State of regulation and implementation of energy and water-saving measures in buildings in Colombia

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Abstract. This article analyzes the status of compliance with “Resolución 0549 de 2015”, which regulates the parameters of sustainable construction in buildings from Colombia, in terms of energy and water consumption. Compliance with these guidelines is in line with the sustainable development goals set out in the 2030 agenda, specifically with SDGs 11, 12 and 13. Thus, the analysis of the history of public policies, which have been in line with the certifications that exist or have existed at the international level, is envisioned. The analysis of buildings with sustainable construction certificates is carried out to verify their concordance with the parameters established in the Colombian regulations. Finally, a contrast is presented between the expectations set forth in the percentage of water and energy savings indicated by the government and the actual values executed. The results show that, the new projects that have been certified as sustainable buildings, more than 50% comply with the minimum percentages of reduction in water and energy consumption.

1. Introduction
The primary purpose of a building is to improve people's quality of life. According to CONPES 3919 [1], a sustainable building is a broad concept that encompasses the rational use of natural resources and offers its users spaces that have a positive impact on their health, happiness, and wellbeing; through rich and healthy environments that respect the environment, ecosystems, and biodiversity. These buildings must be suited to the variability and conditions of the climatic zone in their geographic location; energy efficiency is essential to meet the needs of incorporating climate change to develop a safe territory[2]. Regulations in Colombia establish the parameters of sustainable construction in buildings in terms of energy and water consumption, as per subsequently established in the “Pact for the quality and efficiency of public services: water and energy to promote competitiveness and well-being for all” [3], but currently, the needs of the sector are growing as fast as the requirement to supply them with economic, environmental and social sustainability.

These policies and pacts seek to mitigate the problem of climate change, which is tough and complex, as it involves various fields of science and even all aspects of life in the world, these processes of adaptation and mitigation to climate change should apply to the activity of each profession [4].

2. Legal analysis of “Resolución 0549 de 2015”
Considering the growth in the construction sector in Colombia, in 2015, the Ministry of Housing, City and Territory issued the “Resolución 0549”, which establishes sustainability parameters that contribute to protecting the environment, which has been significantly affected by the development of buildings[5]. At the same time, it shows the importance and national commitment to transform cities, especially green buildings, towards sustainable development.

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Thus, this technical regulation fulfills a series of guidelines that seek to optimize the use of natural resources such as energy and water in constructions built starting from July 2016. Hence, the National Government indicates their concern regarding the misuse of natural resources, as well as the need to minimize the impact of environmental pollution derived from activities of the construction industry.

Under the provisions of Article 80 of the Political Constitution of Colombia of 1991, the government must direct and manage the use of natural resources to preserve sustainable development[6], in addition to encouraging the use of new technologies that reduce the impact caused by human activities, especially the construction of sustainable buildings.

Therefore, Resolution 0549 of 2015, as a regulatory support that guides sustainable development, is an instrument that outlines the guidance parameters aimed at builders that promote water preservation and energy efficiency in the use of buildings. Thus, this technical regulation allows builders to recognize which active or passive measures[7] must be applied to achieve the minimum percentages of water and energy savings indicated in the resolution.

3. Background Climate Change, Sustainable Cities and Buildings

The 2030 Agenda for Sustainable Development was approved by the United Nations General Assembly in September 2015 [8], which addresses priority issues for Latin America and the Caribbean, including sustainable cities and climate change. This agenda established 17 goals and targets associated with them (SDGs: Sustainable Development Goals); Goals 11, 12, and 13 align with the development of sustainable cities and the efficient use of natural resources. Goal 11 is "Sustainable cities and communities: Make cities and human settlements inclusive, safe, resilient and sustainable", it has among its targets to "significantly increase the number of cities and human settlements that adopt and implement integrated policies and plans to promote inclusiveness, resource efficiency, climate change mitigation and resilience to natural disaster also develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030[9], comprehensive disaster risk management at all levels"; Goal 12 "Responsible production and consumption: Ensure sustainable consumption and production patterns" says that "Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure and enabling access to basic services, green and fair jobs, and a better quality of life for all"; and Goal 13 "Climate Action: Take urgent action to combat climate change and its impacts" mentions in one of its targets "Strengthen resilience and adaptive capacity to climate-related risks and natural disasters in all countries". According to current world policies, the Colombian Ministry of Environment and Sustainable Development is advancing in policies to guarantee the Sustainable Development Goals.

