ECBC Implementation Experience-A CASE STUDY

Energy Conservation Building Codes (ECBC)

Presented By:-

ECBC CELL
UPSDA,LUCKNOW

ECBC INTRODUCTION

- ECBC sets minimum energy efficiency standards for design and construction of commercial building
- ECBC encourages energy efficient design or retrofit of building so that
  - Does not constrain the building function, comfort, health, or the productivity of the occupants
  - It has appropriate regard for economic consideration
- Address local design conditions and help improves existing construction practice
- Emphasis on integrated building design approach
- First generation code-ease of use and continues improvement.
- Under the section 15 of Energy Conservation Act 2001, state government is supposed to issue Energy Conservation Building Code (ECBC) for efficient use of energy and conservation.

BUILDINGS CRITERIA IN ECBC

The Code is applicable to buildings or building complexes that have-

- a connected load of 100 kW or greater
- a contract demand of 120 kVA or greater.
- having conditioned area of 500 m2 or more.

APPLICABLE BUILDING SYSTEMS

The provisions of the Code apply to:

- Building envelopes, except for unconditioned storage spaces or warehouses
- Mechanical systems and equipment, including heating, ventilating, and air conditioning (HVAC)
- Service hot water heating
- Interior and exterior lighting
- Electrical power and motors

CASE STUDY-UPERC BUILDING

First Energy Efficient Office 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

FIRST DEMO BUILDING

- Selection of the government building-The building needed for demo building was a government building so that we could set an example for the private sector to make ECBC compliance buildings on larger scales.
- Motivating the building owner-Many rounds of meeting took place with the building owner explaining the benefits of ECBC compliance building in terms of energy saving, financial viability of the project was showcase to them with payback period.
- Motivating the construction agency-Since ECBC was new to the state so its was a major task to explain the techniques used in ECBC compliance building and how to implement. The materials used in the building was also new to them.
- Coordinating between the building owner and the construction agency while implementing ECBC material in the building.

UPERC BUILDING

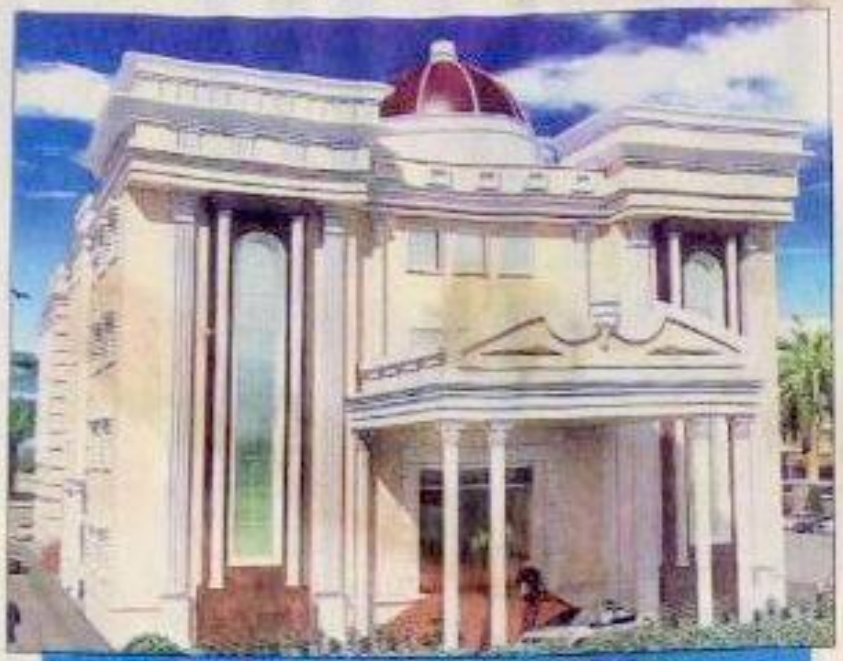
आकार लेने लगी पहली ग्रीन बिल्डिंग

रूमा सिन्हा, लखनऊ

गोमती नगर के विभूति खंड में मंत्री आवास के निकट निर्माणाधीन विद्युत नियामक आयोग सूबे की पहली 'ग्रीन बिल्डिंग' होगी। पांच मंजिला इस इमारत में पारंपरिक बिल्डिंग के मुकाबले तीस फीसद कम एनर्जी खर्च होगी। उ.प्र. राजकीय निर्माण निगम द्वारा नेडा की देखरेख में बनाई जा रही इस बिल्डिंग का निर्माण अगले वर्ष तक पूरा होने की उम्मीद है।

