Assessment of Building Energy by Performing Simulation With BIM

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Abstract : Building Energy Performance is the key factor which has its impact on Building Lifecycle Cost as well as another External Environment impact. It is an emerging need to manage the Building Energy use by mapping its existing condition and manage it accordingly. To manage the energy use effectively it is very much required that current energy use pattern of the building must be analysed in proper manner. In this study it is intended to perform Building Energy analysis with respect to different parameters with the help of BIM. Building Information Modelling (BIM) is proving its versatility in various fields of Civil Engineering. With the help of BIM it is possible to perform the analysis with proper tools and it gives reliable results. An informative model of building is developed by using modelling software and then it is further analysed with the help of different software tools available. Results obtained by these analysis processes are then studied to figure out an optimized solution for better energy use by the building. Aim is to optimize the building energy use by suggesting and implementing various alterations to the building, change in user behaviour in order to make it sustainable as well as reducing cost of building energy use.

***Index Terms - BIM, Building Energy Analysis, Sustainability*.**

I. INTRODUCTION

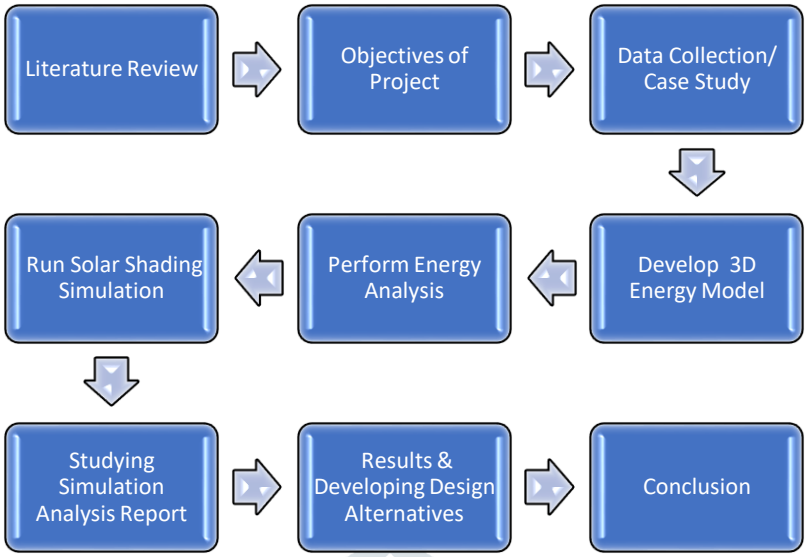
The importance of analyzing energy performance in building design is growing, because of the increasing awareness of its role in building life cycle costs and environmental impacts. However, energy analysis is still mostly done by statistical estimates or using simple static calculations. By utilizing BIM as a data source for energy analysis, the data input will be more efficient and the existing data more reusable.

1.1 Building energy analysis:- Building performance simulation (BPS); formerly known as building energy simulation or building energy modeling is the use of software to predict performance aspects of a building. The objective is to create a virtual model that is sufficiently accurate to form a useful representation of the actual building. BPS forecasts the various energy and mass flows within a building, in order to evaluate one or several performance aspects using computer simulation. Energy analysis in building design has to meet both the cost and schedule requirements of practical projects.

The main barrier of wider usage of dynamic energy analysis methods has been the required big manual input work. Most of the building element specific information needed in energy simulation is described in the building information model (BIM). It also makes possible to benefit spatial whole building models instead of zone based models often used today in energy simulation. Only by using BIM, the verification of energy performance can truly happen in different phases of the building process. Buildings are large consumers of energy and are therefore prime candidates for conservation activities hence alternative building design strategies should be explored and their impact on energy consumption should be assessed. Building energy analysis is the most effective mean to evaluate alternative energy conservation opportunities (ECOs). Such analysis in the early design phases of a project will help forecast the thermal performance of buildings and explore alternative energy conservation measures, therefore, saving operating cost and helping the environment due to less energy use.

1.2 Energy Simulation:- With the expanding interest in energy-efficient building design, whole building energy simulation programs are increasingly employed in the design process to help architects and engineers determine which design strategies save energy and are cost-effective. It is crucial to understand the limitations of different tools in order to successfully integrate building performance analysis in early stages of the design process, as well as capabilities of different software programs for modeling different energy-efficiency design strategies. Simulation models are flexible tools that can be used effectively for analyzing the behavior of systems. A simulation model is normally used to produce a set of selected measures that reflect the performance of the simulated system. In simulation models, the relationships between input and output are implicitly expressed through model sub-systems that are logically linked to one another. In building design, simulation models are used to evaluate the performance of building systems with given predetermined values for the associated design variables. A great deal of information can then be obtained for evaluating the performance of the building system under given conditions.