There are international standards and rules that evaluate the sustainability criteria of a building. For example: ASHRAE 90.1 - 2004 (United States), EN 832 (Germany), GB50189-2005 and GB/T50378-2006 (China), Code 19 (Iran), TS 825 (Turkey). Similarly, guidelines for sustainable construction have been developed, such as LEED US of the Green Building Council (United States)[10]. In terms of international certifications, we also find EDGE (Excellence in Design for Greater Efficiencies), launched in 2014 and which seeks to support the collective ambition to incorporate green buildings and help combat climate change [11]. This certificate is an innovation of IFC (International Finance Corporation), a member of the World Bank Group.

In Colombia, there are two national certifications. There is “Sello Ambiental Colombiano” or Colombian Environmental Seal (SAC) by the Ministry of Environment and Sustainable Development, which includes environmental criteria for design and construction of sustainable buildings for use other than housing in NTC 6112. Unlike in “Resolution 0549 of 2015”, SAC includes additional criteria to the percentages of water and energy savings, and raises guidelines on issues of building materials, location, community and indoor environmental quality. There is also “Referencial CASA Colombia” or Referential CASA Colombia, a local initiative of the Colombian Council of Sustainable Construction (Consejo Colombiano de Construcción Sostenible “CCCS” in Spanish) launched in 2016. The objective of this certification is incorporating sustainability criteria, facilitating cost-efficient structuring of new...
projects, providing solutions in compliance with current regulations and comprehensive sustainability not only with efficient use of resources but also a clear focus on health and well-being [1].

According to the CCCS, the sustainable certification systems that stand out in the market and are in use in Colombia are Leadership in Energy and Environmental Design, LEED, Haute Qualité Environnementale HQE, Building Research Establishment Environmental Assessment Methodology BREAM, Excellence in Design for Great Efficiencies EDGE, and Referencial CASA Colombia [12], as well as the previously mentioned the Colombian Environmental Seal, SAC.

4. The current state of sustainable construction in Colombia

Construction is one of the sectors with the most significant impact on exploitation and consumption of resources. In Colombia, the construction industry consumes 40% of energy, while generating 30% of CO₂, and 40% of waste. It also consumes 60% of the materials extracted from the Earth. Additionally, 20% of all materials used in construction are wasted[13]. In terms of energy, this sector represents 22% of the national demand; and residential buildings constitute 79% of water consumption of the major cities in the country [1].

Compared to previous scenarios, currently in the country, the joint work between the public and private industry shows an increase in the number of companies in construction, which increasingly include sustainability as part of their business strategy, resulting in more than 57 cities and municipalities with sustainable construction projects by 2020. More than 800 projects have, or are in the process of obtaining certification as sustainable construction [14]. These are significant numbers considering the process is not yet mandatory by Colombian legislation.

In terms of numbers, in Colombia, LEED and EDGE certifications predominate with 232 [15] and 201 [16] respectively; likewise, according to reports from Haute Qualité Environnementale, seven projects have HQE certification [17], the same number for CASA certified projects [18] [19]. In comparison, 19 projects are certified under SAC [20], as shown in Table 1.

| Certification seals | Number of projects |
|--------------------|-------------------|
| LEED               | 232               |
| EDGE               | 201               |
| HQE                | 7                 |
| CASA               | 7                 |
| SAC                | 19                |

Regarding the building typology, Resolution 0549 of 2015 is taken as a reference, in which eight categories are established. However, “Viviendas de Interés Prioritario” or Priority Social Housing (also known as VIP housing) are excluded because they were not found within the certified buildings in any of the reviewed certifications. The results obtained are presented in Figure 1.

