4th Intercontinental Geoinformation Days

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Calculate wastage and optimize building energy consumption using GEO BIM

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Keywords
Building Information
GIS
Lod
Energy evaluation
Building Energy Modeling

Abstract

In terms of population growth and increasing greenhouse gas emissions, urban energy planning has become a concern. And with the high speed of urban construction, it is claimed that 40% of the total energy consumption is allocated to the building sector. It is believed that energy modeling and simulation are effective in supporting urban energy planning. Today, the increasing availability of 3D models of cities has facilitated energy simulation at various scales. While the Building Information Model (BIM) allows users to explore a building's energy consumption options, GIS-based building models provide the opportunity to simulate city-wide energy demand. Given that many building energy simulations are based on existing GIS using lower-level detail (LOD) models, the aim of this study is to extract accurate geometric semantic information. Use BIM models to build GIS models with higher LOD. In order to more accurately support the energy simulation of buildings, the meanings of BIM models from various sources are consistent with GIS-based building models, and the geometry of BIM models is converted to conform to GIS-based building model standards. After conversion, the result is used to evaluate the amount of energy lost. And after calculating the energy loss, by changing the building elements, the amount of energy loss is optimized as much as possible.
In this study, according to the location, climate, solar angle and various elements of the residential building, after initial calculation and optimization, the desired result was obtained up to a maximum of 50% reduction in energy loss.

1. Introduction

Kargar Sharifabadet al. The annual energy consumption index of 13 residential complexes with different characteristics was evaluated and compared. First, the method of calculating the energy intensity index was presented. Then the energy intensity index of buildings was calculated and buildings with different characteristics were compared in terms of energy intensity index. Comparison of energy intensity indicators shows that the use of new energy materials significantly reduces the intensity of energy consumption in the building.

In this article, Rahimi Nejad et al. Providing simulation software and calculating the amount of energy in office and residential buildings that has been implemented by Amirkabir University of Technology at the request of the Mahshahr Special Economic Zone Organization. The purpose of this software is to calculate the amount of building energy consumption based on existing standards and optimally so that users and building users can be inspired by this software to minimize their building energy consumption both in the design stage and in the design stage.

Giorgio Agiaro et al. Provide the Energy Development Plan (ADE) modeling method for the CityGML standard. The purpose of this ADE extension is to provide a specific, standard-based model for solving data connection problems in heterogeneous energy applications, as well as for creating detailed details. The results show that having accurate and integrated knowledge in the three-dimensional space of the city, i.e., all the features of the city, infrastructure, functional features and their meaning and their interdependence has an important role in advanced energy simulation and analysis. has it.

Zeya Zhang et al. To calculate urban energy, a new method of integrating GIS and BIM was investigated and this research was conducted in three different buildings. The results of conversion and calculation of heat transfer through the overall shape of the building have been

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Cite this study

Rasti, S., Kiyavarz, M., & Rajabifard, A. (2022). Calculate wastage and optimize building energy consumption using GEO BIM. 4th Intercontinental Geoinformation Days (IGD), 278-281, Tabriz, Iran

tested at various levels. And the comparison in three scenarios shows that by not opening in the calculation of energy loss, the increase of attention can be compared with the opening scenario.

2. Method

2.1. Study area

The city of Firozabad is from the city of Fars province. The center of this city is Firozabad. Its area is 1489 hectares and its height from the sea level is 1600 meters. That Panda's main heights that are drawn from the northwest to the southeast. The city has a temperate climate that Mile is warm. The climat of this region is temperate in winter and very hot in summer and the annual rainfall is 400 mm. The study area is located the following geocoordinate (Fig. 1). The study is done in eight stages (Fig. 2).

