

Green Building Based On BIM

Sanjana jadhav¹, Sunil hiremath², Sunilkumar Hiremath³

¹Student, department of structural engineering, sharnbasva university kalaburagi

²Student, department of structural engineering, sharnbasva university kalaburagi

³Assistant professor, department of structural engineering, sharnbasva university kalaburagi

ABSTRACT

Building Information Modelling (BIM) provides a digital platform for evaluating sustainable design decisions before construction and can be linked with energy-simulation tools to assess operational performance. This study applies BIM to green-building energy analysis using Autodesk Revit for three-dimensional modelling and Green Building Studio (GBS) for simulation after gbXML-based model transfer. The same building model was evaluated at six locations—Brasilia, Mumbai, Calcutta, Bangalore, New Delhi, and Shimla—to examine the influence of climatic location and sun-path conditions on electricity use, fuel consumption, and energy cost. A 30-year lifecycle period with a 6.1% discount factor was adopted in the source analysis. Annual electricity use ranged from 24,604 kWh in Shimla to 34,206 kWh in Mumbai, while annual fuel use ranged from 119 therms in Mumbai to 298 therms in Shimla. The software-reported annual energy cost was lowest for Bangalore at \$2,362 and highest for Brasilia at \$4,029. Corresponding lifecycle costs were \$32,168 and \$54,870, a difference of \$22,702. The study demonstrates that building location materially affects simulated energy performance and that a Revit-GBS BIM workflow can support early-stage comparison of sustainable design alternatives, while interoperability, weather-data quality, and occupancy assumptions remain important limitations.

Keywords: Building Information Modelling; Green BIM; Green Building Studio; Energy simulation; Sustainable construction; Lifecycle energy cost

I. INTRODUCTION

The construction sector consumes substantial quantities of energy, water, and raw materials and therefore has a direct influence on environmental performance and operating cost. Green-building practice addresses these impacts through energy-efficient systems, resource conservation, improved indoor environmental quality, sustainable material selection, and lifecycle-oriented design.

Building Information Modelling (BIM) extends conventional drafting by representing geometry, materials, building components, schedules, and performance information within a coordinated digital model. For sustainable design, BIM can support energy simulation, daylight assessment, material quantity estimation, lifecycle analysis, and comparison of design alternatives before construction [1]–[4].

Interoperability is central to this workflow because building information must be transferred from the authoring environment to analytical software. The study uses Autodesk Revit for model development, gbXML for energy-model data exchange, and Green Building Studio (GBS) for energy analysis. Such workflows can reduce repeated manual entry but may also introduce data-transfer and compatibility limitations [5]–[7].

The present project focuses on the relationship between BIM-based sustainable design and building energy performance. The same digital model is examined under six geographic locations to quantify variations in electricity use, fuel demand, annual cost, and 30-year lifecycle energy cost.

II. OBJECTIVES

- To study the concept and applications of Building Information Modelling in green-building construction.
- To develop a three-dimensional building model using Autodesk Revit.
- To perform building-energy analysis using Green Building Studio.
- To evaluate the effect of building location and the associated sun-path/climatic conditions on energy consumption.
- To assess the role of BIM in improving energy efficiency and supporting sustainable construction practices.

III. LITERATURE SURVEY

BIM research has established its value for coordinated visualization, construction planning, lifecycle information management, and early-stage decision-making. Hartmann et al. discussed applications of 3D and 4D models in construction projects, while BIM handbooks and owner-focused studies emphasize coordination, planning, and information management benefits [2], [4], [8].

For sustainable design, lifecycle assessment and building-performance simulation can be integrated with digital building models. Basbagill et al. examined lifecycle assessment during early-stage design, and Hiyama et al. addressed reuse of BIM information for performance-simulation configuration [3], [5]. Energy-performance studies further show that BIM-supported workflows can assist comparative assessment of domestic and institutional buildings [9], [10].

