CHAPTER 7

BUILDING LABELLING IN BRAZIL
A FOCUS ON ENERGY EFFICIENCY

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According to the Environmental Protection Agency the buildings in which we live, work and play protect us from nature's extremes, yet they also affect our health and environment in countless ways (EPA, 2017). As the environmental impact of buildings becomes more apparent, a field called "green buildings" has gained momentum in the last two decades. The agency defines green, or sustainable buildings as being the practice of creating and using healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition.

The question that arose from this new concept was how to recognize a green or more efficient building. Consumers should not rely only in the producer's own definition of sustainability or efficiency. The Instituto Nacional de Metrologia, Qualidade e Tecnologia (Inmetro) states that, in general, consumers do not have specialized knowledge about the products or buildings they intend to acquire in order to identify which are more cost beneficial, sustainable or economical. On the other hand, the Institute states that suppliers need to differentiate their products justifying the investment to be made by consumers or users (INMETRO, 2017b).

The labelling of products and buildings then intends to provide consumers with useful and comparative performance information. It allows consumers to consider investing in better performance appliances or buildings which have reduced impacts, reduced running costs and that allow realizing savings that outweigh the difference in price. They also stimulate the industry competitiveness, which shall present products that are more efficient (EU, 2017; INMETRO, 2017a).

The application of labels can be mandatory, partly mandatory or voluntary. When buildings are addressed, the labelling can be partially mandatory only for a specific sector or for sale (not being mandatory for rental). The site Building Rating brings useful information about the existing labelling systems throughout the world (http://www.buildingrating.org/).

ENERGY BUILDING LABELLING

The implementation of energy efficiency strategies in buildings not only contributes to lower peak energy demand but can also reduce overall energy use and buildings impact on the environment (KNEIFEL, 2010; NIKOLAOU et al., 2015). The basic principle for improving a building energy efficiency is to use less energy for heating, cooling and lighting without affecting the health and comfort of its occupants (NIKOLAOU et al., 2011; PÉREZ-LOMBARD et al., 2009).

In the specific case of the building energy efficiency labelling, the focus tends to be linked to the country's goal of energy savings.

The energy efficiency building labelling usually considers the building constructive characteristics (walls and roof insulation, glazing type and insulation, external surfaces solar absorption) that are responsible for the building heat exchanges with the exterior climate along with the equipment and electrical systems installed, such as cooling, heating, lighting and water heating. Buildings are generally rated before construction, receiving a label that represents the rating of their systems and construction characteristics. The ratings are divided in building types and can be set for commercial (offices, hotels, shopping centers), public, institutional (schools, hospitals, etc.), or for single and multifamily residential buildings.

One of the questions risen by the World Energy Council (WEC, 2008) is that measures on buildings tend to be focused on new buildings. As new buildings represent a small share of the existing stock, building standards can only have a slow impact on the short term, which however becomes significant in the long-term. A more recent trend is to extend regulations to existing buildings and impose the introduction of energy efficiency certificates for the existing buildings each time there is a change of tenant or a sale (WEC, 2008).

Another issue is that the energy efficiency labelling of a new building generally cannot evaluate the energy performance of the actual building. The World Energy Council (WEC, 2008) also discussed that it seemed that the actual energy performance of new buildings was below what could be expected from the building regulations. According to the council, this could be explained by behavioral factors and by a noncompliance with the building regulations.

In this case, benchmarking evaluations seem to be a path to give more reliable information to consumers, stakeholders and owners about the actual performance of a building.

While benchmarking systems are developed by using the energy performance of a significant number of reference buildings, benchmarking results can be used to encourage poor reference performers (in energy-efficiency) to improve their performance (CHUNG, 2011).

Benchmarking of energy consumption in buildings is also important in their operation, since this benchmarking makes it possible to determine what energy saving goals and strategies can be set for existing buildings and also to check how estimated energy design behaves against similar existing buildings.

THE BRAZILIAN CASE

In Brazil, the building energy matrix is mainly composed by electric energy and the residential, commercial and government buildings accounted for 52% of total electricity consumption in 2019 (EPE, 2020).

