Energy and Environmental Comfort Policies and Standards for Buildings in the Global South

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Abstract This chapter reviews current policy instruments that are relevant in terms of energy and environmental comfort in buildings. Based on an overview of energy indicators worldwide, it comprises detailed information on ten Latin American countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, and Uruguay. For each country, the review covers information on building energy codes, energy labeling, and environmental comfort codes, among other aspects. The conclusions show that there are important differences between countries, where most of them have developed initiatives on energy efficiency in buildings that would indirectly improve comfort, but very few have developed policies and standards specifically on environmental comfort.

Keywords Policies · Standards · Environmental comfort · Building energy codes

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1 Introduction

Environmental comfort standards and policies for buildings are mainly associated, today, with the development of concepts related to access to energy, energy efficiency, and renewable energies. In this sense, the Regulatory Indicators for Sustainable Energy (RISE), developed by the World Bank, allow seeing the differences in development between countries [1, 2].

Regarding energy efficiency indicators, which address multi-dimensional aspects of policies and regulations that affect environmental comfort, it has been seen that among the countries of the Global North and the Global South, there are important development gaps (Fig. 1). Although there are countries in the Global South, such as South Korea, India, Mexico, Singapore, or China, that have made major strides in energy efficiency, most countries have seen much less progress than the Global North. In Table 1 and Fig. 2, it can be seen that the indicators with the largest differences are: Carbon Pricing and Monitoring (I10), Building Energy Codes (I9), and Minimum Energy Efficiency Performance Standard (I7), with a mean difference of more than 50 points. These are followed by Incentives & Mandates: Public Sector (I4), Energy Labeling Systems (I8), and Financing Mechanisms for Energy Efficiency (I6), with differences between 33.5 and 50 points.

The indicators Building Energy Codes (I9) and Minimum Energy Efficiency Performance Standard (I7), reflect the presence of standards that regulate energy performance, so they are related to environmental comfort in buildings. Out of the 92 Global South countries with available information, 44 do not have any type of development for Building Energy Codes (I9), 35 have fewer than 59 points, and 11 are between 60 and 79 points. Only 3 countries score more than 80 points: South Korea, Tunisia, and Qatar. Regarding the Minimum Energy Efficiency Performance Standard (I7) indicator, 25 countries have no development, 43 score less than 59, 12 score between 60 and 79 points, and only thirteen score over 80. South Korea, Mexico, India, Iran, and Costa Rica stand out on scoring over 90 points.

According to the UN Environment Program 2021 Report, countries increasingly recognize that building energy codes are essential for zero-carbon emissions, yet their application remains low in some regions, such as Africa and Latin America. Building energy codes are typically implemented by governments to regulate the construction and operation of buildings to minimize energy use while achieving environmental comfort. They can take many forms, as building energy use depends on numerous aspects, from architectural typologies to the operation and efficiency of heating and cooling systems [3].

Within the Global South, the region of Latin America and the Caribbean has common cultural characteristics and an active exchange of information and cooperation. However, progress in energy efficiency and building comfort policies is uneven among its countries. The Minimum Energy Efficiency Performance Standard (I7) indicator ranges between 0 and 100, where Mexico, Costa Rica, Ecuador, and Brazil stand out with the highest development. Meanwhile, the Building Energy Codes (I9)

