SIMULATION OF ENERGY CONSUMPTION IN EQUATORIAL AND TROPICAL BUILDINGS IN RELATION TO THE ORIENTATION

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ABSTRACT

Increasing pressures on energy resources are giving rise to a great deal of interest in energy-saving issues in all sectors of activity, and particularly in the buildings, where in Cameroon, residential infrastructures alone absorbs about 69% of the energy available. As an extension to the studies carried out on the modeling of energy consumption in buildings in the equatorial zone according to materials types, this study is devoted to the modeling of energy in terms of building orientation. The objective is to contribute to the development of buildings design support tools that use less energy and in respect the environment. The methodological framework focuses on a pilot building for which the final energy consumption is determined each time, with the orientation of the building and the climatic zone in which it is built as main variables. After its implementation on a G+2 building for office use, we noted that the energy consumption according to the orientation of the building depends very strongly on its morphology. This makes it complicated to establish a model for the optimal orientation valid for all the morphologies of given buildings. Nevertheless, for the longitudinal axis of buildings with the morphology of our pilot building oriented in the north-south direction, we obtained a building consuming the least energy with regards to equatorial zones of Guinean and Cameroonian coastal type; When this axis is oriented south west-north east, energy consumptions are minimal in equatorial zone of the Cameroonian type of altitude and in the humid and dry tropical zones and finally, the east-west direction leads to the most economical building in terms of energy consumption for the Sudano-Sahelian climates.

Keywords: Building, Energy, Orientation, Equatorial climate, tropical climate.
1. INTRODUCTION

Given the increasing energy demand and the lack of supply in sub-Saharan African countries, it is essential to identify techniques for rationalizing energy consumption.

A study was carried out on a simulation model of energy consumption in buildings according to materials (William Ngaha Tiedeu, 2013) [10] which made it possible to determine the most appropriate materials according to the climatic zones of our study. Knowing the influence of the type of materials on energy consumption, it is useful to extend the study by analyzing the consumption of energy in a building according to its geographical orientation. The fundamental question is:

How can energy consumption of a building be minimized following a judicious choice of its orientation according to the climatic conditions of the zone in which it will be built in Cameroon?

A previous study focusing on the impact of orientation on indoor thermal comfort in a collective dwelling was undertaken in the case of the new city of Ali Mendjeli Constantine in Algeria (Samira Bellara, 2009) [9] which presented the complexity of the modeling which not only depends on the climatic properties but also on the morphology of the building.

This study is deemed necessary to extend the study up to the calculation of the quantities of energy consumed in the building according to the orientation for a well-known building morphology and to be able to model these physical phenomena in mathematical equations which can be digitally programmed and generalized. All of this is to promote sustainable housing and therefore optimize the energy consumption.

2. MATERIALS AND METHODS

2.1. Typology of buildings related to energy consumption in Cameroon

Each building type has a consumption profile specific to its operating realities. These consumptions are mainly due to lighting, air conditioning and various equipment found in buildings. The table below shows the consumption profiles of our building types:

<table>
<thead>
<tr>
<th>Buildings</th>
<th>% air conditioning</th>
<th>% lighting</th>
<th>% other equipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective Building</td>
<td>20.0</td>
<td>31.4</td>
<td>48.6</td>
</tr>
<tr>
<td>Individual Building</td>
<td>29.2</td>
<td>41.7</td>
<td>29.2</td>
</tr>
<tr>
<td>Administrative</td>
<td>35.1</td>
<td>60.8</td>
<td>4.1</td>
</tr>
<tr>
<td>Parapublic</td>
<td>39.5</td>
<td>50.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Services and activities</td>
<td>59.0</td>
<td>30.8</td>
<td>10.3</td>
</tr>
<tr>
<td>Hotel and touristic activities</td>
<td>68.8</td>
<td>25.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Hospitals</td>
<td>19.5</td>
<td>48.8</td>
<td>31.7</td>
</tr>
<tr>
<td>Schools</td>
<td>9.5</td>
<td>28.6</td>
<td>61.9</td>
</tr>
</tbody>
</table>

http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=11
2.1.1. Centesimal distribution of energy consumption based on the type of lighting according to the buildings type.

