Energy Building Performance And Energy Efficency Level Evaluation

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Abstract

This work concerns energy performance and building classification in compliance with the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level developed to comply with the Law 10295/2001, regarding minimum energy efficiency levels in Brazil. It presents a case study of an office building. It is part of the doctorate thesis in development in the Energy Planning Program at the Federal University of Rio de Janeiro, with a grant of the Electrical Energy Research Center, part of Eletrobrás.
The main purpose is, under the technical, normative and economical perspective, to apply the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level, which will be implemented in 2009. Two kinds of buildings – a design of an office building and an existent school building – will be used as case study.
Specifically the objectives are the classification of the concerned buildings; the study of electrical systems improvement and building envelope proposals, generally and specifically in the case study, to reduce the electrical energy consumption; the emission of CO2 relative to energy consumption; the added cost due to the improvement proposals; and the evaluation of cost-benefit related to the measures that reduce the electrical energy consumption.
The focus is on the methodology developed in the doctorate thesis enabling an approach for the discussion concerning the thesis theme and objectives aforementioned.

Key words: Buildings methodology; building labeling; energy efficiency; architecture.

1. Introduction

The building energy efficiency is related not only to electrical systems and equipment but also to human, climate and architectural variables. With these variables the built space is adapted to the environment where it is located, providing comfort, electrical energy consumption reduction and environment negative impacts reduction
The building energy efficiency should be adopted during the project to enable the use of the design strategies that improve in-operation building energy and thermal performance.
However, when an in-operation building is inefficient regarding the electrical energy consumption, it is possible to obtain improvements by means of electrical energy systems retrofit and building envelope intervention. These procedures present some limitations concerning the project strategies implementation, for example, building orientation and form; and kind of materials that favor the energetic and thermal performance.

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In this paper the focus is the Methodology developed to fulfill the main purpose and specific objectives.

2. Architectural Design Strategies to Reduce the Building Energy Consumption

The bioclimatic architecture design strategies rescue the architectural integration with the environment when one takes advantage of the climate, vegetation, urban design and technical solutions - the building orientation, shading of the facades, natural ventilation and lighting, materials used in vertical and horizontal walls. This way the building becomes a filter for the external conditions promoting a favorable microclimate for the development of activities that are intended to provide comfort and reduce the electricity use. With that, the benefits are avoiding natural resources waste and preventing environmental pollution resulting from the generation and energy use.
To get comfortable buildings regarding the thermal and lighting performance, it is necessary to regulate the external climate variables inside the space built with the aid of suitable materials and design strategies .
Before the beginning of the architectural design stages, a regional (i.e. in the place where the project will be implemented) analysis of the climate and the microclimate should be carried on. In particular, in the State of Rio de Janeiro, where the climate is hot and humid and the daily temperature range is low, the use of natural ventilation and the thermal control of sunlight are key factors to achieve thermal comfort without the use of artificial methods or with those in use (though in small scale). Besides, those factors are also critical to reduce electricity use of the building.
In addition to the climate variables, one should consider the human and architectural variables as a way to obtain comfort, improving the thermal and energy performance, as described below.
Architectural variables (Lamberts,1997): form, function, opaque and transparent walls, building shading, colors, lighting systems, water heating systems, artificial cooling, heat load, natural ventilation systems, evaporation cooling, vegetation;. materials; sun blocking systems; thermal mass of materials.
Climate variables (Lamberts,1997): Macroclimate -solar radiation, latitude, altitude, wind, temperature, humidity; Microclimate- topography, vegetation, soil surface (natural and built).
Human variables (Lamberts,1997): Thermal Comfort - environmental variables, physical activity, clothing, visual comfort, lighting level, contrast, glare.

3. Lighting and Air Conditioning Systems

The efficient lighting systems depend on the technical characteristics; the performance of the elements that compose them; the environment; and the electrical installations design. They are also influenced by some important factors such as: bulbs; lamps; reactors; control and distribution circuits; natural light use; color; coating or environment finishing material.

There are several kinds of bulbs, but for commercial building use fluorescent bulbs are the most used.
The air conditioning system is used for cooling the environments in buildings. Depending on the climate, the use of air conditioning is indispensable, especially in some times. The most used systems are window air conditioning; mini central; split-type mini central, self contained, chiller and fan-coil.
The efficient air conditioning systems depend on the choice of a type, the variables (i.e. human, architectural and climatic) considered in the thermal load estimate, the system temperature control and the temperature adopted according to climate and human activities.

4. Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level

The Standards present technical requirements such as the methods for the classification of public, service and commercial buildings regarding the energy efficiency. The Standards include three main requirements:
Envelope thermal performance;
Installed power and efficiency of the lighting systems;
Air conditioning systems efficiency.
These requirements present efficiency levels varying from A (more efficient) to E (less efficient)
In order to obtain the building classification, it is necessary to evaluate the classification for each requirement (weights are attributed for them). The weights for each requirement are presented below:
Envelope – 30%
Lighting system – 30%
Air conditioning system – 40%

Table 1 presents the classification levels in points.

Tale 1 – Numerical equivalent for each efficiency level

Classification	Points
A	5
B	4
C	3
D	2
E	1

Source: Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level (MME, 2008).

The classification can be obtained by prescriptive method in accordance with formulas in the Standards or by software simulation.

5. Methodology

This work is based on the methodology developed for the evaluation and classification of school and office buildings in compliance with the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level.
Below the sumarized methodology is presented.

(1) Criteria for the building choice:
Lacation in the city of Rio de Janeiro;

Available documents – architectural plans, building material specifications, lighting projects, climate control projects, energy bills;
Access to the place for the field assessment when necessary.
(2) Building characterization:
Project documents examining;
Assessment of the existing situation when the project documents do not present the required information;
Identification of the materials used in the building envelope and inside.
(3) Eletrical systems characterization:
Identification of the air conditioning and lighting systems and their use time.
(4) Climate characterization.
(5) Electrical energy consumption assessment through electrical energy bills of the last twelve months.
(6) Electrical energy indicators assessment.
(7) Assessment of the points that present electrical energy saving potential.
(8) Proposals and preliminary evaluation of possible solutions for the reduction of electrical energy consumption.
(9) Simulation in the software Energy Plus:
Input required by the software;
Simulation of the reference model;
Evaluation of the electrical energy consumption results in comparison with the electrical energy bills.
Simulation adjustment in case there is a discrepancy between the results from the simulation and consumption shown in the bills.
(10) Building classification in compliance with the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level.
(11) Simulation of alternative models by using appropriate projects strategies and different lighting and air conditioning systems that modify the building energy performance and its respective classification in compliance with the concerned Standards.
(12) Classification and choice of the simulated alternative model.
(13) Models CO_2 avoided emissions estimate.
(14) Economical evaluation of the models cost and benefits.
(15) Results analysis.

6.Conclusion

By applying this methodology, it is possible to classify buildings in compliance with the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level; analyze the building energy performance; and assess the cost-benefit for the adopted solutions (in design and retrofit). These procedures are ultimately aimed at reducing electrical energy consumption and better classifying buildings in compliance with the Standards.
With the implementation of the Standards in the case-study existent building and design, it is possible to conduct a critical analysis of the use of this regulation and identify possible difficulties in its implementation, as this will only be put in use in 2009. Moreover the implementation allows the comparison of benefits and difficulties in both cases.
The methodology and the outcome of its application (to be presented in a doctorate thesis) is expected to contribute to the research in the development and practical consolidation of the Standards for Non Mandatory Labeling of Commercial, Services and Public Building Efficiency Level .

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