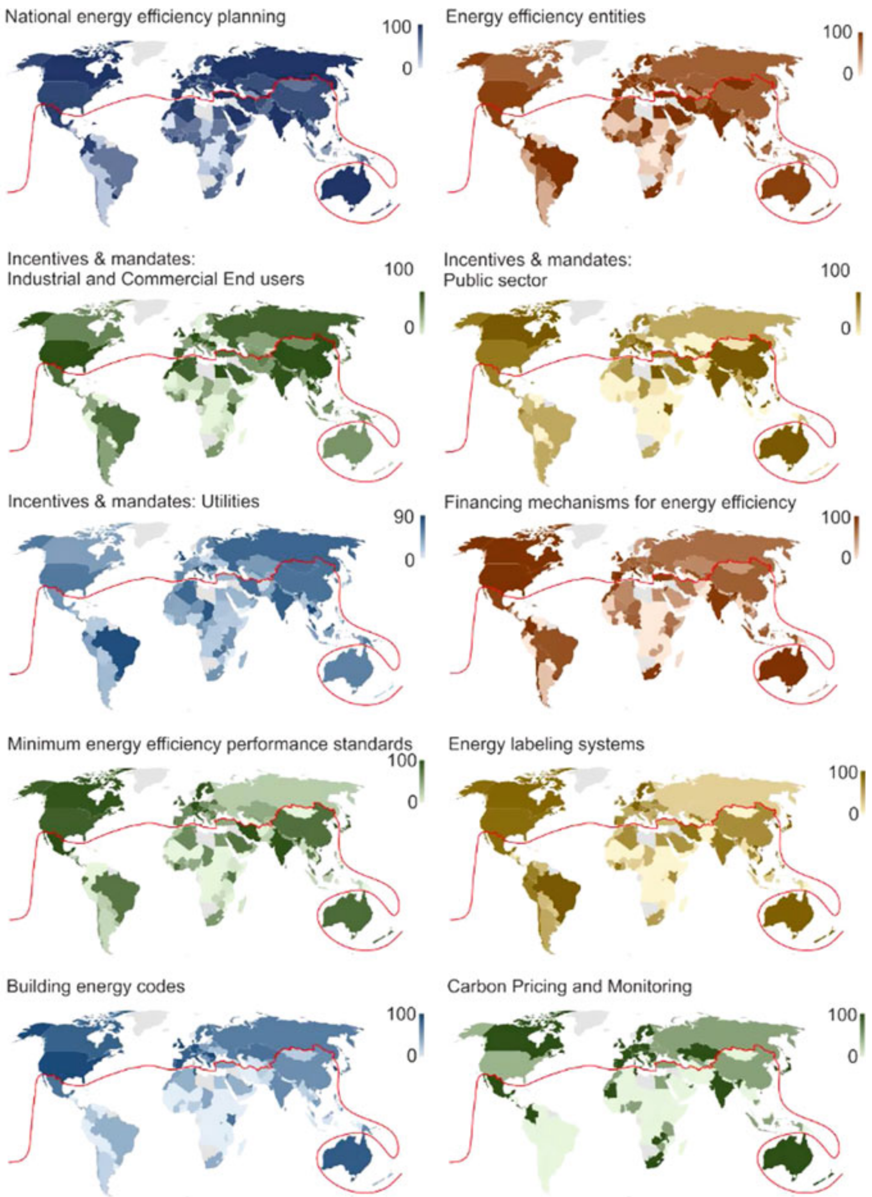

Fig. 1 Indicators associated with energy efficiency for countries in 2019. *Source* Own preparation using [1]

Table 1 Distribution by quartile of indicators associated with energy efficiency in 2019

		I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Global North (n = 43)	Upper whisker	100	100	100	100	86	100	100	100	100	100
	3rd quartile	100	100	100	100	64	91	91	88	87	100
	Median	93	92	75	75	48	75	80	71	73	100
	1st quartile	81.5	75	52	56.5	34.5	65	46	50	56.5	50
	Lower whisker	67	50	0	0	7	40	0	0	27	0
Global South (n = 92)	Upper whisker	100	100	100	100	90	100	100	100	87	100
	3rd quartile	87	100	69	63	53	75	57	52	37	50
	Median	67	67	45.9	25	38	41.5	27.3	25	5	0
	1st quartile	40	29	4	0	23.5	0	0	0	0	0
	Lower whisker	0	0	0	0	0	0	0	0	0	0

Source Own preparation using [1]

