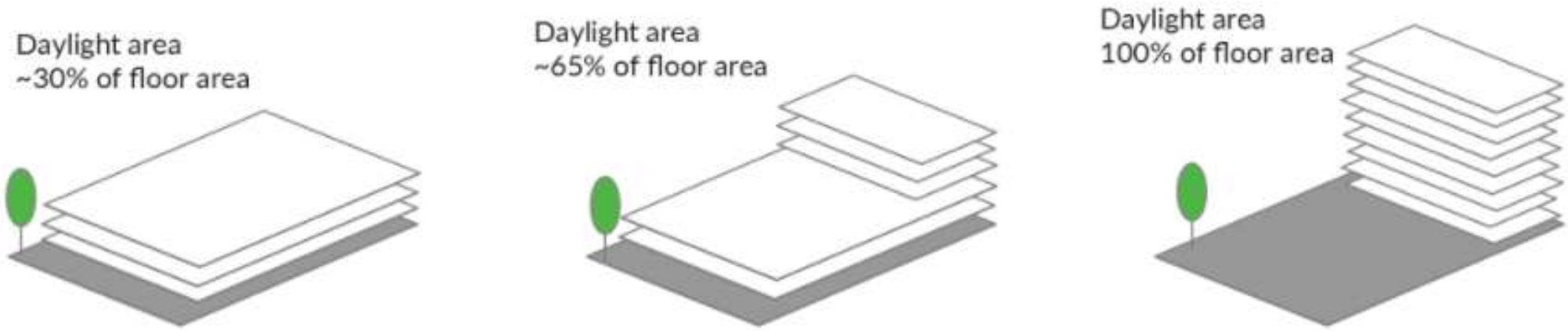
04 Case Studies

05 Q&A

LIGHTING AND CONTROLS

Lighting Systems & Controls

DESIGN CONSIDERATIONS



Source: Edge

Lighting Systems & Controls

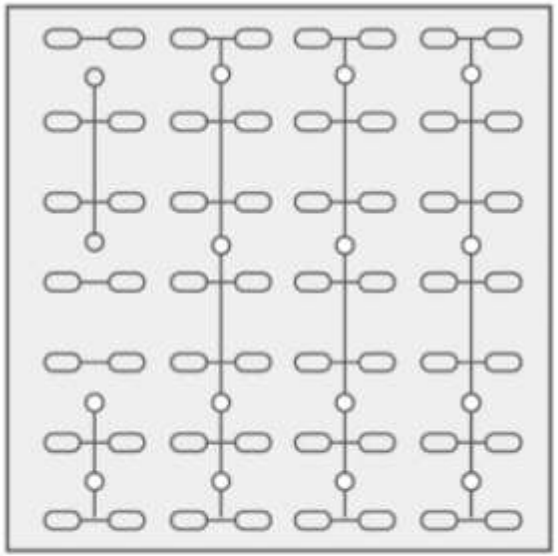
DESIGN CONSIDERATIONS

1. Utilize daylighting and integrate it with electric lighting
2. Add controls to reduce lighting levels when artificial light is not required
3. Choose light fixtures with a good light spread to reduce the total number of luminaires
4. Use efficient lamps with a high light output
5. Use reflective interior colors to maximize light in space

Source: Edge

Lighting Systems & Controls

DESIGN CONSIDERATIONS



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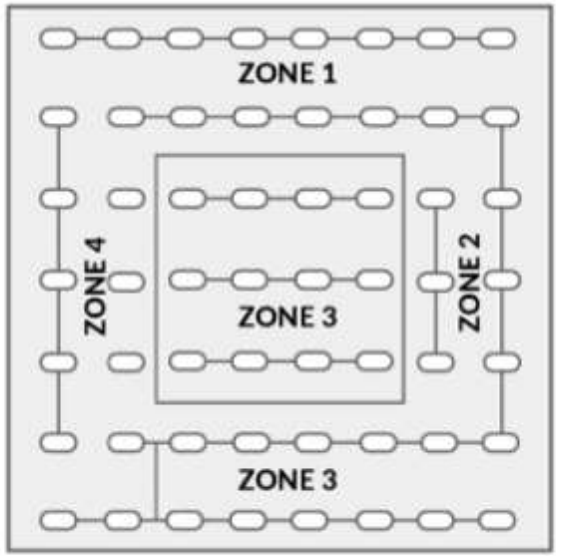
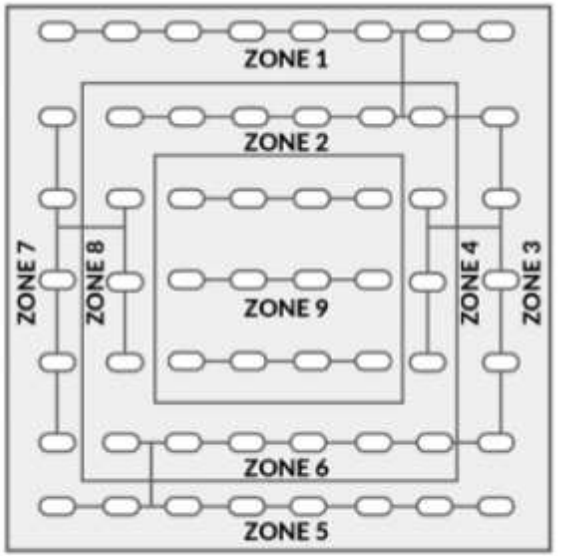


Better



Best

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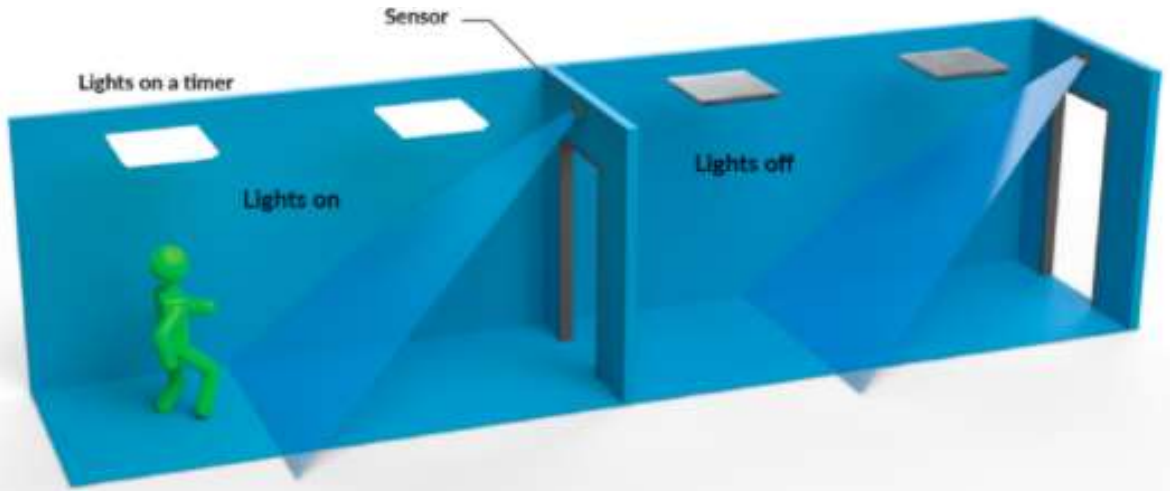


Lighting Systems & Controls

COMPLIANCE MECHANISM

AUTOMATIC LIGHTING SHUTOFF

- 90% of interior lighting fittings in building or **space of building larger than 300 m2** shall be equipped with automatic control device.

- Occupancy sensors shall be provided in:

All building types greater than 20,000 m^2 BUA

I. All habitable spaces less than 30 m2 enclosed by walls or ceiling height partitions.

II. All storage or utility spaces more than 15 m2 in all building types with BUA greater than 20,000 m^2

III. Public toilets more than 25 m^2 controlling at least 80 % of lighting fitted in the toilet. The lighting fixtures, not controlled by automatic lighting shutoff, shall be uniformly spread in the area.