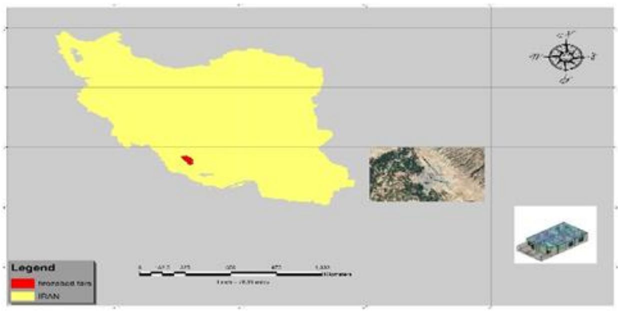

Figure 1. Geographical extent of the Building study

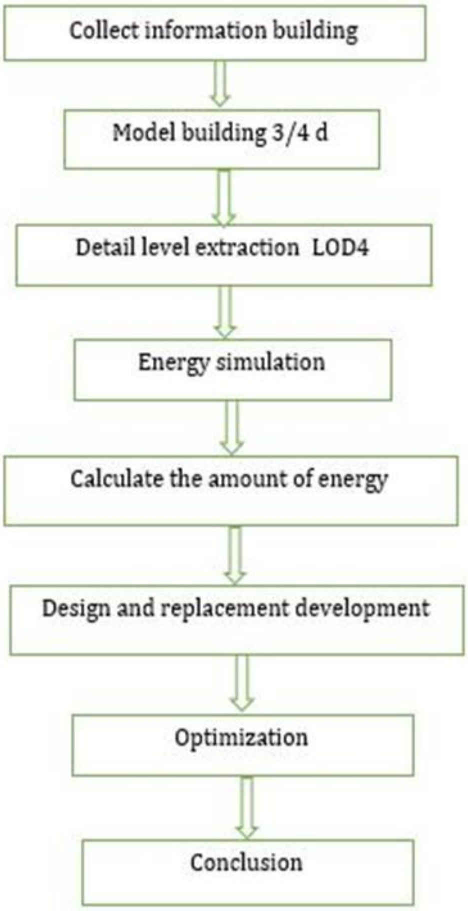

Figure 2. Stages performed in this study

2.2. Collect information building

To collect information for this research, the following criteria are considered: which is divided into three parts building information ،climatic and spatial.

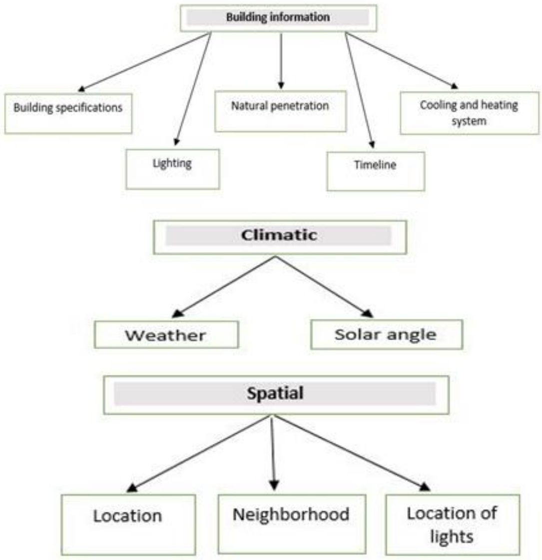

Figure 3. Building information

2.3.1. Sol-Air Values

The heat balance at a sunlit surface gives the heat flux into the surface q/A as

$$q/A=\alpha Et+h(to-ts)-\varepsilon\Delta R \quad (1)$$

α= absorptance of surface for solar radiation
E_t = total solar radiation incident on surface, Btu/h·ft^2
to = outdoor air temperature, °F
ts = surface temperature, °F
ε = hemispherical emittance of surface
ΔR = difference between long-wave radiation incident on surface from sky and surroundings and radiation emitted by blackbody at outdoor air temperature, Btu/h·ft^2

Assuming the rate of heat transfer can be expressed in terms of the sol-air temperature t_e,

$$\frac{q}{A} = h_o(t_e - t_s) \quad (2)$$

and from Equations (1) and (2),

$$t_e = t_o + \frac{\alpha E_t}{h_o} - \frac{\varepsilon \Delta R}{h_o} \quad (3)$$

2.3.2. Calculating Conductive Heat Gain

Conduction through exterior walls and roofs is calculated using conduction time series (CTS).