II. METHODOLOGY



2.1 Details of Case Study :-

- Building Type : Public Building (Hospital or Healthcare)
- Storey : G+4
- Location : Govind Nagar, Nashik, Maharashtra
- No. of Occupants : 50+

2.2 Developing 3D Energy Model :- In order to perform energy analysis for the Hospital building it is required to create a 3D model of building using BIM tool. Building modelling tool Autodesk Revit® has been used to create the informative 3D model of the building.

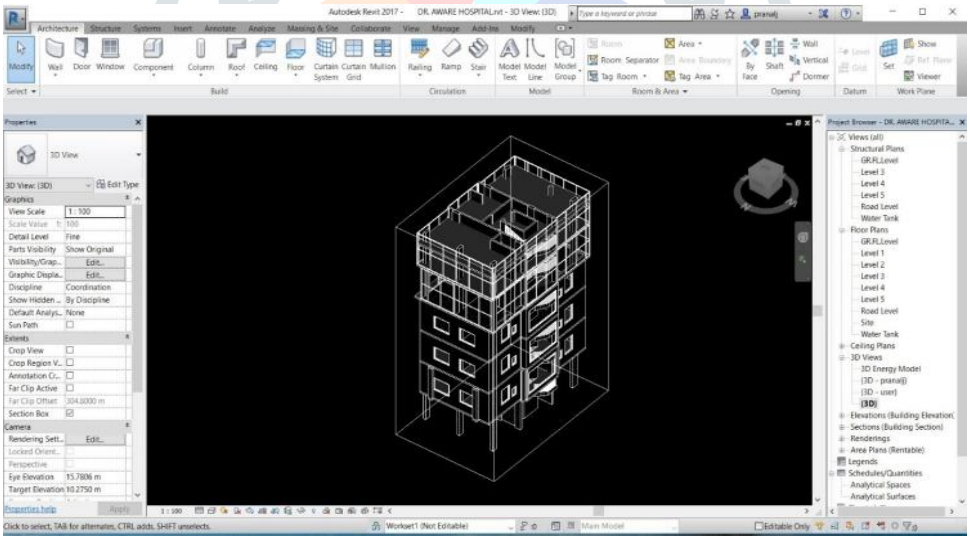


Figure 1. 3D Energy Model

Building Performance Simulation (BPS) in the past known as structure energy simulation or building energy modelling is the utilization of programming to foresee execution parts of a structure. The goal is to make a virtual model that is adequately precise to shape a helpful representation of the genuine structure. BPS estimates the different energy and mass streams inside a structure, so as to assess one or a few performance perspectives utilizing computer simulation. A recreation model is a deliberation of the genuine structure which permits to think about the impacts on abnormal state of detail and to break down key execution pointers without cost-escalated estimations.

Necessary input data for a whole-building simulation:

Climate: ambient air temperature, relative humidity, direct and diffuse solar radiation, wind direction.

Site: location and orientation of the building, shading by topography and surrounding buildings, ground properties

Geometry: building shape and zone geometry

Envelope: materials and constructions, windows and shading, thermal bridges, infiltration and openings

Daylight availability: in certain zone areas, at different time points with variable outside conditions.

2.3 Energy Analysis Setting :- Energy settings control the conduct of the energy model creation. They likewise control the optional utilization of extra data indicated in the Revit model, for example, material properties and heat space properties. When playing out the underlying energy advancement, you don't have to change energy settings. Become familiar with the general worldview of Energy Optimization for Revit before changing the default vitality settings. These are the settings which are to be checked before continuing to reproduction. This vitality setting window has different parameters like Location, Project Phase and so forth.