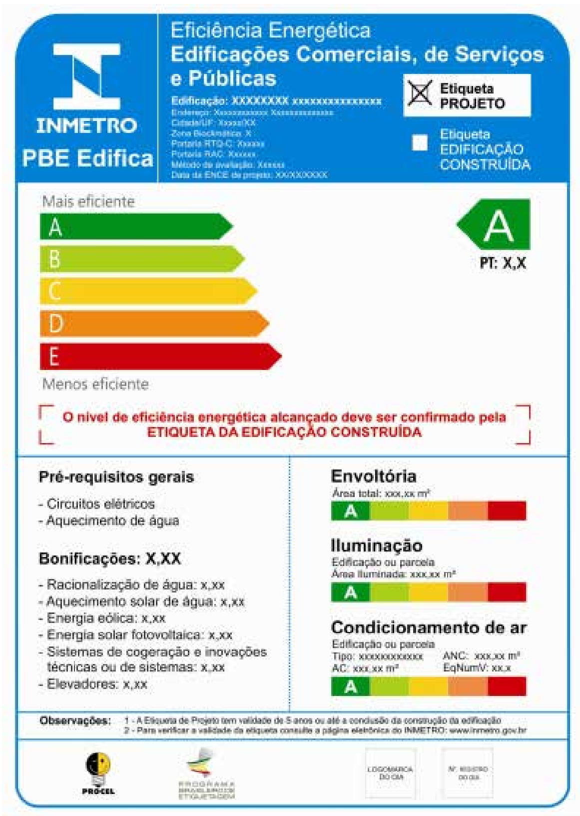
In 2009, as a result of the actions that have taken place after the electric energy supply crisis in 2001, the Non residential Buildings Regulation, Regulamento Técnico da qualidade do Nível de Eficiência Energética em Edificações Comerciais, de Serviço e Públicas (RTQC) was published, followed by the publication of the Residential Buildings Regulation in 2010. These regulations were reviewed and complemented in 2010, 2012 and 2013 (BRAZIL, 2010; BRAZIL, 2012; BRAZIL, 2013). They are voluntary except for federal public buildings for which the labelling is mandatory since 2014 (BRAZIL, 2014).

The Brazilian energy efficiency label is given in two phases: Design and Constructed building and for the commercial, public and service buildings, it can analyze the whole construction of part of the building. New and existing buildings can be evaluated. In RTQ-C, the envelope, the lighting system, the air conditioning system and bonuses are evaluated. Bonuses are related to other systems efficiency, such as elevators, renewable energy or water consumption reduction. When all systems are evaluated a global label is emitted but a partial label can also be emitted provided the envelope is analyzed and only when the global label is emitted bonuses can be accounted for.

In new buildings, five years after the Design Label is published it is considered invalid if the Constructed Building Label is not obtained.

Figure 1 shows the label for the commercial, public and service buildings where it can be seen that buildings are classified from A to E, being A the best performers.

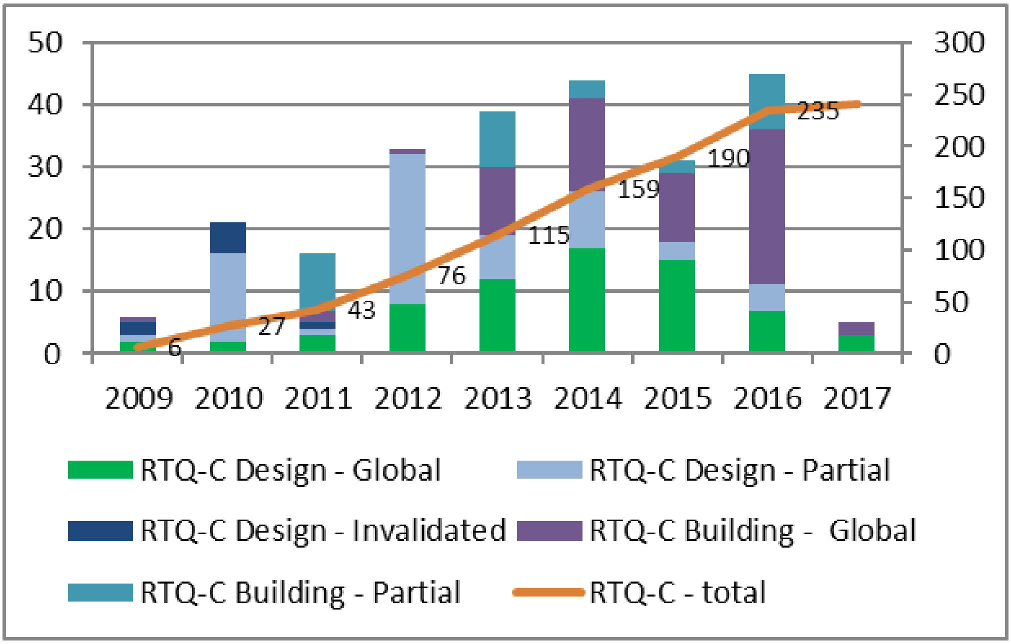
Figure 1 – Label for commercial, public and service buildings emitted in Brazil