Building orientation and location are important because climate, solar exposure, temperature, and ventilation conditions influence heating and cooling requirements. Abanda and Buyers investigated orientation effects using BIM, while other studies cited in the report address interoperability and sustainability-oriented energy modelling [6], [7], [11]. The present work applies these principles through a Revit-to-GBS workflow and compares energy and cost outputs for six locations.

IV. MATERIALS AND METHODOLOGY

BIM model development and interoperability

A three-dimensional building model was created in Autodesk Revit using architectural and structural components including walls, floors, doors, windows, roofs, columns, beams, and slabs. Material and thermal properties were assigned to support building-performance analysis. The completed model was exported in gbXML format and transferred to Green Building Studio for simulation.

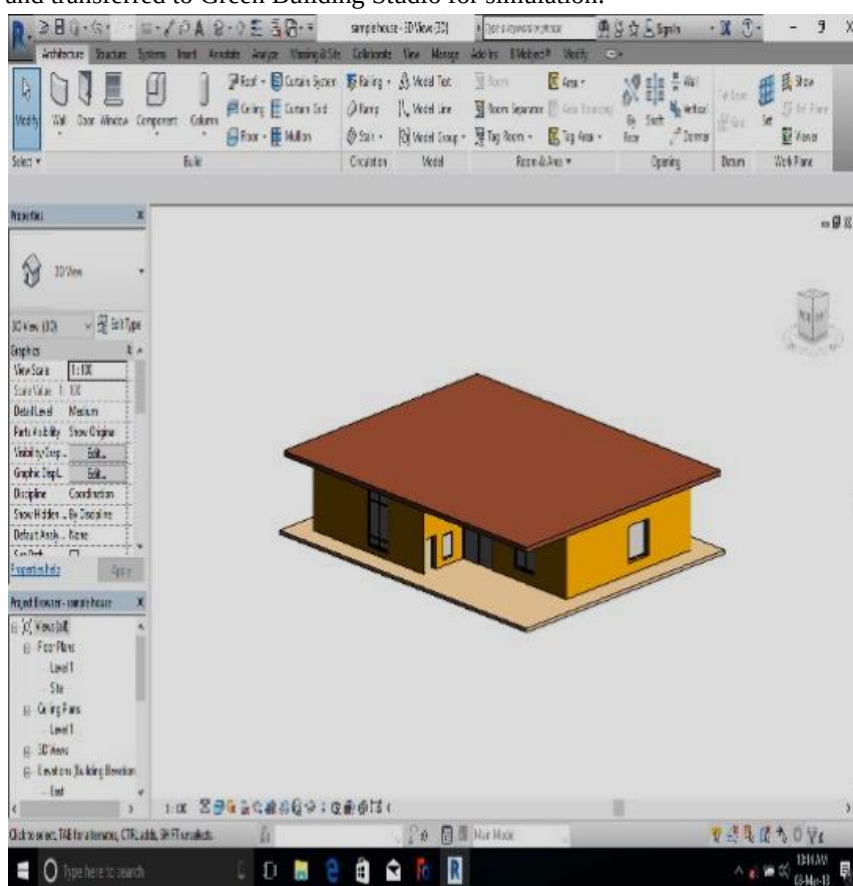


Fig. 1. Building model transferred for interoperability and Revit-based model development.

Energy-analysis workflow

The analysis sequence comprised literature review, selection of BIM and energy-simulation tools, model development, gbXML transfer, energy-model generation, selection of building locations, simulation, and comparison of results. Green Building Studio automatically uses location-dependent weather information and supports evaluation of annual electricity consumption, fuel use, and energy cost.