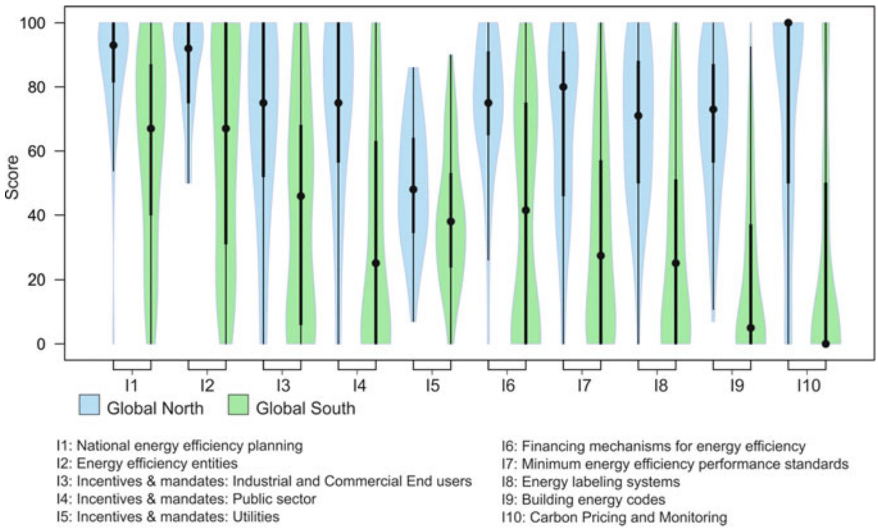

Fig. 2 Scored indicators in energy efficiency encompassing multi-dimensional aspects of policies and regulations. Own preparation, data from [1]

Table 2 Indicators associated with energy efficiency for countries in Latin America and the Caribbean in 2019

Countries	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Argentina	17	33	50	50	28	22	17	50	17	0
Bolivia	17	75	58	0	20	82	23	38	0	0
Brazil	60	100	83	50	86	83	77	100	37	0
Chile	47	75	83	38	38	100	50	83	33	0
Colombia	93	100	50	38	20	100	0	75	25	100
Costa Rica	47	75	75	63	53	50	92	92	0	100
Dominican Rep.	100	17	13	75	20	67	18	17	0	0
Ecuador	100	50	50	75	68	75	78	92	0	0
El Salvador	67	25	0	25	37	50	57	50	0	100
Guatemala	60	58	13	38	30	65	17	17	0	0
Haiti	0	25	0	0	27	63	0	0	0	0
Honduras	17	42	13	63	30	0	17	8	0	0
Jamaica	40	100	50	50	78	90	23	42	37	0
Mexico	93	92	83	75	48	90	100	88	73	100
Nicaragua	33	42	25	63	30	67	47	38	10	0
Panama	83	100	75	75	69	97	58	38	67	50
Paraguay	67	58	0	13	30	0	32	29	0	0
Peru	17	33	0	50	40	0	5	79	0	0
Uruguay	100	83	58	50	72	92	30	38	0	0
Venezuela	17	17	0	0	20	0	0	38	0	0

Source Own preparation using [1]

indicator has values between 0 and 73, with Mexico and Panama scoring the highest (see Table 2).

To show the variability between countries, 10 have been chosen to analyze them in detail: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, and Uruguay (See Fig. 3).

2 Policies and Standards in Latin America

This section presents the main policies, regulations, and standards that regulate energy efficiency and environmental comfort in the building sector in 10 Latin American countries.

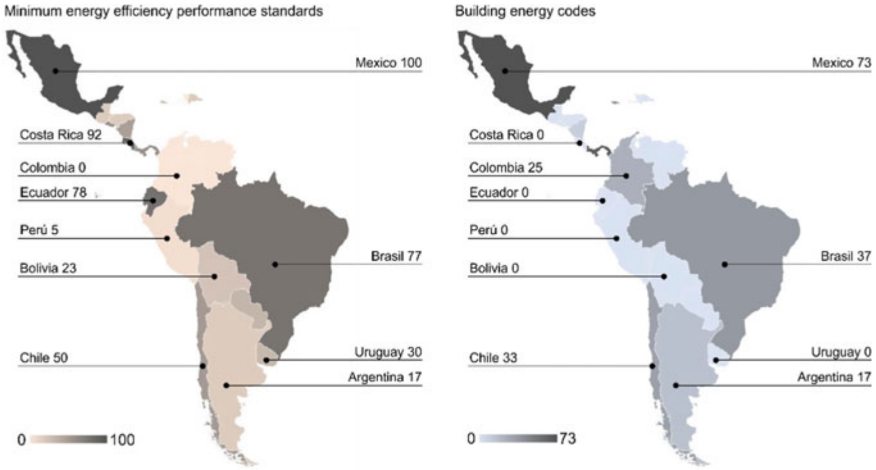

Fig. 3 Scores for Minimum energy efficiency performance standards and Building energy codes of the chosen countries in 2019. *Source* Own preparation using [1]

2.1 Argentina

Argentina kicked off a project between 2018 and 2019 to address the pillars, objectives, and goals for energy transition by 2050. Among the objectives laid out, the diversification of the energy matrix stands out, integrating renewable energies and energy efficiency in dwellings, among others [4].