Source: Brazil (2010).

Figure 2 presents the number of labels of commercial, public and service buildings (RTQ-C) emitted in Brazil from 2009 to July 2017 showing the distribution among design and constructed building labels.

Figure 2 – Number of labels for commercial, public and service buildings emitted in Brazil



Source: Data from INMETRO (2017a).

Since the regulation implementation building, design labels presented a growth tendency, but that started to decrease from 2015 on and this may be related with the Brazilian economic and political crisis. Despite the growth in the number of constructed building labels emitted in 2016 the general situation shows deceleration of the process.

Another figure important to stress is that the total number of labelled buildings in Brazil is still very small if compared to the built scenario in the country and that only two of the labelled buildings could be considered as pre-existing buildings before the labelling process. Many of the buildings that received the constructed building labels are new buildings.

The little number of labels emitted shows that there seems to be a small penetration of the energy efficiency concepts in the construction industry. That may be confirmed by the closure of two of the five accredited inspection organisms for the emission of the Brazilian building labels (INMETRO, 2017b).

The situation is a worrying one once some studies show a growth tendency in the energy use intensity (EUI – W/m^2) in new buildings in Brazil. This may be due to lack of consumers and stakeholder's awareness.

From the 76 buildings that received a global design label, 87% presented an A level and levels B and C level presented 5% of the labels each. There's no building design classified in the D or E levels. For the 68 constructed building labels, there are buildings classified from A to D, being 84% of the buildings classified as A and only 3% of the buildings received a D classification. This large number of A classifications is expected once the labelling is voluntary for most buildings and stakeholders will tend to invest in obtaining the label only when good classifications can be achieved. Studies to implement mandatory labelling for buildings are being undertaken as part of the 2019 *Plano de Aplicação de Recursos* (PAR), a plan for application of resources from the Brazilian energy conservation program PROCEL (2019).