LEED methodology shows a greater predominance in commercial projects, focusing on offices and shopping centers; this constitutes approximately 85% of the buildings certified under this modality. As for EDGE methodology, residential buildings stand out, accounting for 81%.

In the case of the Colombian Environmental Seal SAC, all buildings found correspond to the hotel category. This is due to the fact that this certification methodology focuses on goods and services under a list of established categories, including the SAC category of lodging and accommodation establishments under Colombian Technical Standard NTC 5133 [21].
5. The reality of water and energy-saving measures.

According to the data presented in the census conducted by DANE [22] in 2018, municipalities with population projections over 1,200,000 residents were Barranquilla with 1,232,462, Cali with 2,445,405, Medellin with 2,529,403 and Bogota 8,181,047. Initially, Resolution 0549 of 2015 was to be applied during the first year on these particular municipalities (which exceed the projection), but from the second year on, for all municipalities in the country.

In order to know the enforcement status of Resolution 0549 [5], the analysis is made according to the stipulations of the rule in Section b of Article Three - Scope of application and gradualness; having the contents of the compliance savings table (Table 2) as a reference point, which is considered after one year of issuance of the resolution.

Table 2 Percentages of compliance savings [5]

| Building Type                  | Energy   | Year 2                      | Cold | Warm  | Dry warm | Wet warm |
|--------------------------------|----------|-----------------------------|------|-------|----------|----------|
| Social Housing (VIS)           | Energy   |                             |      |       |          |          |
| No Social Housing (NO VIS)     | Energy   |                             |      |       |          |          |
| Schools                        | Year 2   |                             |      |       |          |          |
| Malls                          | Year 2   |                             |      |       |          |          |
| Offices                        |          |                             |      |       |          |          |
| Hospitals                      |          |                             |      |       |          |          |
| Hotels                         |          |                             |      |       |          |          |
| Social Housing (VIS)           |          |                             |      |       |          |          |
| No Social Housing (NO VIS)     |          |                             |      |       |          |          |
| Water                          |          |                             |      |       |          |          |
| Baseline                       |          |                             |      |       |          |          |

Figure 1 Buildings with certification seals
Given that for this analysis, it is necessary to know the percentages of energy and water savings, only the data of certifications under EDGE [23] and LEED [24] methodologies were reviewed. For other certifications, exact reduction data are not available. It is also necessary to clarify that for these methodologies, analysis was only performed on project data provided by builders. For each case, the area of the project location is according to the stipulations of resolution 0549, Annex 2 Map of Climate Classification in Colombia according to Temperature and Relative Humidity, and the list of municipalities [25].

