Session Topic

# GREEN BUILDINGS MAKING FINANCIAL SENSE

Presentation By: Pooja Shukla

## Presentation Structure

- Study to assess financial feasibility of Green Buildings
- Project on Review & Revision of CPWD documents to incorporate Green Features

## Study : Financial Feasibility Assessment of Green Buildings in India

**Objective:** To assess whether green buildings make financial sense

### Case study selection

- 7 green buildings (5 Star GRIHA or LEED Platinum)
- Institutional and Office buildings
- Day use buildings

## Study : Financial Feasibility Assessment of Green Buildings in India

### Methodology

- **Building design, system and cost details collected** (from all the project teams through primary survey, basic thumb rules were used in consultation with subject experts for filling in data gaps)
- **Green case was developed based on the collected data**
- **For conducting comparative analysis, conventional case was established** (Building details and costs of the conventional case were taken in consultation with subject experts and market survey)
- **Various costs associated with the buildings over their life time were calculated**
  - Single costs: Initial investment costs, capital replacement costs and resale value of building
  - Uniform annually recurring costs: Operation & Maintenance costs
  - Non-uniform annually recurring costs: Energy costs of the building
- **Life of building taken to be 25 years**

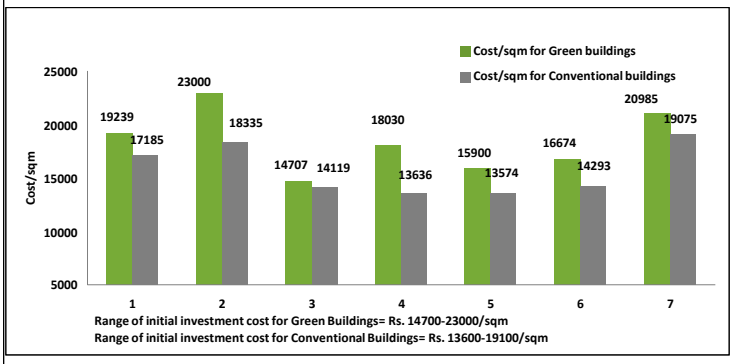
## Study : Financial Feasibility Assessment of Green Buildings in India

### The collected data was analyzed to

- Compare the costs of green buildings with their respective conventional cases.
- Study the factors contributing to the increment in the initial investment costs of green buildings.
- Evaluate the financial viability of incorporating energy efficiency features in buildings with reference to improvement in their energy performance, with use of financial tools like
  - Discounted Payback Period,
  - Life Cycle Cost Analysis,
  - Savings to Investment Ratio

## Study : Financial Feasibility Assessment of Green Buildings in India

### Comparison of Initial Investment Cost (per sq.m.) of Green vs Conventional buildings



## Study : Financial Feasibility Assessment of Green Buildings in India

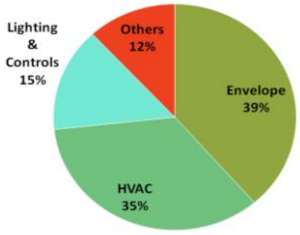
### Increment in Initial Investment Cost of Green vs Conventional Buildings

| Case Study | |
|---|---|
| 1 | 12% |
| 2 | 25% |
| 3 | 4% |
| 4 | 32% |
| 5 | 17% |
| 6 | 17% |
| 7 | 10% |

**Incremental cost ranging from 4-32 %**

## Study : Financial Feasibility Assessment of Green Buildings in India

### Components of Building Cost Increment




| | | |
|---|---|---|
| **Building envelope** | Roof & wall insulation, high performance glazing | **39%** |
| **Systems (HVAC system, Electrical system, BMS)** | Efficient chillers, motors & pumps, VFD, economizers, heat recovery wheel, BMS | **35%** |
| **Lighting& controls** | Energy efficient lamps & fixtures, controls (Daylight & occupancy sensors) | **15%** |
| **Others** | | **12%** |

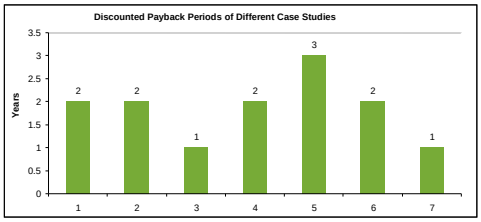
## Study : Financial Feasibility Assessment of Green Buildings in India