This section presents the percentage of each type of lighting equipment used by the building because the optimization of the type of lighting is significant when talking about sustainable development.

![Centesimal distribution of energy consumption in the building](image)

**Figure 1** General profile of energy consumption in the building, (Alexis Kemajou, 2013) [2]

There are several air conditioning systems in buildings. Each system has its advantages and disadvantages. The figure below shows the percentage of each system depending on the type of building.

![Centesimal distribution of energy consumption in the building](image)

**Figure 2** Centesimal distribution of consumption by type of lighting according to the building type (Alexis Kemajou, 2013) [2]
Simulation of Energy Consumption In Equatorial and Tropical Buildings In Relation to the Orientation

2.2. Climate zones studied
The study was conducted on six climate zones. The equatorial climate zone "Cameroonian" being divided into two sub-areas and each considered a specific study class. These six climatic zones of study are defined as follows:

The Guinean-type equatorial climate
- Location: From Kribi to Banyo and from Garoua-Boulaï to Ouesso.
- Temperature and average annual amplitude: 25° C and 2.5° C
- Annual rainfall: 1500 to 2000 mm.
- Reference city: Yaoundé

The equatorial climate of Cameroonian type – sub coastal type
- Location: coast and mountainous regions of the west
- Annual average temperature and amplitude:
  - In the coastal sub-type: 26° C and 2.8° C.
  - Annual rainfall: 2000 to 10 000 mm (Mount Cameroon).
- City of reference: Douala

The equatorial climate type Cameroonian - altitude subtype
- Location: mountainous regions of the west
- Annual average temperature and amplitude: 21° C and 2.2° C.
- Annual rainfall: 2000 to 10 000 mm (Mount Cameroon).
- City of reference: Bafoussam

The tropical humid climate
- Location: around the massif of Adamoua
- Temperature and average annual amplitude: 20° C and 3° C
- Annual rainfall: 1500 mm
- Reference city: Ngaoundéré
Dry tropical climate
- Location: around the basin of “La Bénoué”
- Annual average temperature and amplitude: 28° C and 6.5° C
- Annual rainfall: 1300 mm
- Reference city: Garoua

The Sudano-Sahelian tropical climate
- Location: Far Northern Region
- Average annual temperature and amplitude: 28° C and 7.5° C
- Annual rainfall: 300 to 900 mm
- Reference city: Maroua

2.3. Basic Assumptions

2.3.1. Building Features
The pilot building that will be the subject of the simulation is a G+2 building, for office use with a total floor area of 332 m². It is an existing building; at the premises of the ADB/BM cell of the Ministry of Public Works.

![Figure 4 Picture of the pilote building](image)

Table 1 the pilot building

<table>
<thead>
<tr>
<th>Denomination of the office</th>
<th>Area (m²)</th>
<th>Number</th>
<th>Total area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of the coordinator</td>
<td>20.11</td>
<td>1</td>
<td>20.11</td>
</tr>
<tr>
<td>Office of the coordinator’s secretary</td>
<td>12.71</td>
<td>1</td>
<td>12.71</td>
</tr>
<tr>
<td>Store</td>
<td>8.96</td>
<td>1</td>
<td>8.96</td>
</tr>
<tr>
<td>Meeting hall</td>
<td>26.20</td>
<td>1</td>
<td>26.20</td>
</tr>
<tr>
<td>Cadre’s office</td>
<td>11.51</td>
<td>4</td>
<td>46.04</td>
</tr>
<tr>
<td>Circulation</td>
<td>8.96</td>
<td>1</td>
<td>8.96</td>
</tr>
<tr>
<td>Reprography room</td>
<td>36.68</td>
<td>1</td>
<td>36.68</td>
</tr>
<tr>
<td>Hall/Reception</td>
<td>20.27</td>
<td>5</td>
<td>20.27</td>
</tr>
<tr>
<td>Secretary’s office</td>
<td>12.08</td>
<td>1</td>
<td>12.08</td>
</tr>
<tr>
<td>Office of the deputy coordinator</td>
<td>6.76</td>
<td>1</td>
<td>6.76</td>
</tr>
</tbody>
</table>
Simulation of Energy Consumption In Equatorial and Tropical Buildings In Relation to the Orientation