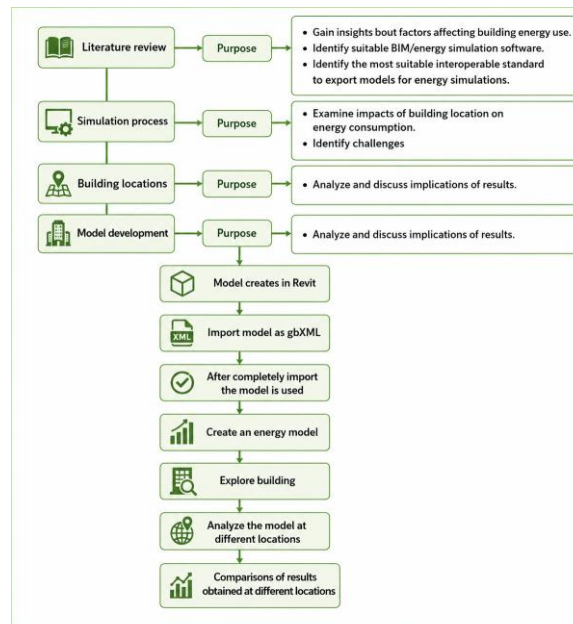


Fig. 2. BIM-based methodology for model development and energy-performance analysis.

Analysis parameters and locations

The study considered building orientation, climatic conditions, material properties, lighting, ventilation and airflow, electricity use, fuel use, and lifecycle energy cost. A 30-year lifecycle period was adopted with a 6.1% discount factor, and the source states that electrical-transmission energy losses were not included. Six locations were used to examine geographic variation in the performance of the same model.

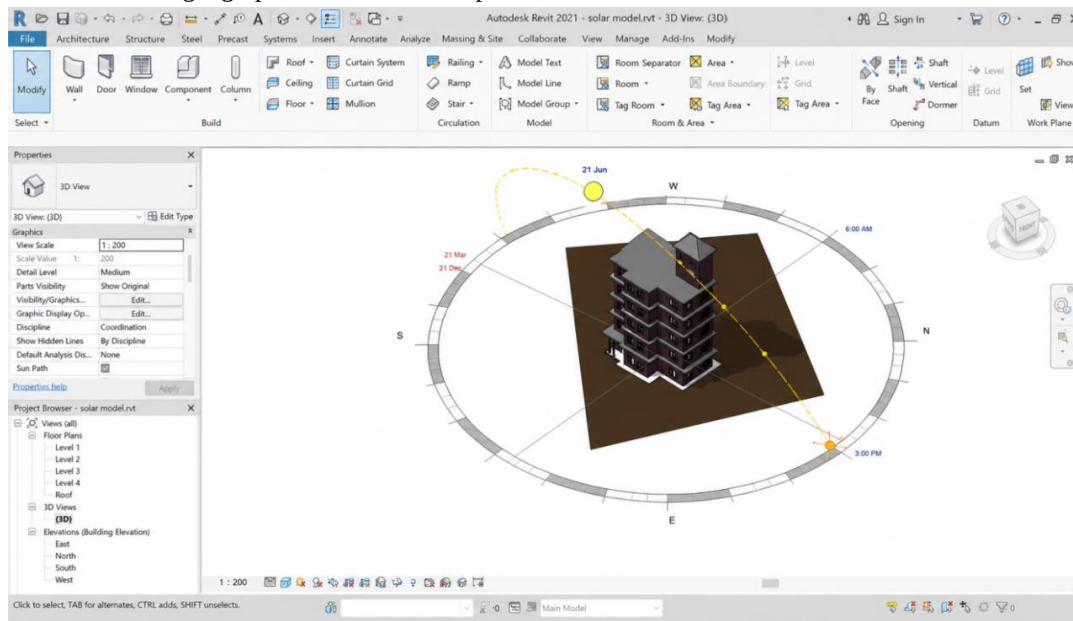


Fig. 3. Sun-path settings used for location-based energy simulation.

