ENERGY EFFICIENCY IN THE BUILDING SECTOR: ADDRESSING THE NATIONAL PRIORITY THROUGH INDIAN GREEN BUILDING INITIATIVES

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I. Introduction:

Infrastructure development of any country is a measure of the country's economic growth. Building sector in India is experiencing a rapid growth (nearly 8-9 % per year) and contributing to the growth of the economy. Increasing the building sector significantly increase the energy demand and hence energy efficiency and conservation becomes a primary concern for energy modellers. Introducing green concepts and practices in the building sector must support important national priorities like Enhanced Energy Efficiency, Water Conservation, Reduction of generation of Waste materials (during construction and in occupancy), Best practices on handling organic and non-organic wastes, Water Conservation, Water Efficiency, Rain Water Harvesting, Preservation of Natural Topography and Lesser usage of virgin materials during construction. Green concepts also realize some indirect benefits like superior air quality, excellent dayligting, health and well-being of the occupants and visitors.

To address the national mission, Indian Green Building Council (IGBC) has propelled a rating system namely "Indian Green New Buildings Rating System" for nearly 25 different building verticals. This rating system encourages to use all possible resources in a self-sustainable manner through **Reduce-Recycle-Reuse-Produce** strategies. The Energy Statistics Report – 2020 released by Ministry of Statistic's and Program Implementation, GoI indicates that the domestic and commercial section alone consumes nearly 32 % (nearly for one third) total electricity consumption which mainly used in lighting, Heating, Ventilation and Air Conditioning (HVAC) system, water pumping motors, electrical and electronics domestic appliances. Reduction of energy efficiency in building sector is highly influenced by the initial design, selection of energy efficient appliances and pattern of usage. Implementation of IGBC rating system ensures the energy savings to the tune of 20-30%. Apart from direct savings on energy and water, IGBC rating system encourages the buildings to segregate the waste at the source itself, use of alternative fuels vehicles for transportation, habit of recycled, reused and rapidly renewable materials which directly reduce the use of virgin materials and recognises adequate ventilation to minimise indoor air pollutants.

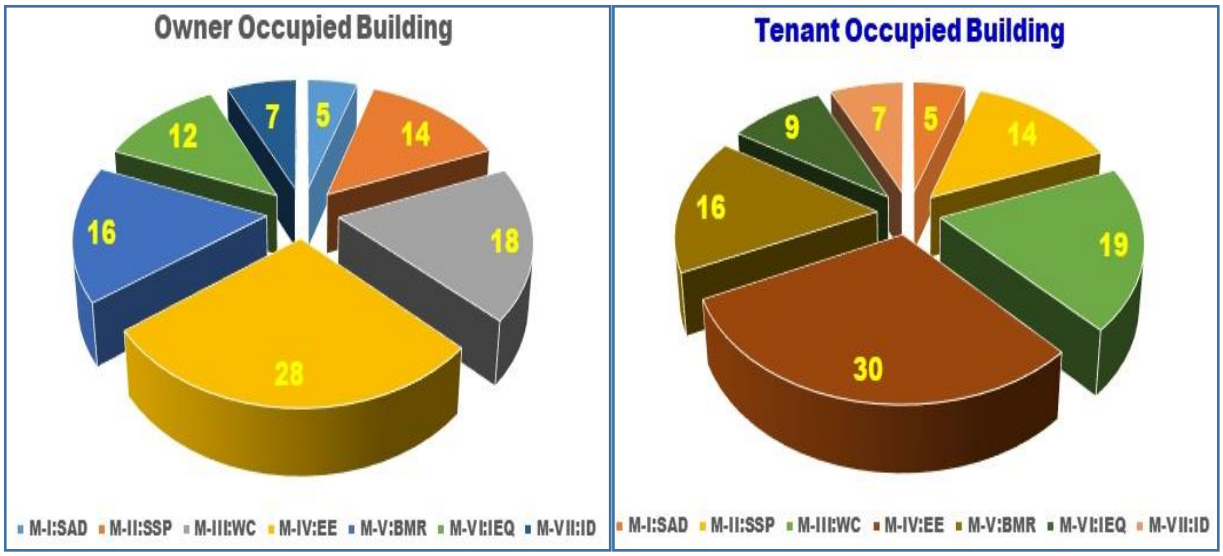
This article mainly focuses on Energy Efficiency measures in Building sector addressing the National importance on energy conservation through Green Building initiatives. Out of the seven prescribed modules proposed by the IGBC; this article concentrates on Energy Efficiency module and emphasis on their procedural implementation.