Table 3 Percentage of savings by EDGE

| Location | Building                | % Savings reached Energy | % Savings reached Water | % Minimum required Energy | % Minimum required Water | Difference Energy | Difference Water |
|----------|-------------------------|--------------------------|-------------------------|---------------------------|-------------------------|-------------------|------------------|
|          |                         | 41                       | 37                      | 35                        | 10                      | 6                 | 27               |
| Hotels   | Casa Nua                |                          |                         |                           |                         |                   |                  |
| Medellín |                         |                          |                         |                           |                         |                   |                  |
| Rionegro | Lagoon                  | 34                       | 46                      | 20                        | 25                      | 14                | 21               |
| Chía     | Calucé Senior           | 30                       | 31                      | 20                        | 25                      | 10                | 6                |
| Apartadó | Ibis Apartadó           | 36                       | 25                      | 45                        | 45                      | -9                | -20              |
| Bogotá   | Zona Franca             | 39                       | 28                      | 20                        | 25                      | 19                | 3                |
| Cali     | Faranda Collection      | 30                       | 21                      | 25                        | 35                      | 5                 | -14              |
| Cúcuta   | Hampton by Hilton       | 34                       | 28                      | 25                        | 35                      | 9                 | -7               |
|          |                         |                          |                         |                           |                         |                   |                  |
| Hospitals| Eps Sanitas             | 24                       | 23                      | 35                        | 10                      | -11               | 13               |
| Bucaramanga |                    |                          |                         |                           |                         |                   |                  |
|          |                         |                          |                         |                           |                         |                   |                  |
| Offices  | Ícono                   | 25                       | 32                      | 30                        | 35                      | -5                | -3               |
| Armenia  |                         |                          |                         |                           |                         |                   |                  |
| Santa Marta | Cámaras de Comercio   | 47                       | 52                      | 40                        | 45                      | 7                 | 7                |
| Medellín | Bancolombia             | 37                       | 39                      | 30                        | 35                      | 7                 | 4                |
| Pereira  | Alturia                 | 31                       | 25                      | 30                        | 35                      | 1                 | -10              |
|          |                         |                          |                         |                           |                         |                   |                  |
| Malls    | Multicine Villa del Río| 29                       | 50                      | 25                        | 25                      | 4                 | 25               |
| Bogotá   | Paseo Villa del Río     | 29                       | 55                      | 25                        | 25                      | 4                 | 30               |
|          |                         |                          |                         |                           |                         |                   |                  |
| Location     | Building        | % Savings reached | % Minimum required | Difference |
|--------------|-----------------|-------------------|--------------------|------------|
|              |                 | Energy | Water | Energy | Water | Energy | Water |
| Sincelejo    | Guacari         | 21     | 51    | 35     | 45    | -14    | 6     |
|              | Edificio Jorge  | 42     | 39    | 45     | 45    | -3     | -6    |
|              | Hoyos           |        |       |        |       |        |       |
|              | Facultad de Artes | 23    | 22    | 45     | 45    | -22    | -23   |
|              | Edificio        | 34     | 44    | 45     | 45    | -11    | -1    |
|              | Laboratorios    |        |       |        |       |        |       |
| Schools      |                 |        |       |        |       |        |       |
| Armenia      | Arboretum       | 41     | 37    | 25     | 25    | 16     | 12    |
| Barranquilla | Edificio Bruxel | 33     | 48    | 45     | 20    | -12    | 28    |
|              | Edificio Biel   | 23     | 46    | 45     | 20    | -22    | 26    |
|              | La Lajita       | 22     | 34    | 25     | 25    | -3     | 9     |