Table 2 Rooms of the first floor of the pilot building

<table>
<thead>
<tr>
<th>Denomination of the office</th>
<th>Area (m²)</th>
<th>Number</th>
<th>Total area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of the coordinator</td>
<td>20,11</td>
<td>1</td>
<td>20,11</td>
</tr>
<tr>
<td>Office of the coordinator’s secretary</td>
<td>12,71</td>
<td>1</td>
<td>12,71</td>
</tr>
<tr>
<td>Meeting hall</td>
<td>35,16</td>
<td>1</td>
<td>35,16</td>
</tr>
<tr>
<td>Cadre’s office</td>
<td>11,51</td>
<td>7</td>
<td>80,17</td>
</tr>
<tr>
<td>Circulation</td>
<td>8,96</td>
<td>1</td>
<td>8,96</td>
</tr>
<tr>
<td>Secretary’s office</td>
<td>36,68</td>
<td>1</td>
<td>36,68</td>
</tr>
<tr>
<td>Office of the deputy coordinator</td>
<td>9,80</td>
<td>1</td>
<td>9,80</td>
</tr>
<tr>
<td>Toilets</td>
<td>12,08</td>
<td>5</td>
<td>20,27</td>
</tr>
<tr>
<td>Hall/Exit</td>
<td>6,76</td>
<td>1</td>
<td>6,76</td>
</tr>
</tbody>
</table>

Table 3 Rooms of the second floor of the pilot building

<table>
<thead>
<tr>
<th>Denomination of the office</th>
<th>Area (m²)</th>
<th>Number</th>
<th>Total area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of the coordinator</td>
<td>20,11</td>
<td>1</td>
<td>20,11</td>
</tr>
<tr>
<td>Office of the coordinator’s secretary</td>
<td>12,71</td>
<td>1</td>
<td>12,71</td>
</tr>
<tr>
<td>Meeting hall</td>
<td>35,16</td>
<td>1</td>
<td>35,16</td>
</tr>
<tr>
<td>Cadre’s office</td>
<td>11,51</td>
<td>7</td>
<td>80,17</td>
</tr>
<tr>
<td>Circulation</td>
<td>8,96</td>
<td>1</td>
<td>8,96</td>
</tr>
<tr>
<td>Secretary’s office</td>
<td>36,68</td>
<td>1</td>
<td>36,68</td>
</tr>
<tr>
<td>Office of the deputy coordinator</td>
<td>9,80</td>
<td>1</td>
<td>9,80</td>
</tr>
<tr>
<td>Toilets</td>
<td>12,08</td>
<td>5</td>
<td>20,27</td>
</tr>
<tr>
<td>Hall/Exit</td>
<td>6,76</td>
<td>1</td>
<td>6,76</td>
</tr>
</tbody>
</table>

The building is 10.50 m high, covered by a roof made of metal surrounded by a parapet wall. The floors are hollow slabs (hollow blocks); The distribution plans and the geographical directions of the building are presented in appendices:

![Figure 2 Distribution plan of the ground floor](http://www.iaeme.com/IJCIET/index.asp)
2.3.2. Building Direction

Given that the idea here is to be able to establish how the energy consumption changes when the orientation changes, we will therefore vary the orientation of our building with the main facade as a base point. This facade (consequently the whole building) will be rotated 8 times and progressively at an angle of 45°. This will allow it to occupy the following orientations:
Simulation of Energy Consumption In Equatorial and Tropical Buildings In Relation to the Orientation

Figure 5 Graphic representation of the building orientations

Table 4 Symbols of different orientations

<table>
<thead>
<tr>
<th>Orientation</th>
<th>East</th>
<th>North</th>
<th>North-East</th>
<th>North-West</th>
<th>South</th>
<th>South-East</th>
<th>South-West</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>E</td>
<td>N</td>
<td>NE</td>
<td>NW</td>
<td>S</td>
<td>SE</td>
<td>SW</td>
<td>W</td>
</tr>
</tbody>
</table>

This variation of the orientation will allow the calculation for a fixed material at a climatic zone, the energy consumption according to the orientation of the building. We obtain

2.3.3. Building envelope

As for the material that will be applied to calculate our energy consumption, we will proceed as follows:

For each city, we will simulate the energy consumption due to air conditioning in the first step with the most used locally material (mortar blocks), in the second step with the optimal material known and recommended (William Ngaha Tiedeu, 2013) [10] in this zone and finally, the orientation of the building will also be varied with the abundant local material.