II. Modules and Respective Credits (both for Owner & Tenant Occupied Buildings):

Table-1 shows the module and their respective credits based on IGBC Green New Building Rating System – Version 3.0 as per abridged reference guide released on September 2016. The total no. of credits are 100 (both for owner and tenant occupied buildings) grouped under seven different modules.

Table-1: Overall Module Description and their Credits

S. No	Module Description	Credits	
		Owner Occupied	Tenant Occupied
1.	Module-I: Sustainable Architecture and Design	5	5
2.	Module-II: Site Selection and Planning	14	14
3.	Module-III: Water Conservation	18	19
4.	**Module-IV: Energy Efficiency**	**28**	**30**
5.	Module-V: Building Materials and Resources	16	16
6.	Module-VI; Indoor Environmental Quality	12	9
7.	Module-VII: Innovation and Development	7	7
Total		**100**	**100**



Graph-1: Representation of Credit Weightages of Individual Modules

From the above table and graph; it is evident that the IGBC new building rating system is generous more on Energy Efficiency as the parameters associated with this module are influenced by both initial and running cost. Implementation of any in-efficient equipment's must increase the running cost for the entire life time of that equipment; which does not ensure the estimated energy savings of nearly 20-30%. In a way, this overall modules show one clear direction to both the Owner operated building and Tenant operated building. Thus fixing the responsibility to each and every one of us, the Owner and the Tenant, to achieve sustainable energy conservation during the total life cycle, by individual and collective contribution towards energy conservation.

III. Emphasis on Energy Efficiency in Module-IV:

Detailed description of Energy Efficiency Module is represented in Table-2. This table summarizes each credit points along with their i) Credit Intention, ii) Compliance options to execute the credits and iii) General points about individual implementation .

Table-2: Summary of Credit Points in Energy Efficiency Module

<table>
<tr><td rowspan="2">1. Ozone Depleting Substances
(OOB: Owner Occupied Buildings
TOB: Tenant Occupied Buildings)</td><td rowspan="2">Credits</td><td>OOB</td><td rowspan="2">Mandatory</td></tr>
<tr><td>TOB</td></tr>
<tr><td colspan="4">Major Points on Energy Efficiency (Not directly related to EE but related to Environment)</td></tr>
<tr><td colspan="4">• Selection of Ozone Depleting Substances for HVAC Application</td></tr>
<tr><td colspan="4">• Selection of Halons free substances for fire suppression</td></tr>
<tr><td rowspan="2">2. Minimum Energy Efficiency</td><td rowspan="2">Credits</td><td>OOB</td><td rowspan="2">Mandatory</td></tr>
<tr><td>TOB</td></tr>
<tr><td colspan="4">Major Points on Energy Efficiency</td></tr>
<tr><td colspan="4">• Total energy consumption should be less than the total base case energy consumption.</td></tr>
<tr><td colspan="4">• Any new IGBC certified building must consume lesser amount of energy and set the energy consumption of the building under baseline criteria.</td></tr>
<tr><td colspan="2">Case-A: Air-Conditioned Buildings:
• Option 1: Building simulation as per ECBC or ASHRAE 90.1-2010 carried out with 24± 2^{0}C.
• Option-2: Prescriptive Approach: as per ECBC or ASHRAE 90.1-2010.</td><td colspan="2">Case-B: Non-AC Buildings: (Prescriptive Approach Only)
Building Envelope: Given importance to i) Solar Heat Gain Coefficient (SHGC), ii) Window Glazing U-Value, iii) Overall Wall Assembly U-Value and iv) Overall Roof Assembly U-Value.
Lighting: LPD (Including lamps and ballasts) should be reduced by min. 10 % over ECBC base case.
Air Conditioning Systems: Considering all unitary ACs with BEE 3-Star rating or COP equivalent to 3.1 or more.
Heating Systems: Heat pumps with a base line COP of 2.5 (for projects more than 150 Heating Degree Days).
Fans: With an efficiency of BEE 3-Star rated or more.
Pumps & Motors: With an efficiency of BEE 3-Star rated or more.</td></tr>
</table>