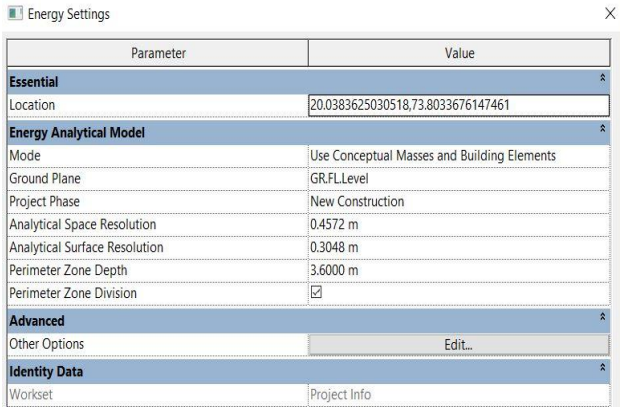


Figure 2. Energy Setting

2.4 Energy Model :- Energy Simulation is the virtual or electronic reenactment of a structure or complex that centers around energy utilization, service bills and life cycle expenses of different energy related things, for example, cooling, lights and boiling water. In the wake of creating 3D building model and applying all the energy settings ; Building Energy Model is made. In this energy model Spaces are made by appropriately characterizing the room boundries and assigning thermal properties to the structure elements. From a physical perspective, a structure is an exceptionally complex framework, impacted by a wide scope of parameters. A simulation model is a reflection of the genuine structure which permits to think about the impacts on abnormal state of detail and to study key performance markers without cost-concentrated estimations.

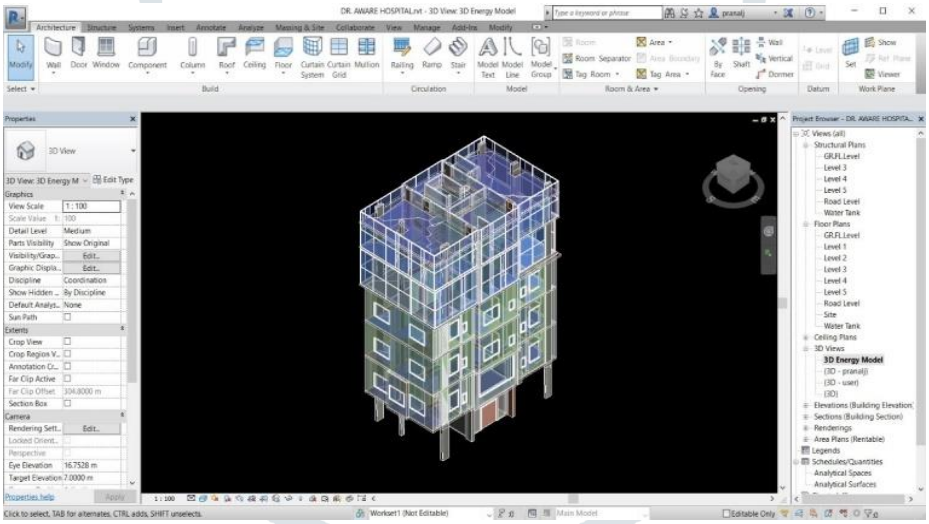


Figure 3. Building Energy Model

2.5 Energy Simulation Report :- Building Energy Simulation reports are generated with the help of Autodesk Green Building Studio® which is an online platform linked to the Autodesk Revit®. Energy Simulations reports are consisting of various parameters and values which gives the idea about existing energy performance of the building. By studying these reports building's existing energy performance can be analysed and design alternatives can also be generated accordingly.

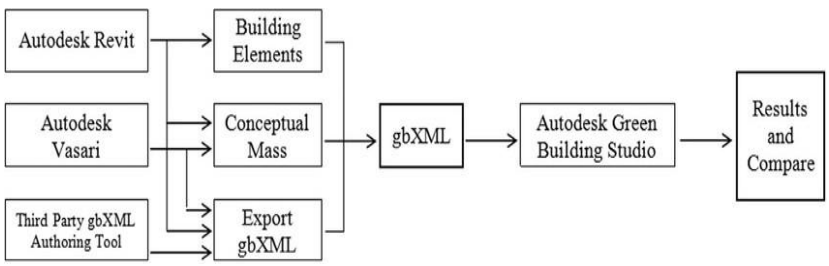


Figure 4. Building Energy Simulation Workflow

III. RESULT AND ANALYSIS

Daylight Simulation is performed by using Autodesk Revit Plug-In Insight; which enables us to study Daylight autonomy of any floor of the building.

