Renewable and Sustainable Energy Reviews 65 (2016) 1216–1231

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Building energy efficiency: An overview of the Brazilian residential labeling scheme

Michele Fossati [a,*], Veridiana Atanasio Scalco [b], Vinícius Cesar Cadena Linczuk [c], Roberto Lamberts [d]

[a] Department of Architecture and Urbanism, Federal University of Santa Catarina, Campus Universitário da Trindade, 88040-900 Florianópolis, SC, Brazil
[b] Pos Graduate Program in Architecture and Urbanism, Department of Architecture and Urbanism, Federal University of Santa Catarina, Brazil
[c] Federal University of Fronteira Sul, Erechim/RS, RS 99700-000, Brazil
[d] Laboratory of Energy Efficiency in Buildings, Department of Civil Engineering, Federal University of Santa Catarina, Florianópolis, SC 88040-900, Brazil

ARTICLE INFO

Article history:
Received 16 November 2015
Received in revised form
3 June 2016
Accepted 26 June 2016

Keywords:
Energy efficiency
Residential buildings
Brazilian Labeling Scheme

ABSTRACT

One of the alternatives to reduce building energy consumption recognized and used internationally is establishing standards for the evaluation and classification of buildings in terms of energy performance. In developed countries, the introduction of energy efficiency codes for residential and non-residential buildings started around the time of the first oil crisis in the mid-70s. Ten years later, Brazil has started implemented measures aimed at the conservation and rational use of energy. Initiatives in this regard began with the implementation of the Brazilian Labeling Program, where consumers are provided with information on the energy efficiency of appliances. However, the first energy efficiency law stimulated the most notable improvement in energy efficiency in 2001 after national energy crisis. As a result, the Regulation for Energy Efficiency Labeling of Commercial, Service and Public Buildings (RTQ-C) was released in February 2009 and the Regulation for Energy Efficiency Labeling of Residential Buildings (RTQ-R) was released in November 2010. Nowadays, the labeling of residential, commercial and service buildings is voluntary and the labeling of federal public buildings is mandatory since 2014. This paper presents a review of the building energy efficiency codes and labeling schemes all over the world, an overview of the Brazilian regulations on energy efficiency and discusses the labeling scheme for residential buildings adopted in Brazil. The process of its implementation, strengths and weaknesses in the present labeling scheme and the similarities and differences in relation to international experiences are described. The results obtained to date indicate that a revision is required in order to achieve a more flexible and economically viable process that will enable the program to be established as compulsory.

Contents

* Corresponding author.
E-mail addresses: michele.fossati@ufsc.br (M. Fossati), veridi@gmail.com (V.A. Scalco), vinicius.linczuk@uffs.edu.br (V.C.C. Linczuk), roberto.lamberts@ufsc.br (R. Lamberts).

http://dx.doi.org/10.1016/j.rser.2016.06.048
1364-0321/

1. Introduction

The continuous growth in energy consumption and its consequences in terms of environmental impact are realities in developed and developing countries and are among the most important issues discussed worldwide in recent decades. The growth in the population, development of the construction sector, increase in comfort levels and time spent inside buildings all indicate that the upward trend in energy demand will continue into the foreseeable future. By 2035, the global energy demand will have grown by more than one-third compared to the current consumption level [1]. China, India and the Middle East will account for 60% of the increase, due to the gradual but significant economic growth which they are experiencing [1]. Table 1 shows the electricity consumption in the top ten countries in 2012. The Brazil's electricity consumption is in eighth position.

The building sector consumes on average one third of the total energy in most countries, and accounts for an even greater proportion of the electricity [4]. Residential buildings accounts for 9,3% of the Brazilian energy consumption [3]. Also, the energy consumption of residential buildings has showed one of the highest growth rates, with an annual average increase of 5.7% during the period 1975–2015. Table 2 shows 2010 information and a projection for the residential sector for the years 2020 and 2030 based on research by the Brazilian Institute of Geography and Statistics (IBGE) and the Energy Research Company (EPE) [5].

Brazil has an electricity matrix predominantly supplied by renewable sources and the internal hydroelectric power generation accounts for 65.2% of the supply (this amount was 81.8% in 2011). On adding imports, 74.6% of Brazil's electricity is generated from renewable sources [3] (Fig. 1). Unfavorable hydrological conditions and increased thermal generation explain the decline in the participation of renewable electricity matrix from 88.9% in 2011–74.6% in 2014 [3,6].

The portion of renewable energy sources supplying the Brazilian energy matrix (39.4%) also remained significantly above the global and the OECD average (Organization for Economic Cooperation and Development), estimated by the International Energy Agency to be 13.2% and 8.6%, respectively [3].

With an essentially clean energy matrix, Brazil, unlike most developed countries, does not have targets for reducing carbon emissions in the energy sector.

This scenario, however, is undergoing transformations [7]. According to the National Energy Plan - PNE 2030 [8], issued in 2007, by 2030 the annual electricity consumption in Brazil will have doubled, and this will lead to an increase in the use of non-renewable sources. Among the strategies to reduce and control the increase in energy demand, for the first time, the PNE 2030 requires as a basic premise for National Energy Efficiency Plan –PNEf [9], issued in 2010, the goal of energy efficiency: aimed at a 10% reduction in the projected demand [8,10].

Since the beginning of 2015, as a result of the lack of integrated resource planning, unfavorable hydrological conditions and increased thermal generation, a tariff flag transfers immediately to the bills the cost of power generation. In this new system, when there is the need to use thermal generation, due to low hydroelectric reservoir levels, the value of the account is raised for consumers.

In this sense, Brazilian government has made efforts to expand and diversify the potential of renewable energy sources. An example of this expansion is the construction of Belo Monte plant with hydroelectric power potential that aims to generate 11.233 MW. Moreover, Brazil still has a huge wind power potential, estimated in 143 GW, concentrated in the Northeastern and Southern regions, and a solar power potential with a territory privileged in terms of solar radiation. However, these two technologies actually involve high costs, being required more incentives for research and adoption to make it more competitive [11]. In this regard, the normative regulation for mini and micro distributed generation to distribution system (RN482/2012) [12], which corresponds the net metering, was a important achievement that can promote a power compensation system and will encourage the adoption of these technologies.

Another important effort seeking greater energy efficiency that is under study refers to automation of distribution system with the implementation of smart meters in residences. Pilot smart grid projects have been implemented in some cities in Brazil with a joint effort of the Brazilian Development Bank (BNDES), Brazilian

Table 1
World electricity consumption – top 10 countries in 2012 (TW h). Adapted from [2].
Source: U.S. Energy Information Administration (EIA). Source to Brazil: [3].

	2008	2009	2010	2011	2012	Part. % (2012)
World	**17,453.36**	**17,388.14**	**18,679.86**	**19,396.64**	**19,710.36**	100
China	3054.08	3270.31	3781.54	4264.31	4467.92	22.7
United States	3865.16	3723.80	3886.40	3882.60	3832.31	19.4
Japan	961.61	935.11	994.80	983.16	921.04	4.7
Russia	855.65	816.12	858.52	869.29	889.33	4.5
India	621.29	669.18	725.49	802.98	864.71	4.4
Germany	544.99	519.43	547.22	543.75	540.12	2.7
Canada	561.60	523.78	526.30	543.73	524.83	2.7
Brazil	428.25	426.03	464.70	480.97	498.38	2.5
Korea, South	402.96	409.23	450.23	472.30	482.38	2.4
France	462.53	446.52	474.17	442.73	451.10	2.3
Other	5703.88	5656.21	5979.45	6113.05	6253.12	31.7