बताते चलें कि सरकार प्रदेश में जल्द एनर्जी कंजरवेशन बिल्डिंग कोड (इसीबीसी) लागू करने की तैयारी में है। इसके तहत प्रदेश में 500 वर्ग मीटर से अधिक क्षेत्र में बनने वाली सभी इमारतों के लिए कोड के तहत निर्माण अनिवार्य होगा। दरअसल केंद्र सरकार के ब्यूरो ऑफ एनर्जी एफीशियंसी द्वारा देश के सभी राज्यों में अनिवार्य रूप से ग्रीन बिल्डिंग कोड लागू किए जाने हैं। बताया जा रहा है कि उत्तर प्रदेश में भी कोड तैयार कर लिए गए हैं, जिन्हें कैबीनेट से मुहर लगने के बाद लागू कर दिया जाएगा।

नेडा को इसके लिए नोडल विभाग बनाया गया है। यही नहीं ब्यूरो द्वारा यहां तीन सलाहकार भी नियुक्त किए गए हैं जो ग्रीन बिल्डिंग बनाने में सहयोग करेंगे। परियोजना अधिकारी राम कुमार बताते हैं कि इसीबीसी के तहत 500 वर्ग मीटर क्षेत्रफल में बनने वाली इमारतों को ग्रीन बिल्डिंग बनाना अनिवार्य होगा। इसके लिए नेडा हर तरह की तकनीकी सलाह उपलब्ध कराएगा। कर्नाटक, आंध्र प्रदेश, पंजाब, पांडीचेरी, राजस्थान में पहले से ही इसीबीसी लागू किया जा चुका है और जल्द उत्तर प्रदेश में भी इन्हें लागू करने की तैयारी है।



विद्युत नियामक आयोग के भवन का प्रस्तावित मॉडल

आर्किटेक्ट अविनाश घई बताते हैं कि विद्युत नियामक आयोग की बिल्डिंग में ग्रीन बिल्डिंग के सभी मानकों को शामिल किया गया है। उन्होंने बताया कि ऐसी बिल्डिंग में एनर्जी की खपत बहुत कम होने के साथ, ताजे पानी का न्यूनतम उपयोग, नॉन टॉक्सिक व रिसाइकिल्ड चीजों का इस्तेमाल किया जाता है। इससे घर के भीतर की हवा भी शुद्ध बनी रहती है। यही वजह है कि इन बिल्डिंग को ग्रीन बिल्डिंग कहा जाता है।

पुरानी बिल्डिंग को भी कर सकते है 'ग्रीन'

केवल नई इमारतों में ही नहीं बल्कि पुरानी बनी इमारतों को भी ग्रीन बिल्डिंग में तब्दील किया जा सकता है। इसके लिए नेडा व ब्यूरो ऑफ एनर्जी एफीशियंसी निशुल्क सलाह देंगे।

प्रदेश में पहला

- एनर्जी कंजरवेशन कोड लागू करने की तैयारी
- अनिवार्य होगा इमारत को 'ग्रीन' बनाना

क्या है ग्रीन बिल्डिंग

- ग्रीन बिल्डिंग यानी पारंपरिक विधि से बनाई गई बिल्डिंग की अपेक्षा जिसमें 30 फीसद कम ऊर्जा की खपत हो।
- बिल्डिंग का ओरिएंटेशन इस प्रकार से जिससे गर्मी कम महसूस हो।
- केवल एलईडी लाइट्स का ही प्रयोग किया जाए।
- सौर ऊर्जा से बिजली तैयार होने के साथ गर्म पानी के लिए सोलर वॉटर हीटर लगे हों।
- एसी व मोटर स्टार रेटिंग अर्थात ऊर्जा बचाने वाली व लाइट, एसी बंद करने व खोलने के लिए सेंसर लगे हों।

विद्युत नियामक आयोग भवन एक नजर में

■ पांच मंजिला भवन ■ कुल भूखंड एरिया-4089.22 वर्ग मीटर ■ कुल कवर्ड एरिया-8854.6 वर्ग मीटर ■ पार्किंग-142 गाड़ियों के लिए

CASE STUDY-UPERC BUILDING

- 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.