The Argentinean Institute of Standardization and Certification regulates the comfort and energy efficiency of buildings through the IRAM Standards, which aim at guaranteeing the hygrothermal habitability conditions of hygiene and healthiness. Among them, IRAM 11605 establishes maximum thermal transmittance values in opaque enclosures, defining three comfort levels: "A" (recommended), "B" (medium), and "C" (minimum), for summer and winter conditions, considering the different bio-environmental zones of the country [5].

Meanwhile, IRAM 11604 establishes the calculation methodology for the Heat Loss Volumetric Coefficient (Gcal) and sets maximum admissible values. This focuses on all buildings located in the template and cold bio-environmental areas [6].

In addition, IRAM 11900, approved in 2017, establishes an Energy Efficiency Label based on a tool that allows measuring the energy efficiency of a dwelling on a scale from "A" to "G". This is based on the Energy Supply Index (IPE, in Spanish) that represents the annual energy requirement for heating, cooling, domestic hot water, and lighting [7, 8]. The Province of Santa Fe authorized a Housing Energy Efficiency Labeling Law, that sets out the obligation of presenting an Energy Efficiency Label for the dwelling for any transfer of ownership that takes place in the region. The impact of this standard has been very important, making energy, economic, and environmental benefits visible on a label, contributing to a change of paradigm for sustainable construction [9].

2.2 Bolivia

Bolivia has shown an end energy consumption per capita that is higher than other Latin American countries [10]. For environmental comfort and/or energy efficiency matters, there is only fledgling progress, which is differentiated by municipalities. Domestically, the National Energy Efficiency Program has focused on fostering the efficient use of electricity, under standards that cover energy savings for household appliances and lighting equipment [11], such as NB 87005:2021 for LED lights (Specifications and Labeling); NB 87007:2021, characteristics and testing methods for domestic refrigeration devices; and NB 87003:2021 for refrigerator labeling and classification [12–14].

At a building level, NB/ISO 9288:2010 regulates thermal insulation and heat transmission through radiation [15]. Likewise, in the Bolivian Guidelines for Project Design and Presentation, it is stated that the architectural design must consider criteria for energy efficiency, sustainability, and protecting Mother Earth [16].

Meanwhile, municipalities have presented laws that cover the reduction of fossil fuel consumption and provide incentives for environmental sustainability in buildings. In the case of Santa Cruz de la Sierra, Regional Law N° 177 regulates rural electrification and alternative and renewable sources of energy, with the basic goal of providing electricity to the entire population, as well as improving the existing electrical services, fostering the transition from fossil fuels to alternative renewable alternatives, and mitigating climate change [17]. Since 2020, through decrees, this municipality, and also Cochabamba since 2017, has provided economic incentives for buildings that adopt environmental sustainability measures that reduce contamination, certifying their constructions as eco-sustainable [18].

2.3 Brazil

In Brazil, the NBR 15220 Standard [19], which is not regulatory in nature, focuses on the thermal comfort of homes, proposing design recommendations considering the bioclimatic zone. NBR 16401-2 from 2008, regulates the thermal comfort for air-conditioning installations and is currently being updated following the ASHRAE 55-2020 Standard, to incorporate the adaptive comfort model [20].

At a regulatory level, NBR 15575 establishes a minimum performance level that new buildings must comply with [21]. This is a comprehensive standard that looks to reach a minimum performance level for each system on the site, with requirements to guarantee habitability (water tightness, thermal, acoustic, and light performance, health, hygiene, and air quality, operation and accessibility, comfort), safety, and sustainability. The thermal performance can be obtained either through a simplified procedure or through computer simulation. The simplified method established minimum requirements for thermal transmittance, thermal capacity, and radiation absorption.