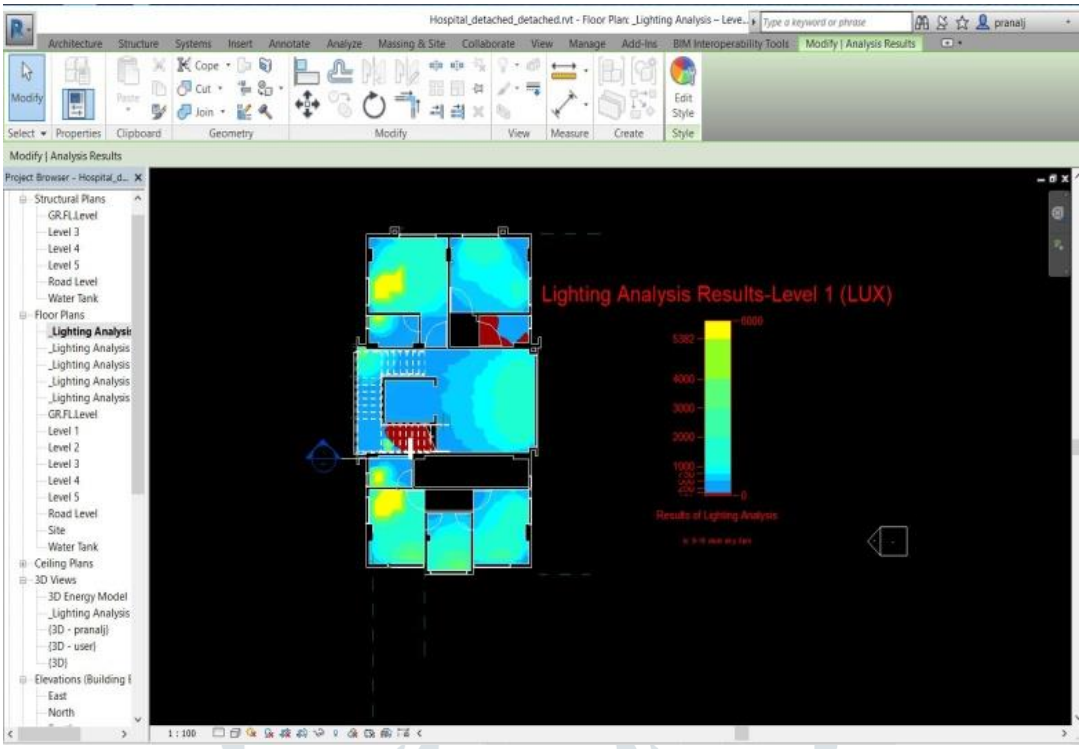


Figure 5. Solar Shading Analysis

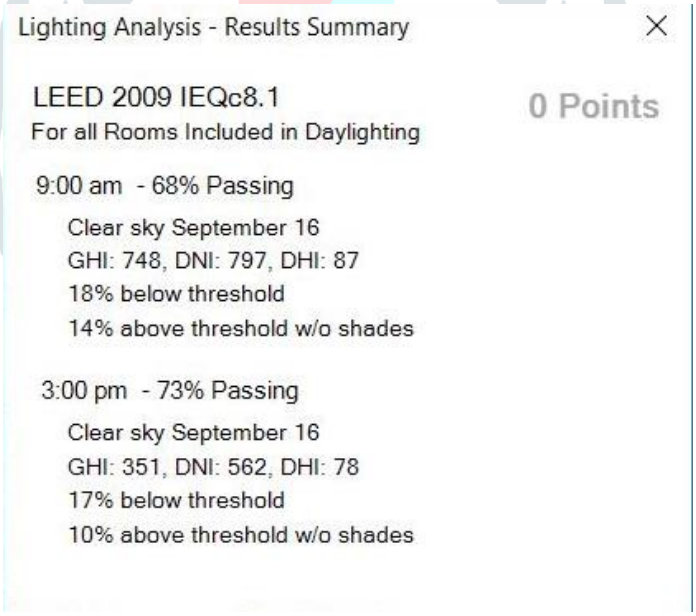


Figure 6. Solar Analysis Summary

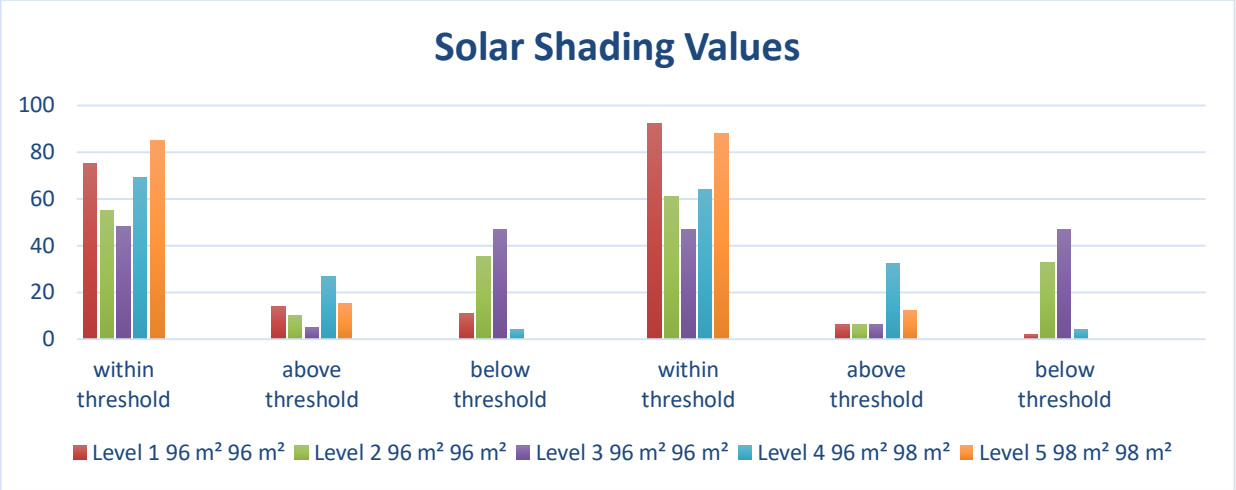


Figure 7. Solar Shading Analysis Values

3.1 Significance of Daylighting Analysis in IGBC Rating System :- The healthcare sector in India is developing at a quick pace and contributing hugely to the development. The division is required to grow a few overlaps in the following decade. There is a fast approaching need to present green ideas and systems in this part, which can help development in a reasonable way. Presenting green ideas in the healthcare sector can help address National issues like disease, pandemics, treatment of bio-restorative waste, water proficiency, vitality productivity, decrease in non-renewable energy source use for driving and all in all protection of regular assets. In particular, these ideas can upgrade patients' well-being, recovery and prosperity. Against this foundation, the Indian Green Building Council (IGBC) has propelled 'IGBC Green Healthcare rating system® to address National needs. This rating program is an instrument which empowers the designer to apply green ideas and reduce ecological effects that are measurable. The rating system likewise covers different climatic zones.

3.2 Benefits of Energy Analysis in IGBC Rating :- Green Hospitals can have tremendous benefits, both tangible as well as intangible. The most tangible benefits are the reduction in water and energy consumption right from day one of occupancy. The energy savings could range from 30 - 40 % and water savings around 20 - 30%. The intangible benefits are improved health and hygiene, enhanced daylight, connectivity with the nature, improved health & hygiene for better infection control, faster recovery of patients by 15%, Reduction in patient stay by 41%.