EPI COMPARISION

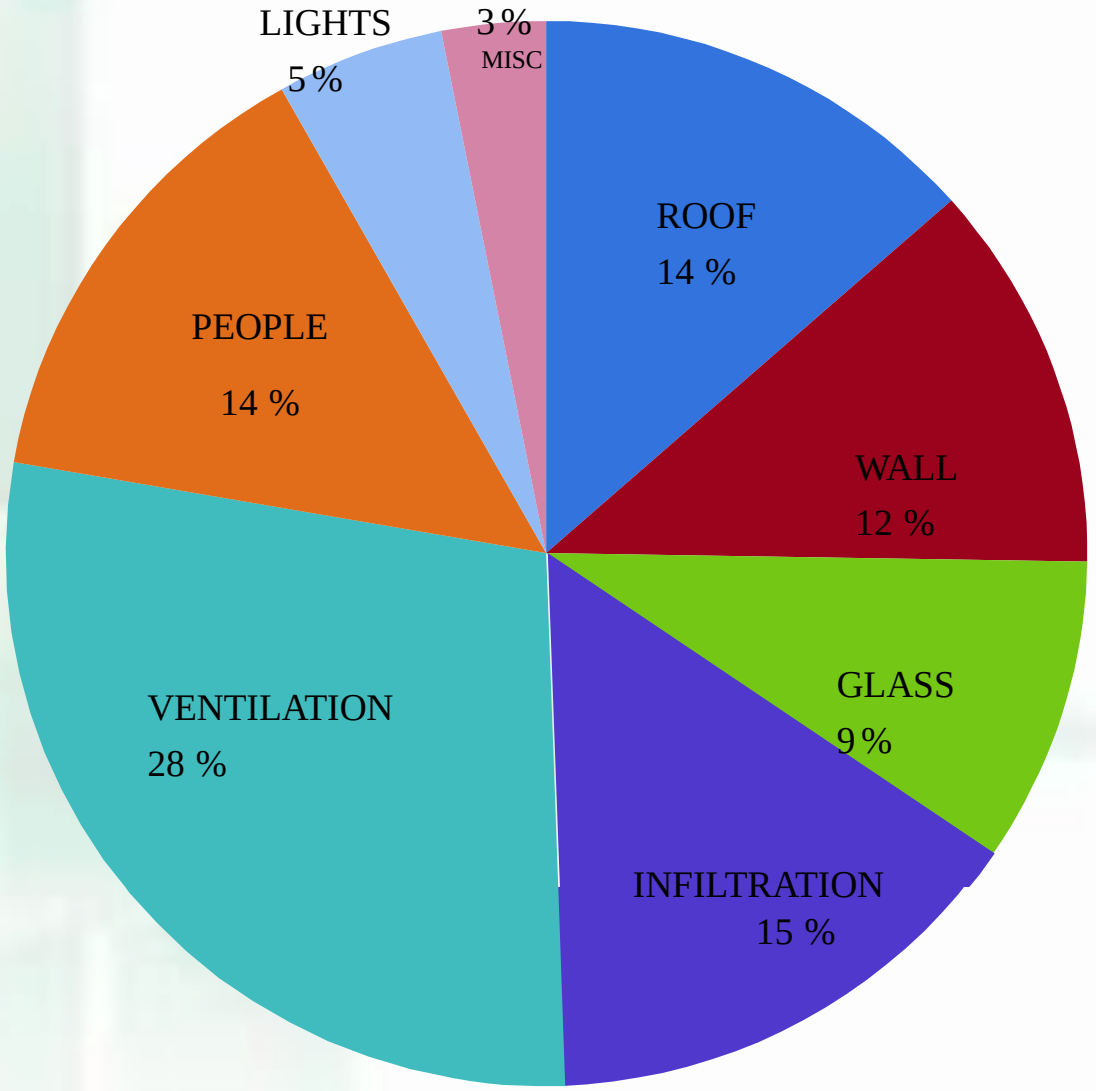
- The alternative that captures the “standard” design or minimum requirements for a project is called the "base case.” The base case for this analysis has been devised using ECBC.
- Based on the energy consumption, annual Energy Performance Index (EPI)will be calculated for base case and for each option in kWh/m2/year as below:-