The new version of NBR 15575, 2021, incorporates a maximum surface for the transparent envelope and allows evaluating buildings under two scenarios: with and without natural ventilation. The performance of buildings with natural ventilation is determined based on occupation hour percentage indicators within an operating temperature range (PHFT), and annual maximum and minimum temperatures. The operation temperature range considered varies with the local climate, with three intervals being possible: from 18 to 26°C, up to 28°C, and up to 30°C.

Brazil has also incorporated the PBE Building Label, which assesses buildings based on primary energy consumption [22]. The classification runs from "A" (most efficient) to "E" (least efficient), comparing the real building consumption with the same building under a reference condition. Labels can be obtained for commercial, service, and public buildings (INI-C), and for residential buildings (INI-R). Currently, this is only mandatory for public buildings. The energy consumption calculation is linked to the procedures defined in NBR 15575.

2.4 Chile

The objectives of the Chilean Energy Policy for 2050 include improving the energy performance of buildings, which enables achieving suitable comfort levels, maximizing efficiency, and moving toward "net-zero energy" buildings [23]. In this vein, the Energy Ministry [24] proposed that housing reduces its thermal demand by 30% before 2026. One of the strategies to reach these goals is the Housing Energy Rating (CEV, in Spanish) [25], which through a voluntary tool, rates energy efficiency with labels from "A+" to "G". The "E" label represents the minimum performance demanded by the mandatory thermal regulation [26], which, since 2000, defines insulation standards for housing envelopes considering the climatic location. Apart from evaluating the energy consumption and demand, the PBTD tool of the CEV system allows evaluating the hours per year that the indoor temperature would be above or below the comfort range.

In addition, some other voluntary certification schemes define comfort standards for residential and non-residential buildings. The Sustainable Housing Certification (CVS, in Spanish) [27] defines thermal comfort standards, where it is expected that free-running dwellings manage to stay for a minimum percentage of the year within the adaptive comfort range, promoting passive design strategies. Similarly, the Sustainable Building Certification (CES, in Spanish) [28] defines comfort standards for non-residential buildings, where thermal comfort is based on ASHRAE 55. The Terms of Reference in Energy Efficiency, TDRe in Spanish, of the Ministry of Public Works [29] establish minimum standards that public buildings must comply with in all the environmental comfort dimensions. All these systems promote passive strategies, applying the adaptive thermal comfort model, and defining minimum standards for daylighting and natural ventilation.

Some cities in southern Chile have Environmental Decontamination Plans (PDAs, in Spanish) which incorporate mandatory standards for new homes in terms of thermal insulation, airtightness, ventilation, and the control of solar gains [30].

2.5 Colombia

The Long-Term Climate Strategy of Colombia, E2050 [31] implements the Paris Agreement, setting the goal of carbon neutrality by 2050, and a reduction of 51% of the GHG emissions by 2030. In this vein, the Net-Zero Carbon Buildings Roadmap [32] establishes short-, mid-, and long-term actions for the construction sector, including life cycle and energy efficiency analysis, among others. Decree 1285 [33], and its mandatory Resolution 0549 [34] regulate parameters for sustainable construction and establish guidelines for saving water and energy in buildings. The energy-saving percentages that must be met consider the type of building and the climate zone, varying between 15 and 45%. Comfort is not directly assessed, but some passive and active strategies linked to energy consumption are proposed [35].

At a regulation level, Retilap 2017 [36] establishes the requirements and measurements that lighting systems must comply with, with values required by area and activity, adapted from the ISO 8995 Standard. There are also resolutions associated with acoustics, mainly for noise control and exposure levels [37].

Although there are Colombian Technical Standards (NTC, in Spanish) associated with comfort, these are voluntary and usually are identical copies of international standards. NTC 5316 [38] is an identical translation of ASHRAE 55:2004, NTC 5183 [39] copies ANSI/ASHRAE 62:2001, while NTC 4595 [40] on educational buildings addresses the four parameters of environmental comfort.

At a public policy level, best practices are promoted in the life cycle of construction activities for the different regions using local technical criteria [41]. For this, sustainable construction guidelines and codes are being generated with more detailed and context-specific recommendations [42]. Colombia does not have its own certification system, but the LEED, EDGE, and CASA Colombia certifications are implemented. The domestic roadmap for net-zero carbon buildings promotes voluntary standards, verified by a third party, as a tool to mobilize the market.