General Points (Applicable for both Case A & B):

- Energy generated by on-site renewable energy sources can be subtracted from the total annual energy consumption.
- Solar water heating system can be equated as electric water heater.

3. Commissioning Plan for Building Equipment & Systems	**Credits**	**OOB**	**Mandatory**
		TOB	

Major Points on Energy Efficiency

- This credit is not directly related to Energy Efficiency. However it ensure that the building's equipment & systems are commissioned and perform to as per the design values.

4. Eco-friendly Refrigerants	**Credits**	**OOB**	**01**
		TOB	**01**

Major Points on Energy Efficiency

- Not directly related to EE; however it is highly related to environment.
- Also this credit is highly applicable to mechanically ventilated buildings. The HVAC system used in these buildings must select the appropriate refrigerants that should have low ODP and GWP. Also it should have lesser life in the atmosphere.

5. Enhanced Energy Efficiency	**Credits**	**OOB**	**15**
		TOB	**15**

Major Points on Energy Efficiency

- This credit is an upgraded view of Mandatory credit on Minimum Energy Efficiency.

Case-A: Air-Conditioned Buildings

- Design the building to comply with ASHRAE 90.1-2010 and Simulation is to be carried out at comfort temperatures of 24± 2^{0}C.
- Credits points are awarded based on % of energy cost savings (to the maximum of 15)
- Additional facilities like Solar Light pipe – to bring natural light to building.
- BLDC fan to be used for adequate air circulation in AC rooms and other areas.
- HVLS fans to be deployed where the floor area of premises is big in size.
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Case-B: Non-Air-Conditioned Buildings

Building Envelope: Given importance to
i) Solar Heat Gain Coefficient (SHGC),
ii) Window Glazing U-Value,
iii) Overall Wall Assembly U-Value
iv) Overall Roof Assembly U-Value

Lighting: LPD in the building interior, exterior and parking areas shall be reduced by minimum 20% (1 credit) over ECBC base case and for 30 % (2 credits).

Lighting Control: Install at least one of the following system as an energy conservation measures; • Daylight sensor, • Occupancy / Motion sensor
• Timer

	Air Conditioning Systems: Considering all unitary ACs with BEE 5-Star rating or COP equivalent to 3.5 or more. **Heating Systems:** Heat pumps with minimum of 10% efficiency over the base line COP of 2.5 (for projects more than 150 Heating Degree Days). Solar Water Heaters using ETC on first priority **Fans:** With an efficiency of BEE 5-Star rated or more. **Pumps & Motors:** With an efficiency of BEE 5-Star rated or more.		
6. On-site Renewable Energy	**Credits**	**OOB**	**6**
		TOB	**8**
Major Points of Energy Efficiency			
• This credit encourages to use on-site renewable technologies (Solar, Wind, Biomass etc.,) in order to reduce the use of fossil fuel energy. • For OOB: The energy generation from onsite RES is at least 1% (to the max. of 6 %) of the total annual energy consumption of the proposed buildings. • For TOB: Onsite RES is at least 2% (to the max. of 8 %) of the total annual lighting energy consumption of the proposed buildings.			
7. Off-Site Renewable Energy	**Credits**	**OOB**	**2**
		TOB	**2**
Major Points on Energy Efficiency			
• Encourages to use on-site renewable technologies (Compliance with MNRE, GoI) in order to reduce the use of fossil fuel energy.			
Option-1 **For OOB:** The project has to invest in off-site renewable energy equivalent to at least 50% (Max. 100 %) of the total annual energy consumption of the building. **For TOB:** The project has to invest in off-site renewable energy equivalent to at least 50% (Max. 100 %) of the total annual lighting energy consumption of the building.	***Option-2*** **For OOB:** The project has to purchase Renewable Energy Certificates (RECs) equivalent to at least 25% (Max. 50 %) of the total annual energy consumption of the building. **For TOB:** The project has to purchase Renewable Energy Certificates (RECs) equivalent to at least 25% (Max. 50 %) of the total annual lighting energy consumption of the building.		
General Notes:	RECs purchased shall be valid for a period of two years. Also RECs purchased in the last 6 months of building operation can also be		