Wall and roof conductive heat input at the exterior is defined by the familiar conduction equation as

$$q_{i,q-n} = UA\left(t_{e,q-n} - t_{rc}\right) \quad (4)$$

$q_{i,q-n}$ = conductive heatinput for the surface n hours ago, Btu/h
U = overall heat transfer coefficient for the surface, Btu/h·ft^2·°F
A = surface area, ft^2
$t_{e,q-n}$ = sol-air temperature n hours ago, °F
t_{rc} = presumed constant room temperature, °F

Conductive heat gain through walls or roofs can be calculated using conductive heat inputs for the current hours and past 23 h and conduction time series

$$q_q = C_0 q_{i,q} + C_1 q_{i,q-1} + C_2 q_{i,q-2} + C_3 q_{i,q-3} + \cdots + C_{23} q_{i,q-23} \quad (5)$$

q_q = hourly conductive heat gain for the surface, Btu/h
$q_{i,q}$ = heat input for the current hour
$q_{i,q-n}$ = = heat input n hours ago
C_0, C_1 etc. = conduction time factors

2.3.3. Heat Gain through Interior Surfaces

Whenever a conditioned space is adjacent to a space with a different temperature (i.e. in a different zone), heat transfer through the separating physical section must be considered.

The heat transfer rate is given by

$$q = UA(t_b - t_i) \quad (6)$$

q = heat transfer rate, Btu/h
U = coefficient of overall heat transfer between adjacent and conditional space, Btu/h·ft^2·°F
A = area of separating section concerned, ft^2
t_b = average air temperature in adjacent space, °F
t_i = air temperature in conditioned space, °F

2.3.4. Fenestration Heat Gain

For windows and skylights, the engine uses the following equations to calculate heat gain:

Direct beam solar heat gain qb:

$$q_b = AE_D SHGC(\theta) \quad (7)$$

Diffuse solar heat gain qd:

$$q_d = A(E_D + E_r) < SHGC >_D \quad (8)$$

Conductive heat gain qc

$$q_c = UA(T_{out} - T_{in}) \quad (9)$$

Total fenestration heat gain Q:

$$Q = q_b + q_d + q_c \quad (10)$$

E_D, E_d and E_r = direct, diffuse, and ground-reflected irradiance
$SHGC(\theta)$ = direct solar heat gaincoefficient as a function of incident angle q; may be interpolated between values
$(SHGC)_D$= diffuse solar heat gain coefficient (also referred to as hemispherical SHGC)
T_{in} = inside temperature, °F
T_{out} = outside temperature, °F
U = overall U-factor, including frame and mounting

2.3.5. Plenum Loads

The space above a ceiling, when used as a return air path, is a ceiling return air plenum The following equations show how temperatures and heat transfer for plenums are calculated in the engine:

$$q_1 = U_c A_c (t_p - t_r) \quad (11)$$

$$q_2 = U_f A_f (t_p - t_{fa}) \quad (12)$$

$$q_3 = 1.1Q(t_p - t_r) \quad (13)$$

$$q_{lp} - q_2 - q_1 - q_3 = 0 \quad (14)$$

$$Q = \frac{q_r + q_1}{1.1(t_r - t_s)} \quad (15)$$

q_1= heat gain to space from plenum through ceiling, Btu/h
q_2 = heat loss from plenum through floor above, Btu/h
q_3 = heat gain "pickup" by return air, Btu/h
Q = return airflow, Btu/h
q_{lp} = light heat gain to plenum via return air, Btu/h
q_{lr} = light heat gain to space, Btu/h
q_f = heat gain from plenum below, through floor, Btu/h
q_w = heat gain from exterior wall, Btu/h
q_r = space cooling load, including appropriate treatment of q_{lr}, q_f and/or q_w, Btu/h
t_p = plenum temperature, °F
t_r = space temperature, °F
t_{fs} = space temperature of the floor above, °F
t_s = supply temperature, °F

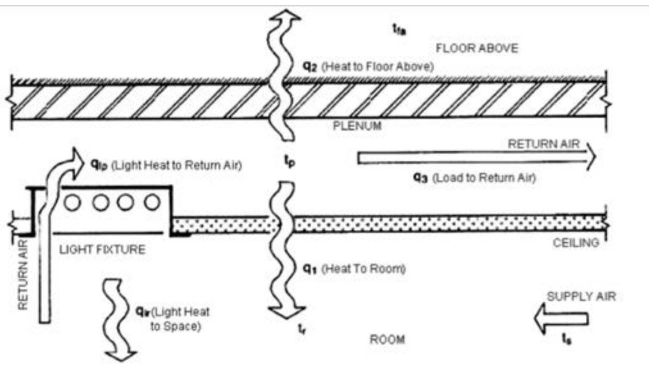

Figure 4. Plenum loads

2.3.6 Solar index calculation relationship

$$I_s = \sum (A_i . S_i . \sigma_i) / V \quad (16)$$

A_i=The area of the permeable part i The output shell of the building in terms of square meters