2.6 Costa Rica

In Costa Rica, the entity in charge of setting building construction, design, and planning standards is the Institute of Housing and Urban Planning (INVU, in Spanish), through Building Regulations [43]. The latest version of the regulations (2018) mentions temperature as a thermal comfort parameter on three occasions, specifically, article 265 of the section on Health Service Buildings mentions that natural ventilation must ensure air circulation and maintain a temperature between 18 and 24°C. Article 270 of the same section adds that all the air in the rooms must be renewed every hour.

The VII National Energy Plan 2015–2030 [44] outlined, within its specific goals, improving the energy efficiency of buildings (objective 1.2.5), as well as promoting the use and making purchases of efficient equipment, household appliances, water heaters, and lights (objectives 1.2.1 to 1.2.4) more accessible. To date, some progress has been made, such as Directive N° 050-MINAE 2019 [45], which includes 9 sustainability criteria that every public building must comply with. However, the strategies to achieve each one of the criteria do not have metrics that allow monitoring progress.

The private sector has promoted the international LEED and EDGE certifications, among others, while banking entities have opened specific lines of credit for buildings that incorporate sustainability criteria.

The RESET—Requisitos para Edificaciones Sostenibles en el Trópico (Requirements for Sustainable Buildings in the Tropics)—certification was created, which later became the voluntary standard, INTE C170:2020 of INTECO [46]. Criteria 11 of the section on Spatial Well-being and Quality of this Standard refers to comfort, indicating that this is determined considering the activity and clothing of the users. As a reference value to comply with, it indicates that the tolerance limit to temperature and relative humidity for people in the tropics are 28°C and 80%, respectively. This means that all buildings whose thermal conditions are lower than 28°C and 80% (WBT 25.3°C) would comply with the criteria, without indicating the lower tolerance limit.

2.7 Ecuador

As of 2006, Ecuador launched a series of policies, projects, and programs to promote energy efficiency in different economic sectors [47–49]. In 2007, 11 Standards were prepared to foster efficient construction and energy management, along with 23 Technical Requirements on energy efficiency, where the NTE INEN 2506 Energy Efficiency in Buildings stands out [50]. In 2011, a chapter was included in the Ecuadorian Building Standard (NEC, in Spanish), which addresses criteria of thermal and acoustic comfort, as well as ventilation, air quality, and lighting requirements [51].

The National EE Plan 2016–2035 (PLANEE) has concrete goals in the buildings' framework so that Ecuador complies with international initiatives focused on "guaranteeing access to affordable, secure, sustainable, and modern energy" (SDG7), and "doubling the global index of energy efficiency improvements" (SE4ALL) [52]. One of the goals by 2035 is that residential, commercial, and public sector energy consumption is reduced by at least 88.8 Mbep, thanks to the energy efficiency measures implemented.

In 2018, a new regulation applicable to buildings was generated, where the section on EE of NEC-HS includes definitions of Thermal Comfort and Well-being [51], but requirements for indoor conditions are not established. However, in the NEC-HS on Air-conditioning, design humidity and temperatures are established in line with the climate (warm climate temperatures between 23 and 25°C, and RH of 45 to 60%; cold climate temperatures between 20 and 23°C and RH of 40–50%). It promotes natural ventilation for air renewal, establishing minimum flows, mainly based on the ASHRAE 62.1 and ASHRAE 62.2 Standards. For lighting, it establishes minimum values between 50 and 300 lux depending on use, with energy efficiency values of its installation of between 6 and 12 W/m^2.

In 2019, the Organic Energy Efficiency Law [53] was published, a goal outlined in PLANEE 2016–2035, which indicates in Article 17 that there must be a rational use of energy, promoting saving energy without reducing comfort and production.

2.8 Mexico

Mexico is one of the countries in Latin America and the Caribbean that has developed most in energy efficiency-related issues [1, 2], through a broad variety of programs and actions, such as the Energy Efficiency Standardization Program, the Energy Saving Program in the Federal Public Administration, the Green Mortgage Program, and the Sustainable Improvement Program for Existing Housing, among others.