# Analysis Results

Life cycle cost of energy efficient buildings is **lower** than conventional buildings

Discounted payback periods ranging from **1 to 3 years**

Savings to investment ratio ranging from **1.9 to 15.3**




# Do Green Buildings Make Financial Sense?

# Yes

# Why is the Question being asked?

## At Present

Green Building = Conventional Building + Green Features

(Conventional = In accordance with general practice, based on established standards/ guidelines)

Conventional needs to be updated

So that

Conventional Building = Green Building

# How do we do it?

**Revise the basis of**

- **Building & system design**
- **Building cost estimation**
- **Building construction**

} **to integrate green**

All across India for building-related works like developing building specifications, preparing estimates, etc. organizations refer to Central Public Works Department (CPWD) documents

So, updating CPWD documents would ensure that energy and resource efficiency becomes part of the conventional building construction process.

# Review and Revision of CPWD Documents to Include Green Parameters

## Objective

To review existing CPWD documents (Specifications, Schedule of Rates, Analysis of Rates, Plinth area rates)

and

Provide recommendations on integration of green building measures in these documents to facilitate ECBC and GRIHA compliance

# Approach

Step 1:To understand the current construction practice adopted by CPWD

Step 2: To assess the existing energy performance of these buildings and then identify energy efficient features required to make these buildings energy efficient -compliant with ECBC and NBC (thermal & visual comfort standards)

Step 3:Review the existing CPWD documents and incorporate green features

# Project Activities

## Assessment of existing CPWD buildings

1. Data collection
   - Secondary (Through project documents)
   - Primary (Through energy survey)
     Building selection criteria:
     - At least 2 buildings of all typologies listed in PAR document should be included-Office, College/ School, Hospital, Hostel, Residential
     - At least 2 buildings from different climate zones of India
2. 13 operational CPWD buildings from all over India were selected
3. Energy Audit of 8 of these buildings was conducted.
4. An assessment of building and system design of these buildings was conducted with respect to energy efficiency.
5. Through computer simulations, energy efficiency features were identified for improving the energy performance of these buildings.

# List of Buildings

| Sl No. | Project name | Location | Climate |
|---|---|---|---|
| 1 | Super Specialty Hospital for Govt. Medical College | Jammu | Composite |
| 2 | Institute of Liver and Biliary Sciences | Delhi | Composite |
| 3 | Trade Centre for STC of India ltd | Bangalore | Moderate |
| 4 | National Sample Survey Organization Building | Lucknow | Composite |
| 5 | CAG's Research &Training Institute Building | Mumbai | Warm & Humid |
| 6 | CAG Building, D.D.U. Marg | New Delhi | Composite |
| 7 | Census Office | Gandhinagar | Hot & Dry |
| 8 | IISER Hostel | Pune | Moderate |
| 9 | Residential quarters | Bikaner | Hot & Dry |
| 10 | Residential quarters | Ahmedabad | Hot & Dry |
| 11 | Dental College at Jamia Milia Islamia University | New Delhi | Composite |
| 12 | Central School, Special Protection Group at Dwarka | New Delhi | Composite |
| 13 | Distance Education Building at Nagarjuna University | Vijayawada | Warm & Humid |

# Project Activities

## Review & Revision of Existing CPWD Documents

1. **CPWD General Specifications for HVAC Works 2004**
2. **CPWD General Specifications for Electrical Works (Internal) 2005**
3. **CPWD General Specifications for Electrical Works part IV (Sub Stations) 2007**

- The documents were reviewed and modifications were suggested (in the soft copy of the existing documents) to incorporate energy efficiency features
- The recommendations for revision of these documents were made in consultation with CPWD officials.
- Various HVAC & Electrical equipment vendors were consulted to collect technical literature on latest feasible technologies available in the market

# Project Activities

4. **CPWD Specifications (Vol.1 & 2) 2009- Civil Works**
5. **Delhi Schedule of Rates 2012**
6. **Analysis of Rates 2012**

- The documents were reviewed and modifications were proposed to incorporate green features
- Detailed specifications of new insulation and masonry items were developed.
- The recommendations for revision of these documents were made in consultation with CPWD officials.