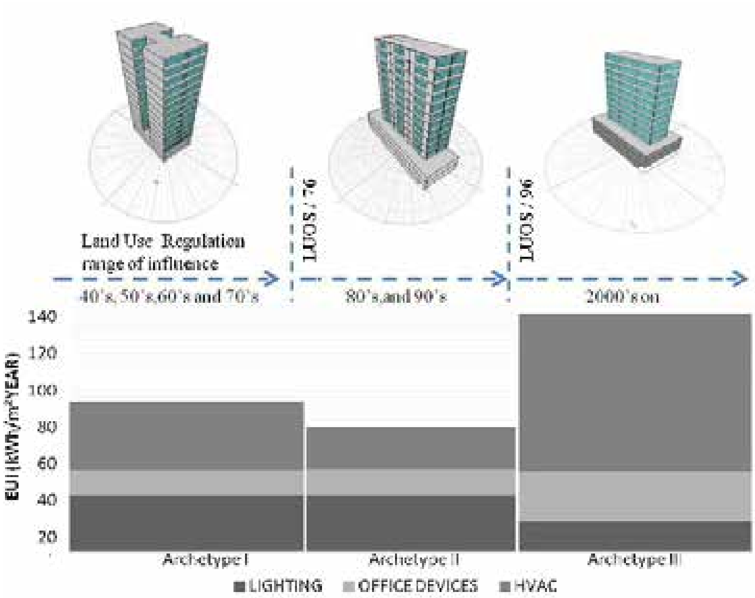
ENERGY CONSUMPTION ESTIMATION OF OFFICE BUILDINGS IN BELO HORIZONTE

Alves et al. (2017) in a theoretical study carried out for Belo Horizonte, Minas Gerais, determined typical office building characteristics according to the urban legislation development since 1940 and based in Google Maps surveys and on *in loco* visits. The authors proposed a division of office building towers in three archetypes according to the building time of construction (1940s to 1970s; 1980s to 1990s and from 2000 on) defining the main constructive characteristics and installed systems of each archetype. For each of these, energy models were created in order to assess the energy use intensity, EUI ($kWh/m^2/year$). The analysis of the EUI baselines highlighted differences between the archetypes, explaining the impact of the design conception based on land use regulation and of the technical choices on the overall electricity consumption.

Figure 3 shows the average resulting electrical energy consumption of the three archetypes in EUI in $kWh/m^2/year$. The study showed that new office buildings in the city, represented by archetype III, tend to be centrally conditioned with an average consumption of 140 $kWh/m^2/year$ and consume up to 40% more energy than buildings from previous decades that operate in mixed air conditioning mode. The authors identified archetype III as being a tendency to the new office buildings in the city.

The older buildings, on the other hand, tend to have a higher EUI for lighting and air conditioning due to the usage of nonefficient equipment. It is important to stress that, in simulating archetypes I and II, the buildings were set to operate using HVAC (heating, ventilation, and air conditioning) when temperature was above comfort levels. But as Belo Horizonte presents a mild temperate climate, with hot summers and mild winters, for most of the year buildings can use natural ventilation as their main conditioning mode and only when it is hot cooling is turned on. Therefore, to diminish the city energy demand, buildings that allow natural ventilation should be strongly encouraged according to the authors.

Figure 3 – Energy use intensity of office building towers in Belo Horizonte, Brazil



Source: Alves et al. (2017).

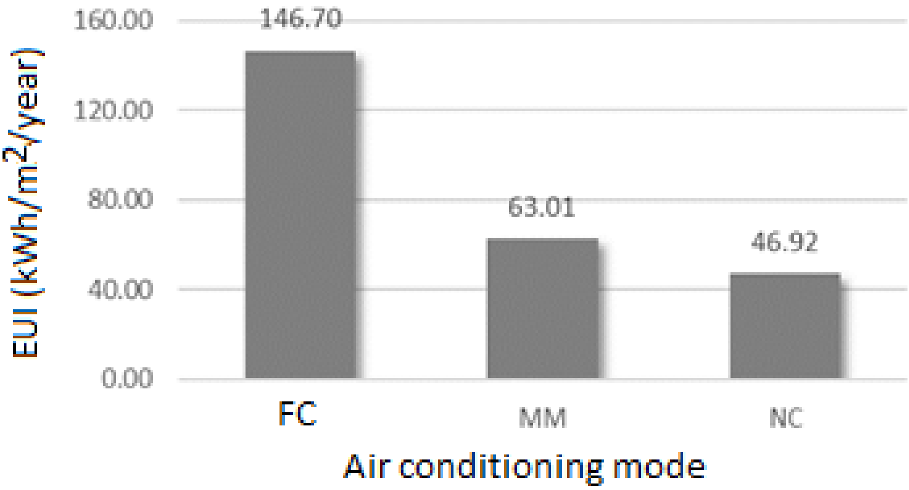
ENERGY BENCHMARKING OF OFFICE BUILDINGS IN BELO HORIZONTE

This study was corroborated by Veloso (2017) who proposed a benchmarking for 78 office building towers classification also in Belo Horizonte, according to their measured energy consumption. While Alves et al. (2017) produced computer simulations of prototypes for the city office towers, Veloso (2017) used measured energy consumption data obtained from the electric energy company and building plans obtained from the City Hall of Belo Horizonte to obtain EUI information.