Lighting Systems & Controls

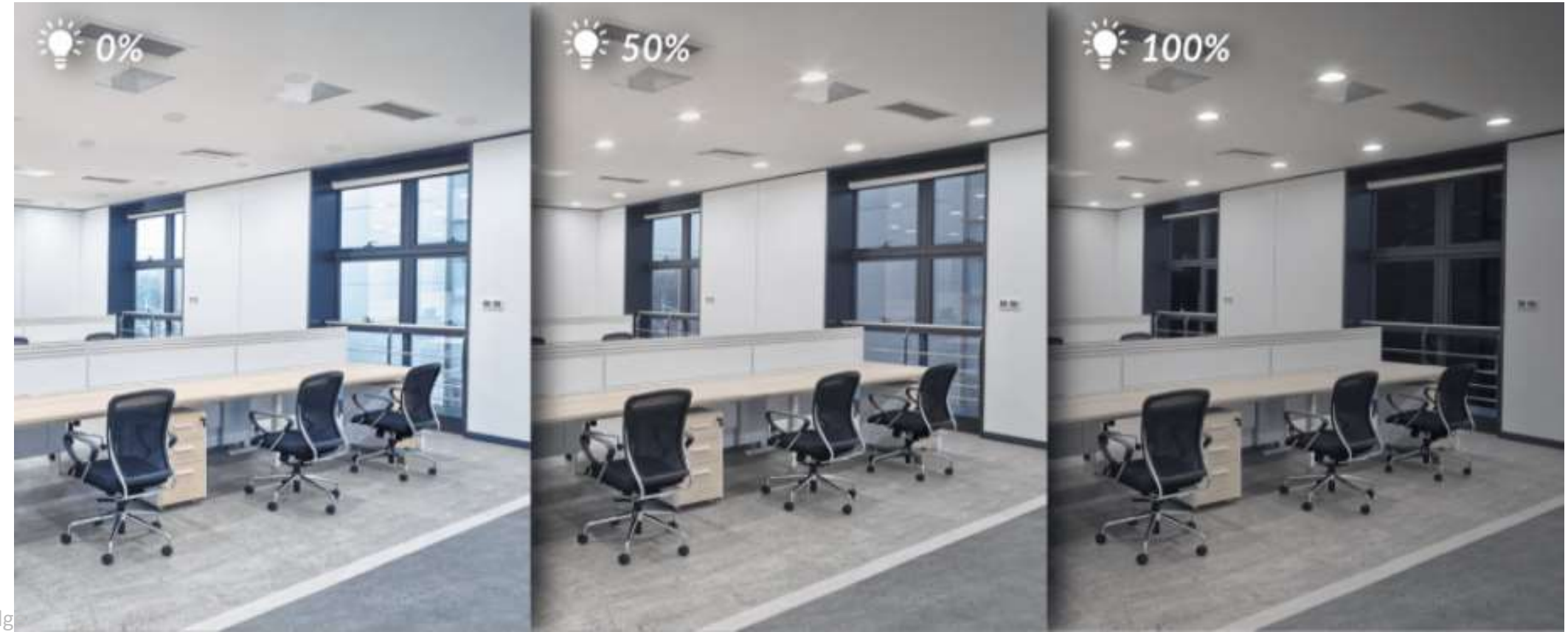
COMPLIANCE MECHANISM

3.1 AUTOMATIC LIGHTING SHUTOFF

In corridors of all Hospitality greater than 20,000 m2 BUA

I. Minimum 70% and maximum 80% of lighting fitted in the public corridor.

II. The lighting fixtures, not controlled by automatic lighting shut off, shall be uniformly spread in the area



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Lighting Systems & Controls

BUILDING AREA METHOD

- Determine the allowed lighting power density (LPD) from Table 6.1 of ECBC for each appropriate building area type
- Calculate the gross lighted floor area type multiply the allowed watts sq.mt .Listed for each selected building type by the corresponding lighted floor areas to determine the allowed LPD
- The sum of all the interior lighting power for various areas of the building cannot exceed the total watts to be in compliance

Table 6-1 Interior Lighting Power for ECBC Buildings – Building Area Method

Building Type	*LPD (W/m²)*	*Building Area Type*	*LPD (W/m²)*
Office Building	9.50	Motion picture theater	9.43
Hospitals	9.70	Museum	10.2
Hotels	9.50	Post office	10.5
Shopping Mall	14.1	Religious building	12.0
University and Schools	11.2	Sports arena	9.70
Library	12.2	Transportation	9.20
Dining: bar lounge/leisure	12.2	Warehouse	7.08
Dining: cafeteria/fast food	11.5	Performing arts theater	16.3
Dining: family	10.9	Police station	9.90
Dormitory	9.10	Workshop	14.1
Fire station	9.70	Automotive facility	9.00
Gymnasium	10.0	Convention center	12.5
Manufacturing facility	12.0	Parking garage	3.00

In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

Lighting Systems & Controls

SPACE FUNCTION METHOD

- Determine the appropriate building type and their allowed lighting power densities.
- For each space enclosed by partitions 80% or greater than ceiling height, determine the gross interior floor area.
- The lighting power allowance for a space is the product of the gross lighted floor area of the space times the allowed lighting power density for that space.
- The interior lighting power allowance for the building is the sum of the lighting power allowances for all spaces.

Space Function	LPD (W/m^2)
• For Reading Area	12.9
Hospital	
• For Emergency	29.1
• For Recovery	8.6
• For Nurse Station	10.8
• For Exam Treatment	16.1
• For Pharmacy	12.9

Space Function	LPD (W/m^2)
Office-enclosed	11.8
Office-open plan	11.8
Conference/Meeting/Multipurpose	14.0
Classroom/Lecture/Training	15.1
Lobby*	14.0
• For Hotel	11.8
• For Performing Arts Theater	35.5

Interior Lightning Power- Space Function Method

Lighting Systems & Controls

EXTERIOR LIGHTING POWER

The connected exterior lighting power must not exceed the allowed limits by ECBC.

Trade−offs between applications are not permitted.

Table 6-7 Exterior Building Lighting Power for ECBC Buildings

Exterior lighting application	Power limits
Building entrance (with canopy)	10 W/m^2 of canopied area
Building entrance (w/o canopy)	90 W/ linear m of door width
Building exit	60 W/lin m of door width
Building façade	5.0 W/m^2 of vertical facade area
Emergency signs, ATM kiosks, Security areas facade	1.0 W/m^2
Driveways and parking (open/ external)	1.6 W/m^2
Pedestrian walkways	2.0 W/m^2
Stairways	10.0 W/m^2
Landscaping	0.5 W/m^2
Outdoor sales area	9.0 W/m^2

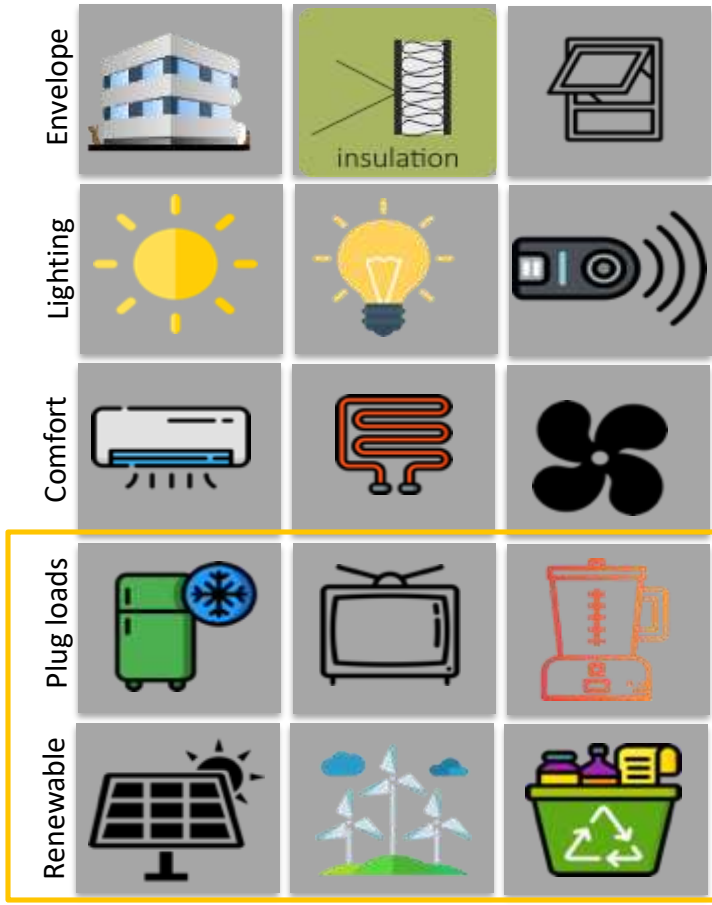
ELECTRICAL AND RENEWABLE ENERGY SYSTEMS

Building Components - ECBC

Electrical Power & Plug Loads

Supply Side Efficiency

Demand Side Efficient Appliances

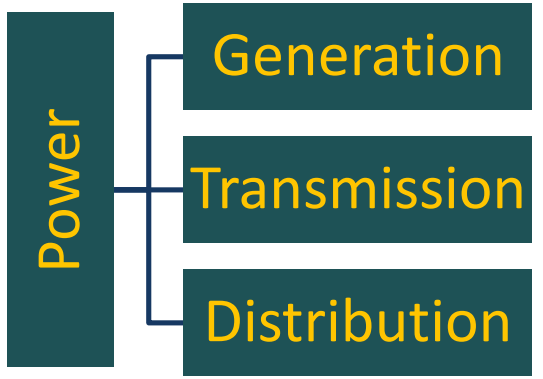


Electrical Power & Renewable Energy

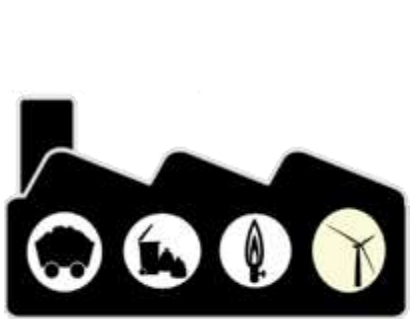
INTRODUCTION

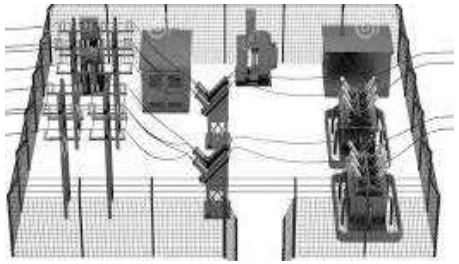
Electricity is one the most important discovery but is not physically visible.