# Project Activities

## Review & Revision of Existing CPWD Documents

**Delhi Schedule of Rates and Analysis of Rates**

- A list of Civil Works related items proposed for inclusion in the Delhi Schedule of Rates, was prepared.
- Several manufacturers of energy efficient products were contacted to collect information on their products including cost related information.
- Based on the information provided by the manufacturers description of each proposed item and their corresponding rates was provided.
- Detailed analysis of rates of each proposed item was also provided.

Analysis of rates of new items.pdf

# Project Activities

## Review & Revision of Existing CPWD Documents

Two additional documents were prepared

1. 'Guidelines for Energy Efficient Building Design'-It provides guidelines for optimized building design for reducing the conventional energy demand of the buildings.

2. 'Energy Efficient Building Envelope'- provides the recommended Thermal transmittance values (U-value) for Wall assembly, roof assembly and glazing as per ECBC requirements. It describes the procedure to calculate U-Value. Examples of some typical wall/roof assembly and glazing options to achieve the recommended U values were given.

# Project Activities

## Revision of Plinth Area Rates: Civil Works

*Step 1: Review project documents and extract items that would be affected if the buildings were to be green*

The project documents (detailed estimates, agreement, final bills, etc) related to civil works collected for CPWD buildings, were reviewed to extract the items that would be affected if these buildings were to be made ECBC and GRIHA compliant.

*Step 2: Calculating the present cost of the items extracted in step 1*

The present cost of the items that would be affected if these buildings were to be made ECBC and GRIHA compliant, was calculated using the latest Delhi Schedule of Rate published in 2012. For items whose cost is not available in DSR 2012, present market rate was taken.

*Step 3: Calculating the present cost of the items extracted in step 1, if they were to be green*

The present cost of the green items, was calculated using the latest Delhi Schedule of Rate published in 2012 and present market rate.

# Project Activities

*Step 4: Calculating the increment in cost by addition of green feature*

The item wise additional cost incurred by addition of energy efficiency and other green features was calculated by subtracting the cost of conventional item from the cost of green item. The total increment in the civil works cost by addition of energy efficiency and other green features was calculated by adding up all the item wise increment in cost.

*Step 5: Normalizing the total project Civil Works cost*

The buildings were selected from all over India and were built in different years, thus, it was required to normalize the building costs as if they were built in Delhi in the reference year. The reference year has been taken as year 2011.

This normalization of cost was done by using cost index values of different cities in different years provided by CPWD.

# Project Activities

*Step 6: Calculating % increment in the cost due to green features*

The total increment in the civil works cost by addition of energy efficiency and other green features, calculated by adding up all the item wise increment in cost (calculated in step 4) was divided by the normalized total project Civil Works cost (calculated in step 5), to get the percentage increment in the cost.

| | Building Name | Typology | Location | Climate | AC/Non AC | Year | % increment in total Civil Works cost |
|---|---|---|---|---|---|---|---|
| 1 | Institute of Liver & Biliary Sciences | Hospital | Delhi | Composite | AC | 2004 | 1.2% |
| 2 | Dental College at Jamia Milia Islamia | College | Delhi | Composite | AC | 2007 | 2.1% |
| 3 | Kendriya Vidyalaya | School | Delhi | Composite | Non AC | 2008 | 3.9% |
| 4 | Residential Quarters | Residential | Ahmedabad | Hot & Dry | Non AC | 2005 | 2.3% |
| 5 | Super Speciality Hospital | Hospital | Jammu | Composite | AC | 2007 | 5.9% |
| 6 | IISER Hostel | Hostel | Pune | Moderate | Non AC | 2007 | 5.8% |
| 7 | Census Office | Office | Gandhinagar | Hot & Dry | Non AC | 2005 | 4.3% |
| 8 | Centre for Distance Education Bldg, Nagarjuna University | College/Office | Vijaywada | Warm & humid | Non AC | 2006 | 7.0% |
| 9 | Residential Quarters | Residential | Bikaner | Hot & Dry | Non AC | 2006 | 6.6% |
| 10 | NSSO Office | Office | Lucknow | Composite | Non AC | 2005 | 5.5% |
| 11 | RTI & Hostel Bldg for CAG | Hostel/ Training Institute | Mumbai | Warm & humid | AC | 2011 | 3.5% |