Standardization in energy efficiency has been the most successful cost-benefit public policy in Mexico and has consisted of developing technical specifications that seek to limit energy consumption in equipment and systems, as well as buildings. The issuing of the Official Mexican Standards on Energy Efficiency (NOM-ENER) began in 1995, and to date there are 33 NOM-ENERs, entailing a reduction of 45.9% in residential energy intensity between 1995 and 2015 [54, 55]. In addition, the standardization program has been accompanied by the creation of conformity assessment processes run by laboratories, certification entities, and verification units accredited by the Mexican Accreditation Entity (EMA, in Spanish). NOM-2008-ENER-2021 (energy efficiency in buildings, non-residential building envelope) and NOM-020-ENER-2021 (energy efficiency in buildings, habitational use building envelope) stand out, which it is deemed can entail an improvement compared to the indoor environmental conditions, but that do not set requirements in this regard [56].

In 2019, the NMX-C-7730-ONNCCE-2018 Mexican Standard on "Ergonomics of the thermal environment—analytic determination and interpretation of thermal comfort through the calculation of the VME and PEI indexes and local thermal climate criteria" came into force, an adoption that is identical to ISO 7730:2005 [57]. In 2020, the NMX-577-ONNCCE-2020 Standard was developed, which is currently undergoing consultation. This establishes the parameters, values, documentation, and methodologies to evaluate the indoor environment quality expected of a building, from the design characteristics described in the executive project, to procure occupant comfort and health. Likewise, it allows evaluation of the energy performance of systems that contribute to reaching indoor environmental comfort, to limit energy consumption [58].

Mexico is the only Latin American country that does not have a domestic construction regulation, as each municipality has attributions to issue its own [59]. However, in the state or municipal regulations, no requirements regarding the environmental conditions of spaces are seen.

2.9 Peru

Since 2014, the National Building Regulation (RNE, in Spanish)—Building License includes the management document, EM. 110 Thermal and Light Comfort with Energy Efficiency, which is the first national standard that seeks to improve, from the architectural design, the thermal and light comfort conditions through the energy efficiency of the buildings [60]. The standard establishes and characterizes zones of the Republic of Peru by bioclimatic criteria for construction, and determines technical guidelines and parameters for thermal and light comfort for each zone defined. It is applied for new habitable buildings, along with extensions, remodeling, repair, and/or conditioning. Apart from sources such as ASHRAE or ISO, this standard uses as a reference, the Argentinean, Chilean, and Spanish regulations related to comfort and energy efficiency. With regard to thermal comfort, maximum thermal transmittance limits (U) are established for the roof, wall, and floor, the absence of condensation, and carpentry standards for window permeability. For light comfort, they determine minimum window areas following the calculation method that the standard determines, as well as indicating minimum characteristics that must be obtained from the manufacturer on aspects such as density, thermal conductivity, and solar factor, among others.

Law 3381–2018 CR also exists. This strengthens the attention paid to frosts through improved housing [61]. It rules that the Ministry of Housing, Construction, and Sanitation, through the National Rural Housing Program, must implement improvements under bioclimatic design strategies that improve thermal comfort under extreme weather situations, such as frosts. This law outlines a government policy that has mainly focused on financing rural housing to improve thermal comfort.

2.10 Uruguay

At a national level, Uruguay has developed the Energy Policy 2005–2030 and the National Energy Efficiency Plan 2015–2024 [62, 63], where actions are laid out to move toward the reduction of energy consumption by 2025. Among these actions, the development of a set of technical standards to evaluate the energy performance of buildings stands out. Its goal is to contribute to the development of a building energy efficiency certification program. These standards are mainly adoptions of the international ISO Standards and are voluntary in nature.

As for the residential sector, currently, there is no domestic regulatory framework, though there are uneven requirements between the administrative units and without a direct relationship with climatic zoning [64]. These requirements focus on ventilation and lighting conditions (minimum areas of openings) based on principles of hygiene. Although there are regulations in some administrative units that include sustainability approaches of buildings, energy efficiency, and GHG reduction, in these cases energy efficiency is addressed by the reduction of the energy demand for thermal conditions, establishing minimum energy quality requirements for the envelope (thermal transmittance and solar factors), focusing exclusively on new housing.