Table 1. Energy-analysis locations, coordinates, and actual energy rates

Location	Longitude	Latitude	Electricity rate (\$/kWh)	Fuel rate (\$/therm)
Brasilia (Brazil)	14.23°S	51.93°W	0.17	1.21
Mumbai	19.07°N	72.87°E	0.05	1.41
Calcutta	22.5°N	88.36°E	0.07	0.59
Bangalore	12.9°N	77°34'E	0.05	0.40
New Delhi	28°40'N	77°2'E	0.11	0.51
Shimla (HP)	31°06'N	77°13'E	0.05	1.41

V. RESULTS AND DISCUSSION

Annual energy performance

Table 2. Annual energy use and software-reported annual energy cost

Location	Electricity use (kWh)	Fuel use (therms)	Annual energy cost (\$)
Brasilia (Brazil)	32,272	125	4,029
Mumbai	34,206	119	2,830
Calcutta	31,638	167	2,662
Bangalore	27,826	173	2,362
New Delhi	29,902	294	2,623
Shimla (HP)	24,604	298	3,325

Note: The results table reports Calcutta's annual cost as \$2,662, whereas a narrative sentence in the report states \$2,593. The table value is used here because it is also used in the report's average-cost calculation.

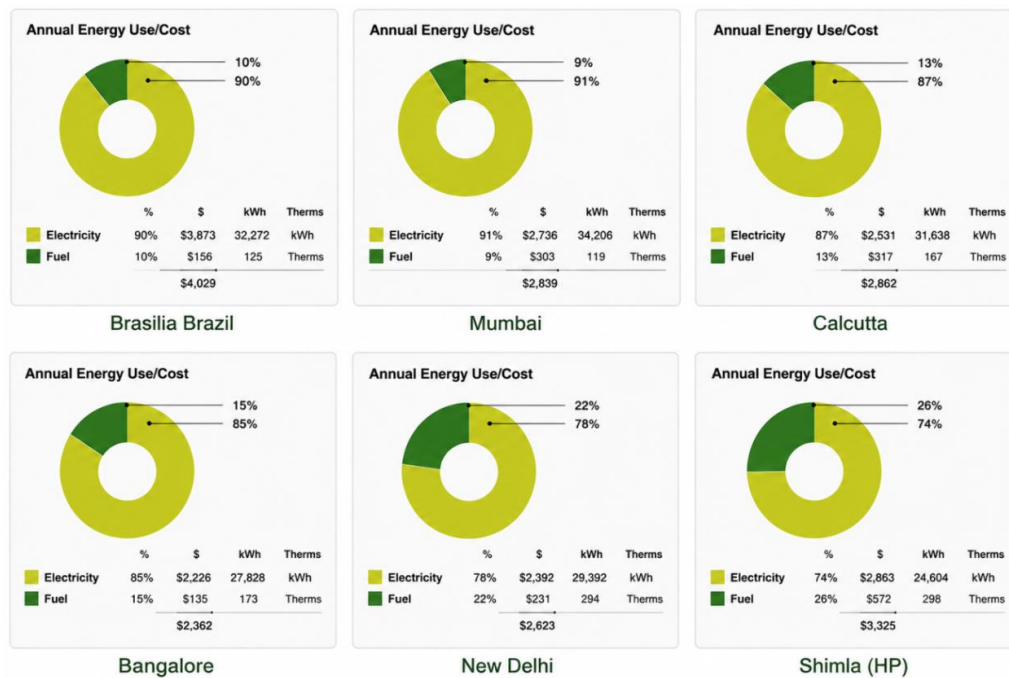


Fig. 4. Green Building Studio annual energy-use and cost outputs for the six locations.

Annual electricity use was highest in Mumbai at 34,206 kWh and lowest in Shimla at 24,604 kWh. Fuel use showed the reverse climatic tendency, with Mumbai recording the lowest annual fuel demand at 119 therms and Shimla the highest at 298 therms. The lowest software-reported annual energy cost occurred in Bangalore (\$2,362), while Brasilia recorded the highest value (\$4,029). These results demonstrate that geographic and climatic conditions materially change the simulated operating-energy profile of an otherwise common building model.