Increment was in the range of 1.2 to 7%, and an average of **4.4%.**

# Project Activities

**Following are the green measures that were considered while calculating the incremental cost in Civil Works**

## Envelope measures

**Roof**
- Over deck insulation with 50mm Polyurethane foam slab
- Application of high SRI reflective paint on the roof

**Wall**
- Brick work in super structure with Autoclave Aerated Concrete (AAC) blocks
- Half brick masonry in superstructure with fly ash bricks

**Window**
- Non AC buildings: 6mm glass with reflective coating
- AC buildings: High performance double glazed unit

## Paints

- Replacement with low VOC options

## Sanitary fixtures

- Replacement of WC (Indian and European types) with dual flush EWC fittings
- Replacement of conventional pillar cocks with pillar Cocks with infrared sensor and foam flow technology (Only in hospital buildings)

# Project Activities

## PAR - HVAC Works and Lighting Controls

- The present PAR document does not include cost of lighting controls and air conditioning. However, as part of this project, it was suggested to include the cost of these items in the PAR.
- In consultation with Electrical department officials, and with inputs from the manufacturers the
  - Per TR Cost for HVAC works has been worked out for different types of energy efficient air conditioning systems
  - Per unit area cost of lighting controls ( as per ECBC) has been worked out

# Project Activities

## Proposed Plinth Area Rates- HVAC System

Based on the cost data provided by various manufacturers, cost per TR for different types of energy efficient air conditioning systems have been worked out as follows:

| | Type of Energy Efficient Air Conditioning Systems | Cost Per TR |
|---|---|---|
| 1 | BEE rated 5 star unitary air conditioner (Window /Split AC) | Rs. 35000 |
| 2 | Split air conditioner with invertor technology | Rs. 45000 |
| 3 | Variable refrigerant flow/volume (VRF/VRV) with centralized controls | Rs. 65000 |
| 4 | Green centralized air conditioning system* | Rs. 90000 |

***It includes**

- **ECBC compliant chiller machine**
- **EFF1 type motors for chilled water, condenser water pumps and cooling tower, AHU fans.**
- **High efficiency (minimum 75%) chilled water and condenser water pump efficiency.**
- **Variable speed drive on chilled water pumps and AHU fans.**
- **Chiller plant optimizer**

# Project Activities

## Proposed Plinth Area Rates- BMS

Based on the cost data provided by various manufacturers, cost of Building Management System Works has been worked out as follows:

| Type of BMS System | Cost per Input/output point |
|---|---|
| **BMS system with MS conduit** | Rs 10,000 per Input/output point |
| **BMS system with PVC conduit or armoured cable** | Rs 8,000 per Input/output point |

# Project Activities

## Proposed Plinth Area Rates- Lighting Controls

To integrate lighting controls (as per ECBC) in the artificial lighting system, two options have been recommended. Based on the cost data provided by various manufacturers, cost per square feet for lighting controls for both options has been worked out as follows:

**Option 1 ( Localized ON/OFF) - Rs. 10/Sq. Feet**

The lighting control option 1 shall include the following

- Localized control where daylight sensor helps to switch ON/OFF the connected lighting circuit
- Dual (Infrared & ultrasonic) occupancy sensors for major and minor motion or Passive Infrared (PIR) for major motion only.
- Timer control switch (chronological & astronomical programmed) for controlling the lighting system during non- operating hours.
- Remote control to manual override and control the specific group of lighting from a single place.

**Option 2 (Centralized dimming) - Rs. 35/Sq. Feet**

The lighting control option 2 shall include the following

- Centralized control where lighting circuits can be controlled from any place.
- Lighting fixtures shall be equipped with 0-10 V dimmable ballast.
- Dual (Infrared & ultrasonic) occupancy sensors for major and minor motion or Passive Infrared (PIR) for major motion only.
- Timer control switch (chronological & astronomical programmed) for controlling the lighting system during non- operating hours.
- Remote control to manual override and control the specific group of lighting from a single place.
- CAT 6 type control wiring.

## Project Activities

Once all the recommendations get incorporated in the CPWD documents, green features will be inbuilt in the CPWD Specifications and Rates.

The cost of green features will become part of the Project Estimates at all stages.

## Thank You