2.3.4. Assumptions on lighting and control building apparatus

We decided to fix the various equipment and the number of people occupying the rooms of our building. These values have been stopped in relation to the equipment that has been identified in some offices and has been generalized; that is why, we have stopped the standing of the recapitulated parts to be air-conditioned and therefore, in our model, the daily consumption due to the electrical equipment and the lighting of our building will be known and fixed. This energy will be multiplied by the number of days of service of our building following the month in order to obtain the monthly energy consumed.

2.3.5. Occupant Assumptions

It is very difficult to say exactly how busy our building is, because it is an administrative building with infinite entrances and exits. Nevertheless, we decided to set the average occupancy time to 8 hours per day.

2.3.6. Flowchart for determining the annual energy consumption

It is important to present the algorithm of calculation because it allows to better understand the logic that we have adopted to realize it. It is organized as below:
Figure 8 Flowchart for determining the annual energy consumption


The heat balance will be carried out at the time when the refrigeration charges will be maximum. This cooling time must coincide with the time of the highest solar contributions and the maximum internal loads (maximum number of persons or operation of the equipment).

If the maximum hours of external loads (solar radiation) and internal loads do not coincide, then, we must choose the maximum refrigeration load time depending on the operation of the premises.

Calculation of heat inputs
We divided them into 7 types of calorific energy

Energy input by sunlight on the walls
\[ \rho_e = K \times S \times \left( \frac{\alpha E}{H_e} \right) \]  (1)

Energy supply by sunlight on the glazing
\[ \rho_e = S \left[ K \left( \frac{\alpha E}{H_e} \right) + \tau E \right] \]  (2)
Energy transmission on the walls
\[ \rho_t = K \times S \times d \times (T_e - T_l) \]  
(3)

Energy intake by Air Renewal
\[ \rho_r = N \times \rho \times q_v \times \Delta H \]  
(4)

Energy input from occupants
\[ \rho_o = N \times M_{th} \]  
(5)

Energy input due to lighting
\[ \rho_{ec} = \sum P_i \]  
(6)

Energy inputs due to equipment
\[ \rho_{equi} = \sum P_i \]  
(7)

Energy input due to thermal bridges
\[ \rho_t = k \times L \times (T_e - T_l) \]  
(8)

Where:
- K = Coefficient of thermal transmission of the wall or glazing in W/m²°C
- S: Surface area of the wall or window under consideration (m²)
- \( \Delta T \): Difference in temperature between the two faces of the wall under consideration (°C)
- \( \alpha \): Absorption coefficient
- \( \lambda \): thermal conductivity W.m⁻¹°C⁻¹
- \( \tau \): Transmission coefficient
- N: Number of people
- \( q_v \): Air refreshment rate (m³/h)
- \( M_{th} \): Heat of metabolism (depends on activity) (W)
- \( P_i \): Active power (W)

Each type of energy has a transfer time throughout the day. But for the calculation of our air conditioner we are looking for the most critical situation and that is why we choose to do the calculations in a precise time when all these loads are present. We also decide the operating time of our air conditioner to be able to extract all that heat.

The refrigerating capacity is then given by the relation:
\[ \phi_i = \sum \frac{\rho_{i} \times t_i}{t_f} \]  
(9)

Having thus the value of our refrigerating power, we are able to choose an air conditioner whose power will make it possible to extract the heat present inside the building.

The building is modeled in the software CoDyBa and with the aid of the weather files that are input, the evolution of the internal temperature of the room is simulated.