	Considered for Credit calculation.
	RECs can be either solar or non-solar or both.
	Small hydro power projects with 25 MW or lesser size shall only be considered for this credit.
	RECs must be purchased through an Authorised Agency of exchange (with a legal contract should exist between the Authorised Agency and the Project).

8. Commissioning, Post-installation of Equipment & Systems	**Credits**	**OOB**	**2**
		TOB	**2**

Major Points on Energy Efficiency

- This credit is an upgraded view of Mandatory credit on Commissioning Plan for Building Equipment & Systems.
- Verify and ensure that the building equipment & systems are commissioned to achieve performance as envisaged at the design stage.

9. Energy Metering and Management	**Credits**	**OOB**	**2**
		TOB	**2**

Major Points on Energy Efficiency

- Encourage to provide sub-metering and continuous monitoring for improvement opportunities in building's energy performance.
- As per the BEE mantra; Monitor to Target; this credit enables the project team to continuously monitor their regular energy consumption.

Case-A: Energy Metering	**Case-B: Building Management System**
Provide sub-metering for at least five of the following energy usage: • Interior & Common area lighting • Exterior area lighting • Municipal water pumping • Ground water pumping • Treated waste water pumping • Renewable energy generation	Demonstrate that the building management system is in place to monitor and control the following systems, as applicable: • Air-conditioning management system • Lighting management system • Renewable energy management system • Elevator management system • Fresh air monitoring system • CO_2 control and monitoring system

• Power backup systems (Generators sets, Gas turbines, etc.,) • Elevators, Escalators, Travelators, etc., • BTU meter for chilled water consumption (Applicable for tenant-occupied buildings only) • Any other energy consuming equipment and systems	• Building Energy Management system • Solar water ETC type to Bath rooms and Kitchen areas • Boiler management control for kitchen / canteen purpose • Diesel Generator monitoring and management. • Retrofit Aerators in all the water taps meant for cleaning application so as to reduce water consumption. • Surge Protection system to guard against Switching & Lightning Surges. • ESC Lightning Arrestor system. • Maintenance Free Earth Grid system.
Additional Metering Options	
• Unitary AC to have KWH meter & Run hour meter. • LPG monitoring by weight and flow meter (represented in kg / h). • Monitoring of Water consumption in kitchen / bathrooms usage. • Boiler monitoring and control – for Kitchen and Bathrooms usage. • Fuel consumption for boiler- to account for. • Diesel consumption for the DG set and its Units Per Litre (UPL) monitoring • Heat pump as stand by to Solar water heater instead of Storage water heater	

IV. Benefits of Energy Efficiency Module:

IGBC has a clear vision on promoting Energy Efficiency of any new or existing buildings by implementing the standards strictly. Implementation of such credits not only benefit to conserve energy; but also reduce the impact on environment.

Table-3 provides both tangible and intangible benefits from earned credits (excluding mandatory credits) of Energy Efficiency Modules proposed by IGBC.

