



Energy efficiency labeling of buildings: An assessment of the Brazilian case

Norma do Nascimento Batista^{a,b,*}, Emilio Lèbre La Rovere^a, João Carlos Rodrigues Aguiar^b

^a Interdisciplinary Environment Laboratory, LIMA, Alberto Luís Coimbra Institute of Research and Graduate Studies in Engineering, COPPE, Rio de Janeiro Federal University, UFRJ, LIMA/COPPE/UFRJ, Rio de Janeiro, Brazil

^b Department of Special Technologies, Electric Energy Research Center, Eletrobras Cepel, Rio de Janeiro, Brazil

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ABSTRACT

This paper addresses the application of Energy Efficiency Rating Technical Quality Regulations for Commercial, Service and Government Buildings – RTQ-C in order to ascertain whether the conventional construction system for buildings complies with these requirements. Additionally, it investigates the contribution of labeling to reducing electricity consumption by the building. To do so, the RTQ-C was applied to two buildings in order to calculate the efficiency levels of their envelopes and possible alterations are proposed for upgrading the envelope performance where pertinent. It is noted that conventional buildings adopting measures such as painting the walls and roof white, in addition to using smoked glass, are sufficient to bring the rating up to an A grade. As no specific concern was noted in the architectural designs for the buildings studied, making use of design strategies that minimize the use of electricity in these buildings, the findings of these case studies may well indicate that the RTQ-C has adopted technical requirements that are not particularly stringent. Consequently, it is believed that these requirements should be reviewed during a second stage, in order to make them more restrictive and attain further improvements in the constructed environment with better energy efficiency for buildings.

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1. Introduction

The energy efficiency of buildings is a matter of interest worldwide, accounting for some 40% of annual global energy consumption [1]. In Brazil, the residential, commercial and government sectors accounted for 45% of total electricity consumption in 2008, with the commercial and government sectors consuming 22.7% [2].

Labeling is viewed as an effective tool for reducing energy consumption by buildings. According to the World Energy Council [3], labeling and minimum energy efficiency criteria are the top-performing options for obtaining fast improvements. Moreover, Brazil's National Institute of Metrology, Standardization and Industrial Quality – INMETRO [4] notes that when labeling is associated with performance goals, it constitutes an important tool for reducing energy consumption in Brazil, through encouraging technological upgrades in the fabrication of equipment earmarked for the domestic market, boosting the supply of good to consumers with better energy performances and thus bringing up their quality to international levels.

A major step forward towards greater energy efficiency in Brazil was the approval of its Energy Efficiency Act, introduced through Law N 10,295 [5] on October 17, 2001, which rules on Brazil's National Energy Conservation and Rational Use Policy.

This act strengthened Brazil's National Electricity Conservation Program (PROCEL) which launched its energy efficiency action plan for buildings (PROCEL Edifica) in 2003. One of the outcomes of this action plan, compliant with Law N 10,295 was the drafting of the Energy Efficiency Rating Technical Quality Regulations for Commercial, Service and Public Buildings – RTQ-C and supplementary documents [6–8]. These technical regulations were approved through Edict No 53 promulgated on February 27, 2009 by INMETRO and published in the Federal Government Gazette (DOU) on March 3, 2009. This was undoubtedly a watershed for the civil construction sector, as it ushered in a new set of dynamics guiding the quest for architectural solutions and supplementary lighting and air-conditioning projects that upgrade the thermal and energy performances of buildings designed. Alongside construction companies, architects, engineers and the manufacturers of construction materials and the consumer market will certainly be subject to changes in the ways that buildings are conceptualized, constructed and sold. More specifically, construction companies and building owners may well look ahead to the possibility of deploying the comparative advantages offered by a labeled building, particularly because of what the maximum efficiency level may represent in the sales process, stressing the reduction in energy consumption reflected in monthly electricity bills, heat-related comfort and

* Corresponding author at: Laboratório Interdisciplinar de Meio Ambiente, Rua Athos Silveira Ramos, Centro de Tecnologia, Bloco I, Sala 208, Ilha do Fundão 21945-970. C.P. 68565, Rio de Janeiro, Brazil. Tel.: +55 212 562 8759; fax: +55 212 562 8805.

E-mail addresses: normabaptista@ppe.ufrj.br, nnbaptista@hotmail.com (N.d.N. Batista), emilio@ppe.ufrj.br (E.L.L. Rovere), jocarlos@cepel.br (J.C.R. Aguiar).

marketing activities highlighting green buildings, in order to add value to these products. This approach would result in financial benefits for the builder, the owner and user of the building.

Initially, although compliance is still voluntary, these technical regulations will become mandatory within a period that has not yet been defined, introduced in order to establish the conditions required for labeling the energy efficiency of commercial, service and government buildings through Brazil's National Electricity Conservation Label (ENCE) scheme [6–8]. Although Brazil is merely starting out along the road towards efficiency energy labeling for buildings, there is no doubt that labeling buildings will drive the development of architectural designs and the revitalization of existing buildings with higher quality, from the energy use standpoint, in addition to retrofitting existing buildings. According to Geller [9], the dissemination of information could well be more effective when combined with other policies such as: financing incentives, voluntary agreements or regulations. For example, the building education and training of constructors and legislators have been effective in the USA, conducted simultaneously with the adoption of more rigid energy efficiency standards for buildings [10].