Electrical power comprises with different electric equipment and systems installed in a facility.



POWER NETWORK SCHEMATIC





POWER GENERATION → TRANSMISSION → SUB STATION → SUB TRANSMISSION → UTILITY

Transformers

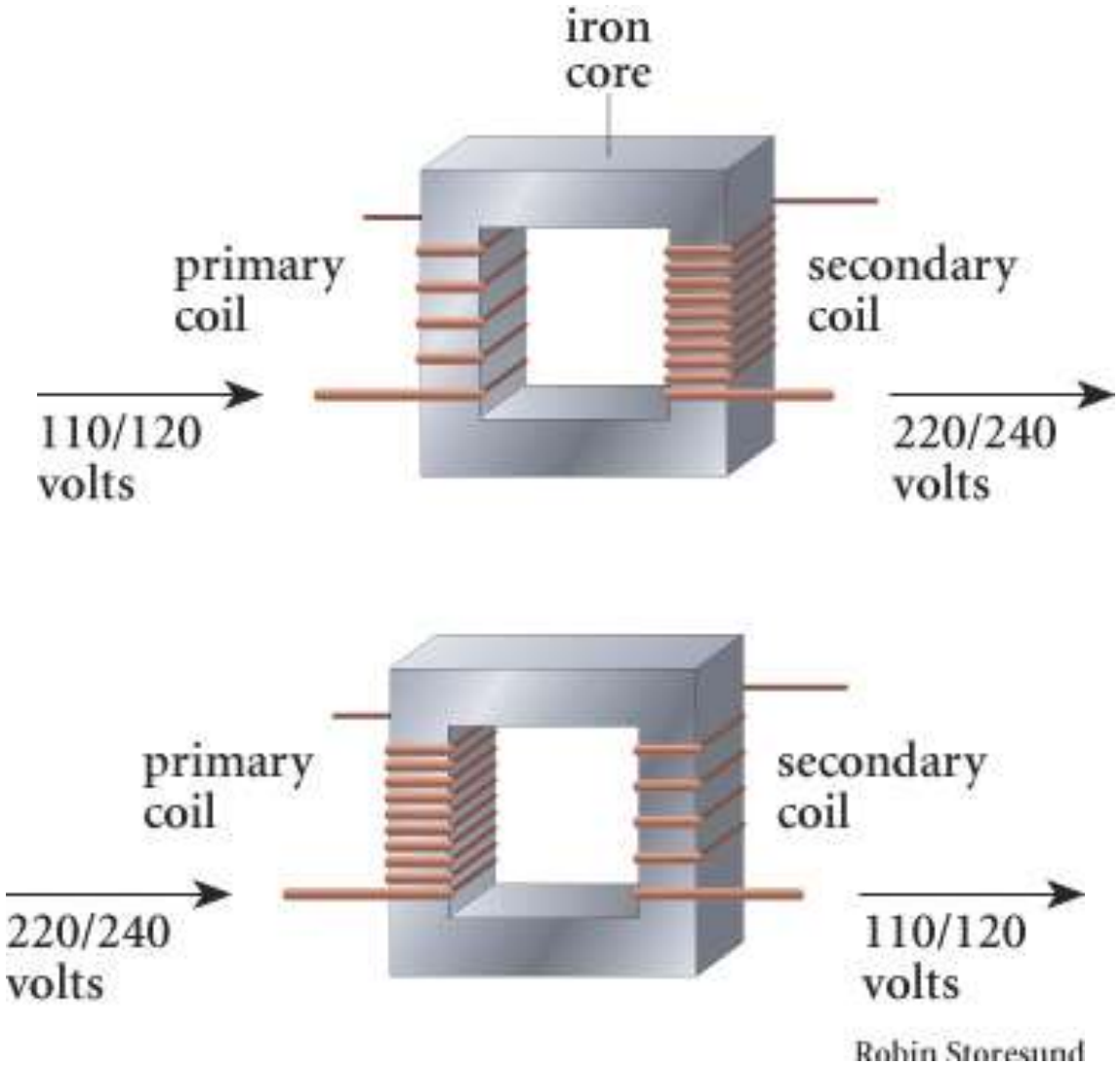
INTRODUCTION

Transformers are usually used in Alternating Current system to step up or step down of system voltage.

High Voltage System (>33 kV up to 1200 kV)

- Reduced conductor size and investment on conductors
- Reduced transmission losses and voltage drop

Voltage stepped-down for power supply distribution to various sections and equipment



Transformers

DRY TYPE TRANSFORMER LOSSES

Table 7-1 Permissible Losses for Dry Type Transformers

Rating kVA	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*
	Up to 22 kV class		33 kV class	
100	940	2,400	1,120	2,400
160	1,290	3,300	1,420	3,300
200	1,500	3,800	1,750	4,000
250	1,700	4,320	1,970	4,600
315	2,000	5,040	2,400	5,400
400	2,380	6,040	2,900	6,800
500	2,800	7,250	3,300	7,800
630	3,340	8,820	3,950	9,200
800	3,880	10,240	4,650	11,400
1,000	4,500	12,000	5,300	12,800
1,250	5,190	13,870	6,250	14,500
1,600	6,320	16,800	7,500	18,000
2,000	7,500	20,000	8,880	21,400
2,500	9,250	24,750	10,750	26,500

* The values as per Indian Standard/BEE Standard & Labeling notification for dry type transformer corresponding to values in this table will supersede as and when the Indian standards/ BEE Standard & Labeling notification are published.

Transformers

OIL FILLED TRANSFORMER LOSSES

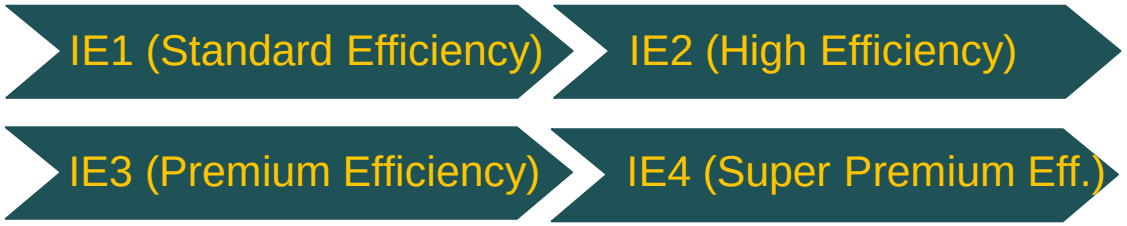
Voltage Drop Allowed
: For Feeder 2% max
: For Branch Circuit 3% Max

Table 7-2 Permissible Losses for Oil Type Transformers.

Rating (kVA)	Impedance (%)	Max. Total Loss (W) for transformers up to 11 kV class					
		ECBC Building		ECBC+ Building		SuperECBC Building	
		50 % Load	100% Load	50 % Load	100% Load	50 % Load	100% Load
16	4.5	135	440	108	364	87	301
25	4.5	190	635	158	541	128	448
63	4.5	340	1,140	270	956	219	791
100	4.5	475	1,650	392	1,365	317	1,130
160	4.5	670	1,950	513	1,547	416	1,281
200	4.5	780	2,300	603	1,911	488	1,582
250	4.5	980	2,930	864	2,488	761	2,113
315	4.5	1,025	3,100	890	2,440	772	1,920
400	4.5	1,225	3,450	1,080	3,214	951	2,994
500	4.5	1,510	4,300	1,354	3,909	1,215	3,554
630	4.5	1,860	5,300	1,637	4,438	1,441	3,717
1,000	5	2,790	7,700	2,460	6,364	2,170	5,259
1,250	5	3,300	9,200	3,142	7,670	2,991	6,394
1,600	6.25	4,200	11,800	3,753	10,821	3,353	9,924
2,000	6.25	5,050	15,000	4,543	13,254	4,088	11,711
2,500	6.25	6,150	18,500	5,660	16,554	5,209	14,813

Energy Efficient Motors

- Minimum acceptable nominal full load motor efficiency not less than IS -12615 standard for energy−efficient motors:



- All permanently wired polyphase motors of 0.375 kW or more serving the building and expected to operate more than 1,500 hours per year & all permanently wired polyphase motors of 50kW or more serving the building & expected to operate more than 500 hours per year
- Motor horsepower ratings shall not exceed 20% of the calculated maximum load
- being served.
- Motor nameplates shall list the nominal full-load motor eficiencies and the full - load power factor.

Power Factor Correction

All 3 phase shall maintain their power factor at the point of connection as follows:

1. 0.97 for ECBC Building
2. 0.98 for ECBC+ building
3. 0.99 for SuperECBC building

Diesel Generator (DG) Sets

BEE star rated DG sets shall be used in all compliant buildings. DG sets in buildings greater than 20,000 m^2 BUA shall have:

1. minimum 3 stars rating in ECBC Buildings
2. minimum 4 stars rating in ECBC+ Buildings
3. minimum 5 stars rating in SuperECBC Buildings

Check-Metering and Monitoring

- **Services exceeding 1000 kVA** shall have permanently installed **electrical metering to record demand (kVA), energy (kWh), and total power factor.** The metering shall also display current (in each phase and the neutral), **voltage** (between phases and between each phase and neutral), and **Total Harmonic Distortion** (THD) as a percentage of total current.