The weather data used for our simulation dates from year 2008, for each month, we use the typical meteorological day to evaluate the evolution of the internal temperature in the building.
3. RESULTS AND DISCUSSIONS

3.1. Equatorial Guinea climate zone type

This curve shows that the choice of the air conditioner creates significant gaps on the energy consumption between the South and South-East directions. The same is true of the North and West directions. It is also observed that the basic thermal comfort is minimal according to the orientation x when the energy necessary to restore this comfort is maximum. The following table shows the classification of the optimal orientation of the main façade of our building (consequently of the building) recommended:

**Table 5** Classification of the optimal orientation of the main façade of the building for Guinean-type equatorial climate (Yaoundé)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>West</td>
<td>East</td>
<td>North-East</td>
<td>North-West</td>
<td>South</td>
<td>South-East</td>
<td>South-West</td>
<td>North</td>
</tr>
</tbody>
</table>

Compared to the geographical north, we advise to orient the building in this direction:

**Figure 10** Real and theoretical energy consumption due to air conditioning (Yaoundé)

**Figure 11** Recommended orientation of the building for Guinean-type equatorial climate (Yaoundé)
3.2. Equatorial climate zone of Cameroonian type coastal subtype

**Figure 12** Real and theoretical energy consumption due to air conditioning (Douala)

The choice of the air conditioner creates significant alternating Gaps on the evolution of the energy whereas the evolution of the net energy useful to the air conditioning has a less disordered evolution and tightness. To the right of the graph, we have the classification of the advised orientation of the main facade of the building:

**Table 6** Classification of the optimal orientation of the main facade of the building for Guinean-type equatorial climate zone of Cameroonian type coastal subtype (Douala)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>West</td>
<td>East</td>
<td>North-East</td>
<td>North-West</td>
<td>South-East</td>
<td>South</td>
<td>South-West</td>
<td>North</td>
</tr>
</tbody>
</table>

In relation to the geographic north, we advise to orientate the building in this direction.

**Figure 13** Recommended orientation of the building for Guinean-type equatorial Cameroonian type coastal subtype (Douala)
3.3. Equatorial climate zone of the Cameroonian type altitude subtype

![Graph showing real and theoretical energy consumption due to air conditioning (Bafoussam)](image)

**Figure 14** Real and theoretical energy consumption due to air conditioning (Bafoussam)

At the level of the actual consumption curve due to air conditioning, it can be seen that the choice of air conditioner creates significant overconsumption in the east and northeast. It is also observed that the shape of the two curves is not similar; so there is no good correlation between them. The following table shows the classification of the optimal orientation of the main façade of our building (consequently of the building) recommended:

**Table 7** Classification of the optimal orientation of the main façade of the building for Guinean-type equatorial climate zone of Cameroonian type altitude subtype (Bafoussam)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>South-East</td>
<td>South</td>
<td>North-west</td>
<td>west</td>
<td>North-East</td>
<td>East</td>
<td>North</td>
<td>South-west</td>
</tr>
</tbody>
</table>

![Diagram showing recommended orientation of the building for Guinean-type equatorial climate zone of the Cameroonian type altitude subtype (Bafoussam)](image)

**Figure 15** Recommended orientation of the building for Guinean-type equatorial climate zone of the Cameroonian type altitude subtype (Bafoussam)
3.4. Wet tropical climate zone

Consumption of energy is tightened considerably when the theoretical consumption is calculated, while slight gaps are observed when choosing air conditioners in the catalog. The classification of the optimal orientation of the main façade of our building (consequently of the building) recommended is the following:

Table 8 Classification of the optimal orientation of the main façade of the building for wet tropical climate zone (Ngaoundéré)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>South-East</td>
<td>North-West</td>
<td>East</td>
<td>West</td>
<td>South</td>
<td>North-East</td>
<td>North</td>
<td>South-West</td>
</tr>
</tbody>
</table>

Figure 16 Real and theoretical energy consumption due to air conditioning (Ngaoundere)

Figure 17 Recommended orientation of the building for wet tropical climate zone (Ngaoundéré)
3.5. Dry tropical climate zone

Figure 18 Real and theoretical energy consumption to air conditioning (Garoua)

Here, the two curves have similar patterns (good correlation) and the variation of energy as a function of orientation is more or less linear.