However, at the current stage of building labeling in Brazil, there are no economic or tax incentives such as performance bonuses for construction standards or reductions in building taxes that would prompt interest in labeling among construction companies or owners. These incentives would be a way of stepping up the number of applications for labeling among owners and construction companies during the design phase as well as when revitalizing a building already in operation. On the other hand, Brazil's National Energy Efficiency Plan 2010–2030, which is currently being drawn up, makes provision for several actions under the aegis of building labeling, including capacity-building, disclosure and dissemination. It also addresses encouragement for including the energy efficiency concept in new and existing public buildings.

The energy performance of new buildings can be improved through labeling at the various project design stages, as the potential energy savings of a building are introduced at various design stages: architectural scheduling; draft design; project design development; construction system; construction management; post construction and maintenance. For example, during the draft design phase, potential savings vary between 40% and 50%; during the project design development stage, estimated potential savings vary from 30% to 40% [11]. In an existing building, improvements can be introduced through retrofitting systems that use electricity, together with interventions in the building envelope – although with some constraints in this case, as some project design strategies cannot be adopted, such as placement, shape and the use of materials that enhance heat and energy performances. However, according to Yilmaz [12], among the project design parameters affecting the thermal comfort of buildings and ensuring energy conservation during construction, the building envelope is the most relevant, as this is what separates the indoor environment from the outdoors.

According to INMETRO [13], five buildings were labeled in Brazil in 2009, in four bioclimatic zones BZ 1; BZ 2; BZ 3; and BZ 8. By July 2010, five buildings had been labeled in BZ 3. The prescriptive method was used to rate the efficiency levels of these buildings, which consists of an analytical proceeding that uses the equations presented in the RTQ-C (as shown in Section 2), with the entry date addressing the characteristics of the three systems covered by these regulations – envelope, lighting and air-conditioning. The envelopes of all these buildings were rated as A grade. For the buildings labeled in 2009, the justifications in general are: the use of shade elements, low percentage of openings and higher performance glass. The outcome of rating the building envelopes in terms of the characteristics of the labeled buildings

draws attention to the criteria adopted in the RTQ-C, which may not be sufficiently stringent to encourage architectural designs adapted to climate conditions, ensuring heat related comfort in the building with significant reductions in electricity consumption, while helping mitigate the adverse impacts arising from its use. The relevant quantification of electricity consumption associated with each rating level for a building cannot be determined through the prescriptive method, meaning that it will be necessary to conduct another study using the simulation method through appropriate software. This method consists of comparing the thermo-energy performance of a real building with benchmark buildings (A–D), necessarily conducting simulations of the real and benchmark models. In Brazil, this practice is limited, as it is necessary to train practitioners in the use of the software.

Returning to the ratings of the labeled buildings, it is felt that, although the number of labeled buildings is not significant for a representative sample of the universe of buildings in various parts of Brazil, the following influences may be drawn: the minimum standard for building envelopes should encompass the criteria required for an A grade label; and the Regulations need to update the criteria adopted for energy efficiency ratings of envelopes. However, it is felt that the number of labeled buildings is not large enough to conduct any conclusive assessment of the criteria adopted for envelopes in the regulations, nor to define the minimum standard to be adopted for buildings.

As presented, the purpose of this paper is to ascertain whether the conventional construction system complies with the requirements in the regulations, while also striving to investigate the contributions of building labeling to reducing their energy consumption. To do so, the Energy Efficiency Rating Technical Quality Regulations for Commercial, Service and Government Buildings are applied, using the prescriptive method, in order to assess the envelope performance of two buildings used for educational purposes at a school in Rio de Janeiro, Brazil. The building envelope energy efficiency rating procedure is outlined: the energy efficiency ratings are calculated; and the outcomes are assessed in order to propose possible changes to the building envelopes that would improve their ratings. Finally, a brief evaluation is presented of the efficacy and effectiveness of these building envelope regulations, in addition to assessing the method, based on the findings of this study.

2. Energy Efficiency Rating Technical Quality Regulations for Commercial, Service and Government Buildings – RTQ-C – overview of the procedure [6,7]

These technical regulations encompass buildings with a total useful area of at least 500 m² and/or with electricity supplied at a voltage of at least 2.3 kV, with and without air conditioning or partially air conditioned. These buildings are designed for mixed use: residential and commercial; residential and services; or residential and government, although in this case the non-residential portion with a total minimum useful area of 500 m² is assessed separately.

Energy efficiency building labeling must comply with the criteria set forth in these regulations, which address the building envelope performance, the lighting system efficiency and capacity, and the air-conditioning system efficiency. In order to allocate energy efficiency ratings, two methods may be used: prescriptive and simulation.

These regulations specify the building efficiency ratings, which vary from A (most efficient) to and (least efficient), divided into three requisites: building envelope; lighting system; and air conditioning system. For the efficiency rating of each requirement, a number of points are assigned called the numerical equivalent – NumEq, which is used to calculate the general rating of the building.

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