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

HEAT GAIN ANALYSIS

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 COMPONENT	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: 0.36 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**

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)
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]
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

COST ANALYSIS

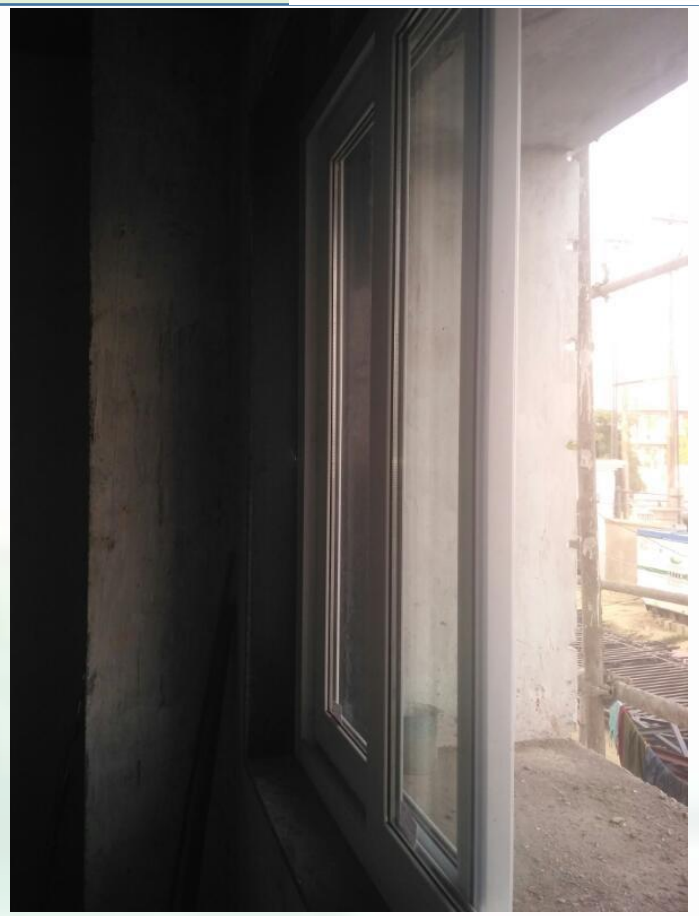
HVAC	Package type AC Tonnage = 200 TR Rate = 32,000 Rs/TR Cost =Rs 64,00,000 [Ref : CPWD Plinth Area, E & M]	VRV System Tonnage = 200 TR Rate = 55,000 Rs/HP Cost = 1,35,74,000 Rs [Ref :CPWD Plinth Area, E & M]	Radiant Cooling System Tonnage = 200 TR Rate = 1,20,000 Rs/TR Cost = 2,40,00,000 Rs [Ref : 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]
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

CONSTRUCTION STAGE



PRESENT STAGE

CHALLENGES IN IMPLEMENTATION OF ECBC

- Cost of the ECBC-compliant building is little higher, so financial justification of incremental cost is sometimes difficult to convince the owner of building.

- Due to involvement of various agencies, takes more time in implementation.

- Inadequate professionals and trained manpower in sector also Lack of knowledge about simulation softwares.

- Non-availability of demonstrated case studies to compare the performance between ECBC compliant and Base Line buildings.

- Limited awareness on availability of ECBC-Compliant materials.

CONCLUSIONS

- Energy Efficient buildings is expected to use about 39% less energy than the national benchmark (110 kWh/m2/year compared with 180 kWh/m2/year).

- Energy Efficient buildings can achieve about 50% energy saving over the baseline design with initial cost increase of 07% to 15% and payback period of 5 to 7 years.

- We can make existing building an energy efficient building through Retrofitting. Energy can be save up to 30%.

- **Special thanks to UNDP-GEF-BEE for providing the 50% of the incremental cost to the building owner, which acted as a boost for them for the adoption of ECBC measures.**

THANK YOU