- Services not exceeding 1000 kVA but **over 65 kVA** shall have permanently installed electric **metering to record demand** (kW), **energy** (kWh), and **total power factor** (or kVARh).

- Services **not exceeding 65 kVA** shall have permanently installed electrical **metering to record energy** (kWh).

SOURCE: E Source Technology Atlas Series, Volume II DrivePower (1999)

Power Distribution System Losses

The power cabling shall be sized so that the distribution losses do not exceed

a) 3% of the total power usage in ECBC Buildings
b) 2% of the total power usage in ECBC+ Buildings
c) 1% of total power usage in SuperECBC Buildings

Record of design calculation for the losses shall be maintained. Load calculation shall be calculated up to the panel level.

Uninterruptible Power Supply (UPS)

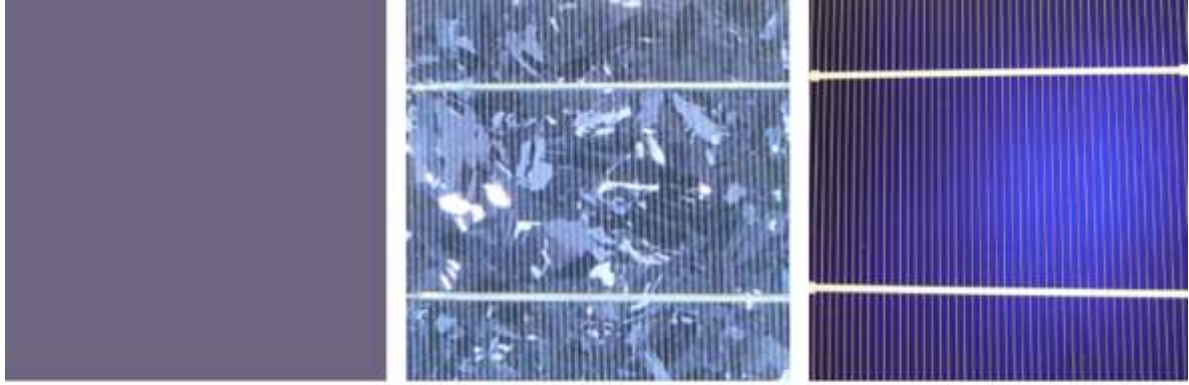
In all buildings, UPS shall meet or exceed the energy efficiency requirements listed in Table. Any Standards and Labeling program by BEE shall take precedence over requirements listed in this section.

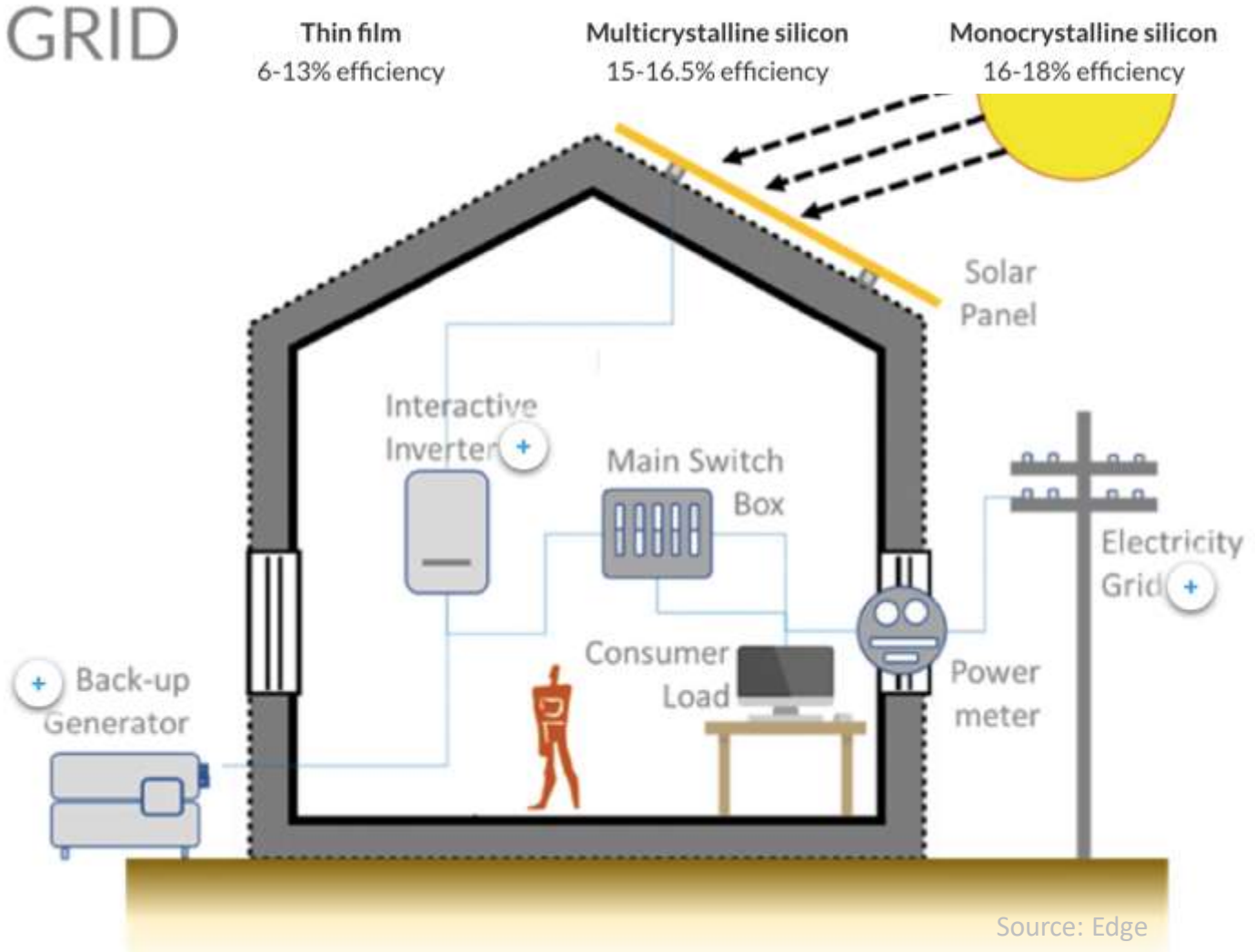
UPS Size	Energy Efficiency Requirements at 100% Load
kVA<20	90.2%
20<=kVA <=100	91.9%
kVA>100	93.8%

SOURCE: E Source Technology Atlas Series, Volume II DrivePower (1999)

Building Components - ECBC

Renewable Energy





Source: Edge

Renewable Energy Systems

All buildings shall have provisions for installation of renewable energy systems in the future on rooftops or the site.

Renewable Energy Generating Zone (REGZ)

a) A dedicated REGZ equivalent to at least 25 % of roof area or area required for generation of energy equivalent to 1% of total peak demand or connected load of the building, whichever is less, shall be provided in all buildings.

b) The REGZ shall be free of any obstructions within its boundaries and from shadows cast by objects adjacent to the zone

c) ECBC+ and SuperECBC building shall fulfil the additional requirements listed in Table 7-5 and Table 7-6 respectively.

Building Type	Minimum Electricity to be Generated in REGZ
All building types except below	Minimum 2% of total electrical load
Star Hotel > 20,000 m^2 Resort > 12,500 m^2 University > 20,000 m^2 Business > 20,000 m^2	Minimum 3% of total electricity load

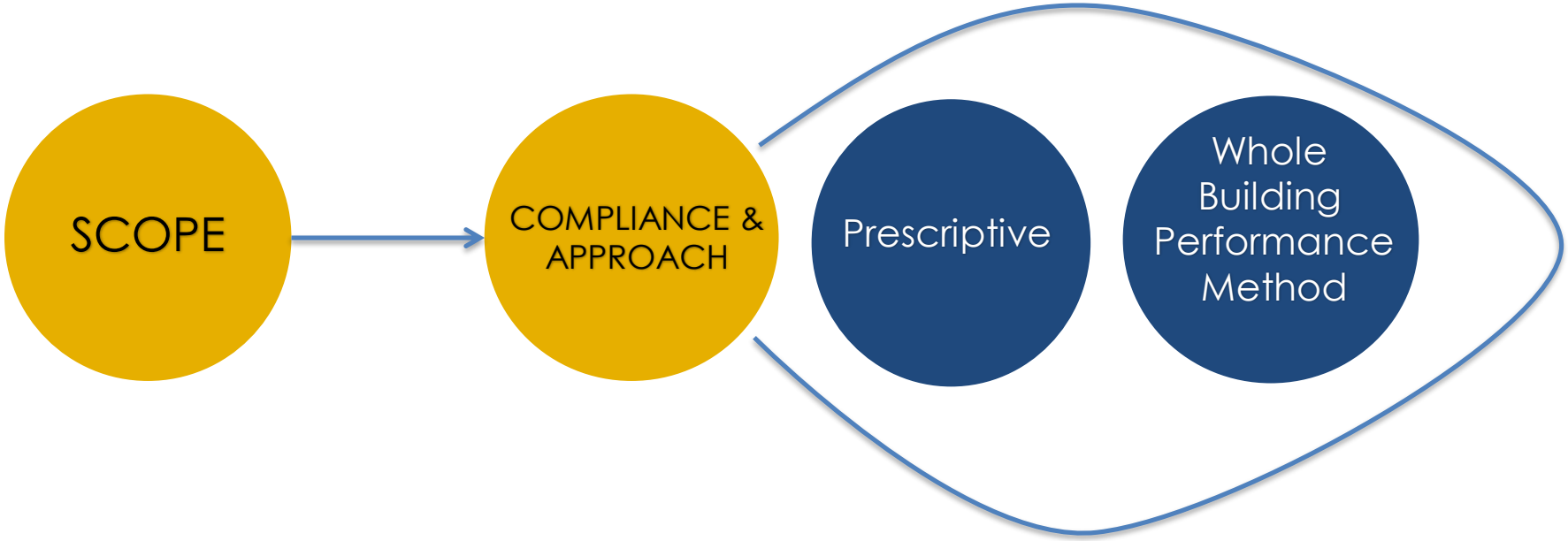
SOURCE: E Source Technology Atlas Series, Volume II DrivePower (1999)

WHOLE BUILDING SIMULATION METHOD

COMPLIANCE & APPROACH

ECBC 2017

The purpose of the Energy Conservation Building Code (Code) is to provide minimum requirements for the energy-efficient design and construction of buildings. The Code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements.