Table-3: Tangible and Intangible Benefits of Energy Efficiency Module

S. No	Credit Description	Benefits	
		Tangible	Intangible
1.	Eco-friendly Refrigerants	No direct relation in Energy Efficiency. However eco-friendly refrigerants assist the HVAC utilities to consume less power.	Reduction of environmental impacts (Special intention to Ozone Layer Depletion)

2.	Enhanced Energy Efficiency	Direct energy savings through installation of Energy Efficient Equipment's	Restricts the excessive energy usage and thereby reduce negative environmental impacts
3.	On-site RES	Reduction of usage of conventional energy and to promote RES.	Encourages to promote green energy and minimise the environmental impacts.
4.	Off-site RES		
5.	Commissioning, Post-installation of Equipment & Systems	This credit is available only to inspect whether the project implemented all the measures proposed in the design stage.	
6.	Energy Metering and Management	• Examines the pattern of energy generation and usage • Relative energy monitoring of one or more energy consuming devices	• Identification of improvement opportunities in performance.

V. Codes and Standards Associated with Energy Efficiency:

The credits and their complete descriptions are carefully designed by the IGBC by referring most of the Codes and Standards represented by National and International Energy conservation implementing agencies like ASHRAE (90.1-2010 standard), BEE (selection of energy efficiency star rated equipment's), ECBC codes for whole building performance analysis and MNRE for on-site/off-site and purchase of Renewable Energy Certificates.

VI. Details of Other Modules Assisting Energy Efficiency:

Apart from the dedicated module on Energy Efficiency; IGBC designed equal weightages to other innovative parameters like site selection, water conservation, Indoor air quality etc.,. Table-4 provides an analysis on other credits promoting (either directly or indirectly) energy conservation and energy efficiency.

Table-4: Other Modules Assisting Energy Efficiency

S. No	Credit Description	Recommended Practices under IGBC & Benefits on Energy Efficiency
1.	Passive Architecture (Sustainable Architecture and Design)	Implementation of passive architecture would be able to save at least 2% (Max. 4 %) energy savings of total annual energy consumption.
2.	Heat Island Reduction-Roof (Site Selection and Planning)	Reduction of Heat load on HVAC system and hence potential to save energy (Indirect).
3.	Outdoor Light Pollution Reduction (Site Selection and Planning)	Reduction of LPD by 30 % for building facades and exterior areas as per ASHRAE-90.1-2019
4.	Management of Irrigation System (Water Conservation)	Implementation of efficient irrigation systems must reduce the pumping energy.
5.	Dayligting (Indoor Environmental Quality)	Reduces the requirement of artificial lighting and thereby reduced the energy consumption.
6.	Water Use Reduction for Construction (Developmental Credit)	Reduces the pumping energy requirement during construction.

VII. Conclusion:

IGBC is a holistic approach promoting;

i) Energy conservation

ii) Water conservation

iii) Health and occupant wellbeing

iv) Effective waste handling and disposal

v) Best living standards

Out of all the modules projected by IGBC; Module Energy Efficiency is given higher importance by allotting;

i) Higher credits

ii) Maximum mandatory credits

The demand for energy has grown in Indian building sector and it requires high level of energy intensity. Building sector has to implement efficient use of energy resources, conservation and curtailment of wasteful consumption. IGBC conceptually designed the modules by providing

more significance on energy efficiency in order to emphasis the energy saving as a National importance.

VIII. Abbreviations:

ASHRAE	American Society on Heating Refrigeration and Air Conditioning Engineers
BEE	Bureau of Energy Efficiency
BTU	British Thermal Unit
COP	Coefficient of Performance
IGBC	Indian Green Building Council
HVAC	Heating, Ventilation and Air Conditioning
LPD	Lighting Power Density
OOB	Owner Occupied Buildings
TOB	Tenant Occupied Buildings
MNRE	Ministry of New and Renewable Energy
ECBC	Energy Conservation Building Code
REC	Renewable Energy Certificates
RES	Renewable Energy Systems
SHGC	Solar Heat Gain Coefficient

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