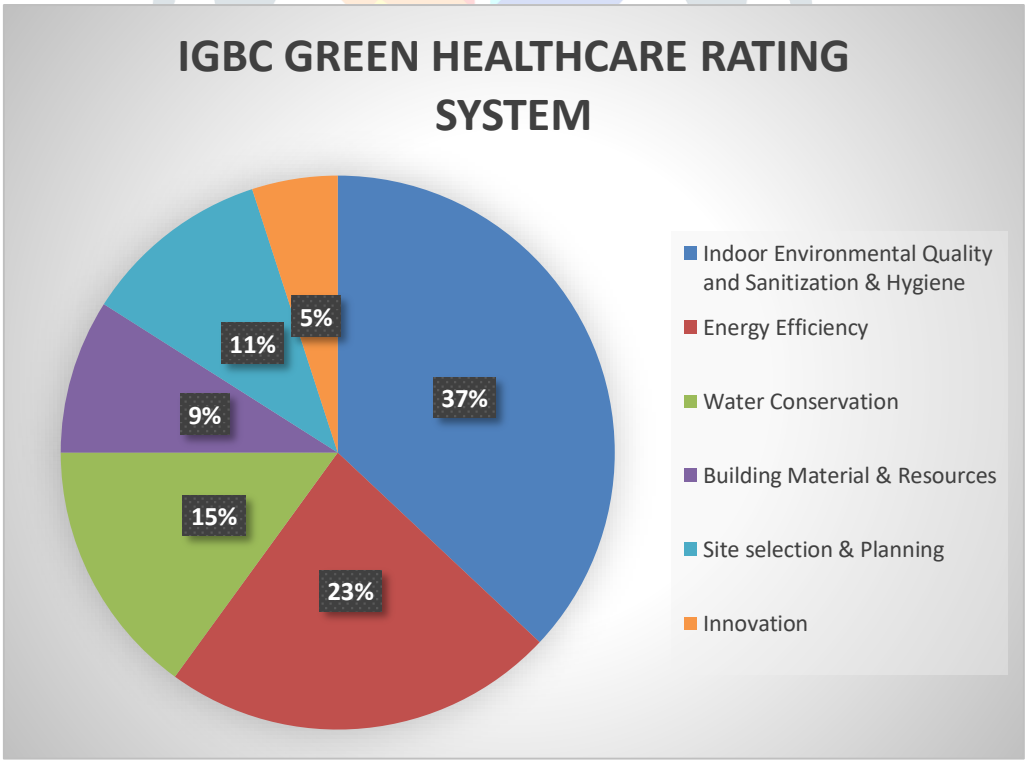


Figure 8. IGBC Green Healthcare Rating System *(Source: IGBC Abridged Reference Guide)*

3.2.1 Energy Efficiency:- The healthcare sector is a large consumer of electrical energy. Through IGBC Green Healthcare rating system, these facilities can reduce energy consumption through energy efficient – building envelope, lighting, air conditioning systems, etc., The energy savings that can be realized by adopting this rating programme can be to the tune of 20 - 30%.

3.3 Points Award for Energy Analysis (Daylight Simulation) :-

INDOOR ENVIRONMENTAL QUALITY & WELL BEING

Healing Architecture- Day lit Spaces

IEQ Credit 1.1

Point(s): 1, 2

Intent:

Incorporate principle of healing architecture through adequate daylighting, thereby facilitating faster recovery

Compliance Options:

- **Day lit spaces**
  - Demonstrate that atleast 25% of regularly occupied spaces achieve daylight illumination levels of minimum 110 Lux. Areas with daylight illumination levels more 2,200 Lux shall not be considered.

    The project can design the systems for reducing the glare.

Percentage of Patient area with daylighting	Percentage of other regularly occupied spaces with daylighting	Points
25 %	25 %	1
50 %	50 %	2

The project can demonstrate the compliance through either of two methodologies:

- **Option 1: Simulation Approach**

  Demonstrate the compliance through computer simulation in a clear sky condition on 21st September at 12 noon, at working plane.

IGBC Green Healthcare Rating- Checklist			
Module		New Healthcare Facility	Existing Healthcare Facility
Energy Efficiency			
EE Mandatory Requirement 1	Ozone Depleting Substances	Required	Required
EE Mandatory Requirement 2	Minimum Energy Efficiency	Required	Required
EE Mandatory Requirement 3	Commissioning Plan for Building Equipment & Systems	Required	Not Applicable
EE Credit 1	Eco-friendly Refrigerants	1	1
EE Credit 2	Enhanced Energy Efficiency	12	12
EE Credit 3	On -site Renewable Energy	5	5
EE Credit 4	Off-site Renewable Energy	2	2
EE Credit 5	Commissioning, Post-installation of Equipment & Systems	1	Not Applicable
EE Credit 6	Energy Metering & Management	2	2

Figure 9. IGBC Green Healthcare Rating Checklist

IV. CONCLUSION

In most eco-input frameworks look into, energy utilization data has been spoken to clients utilizing various diagrams and specialized units, which are not effectively conceivable to numerous clients. The BIM-energy joining strategy created in this paper gives a novel data representation technique that empowers spatial energy utilization perception utilizing various hues in an as-fabricated BIM. These shading coded models make a stylishly intriguing User interface and may build client commitment and prediction of energy information, possibly affecting energy utilization practices. The incorporation of a shading based regularizing correlation energy simulation into a BIM model speaks to an essential advance toward extending our comprehension

of the effect of eco-feedback data representation on cultivating expert ecological practices. From this undertaking work it tends to be presumed that Building Energy Analysis has its noteworthiness for accomplishing manageability benchmarks.
Energy Analysis gives out outcomes for existing situation of Building's Energy Demand and its Energy Potential along with compliance of achieving points for IGBC Rating System; which eventually helps in Designing Alternatives for Energy Harvesting from normal sources and decreasing it's any unfavorable impact on Environment.

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