Veloso et al. (2017) had previously identified that the air conditioning mode is the most relevant feature in determining the energy use intensity of a building in the city. Therefore, in Veloso's (2017) study, the building towers were divided in three categories according to their air conditioning type: fully conditioned (FC); conditioned in mixed mode (MM) and not artificially conditioned (NC), as it can also be seen in Figure 3.

Figure 4 presents the average annual measured electric energy use intensity (EUI) of the 78 towers according to their air conditioning mode.

Figure 4 – Mean EUI (kWh/m²/year) of 78 office building towers in Belo Horizonte divided according to their air conditioning mode



Source: Adapted from Veloso (2017).

It can be seen in Figure 4 that the values found by Alves et al. (2017) for the archetype III (centrally conditioned towers) present a close correlation to the energy consumption of fully air-conditioned towers with a measured energy use intensity of 146 kWh/m²/year against a predicted consumption of 140 kWh/m²/year.

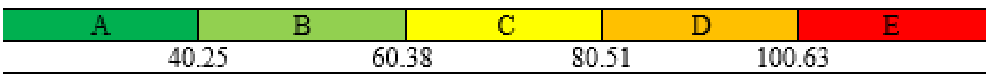
The other categories though do not present such a close correlation with archetypes I and II as the archetypes consumption of building from the 1940s to 1990s is relatively higher than what Veloso found for towers that operate in mixed mode (using split or window systems only in hot periods) or in naturally ventilated buildings. It is important to stress that MM towers consume 20% less energy than archetype II that would represent buildings that operate in mixed mode. The difference in prediction may be due to a simultaneity factor (that is, it is expected that not all individual air conditioning systems operate at the same time) that was not used in Alves research and that appears in Veloso's measured data.

For the benchmarking proposition, Veloso (2017) used a classification shown in Figure 5 based on the European methodology presented in EN 15217: *Energy Performance of Buildings - Methods for expressing energy performance and for energy certification of buildings* (ESO, 2007). This standard presents energy performance indicators and the methodology for the establishment of energy classes.

The European methodology established a building classification in levels from A to G and was therefore adapted to the Brazilian system that presents classification levels from A to E.

The reference classification index (s) proposed in this regulation, is defined as the ratio between the typical energy consumption value of the buildings (benchmark performance index, EUIR) and the energy performance achieved by 50% of the real estate stock (EUIs). Since there is no EUIR defined for Brazil, the value used in this ranking was of 0.50 as the *Plano Nacional de Energia 2030* (PNE) (BRAZIL, 2007), estimates a potential reduction in electricity consumption of approximately 50% with the implementation of efficiency actions and this was the figure used for this index. The EUIs value was estimated as being the median annual energy consumption per area of the sample towers corresponding to 80.51 kWh/m^2/year. The benchmarking limits are then presented in Figure 5.

Figure 5 – Benchmarking limits of electric energy consumption for office building in Belo Horizonte, Brazil



Source: Veloso (2017).

As it can be seen in Figure 5, with this classification most fully conditioned buildings would be classified within the level E. This may discourage designers and stakeholders to improve energy efficiency in those buildings. Therefore, if an office building benchmarking classification is to be proposed to the city it must be discussed if different scales should be set for different conditioning modes.

DISCUSSION

The studies presented here lead to an interesting discussion of how to stablish indexes and ranges that can represent the energy efficiency of a building.

If Veloso's (2017) benchmarking proposition for office building towers is used, the towers with central air conditioning tend to present lower classifications once their energy use intensity is higher than in the towers that operate in mix mode or that are naturally ventilated, a condition that is possible in the city of Belo Horizonte once its climate is fairly mild (Koppen's Cwa).

This is the case of one building in the city that presents central air conditioning and that received an A classification in the Brazilian labelling system. As this building consumes 119 $kWh/m^2/year$ it would receive an E classification in the proposed benchmarking.

This may turn to be an awkward situation and a solution would be to separate buildings according to their conditioning system, but in this case, consumers, stakeholders and specially designers would not be aware of the impact the air conditioning mode choice has in the final consumption of a building.

This is not a discussion that can be finalized here but it is expected that it can open an interesting subject for debate. Are the fully air-conditioned buildings receiving green building labels as efficient as they could be? Are these the buildings to be featured as exemplary?

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