Features of Energy Efficient Buildings and Relevance to GHG Emission

Webinar : 2 September 2016
Emissions

Perception: Emissions are bad

Perspective: All Emissions are not Bad

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All Emissions are Not Bad

- In nature, emissions is like breathing
  - Humans take almost 7-10 Kg of air / day

- Tree example
  - Gives out oxygen
  - Still grows in abundance

- Question is:
  - How much can we emit?
How Much Did we Emit?

- About 30 Billion tons of CO₂ released into atmosphere every year*
  - 1970s
    - How much oil is left?
  - 2000s
    - Whatever is left, can we burn?

*Source: 'The Ecology of Commerce' by Paul Hawken
Why are we scared of GHG emission?

- Coal is the predominant source of power production
  - 55-60% of total power production
  - 556 Million tones of coal consumption/year
  - GHG India: 1850 Million tonnes

- How much emission?
- Can we continue it?
- Can we tolerate?
  - heat waves
  - increase in global temperature
  - climate change

*Exploring the environment, NASA
http://ete.cet.edu/gcc/?/resourcecenter/slideshow/3/1

Energy reduction in 1 kWh is equal to 3 kWh savings in generation

Energy is one of the major inputs for the Industrial Output & Economic Growth of any country.
Features of
Energy Efficient Buildings
& GHG Emission
Building sector in India

- Building consumes 40% of the total energy
- Contributes 35% GHG emission
- Expected growth in building stock
  - Five fold increase from 21 billion sft in 2005
  - 104 billion sft in 2030

Significant potential for improving energy efficiency in buildings

- India plan to reduce emission intensity
  - 33-35% by 2030 from 2005 level

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Type of buildings?

- Residential buildings
  - Residential society / Multi-dwelling / Individual home
- Commercial buildings
  - Office / IT / ITES / Hospital / Hotel / Data Center
- Industrial building
  - Mfg industries, process load is involved

What is common in all building types?
1. Building envelope (Wall, roof and glass)
2. Lighting
3. HVAC
4. Equipment
How to measure energy efficiency in buildings?

- **Energy Performance Index (EPI)**
  - kWh/ sq m / year

- **Whole building simulation approach**
  - Energy cost/ energy consumption shall be lesser in Proposed case than the Base case

- **Chiller / Cooling**
  - kW/TR or Cool SFT/TR or Cool CFM/TR

- **Lighting**
  - Efficacy (lumen/W)
# Energy Efficiency Measures

## Envelope:
- Orientation
- Roof insulation
- High SRI coating
- Wall insulation
- Efficient glazing (lower SHGC)
- Sun film for glazing in the identified locations

## Lighting:
- Install/retrofitting lighting with LED
- Occupancy sensor
- Daylight sensor
- Voltage stabilizer
- Switching off idle running transformers
- Optimize the load on transformer

## HVAC:
- Selection of energy efficient chillers (<0.55 kW/TR)
- Efficient Motor, Fan and Pumps
- Use of IE2-IE3 motors
- Optimize the loading of chillers
- Adiabatic cooling for air cooled condenser
- Thermostatic expansion valves-EEV
- Installation of online condenser cleaning system
- VFDs pumps and AHU fans
- Installation VFD - cooling tower
- Avoid flow through idle running chillers
- Use of stand cooling towers
- Integration with geothermal based water condensers

## Equipment:
- Use of star rated appliances

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Tools: Energy Efficiency in Buildings

Building Energy Simulation tools:

New Buildings & Existing Building
Energy Efficiency in Buildings

Base case and Proposed case simulation model

Input parameters
- Envelope
- Lighting
- Equipment
- HVAC
- Scheduling

Online - Questionnaire
1. Annexure-1 Project Specifications
2. Annexure-2 IEQ Conditions

Offline - Site visit/questionnaire
1. Architectural drawings
2. HVAC drawings
3. Equipment & system specifications
4. Building envelope specifications
5. Scheduling etc.

Site visit → Data collection → Building Modeling → Simulation Run 1

Mismatch b/w simulation & measured energy consumption → Calibration

Develop "Standard" and "As Is" simulation models

Energy Performance Comparison → Further performance improvements

Economic analysis: ROI and Payback Calculations → Final Recommendations

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Calibration: Existing buildings

- Calibration of simulation model
  - As per protocols of IPMVP, FEMP, ASHRAE 14P

- Building level

- Component/equipment level
Energy Efficiency Measures and benefits

- Energy savings: parametric analysis

0.82 kg of CO2 per kWh
Twice as much as that of the EU
Lighting Energy Efficiency

Retrofitting of existing fixtures by LED fixtures

<table>
<thead>
<tr>
<th></th>
<th>LPD (W/ft²)</th>
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</thead>
<tbody>
<tr>
<td>Base case</td>
<td>1.04</td>
</tr>
<tr>
<td>Proposed case</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Existing Lighting Fixtures
- 72 W/ fixture
- Efficacy : 60
- No of fixtures : 211

Proposed Lighting Fixtures
- 38 W/ fixture
- Efficacy : 132
- No of Fixtures : <100
Retrofitting : Lighting Energy Efficiency

- Lighting energy saving : 52 %
- Cooling energy saving : 4 %
- Cost of fixtures : 5 lacs
- Payback : 3-4 years

Operational cost saving : Rs. 1.5 lacs/ annum
Lighting contour

Wing A
- Maximum lux: 617
- Minimum lux: 34.6
- Mean lux: 270

Wing B
- Maximum lux: 601
- Minimum lux: 33.4
- Mean lux: 255

Overall mean: 262
Optimise: No. of Lighting fixtures

- **Installed lighting fixtures**
  - Installed fixtures: 36 of 74 W
  - Lighting load: 2,664 W

- **Recommended lighting fixtures**
  - No. of fixtures: 24 of 40 W
  - Lighting load: 960 W

- **Savings**: 1704 W

- **Reduction in lighting consumption**: 63 %

- **Annual savings**
  - 1363 KWh (operation 8 hrs x 100 days)
  - GHG reduction: 1172 kg CO2
What needs to be done?

- Intellectual decision in selecting Energy Conservation Measure (ECM)
  - LCA analysis

- Adoption of IGBC Green building rating system
  - Reduction in energy, water & resources
    - Thereby reduction in GHG emission

- Building energy simulation
  - Simulation for new buildings
  - Calibrated simulation for existing buildings
    - Enable better predictions of energy efficiency measures
  - Help in strategic decisions
    - Energy & GHG reduction
  - Approach towards net zero energy/ carbon buildings

- Renewable energy integration

Significant potential in existing building stock

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## Energy Efficiency and Environmental Benefits

<table>
<thead>
<tr>
<th>Environmental Benefit Category</th>
<th>Benefits / Million Sq ft</th>
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<tbody>
<tr>
<td>CO$_2$ reduction</td>
<td>12,000 Tons</td>
</tr>
<tr>
<td>Energy savings</td>
<td>15,000 MWh</td>
</tr>
<tr>
<td>Water savings</td>
<td>45,000 KL</td>
</tr>
<tr>
<td>Construction waste diverted from landfills</td>
<td>450 Tons</td>
</tr>
</tbody>
</table>

- Hospital Dehradun IGBC Gold
- GNRC Hospital Guwahati IGBC Gold

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Go Green....

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