METHODS OF ECBC COMPLIANCE & IMPLEMENTATION

- Whole building performance method
- Prescriptive method
  - Tradeoff method

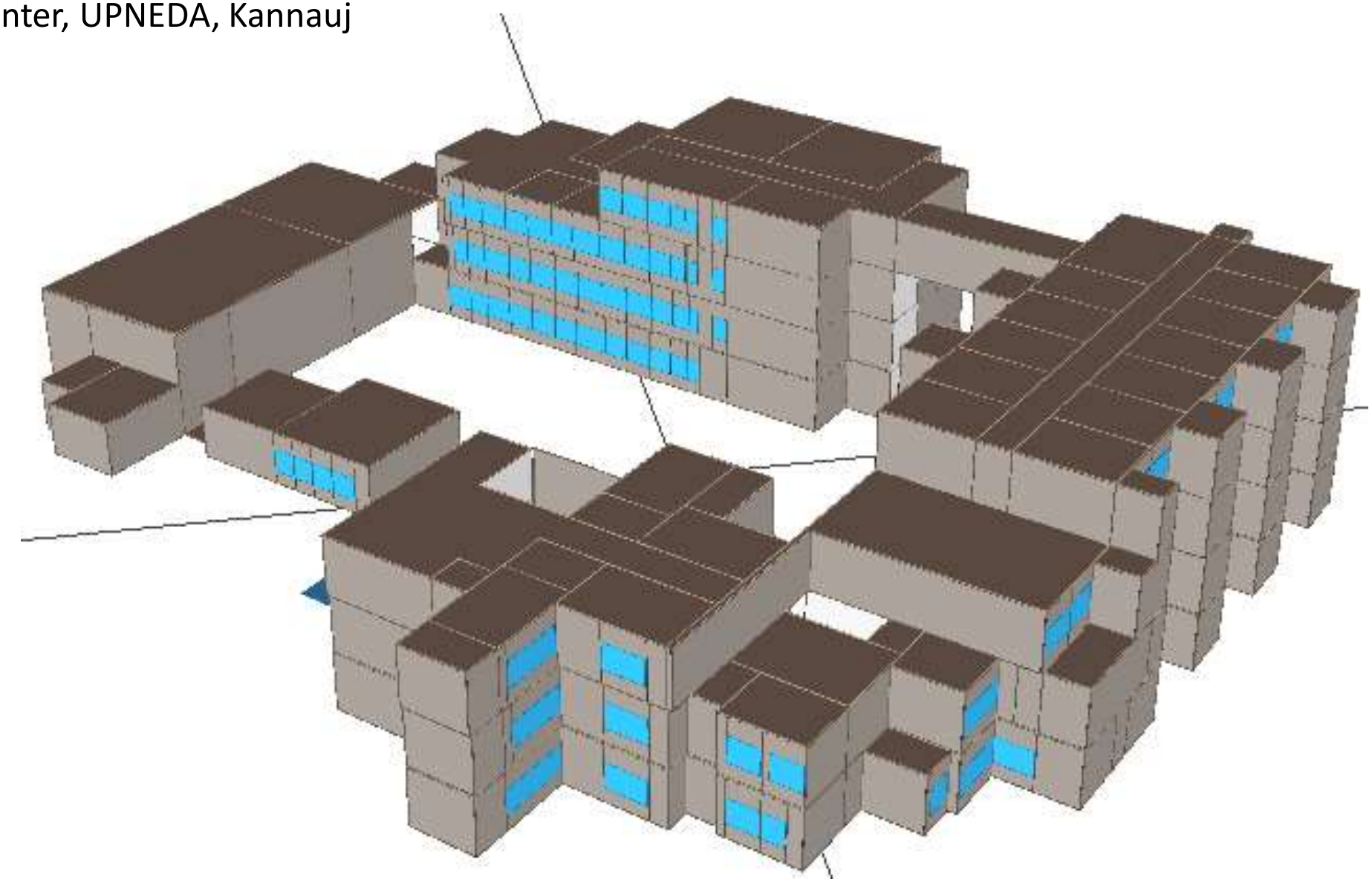
14. Appendix E: BEE approved list of software to show compliance[3]

Table 14-1 Bureau of Energy Efficiency Approved Software for Demonstrating Compliance with ECBC

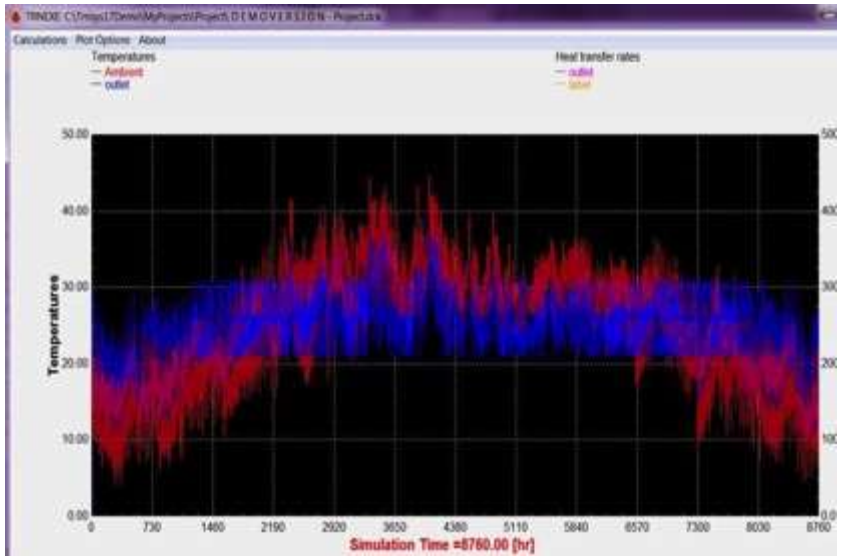
Analysis	Software
Whole Building Performance Method	AECOsim
	Design Builder
	DOE2
	EnergyPlus
	eQUEST
	HAP
	IDA-ICE
	IES-VE
	OpenStudio
	Simergy
	Trace700
	TRNSYS
	Visual DOE
	BEP-EMIS