Thirty-year lifecycle energy performance

Table 3. Thirty-year lifecycle energy use and software-reported lifecycle cost

Location	Lifecycle electricity (kWh)	Lifecycle fuel (therms)	Lifecycle cost (\$)
Brasilia (Brazil)	968,169	3,754	54,870
Mumbai	1,026,184	3,571	38,541
Calcutta	949,164	5,018	36,259
Bangalore	834,842	5,190	32,168
New Delhi	897,081	8,838	35,727
Shimla (HP)	738,130	8,961	45,282

Over the 30-year period, Bangalore produced the lowest software-reported lifecycle cost of \$32,168, whereas Brasilia produced the highest at \$54,870. The difference between these two locations was \$22,702. The report calculated an average lifecycle cost of \$40,474.5 across the six locations and an average annual software-reported energy cost of approximately \$2,971.9.

Software-reported and rate-based cost comparison

Table 4. Comparison of software-reported and rate-based energy costs

Location	Software annual (\$)	Rate-based annual (\$)	Software lifecycle (\$)	Rate-based lifecycle (\$)
Brasilia (Brazil)	4,029	5,638.24	54,870	169,131.2
Mumbai	2,830	1,878.3	38,541	51,544.6
Calcutta	2,662	2,313.3	36,259	69,503.5
Bangalore	2,362	1,460.5	32,168	43,818.0
New Delhi	2,623	3,451	35,727	98,846.6
Shimla (HP)	3,325	1,650.3	45,282	49,541.5

Note: The report calls the second approach a 'traditional method'; it applies location-specific electricity and fuel tariffs to the software-derived energy-use quantities.

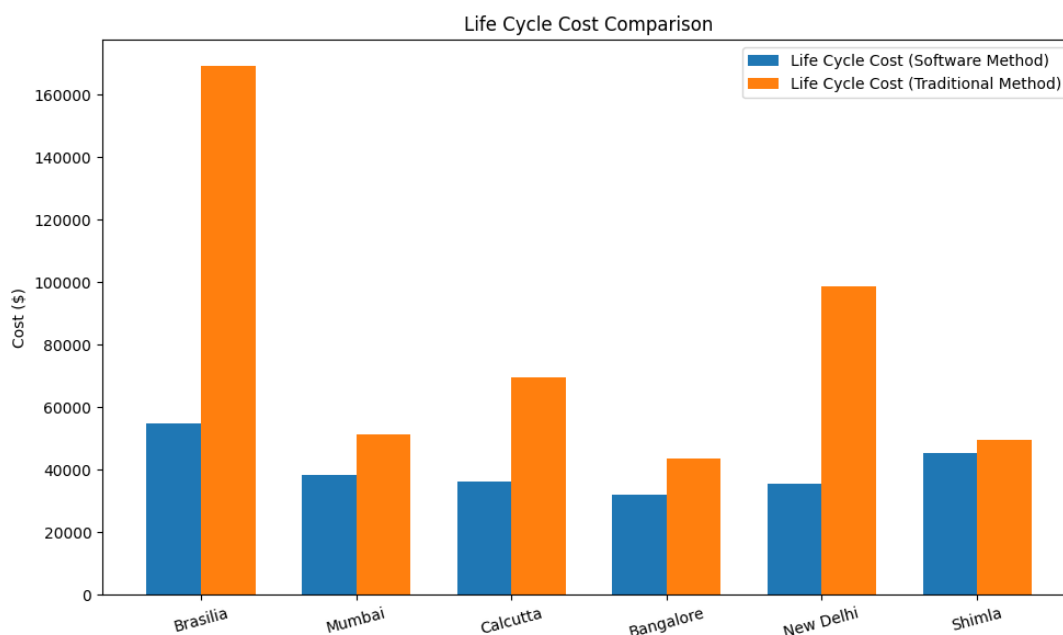


Fig. 5. Comparison of software-reported and rate-based lifecycle energy costs.