A National Building Regulation—Housing Hygiene is under development, which establishes minimum requirements to improve the thermal quality of the envelope, without defining a performance baseline with given comfort levels, or criteria by climatic region or type of building [64]. On the other hand, public housing policies have had demands on the energy quality of the envelope in specific programs since 1999, and since 2011 for the construction of housing with non-traditional construction systems [65].

Although there are no local certifications, the Housing Environmental Sustainability Model (Suamvi, in Spanish), developed at a regional level by the Intendance of Montevideo, stands out. Currently, there are aspirations for the creation of a Suamvi Seal [66]. This model integrates the dimensions of air quality, acoustic comfort, energy quality of the envelope, and the incorporation of renewable energies.

3 Discussion

All the countries revised in this chapter have energy policies or similar initiatives that establish short-, mid-, and long-term actions to reduce greenhouse gas emissions, motivated by the Paris Agreement. In 2020, 136 countries worldwide included actions for addressing building-related emissions or improving energy efficiency [3]. Among them, some of the countries reviewed in this chapter, such as Argentina, Chile, Colombia, Mexico, and Uruguay, are found. One of the main actions is the development of building energy codes, where Latin American countries are quite behind when compared to the countries of the Global North. Among the countries that have building energy codes, these are voluntary, or mandatory for part of the sector (usually the residential sector). This implies a great difference from the countries of the Global North, where building energy codes are mandatory for the entire sector. These codes focus on improving the energy performance of buildings, aiming at reducing energy consumption. In general, occupant comfort goals are not explicitly mentioned, but it is assumed that comfort would be a consequence of improving performance.

In energy label matters, all the countries reviewed have an equipment labeling system, but just Argentina, Brazil, and Chile have energy labeling for buildings, and

Mexico has one for building envelopes. The Province of Santa Fe, in Argentina, which has implemented mandatory labeling for housing, and Brazil, where labeling is mandatory for public buildings, stand out. In other countries, this has been implemented as voluntary, looking to make this a mandatory policy in the future.

For building sustainability certification, the LEED international certification has had a great impact on the countries reviewed. In addition, the EDGE certification, exclusively developed by the World Bank for developing countries, has become quite popular in the region. Only some countries have developed their own certifications, such as the Procel EDIFICA in Brazil, or the CES certification for public use buildings, and CVS for housing in Chile. In addition, the CASA Colombia certification is a local development based on international standards. All of these are voluntary systems.

The regulations for comfort are much scarcer and, in general, replicate international standards, such as the ASHRAE or ISO, to address procedures and standards on thermal comfort, acoustics, air quality, and light comfort. In some isolated cases, comfort standards are included in the building energy codes, such as the Brazilian standard NBR 15575, which establishes thermal comfort requirements to evaluate the thermal performance of buildings under natural ventilation conditions [21]. This initiative is very important, as it promotes the passive behavior of buildings using natural ventilation, alongside adaptive comfort ranges.

In other countries, the ambiguity of thermal comfort regulations is questioned, such as the lack of reference to studies that are based on comfort limit values. These issues have not been a priority in most of the countries reviewed, mainly as buildings traditionally do not use any heating or cooling system, thus consuming very little energy. It is important to consider that Latin American countries have pretty benign or warm template climates, where there is little need for air-conditioning, or there is a high adaptation of the occupants. For example, a study in the city of Cuenca, Ecuador, determined that 65% of the users stated that their home is comfortable, and just 2% said that they use a type of heating, with outdoor temperatures under 18°C most of the year [67]. This is similar to several large cities in the Andean region.

4 Conclusions

This chapter reviews current policy instruments that are relevant in terms of energy and environmental comfort in buildings in ten countries of Latin America. From the review, it can be concluded that there are important differences between countries. Some of them have a strategy articulated by energy policies with short-, mid-, and long-term goals, that include a series of standards and initiatives that would allow reaching the goals as long as their implementation is effective and efficient. However, others are at a fledgling stage.

Some countries have building energy codes that lay down thermal performance requirements, where comfort would be a result of the thermal improvements, but very few define specific requirements for comfort, and certainly not mandatory ones.

Recent economic, environmental, and social changes have increased occupant expectations for comfort, increasing the need to regulate this issue considering the knowledge generated at a local level, including the identification of benchmarks and gaps.

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