WHOLE BUILDING ENERGY SIMULATION

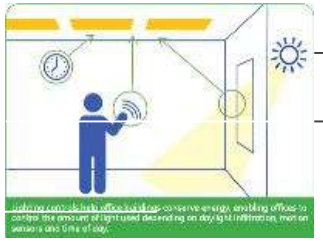
Training Center, UPNEDA, Kannauj

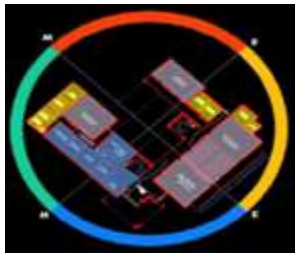


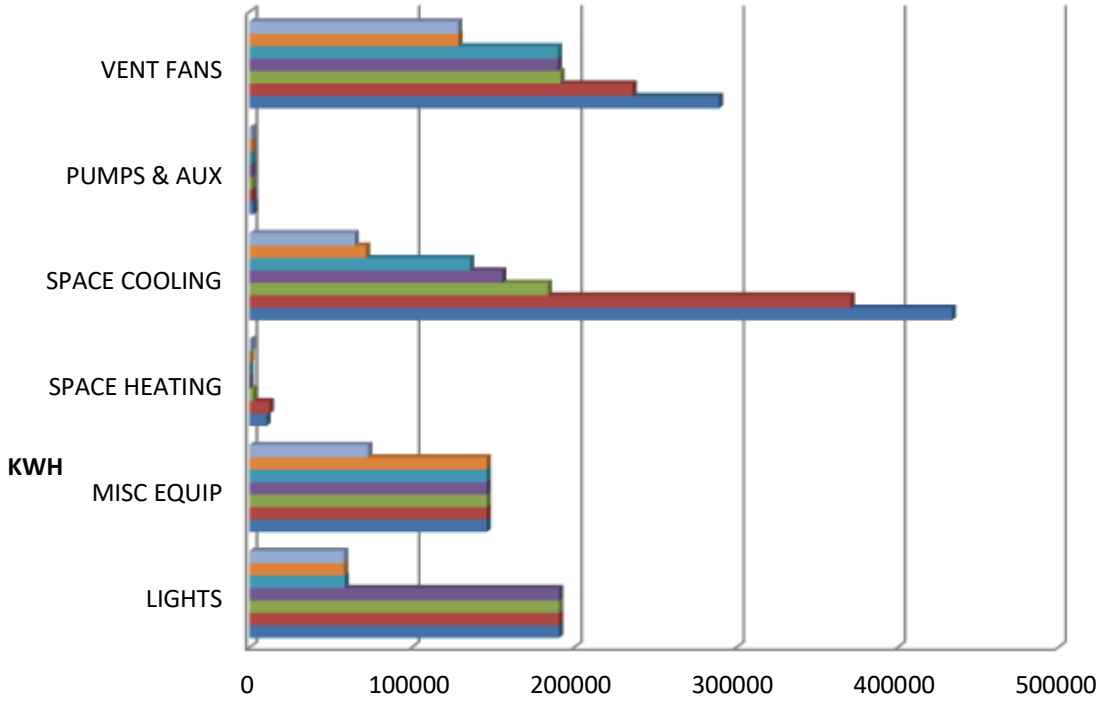
WHOLE BUILDING ENERGY SIMULATION



WHOLE BUILDING ENERGY SIMULATION

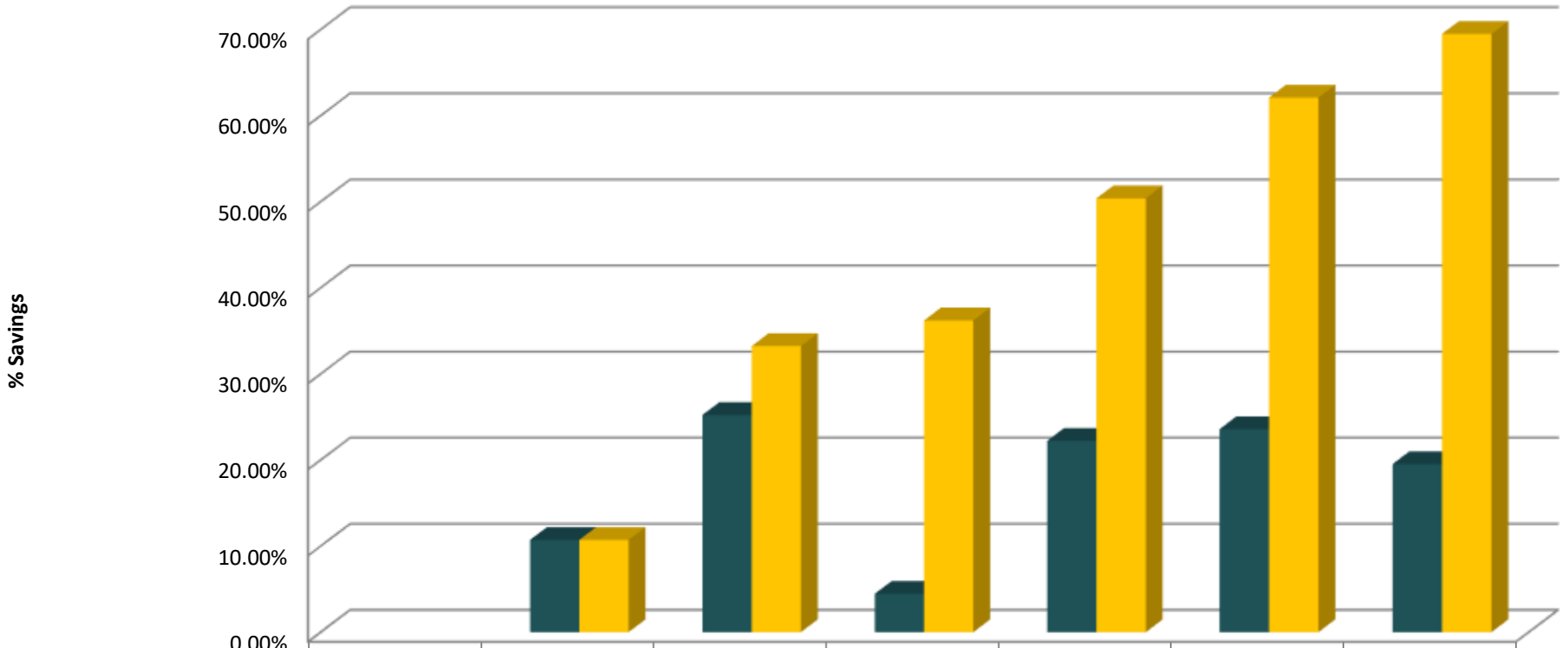






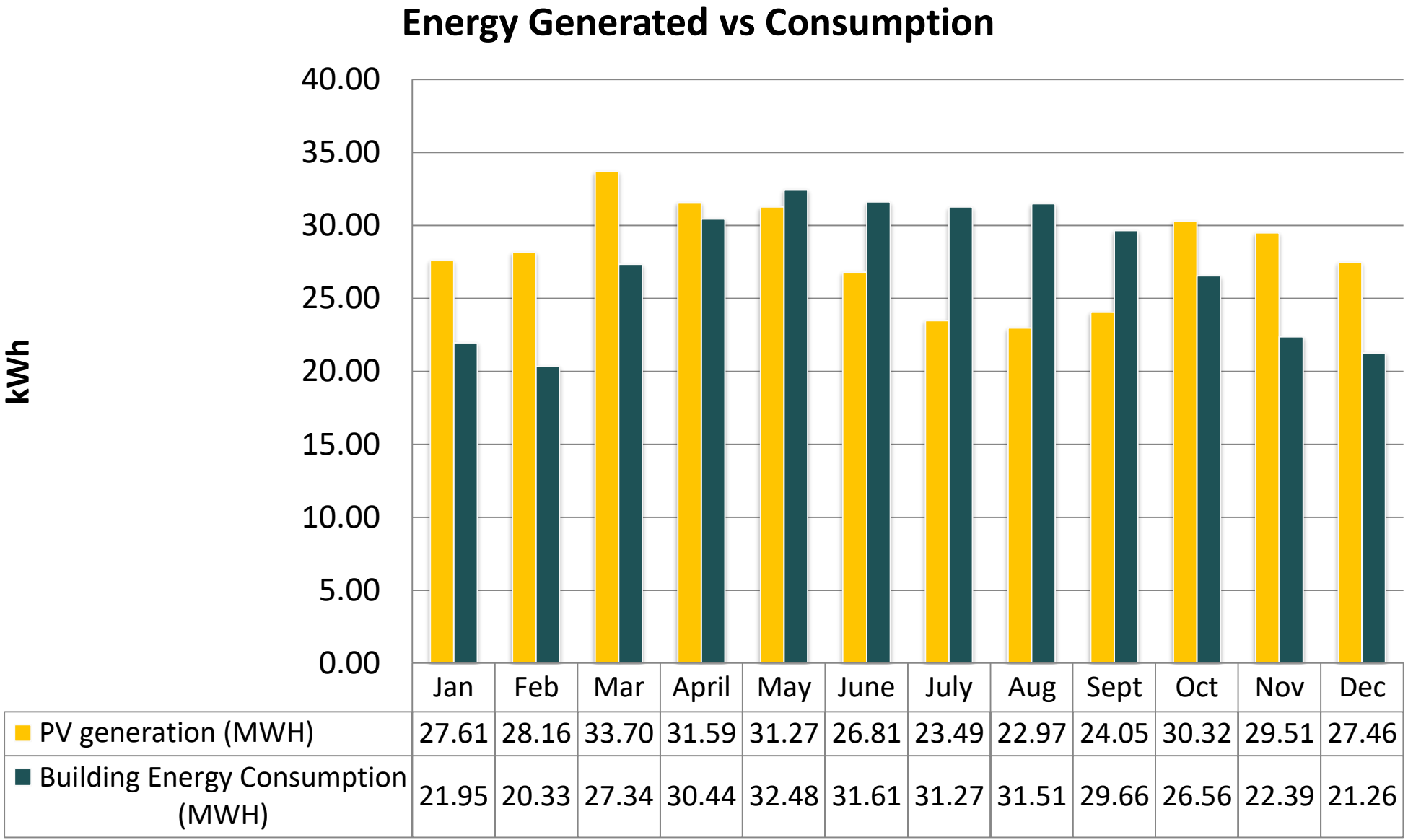
	LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	PUMPS & AUX	VENT FANS
Efficient equipment	58218	73053	1066	64780	1587	128514
HVAC - VRV and BEE 5 star split A/C	58218	146106	238	71758	1587	128690
Efficient lighting, Occupancy and Daylight sensors	58671	146106	11	135815	1587	189899
Wall and Roof Insulation, Efficient glazing and shading	190728	146106	0	155728	1587	189965
EAT	190728	146106	2302	183726	1587	191593
Orientation @ 45 deg to North and Space Adjustment	190728	146106	12432	370642	1581	236091
As Is Desgin Case	190728	146106	10443	433651	2372	289188