Si = solar transfer coefficient for transient light fraction i
6i=The reduction coefficient is related to the position of the permeable surface
V: The total volume of controlled space of the building or section

3. Results

Table 1. This is the example of table formatting

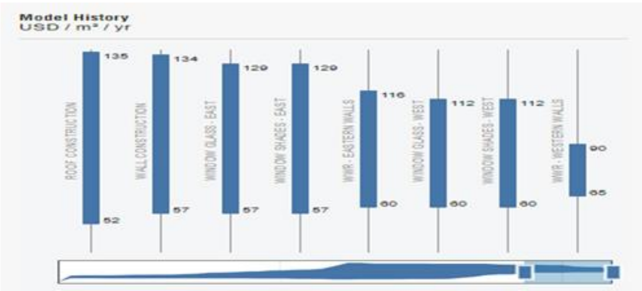

Figure 5. Graph before optimization

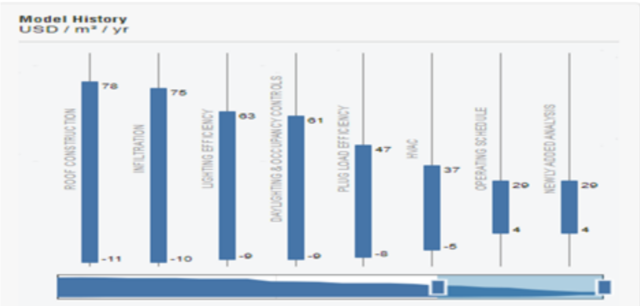

Figure 6. Graph after optimization

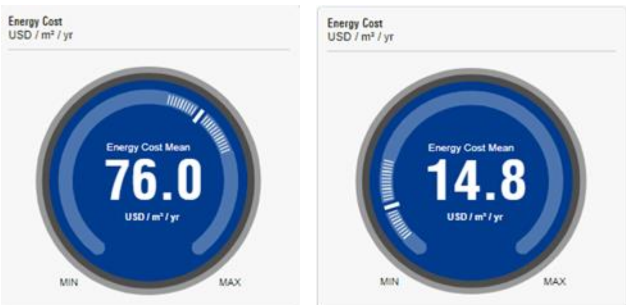

Figure 7. Cost of energy consumption before and after optimization

4. Conclusion

The issue of energy and the access of more and more industrialized countries in the world to cheap energy sources, has created many challenges and this is one of the most important and common topics in the world today. The construction sector is so concentrated that the construction sector is the largest consumer in the country with more than 40% of energy consumption. On the other hand, various studies in different parts of the world show that buildings are the largest consumers of energy compared to other types of uses. Using simple, affordable and affordable practical strategies to reduce energy consumption and optimization solutions to reduce the demand for mechanical systems and improve the quality and thermal comfort is a way to increase the efficiency of residential buildings in terms of energy consumption. Given that in the future, most buildings will be high-rise and equipped with energy management technologies. This article examines the possibility of optimization in such buildings. Optimization of energy consumption in buildings such as the building studied in this study and providing appropriate energy saving solutions in different sectors showed that by considering different criteria in terms of building information, climate, and location as in Table (2222) presented showed that the optimal building is up to 50% possible and based on research findings. Optimal directions for the establishment of the building were estimated as south-southeast and southwest directions. Among the directions, the south direction was identified as the optimal direction due to maximum absorption in cold times of the year and less energy absorption in hot times of the year.

Table 2. Calculations wasted after wasted after optimization

Components	Cooling		Heating	
	Loads (W)	Percentage of Total	Loads (W)	Percentage of Total
Wall	882	3.10%	1,849	12.23%
Window	5,304	18.66%	1,559	10.31%
Door	170	0.60%	496	3.28%
Roof	18,177	63.93%	8,364	55.31%
Skylight	0	0.00%	0	0.00%
Partition	0	0.00%	0	0.00%
Infiltration	0	0.00%	0	0.00%
Ventilation	76	0.27%	2,854	18.88%
Lighting	878	3.09%		
Power	564	1.98%		
People	1,797	6.32%		
Plenum	0	0.00%		
Fan Heat	582	2.05%		
Reheat	0	0.00%		
Total	**28,431**	**100%**	**15,123**	**100%**

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