The following table shows the classification of the recommended optimal orientation for our building:

Table 9 Classification of the optimal orientation of the main façade of the building for dry tropical climate zone (Garoua)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>South-East</td>
<td>South</td>
<td>North-West</td>
<td>West</td>
<td>North-East</td>
<td>East</td>
<td>North</td>
<td>South-West</td>
</tr>
</tbody>
</table>

Figure 19 Recommended orientation of the building for dry tropical climate zone (Garoua)
3.6. Tropical-Sudano-Sahelian-type climate zone

The two curves have similar patterns except in the direction of the Northeast where a peak is observed.

The classification of the optimal orientation of the main view of our building (consequently of the building) recommended is the following:

Table 10 Classification of the optimal orientation of the main façade of the building for dry tropical soudano sahelian-type climate zone (Maroua)

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>South</td>
<td>South-East</td>
<td>North</td>
<td>West</td>
<td>North-East</td>
<td>East</td>
<td>South-West</td>
<td>North-West</td>
</tr>
</tbody>
</table>

Compared to the geographical north, we advise to orient the building in this direction

Figure 20 Real and theoretical energy consumption in air conditioning (Maroua)

Figure 21 Recommended orientation of the building for dry tropical soudano sahelian-type climate zone (Maroua)

3.7. Discussion

In general, we find that the orientation which consumes the least energy is not that recommended in books, simply the following reasons:

- The consumption of energy strongly depends on the morphology of the building; such as shapes, apertures, height. The consumptions oscillate differently depending on the orientation.
Recommendations made in most of the literatures reviews deal with cases in northern countries, but in the tropical zone, very few studies have been done in this regard.

Our building has practically the same volume of glazing on the front and back facades; No room to be air-conditioned has windows on the left or right facades. This particularity also influences the results.

We have also made other interpretations, namely:

The classification in terms of energy consumption remains virtually the same when materials are changed.

It is generally observed that the illumination in our climatic zones is very often at the peak in the time slots from 10h - 13h.

The mathematical model set up is only valid for buildings with the morphology hereby studied.

Index of consumption of air-conditioned buildings in tropical humid climate (kWh/m²/year) is within the margin of what is recommended

In order to carry out the classification of the various orientations treated, we have evaluated the net theoretical energy useful for air conditioning. For each city, we superimpose on the same graph the actual energy consumption due to air conditioning and that theoretically useful.

4. CONCLUSION

The aim of this work was to establish relations between energy consumption and building orientation, as well as a method of energy consumption forecast in the building in function of building orientation.

In order to achieve this, the research plan provided for the creation of a model for the determination of consumption values for the 112 cases examined (6 climatic zones, 2 to 3 materials for 8 orientations each as presented in the Algorithm), and finally an interpretation that will help in the decision making. The exploitation of the results obtained is specific to the buildings which have the same morphology as our pilot building and their interpretations have made it possible to reach the following conclusion:

The studies carried out on the typology of buildings in Cameroon reveal that more than 35% of the energy consumed in administrative buildings is due to air conditioning, generally of the split system type. This energy is generally poorly exploited, creating significant over consumption which justifies our interest in proposing a solution to reduce the energy consumption at the base.

For the building type of our study, in equatorial zones of Guinean type and coastal Cameroonian type, the smallest energy consumption is obtained when orienting its longitudinal axis in the North-South direction;

For the building type of our study, in the equatorial zone of Cameroonian type of altitude and the humid and dry tropical zones, the smallest energy consumption is obtained when its longitudinal axis is oriented in the south-west north-East direction;

For the building type of our study, in the Sudano-Sahelian tropical zone, the smallest energy consumption is obtained when orienting its longitudinal axis from east to west

It is be necessary to indicate that it is imperative to jointly carry out a good architectural construction policy to enhance solar insulation and protection:

As well as natural cooling by ventilation;
Given the complexity characterizing energy issues, we will advocate extending the scope of research to the following question:

A given set of dwellings composed of an entity that can be assimilated to a base element already studied.

REFERENCES