WHOLE BUILDING ENERGY SIMULATION



	As Is Desgin Case	Orientation @ 45 deg to North and Space Adjustment	EAT	Wall and Roof Insulation, Efficient glazing and shading	Efficient lighting, Occupancy and Daylight sensors	HVAC - VRV and BEE 5 star split A/C	Efficient equipment
Savings W.R.T Previous case		10.71%	25.22%	4.46%	22.22%	23.58%	19.52%
Savings W.R.T As Is Case		10.71%	33.24%	36.21%	50.39%	62.09%	69.49%

WHOLE BUILDING ENERGY SIMULATION



	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
PV generation (MWH)	27.61	28.16	33.70	31.59	31.27	26.81	23.49	22.97	24.05	30.32	29.51	27.46
Building Energy Consumption (MWH)	21.95	20.33	27.34	30.44	32.48	31.61	31.27	31.51	29.66	26.56	22.39	21.26

CASE STUDIES

CASE STUDY

First Energy Efficient Govt. Building in Uttar Pradesh

Project	UPERC Office Building , Lucknow
Location	Vibhuti Khand, Gomti nagar, Lucknow
Total Project Area	5288 sqm
Number of buildings and designation	Single building
Type of building	Office building
Climate	Composite
Occupancy	5 days a week, Daytime occupancy

EPI- Comparison

- The alternative that captures the “standard” design or minimum requirements for a project is called the "base case.” The base case for this analysis has been devised using ECBC.
- Based on the energy consumption, annual Energy Performance Index will be calculated for base case and for each option in kWh/m2/year.
- The base case EPI was found to be **123.2 kWh/m2/year** based on an area of 5288 m2. The EPI was found to be **86.67 kWh/m2/year**, 100.75 kWh/m2/year and 109.5 kWh/m2/year for Option 1, Option 2 and Option 3 respectively.
- EPI of Option1, Option 2 and Option 3 after considering the energy generated from SPV are equal to **67.7 kWh/m2/year**, 81.9 kWh/m2/year and 90.7 kWh/m2/year respectively.
- The alternative that captures the “standard” design or minimum requirements for a project is called the "base case.” The base case for this analysis has been devised using ECBC.

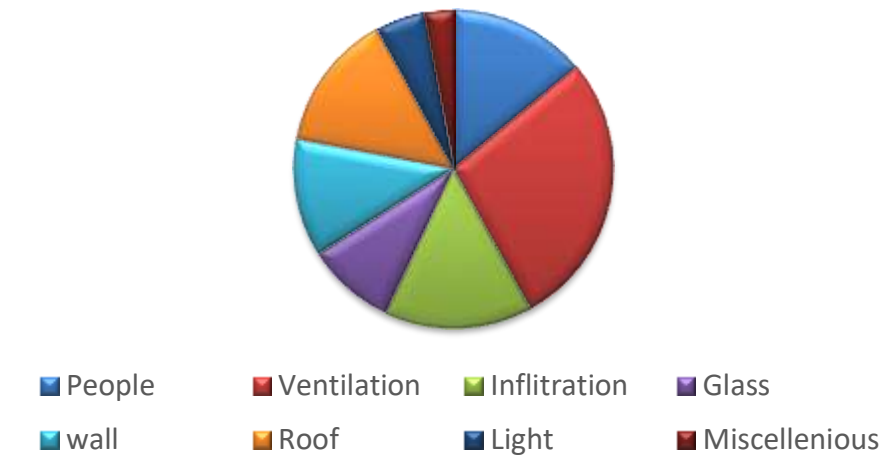
Heat Gain Analysis

- Based on the energy consumption, annual Energy Performance Index (EPI)will be calculated for base case and for each option in kWh/m2/year as below:-

EPI (kWh/m2/year)	Base Case kWh/m2/year	Option 1	Option 2	Option 3
Without SPV Plant	123.2	86.67	100.75	109.5
With SPV Plant	123.2	67.7	81.9	90.7

As shown in figure, maximum heat gain is through wall and roof, so we had to propose changes to the building envelope to reduce heat gain through building materials and for better efficiency and energy savings.

Building Components	Materials	U VALUE IN W/sqm. K
Wall	230mm Brick Wall	1.9
Glazing	ET 150	5, SC-0.58
Roof	150 mm RCC Roof	2



U-Value of Components

Component	Option 1	Option 2	Option 3
Wall	Wall Assembly detail: 1. Outside plaster 15 mm 2. External AAC wall 200 mm 3. Inside Cement Plaster 12mm 4. XPS Insulation 50mm Wall U Value: 0.305 W/m2K	Wall Assembly detail: 1. Outside plaster 15 mm 2. External Fly brick wall 230 mm 3. XPS Insulation 100 mm 4. Inside plaster 12 mm Wall U Value: 0.197 W/m2K	Wall Assembly detail: 1. Outside plaster 15 mm 2. External Clay brick wall 230 mm + 100mm cavity + 230mm CLAY Brick Wall 3. Inside plaster 12 mm Wall U Value: 0.221 W/m2K
Roof	Roof Assembly detail: 1. RCC roof Slab 125 mm 2. PUF Insulation 50mm thick 3. Suitable water proofing membrane 4. Screed Plaster 40mm 5. Internal Ceiling Plaster Roof U Value: 0.33 W/m2K	Landscaped terrace 1. RCC Slab 2. PCC 75 mm 3. Water Proofing sheet 4. Gravel 100 mm 5. Geo fabric membrane 6. Sweet Soil Roof U Value: 1.05 W/m2K	Roof Assembly detail: 1. RCC roof Slab 2. PCC 40mm 3. Suitable water proofing membrane (negligible effect on thermal conductivity) 4. Tile 20mm Roof U Value: 2.05 W/m2K

Comparative Analysis

Component	Option 1: As-is case	Option 2	Option 3
Wall	1. Outside plaster 15 mm 2. External AAC wall 200 mm 3. Inside Cement Plaster 12mm 4. XPS Insulation 50 mm	1. Outside plaster 15 mm 2. External Fly Ash wall 230 mm 3. Inside plaster 12 mm 4. XPS Insulation 100 mm	1. Outside plaster 15 mm 2. External Clay Brick wall 230 mm + 100mm cavity +230 mm clay brick wall 3. Inside plaster 12 mm
Roof	1. RCC roof Slab 125 mm 2. PUF Insulation 50mm thick 3. Suitable water proofing membrane 4. Screed Plaster 40mm 5. Internal Ceiling Plaster 6mm	Landscaped terrace 1. RCC Slab 2. PCC 75 mm 3. Water Proofing sheet 4. Gravel 100 mm 5. Geo fabric membrane 6. Sweet Soil	1. RCC roof Slab 2. PCC 40mm (1:2:4) 3. 50mm screed 4. Tile 20mm
Glass	SKN 744II	Planitherm - Mint Green (PLT TG) Planilux	Envision 765II, Planilux (Clear Glass)

Comparative Analysis

Component	Option 1: As-is case	Option 2	Option 3
HVAC	VRV system for the entire building	Radiant cooling with Chilled Beams for the entire building	Chilled Water System
Lighting	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area
Renewables	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)
EPI	67.7 kWh/m2/year	81.9 kWh/m2/year	90.7 kWh/m2/year
Savings	51%	41.5%	35.1%

Cost Analysis

Component	Base Case	OPTION 1	OPTION 2	OPTION 3
WALL	230mm Brick Wall Volume = 640 cu m Rate = Rs 5667.55/ cu m Cost =Rs 36,27,232 [Ref : DSR 2014 6.4.1]	1.AAC Wall 200 mm 2.XPS Insulation 50 mm AAC Volume = 640 cu m Rate = Rs 6386.95/ cu m Cost =Rs 40,87,648 XPS Area = 2469.4 sqm Rate = 1056 sqm Cost = Rs 26,07,686.40	1.Fly Ash Wall 230 mm 2.XPS Insulation 50 mm FLY ASH Volume = 640 cu m Rate = Rs 6386.95 / cu m Cost =Rs 40,87,648 XPS Area = 2469.4 sqm Rate = 1056 sqm Cost =Rs 26,07,686.40	230mm Brick Wall + air gap + 230mm Brick Wall Volume = 1280 cum Rate = Rs 11335.1/ cu m Cost =Rs 72,54,464 [Ref : DSR 2014 6.4.1]

Cost Analysis

Component	Base Case	OPTION 1	OPTION 2	OPTION 3
ROOF	150 RCC Roof No insulation	PUF Area = 713 sqm Rate = 907.36 Rs/sqm Cost =Rs 6,46,947.68 [Ref : Market Rates]	150 RCC Roof + Terrace garden No Insulation	150 RCC Roof + 20mm Tile Area = 2469.4 sqm Rate = 300 Rs/sqm Cost = Rs 7,40,820
GLASS	ET 150 Area = 375 sqm, Rate = 1300 Rs/sqm Cost = Rs 4,87,500	SKN 744II Area = 375, sqm Rate = 3100 Rs/sqm Cost = Rs 11,62,500	PLT TG Area = 375, sqm Rate = 2500 Rs/sqm Cost = Rs 9,37,500	ENVISION 765 Area = 375 sqm, Rate = 3100 Rs/sqm Cost = Rs 11,62,500
HVAC	Package type AC Tonnage = 200 TR Rate = 32,000 Rs/TR Cost =Rs 64,00,000 [Ref : CPWD Plinth Area, E & M]	VRV System Tonnage = 200 TR Rate = 55,000 Rs/HP Cost = 1,35,74,000 Rs [Ref :CPWD Plinth Area, E & M]	Radiant Cooling System Tonnage = 200 TR Rate = 1,20,000 Rs/TR Cost = 2,40,00,000 Rs [Ref : CPWD Plinth Area, E & M]	Chilled Water System Tonnage = 200 TR Rate = 1,05,000 Rs/TR Cost = 2,10,00,000 Rs [Ref : CPWD Plinth Area, E & M]