The rate-based calculation produces a different cost profile because the local electricity and fuel tariffs vary substantially. Bangalore remains the lowest-cost location in both the software annual and lifecycle cost tables, while Brasilia is the highest in both software cost measures and also has the highest rate-based lifecycle cost. The comparison illustrates that energy consumption and monetary cost should be interpreted separately: a location with lower energy demand does not necessarily have the lowest cost when local tariffs differ.

Role of BIM and study limitations

The Revit-GBS workflow demonstrates how a coordinated BIM model can be reused for energy simulation before construction, enabling rapid comparison of location-dependent performance and lifecycle implications. The report also identifies interoperability as a practical limitation because gbXML transfer may cause information loss or modelling inconsistencies. Weather-station selection and occupant behaviour introduce additional uncertainty in simulated energy demand.

Although building orientation is included among the analysis parameters and sun-path settings are demonstrated, the report does not provide a separate numerical table comparing orientation alternatives. Accordingly, the quantitative conclusions of this article are restricted to the six location-based simulations and the cost comparisons actually reported. The study also does not provide measured operational-energy data for external validation of the simulations.

VI. CONCLUSION

- The Autodesk Revit-to-gbXML-to-Green Building Studio workflow provided a practical BIM-based procedure for evaluating green-building energy performance before construction.
- The same building model produced different annual electricity and fuel demands across the six locations, confirming a strong location- and climate-related influence on simulated performance.
- Mumbai recorded the highest annual electricity use at 34,206 kWh, while Shimla recorded the lowest at 24,604 kWh; annual fuel use ranged from 119 therms in Mumbai to 298 therms in Shimla.
- Bangalore produced the lowest software-reported annual energy cost (\$2,362) and lifecycle cost (\$32,168), whereas Brasilia produced the highest corresponding values of \$4,029 and \$54,870.
- The software-reported lifecycle cost difference between Bangalore and Brasilia was \$22,702 over the adopted 30-year period.
- BIM-based energy simulation can support sustainable design decisions, but interoperability, weather data, occupancy assumptions, and the absence of measured-energy validation should be considered when interpreting the results.

REFERENCES

- [1] Autodesk Revit white paper. Available from the Autodesk Revit transition white paper. Date accessed in the report: 2011.
- [2] Harvey M, Bernstein F, Leed AP, Jones SA, Russo MA. The business value of BIM for owners. Smart Market Report. 2014; pp. 1–98.
- [3] Basbagill JF, Flager F, Lepech M, Fischer M. Application of lifecycle assessment to early stage building design for reduced embodied environment impacts. Build Environment. 2013;60:81–92.
- [4] Hartmann T, Gao J, Fischer M. Areas of application for 3D and 4D models on construction projects. Journal of Construction Engineering and Management. 2008;134(10):776–785.
- [5] Hiyama K, Kato S, Kubota M, Zhang J. A new method for reusing building information models of past projects to optimize the default configuration for performance simulations. Energy and Buildings. 2014;73:83–91.
- [6] Steel J, Drogemuller R, Toth B. Model interoperability in building information modeling. Software System Model. 2012;11:99–109.
- [7] Stundon D, Spillane J, Lim JP, Tansey P, Tracey M. Building information modelling energy performance assessment on domestic dwellings: a comparative study. Proceedings of the 31st Annual ARCOM Conference. 2015.
- [8] Teicolz P, Sacks R, Liston K. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. 2nd ed. Wiley; 2011.
- [9] Moakher P, Pimplikar S. Building information modelling and sustainability using design technology in energy efficiency modelling. IOSR Journal of Mechanical and Civil Engineering. 2012;1(20):10–21.
- [10] Niewoehner D. BIM and life-cycle analysis help to determine value of green strategies. Laboratory Design. 2010;15(2):3–7.
- [11] Abanda FH, Buyers L. An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modeling). Energy. 2016;97:517–527.