Cost Analysis

Component	Base Case	OPTION 1	OPTION 2	OPTION 3
Lighting Cost	18,56,000 Rs	30,44,600 Rs	30,44,600 Rs	30,44,600 Rs
Cost Of Occupancy Sensors	0	Rate = 4447 Rs/ Unit Cost = 25* 4447 = Rs 1,11,175 [Ref : DSR 2014]	Rate = 4447 Rs/ Unit Cost = 25* 4447 = Rs 1,11,175 [Ref : DSR 2014]	Rate = 4447 Rs/ Unit Cost = 25* 4447 =Rs 1,11,175 [Ref : DSR 2014]
Overall Energy consumption	956.25 x 10^3 KWH/Yr (9,56,250 units)	557.02 x 10^3 KWH/Yr (5,57,020 units)	594.7 x 10^3 KWH/Yr (5,94,700 units)	620.3 x 10^3 KWH/Yr (6,20,300 units)
Overall Cost	1,23,70,732 Rs	2,52,34,557 Rs	3,47,88,609.40 Rs	3,33,13,559 Rs
Extra Cost Incurred	0	1,28,63,825 Rs	2,24,17,877.40 Rs	2,09,42,827 Rs
Saving/annum	0	27,94,610 Rs	25,30,850 Rs	21,34,650 Rs

Payback period

OPTIONS	Energy Savings (KWH/Yr)	Money on Electricity bill saved Each Yr (Rs)	Extra Cost Incurred (Rs)	Payback Time (Years)
Option 1	399.23 x 10^3 (51%)	27,94,610	1,28,63,825	4.6
Option 2	361.55 x 10^3 (41.5%)	25,30,850	2,24,17,877	8.8
Option 3	335.95 x 10^3 (35.1%)	21,34,650	2,09,42,827	9.8

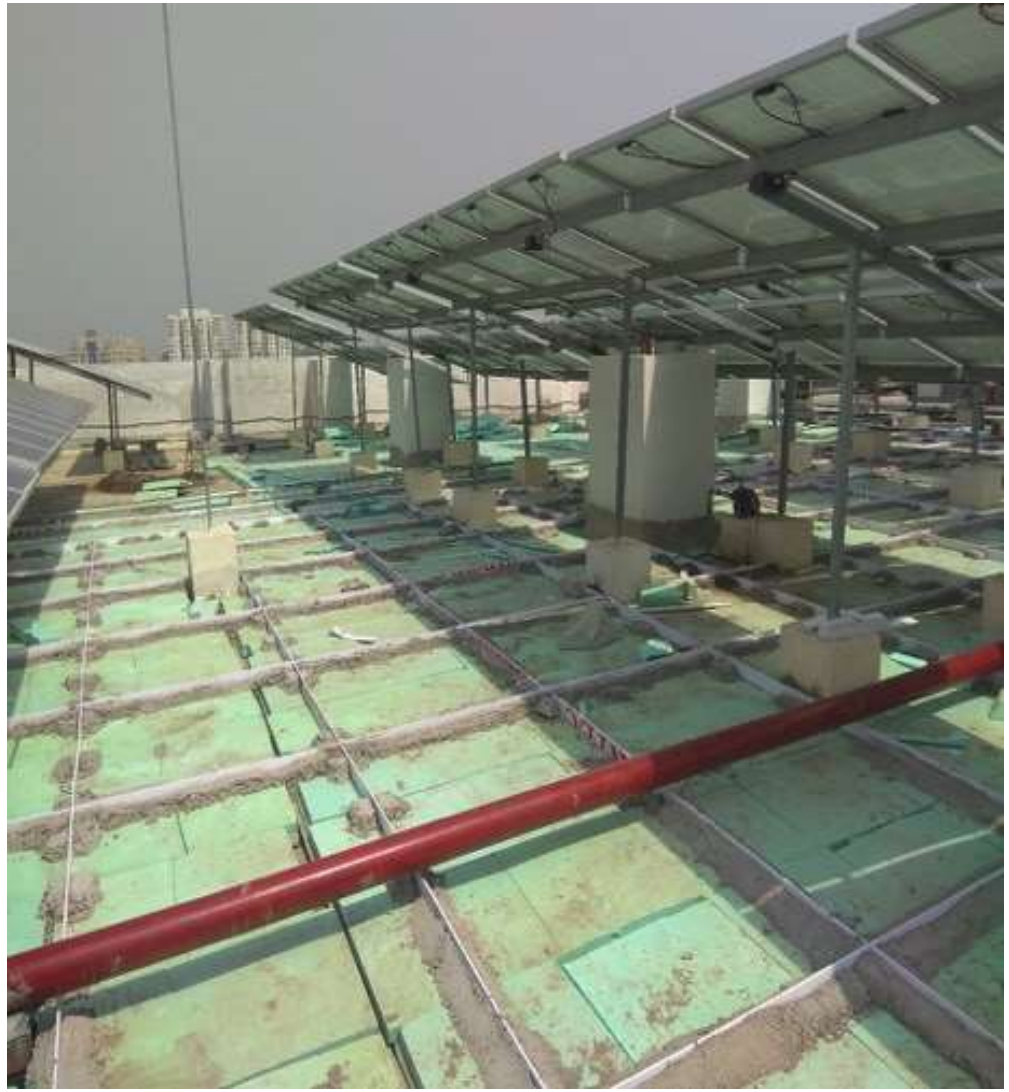
CONSTRUCTION STAGE AT WHICH PROJECT WAS SELECTED

XPS INSULATION FOR WALLS

XPS is being placed in the paneling for wooden interior and on other area covering it with gypsum board

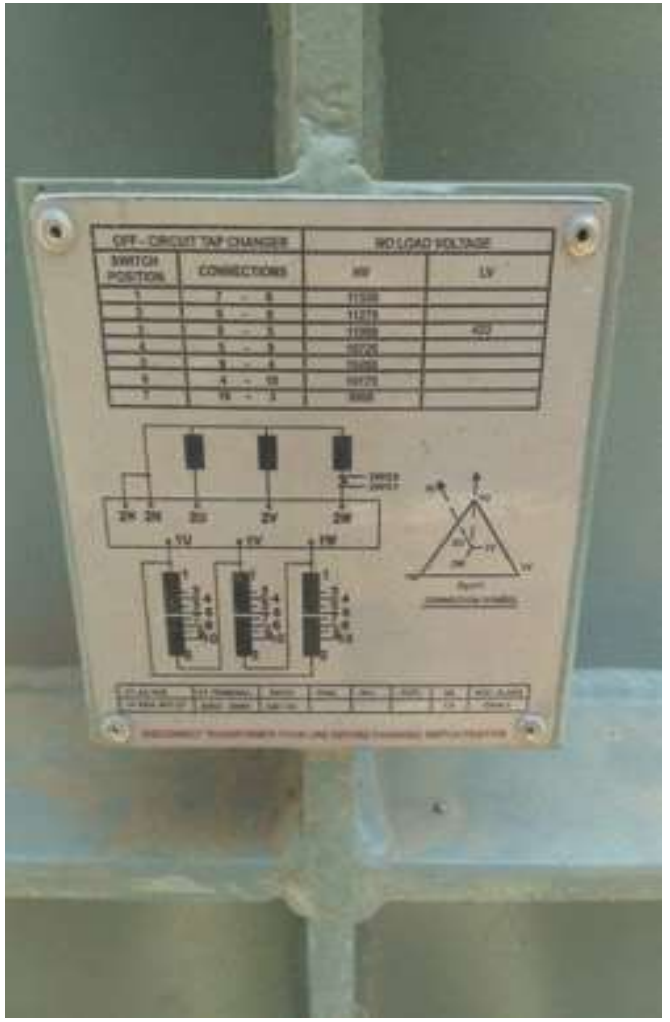
XPS INSULATION FOR WALLS

OVER DECK INSULATION ON ROOF



GLAZING

LEVEL 1 TRANSFORMER



REGENRATIVE LIFT

LED LIGHTS/OCCUPANCY SENSOR

ROOF TOP SOLAR PV PLANT

INAUGURATION

- Inauguration by Honorable Vice-President of India **Shri M. Venkaiah Naidu** in the presence of Honorable Governor of Uttar Pradesh **Shri Ram Naik** and Chief Minister **Shri Yogi Adityanath.**
- **Rated 5 star by Green Building Rating Agency**

Actual EPI of UPERC Building

S.No.	Year	Month	Electricity Consumption As per Electricity bill (KWH)	Built-up Area (m^2)	EPI kWh/m2/year
1	2019	January	15596	5288.00	36.09
2	2019	February	5700		
3	2019	March	11324		
4	2019	April	19020		
5	2019	May	28752		
6	2019	June	20364		
7	2019	July	23952		
8	2019	August	16464		
9	2019	September	15004		
10	2019	October	10160		
11	2019	November	8996		
12	2019	December	15540		
			190872		

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