|              | Novum Ricaurte  | 23     | 53    | 25     | 25    | -2     | 28    |
|              | La Crystalina   | 25     | 34    | 25     | 25    | 0      | 9     |
|              | Veramonte Living| 25     | 34    | 25     | 25    | 0      | 9     |
|              | Las Violetas    | 25     | 34    | 25     | 25    | 0      | 9     |
|              | Valenti         | 22     | 38    | 25     | 25    | -3     | 13    |
|              | Park Living     | 26     | 34    | 25     | 25    | 1      | 9     |
|              | Prado Park      | 28     | 43    | 25     | 25    | 3      | 18    |
|              | 176 Park        | 23     | 44    | 25     | 25    | -2     | 19    |
|              | Cantabria       | 27     | 38    | 25     | 25    | 2      | 13    |
|              | Boreal          | 34     | 43    | 25     | 25    | 9      | 18    |
|              | Colsubsidio     |        |       |        |       |        |       |
|              | Orba 130        | 24     | 24    | 25     | 25    | -1     | -1    |
|              | Acereto         | 28     | 42    | 25     | 25    | 3      | 17    |
|              | Tekto           | 21     | 38    | 25     | 25    | -4     | 13    |
|              | Arrecife 106    | 22     | 32    | 25     | 25    | -3     | 7     |
|              | 127 Living      | 24     | 26    | 25     | 25    | -1     | 1     |
| Bogotá       | Caminos de      | 21     | 32    | 25     | 20    | -4     | 12    |
|              | Providencia     |        |       |        |       |        |       |
|              | Terrasabana     | 29     | 55    | 25     | 25    | 4      | 30    |
|              | Oikos           | 25     | 26    | 25     | 25    | 0      | 1     |
|              | Artiko 66       | 26     | 41    | 25     | 20    | 1      | 21    |
|              | Nordika         | 37     | 37    | 25     | 20    | 12     | 17    |
|              | El Castillo     | 26     | 24    | 25     | 20    | 1      | 4     |
|              | Parque de las   | 21     | 35    | 25     | 25    | -4     | 10    |
|              | Flores          |        |       |        |       |        |       |
|              | Lunaria         | 24     | 35    | 25     | 25    | -1     | 10    |
|              | Provenza        | 27     | 34    | 25     | 25    | 2      | 9     |
| Location   | Building     | % Savings reached | % Minimum required | Difference |
|------------|--------------|-------------------|--------------------|------------|
|            |              | Energy | Water | Energy | Water | Energy | Water |
| Floridablanca | Malibú        | 37     | 43    | 25     | 20    | 12     | 23    |
|             | Arenillo      | 28     | 33    | 25     | 25    | 3      | 8     |
|             | Algarrobo     | 25     | 34    | 25     | 25    | 0      | 9     |
|             | Laurel        | 25     | 34    | 25     | 25    | 0      | 9     |
|             | Bio           | 40     | 36    | 25     | 25    | 15     | 11    |
| Ibagué      | Wakarí        | 32     | 34    | 25     | 25    | 7      | 9     |
|             | Ariza Torre 2 | 30     | 36    | 25     | 25    | 5      | 11    |
|             | Entrepáquies  | 26     | 42    | 25     | 25    | 1      | 17    |
|             | Torre Oporto  | 31     | 36    | 25     | 25    | 6      | 11    |
|             | Ícono         | 35     | 48    | 25     | 25    | 10     | 23    |
|             | Solarium      | 38     | 45    | 25     | 25    | 13     | 20    |
| Itagüí      | Infinity      | 28     | 29    | 25     | 25    | 3      | 4     |
|             | Torre Oriente | 25     | 29    | 25     | 25    | 0      | 4     |
| Jamundí     | Flamingo      | 30     | 31    | 25     | 20    | 5      | 11    |
|             | Fragata       | 37     | 35    | 25     | 25    | 12     | 15    |
| La Calera   | Calera Gardens| 27     | 31    | 25     | 25    | 2      | 6     |
| La Estrella | Ocre          | 33     | 41    | 25     | 25    | 8      | 16    |
| Los Patios  | Tucán         | 22     | 28    | 25     | 20    | -3     | 8     |
| Manizales   | Reserva de Milán | 36   | 45    | 25     | 25    | 11     | 20    |
|             | Montreal      | 26     | 37    | 25     | 25    | 1      | 12    |
| Medellín    | Wall          | 35     | 25    | 25     | 25    | 10     | 0     |
|             | Salamanca     | 25     | 32    | 25     | 25    | 0      | 7     |
|             | Arreboles     | 28     | 40    | 25     | 25    | 3      | 15    |
| Palmira     | Melao         | 26     | 29    | 25     | 25    | 1      | 4     |
|             | Nobori        | 31     | 33    | 25     | 25    | 6      | 8     |
|             | La Gran Reserva| 31   | 41    | 25     | 25    | 6      | 16    |
| Pereira     | Makaua del Valle | 30 | 30    | 25     | 25    | 5      | 5     |
|             | Sierra Viento | 39     | 37    | 25     | 25    | 14     | 12    |
|             | Makaua del Viento | 29 | 33    | 25     | 25    | 4      | 8     |
| Pitalito    | La Castellana | 30     | 24    | 25     | 25    | 5      | -1    |
|             | Cipes         | 27     | 24    | 25     | 25    | 2      | -1    |
| Popayán     | Llanos de Calibio | 34 | 52    | 25     | 25    | 9      | 27    |
| Rionegro    | Riovivo       | 44     | 42    | 25     | 25    | 19     | 17    |
| Sabaneta    | Monteflor     | 26     | 38    | 25     | 25    | 1      | 13    |
|             | Poblando      | 43     | 33    | 25     | 20    | 18     | 13    |
| Santa Marta | Senderos      | 27     | 34    | 25     | 20    | 2      | 14    |
|             | Ambar Infinity| 31     | 36    | 25     | 20    | 6      | 16    |
| Sopó        | Pionoo Green  | 21     | 33    | 25     | 25    | -4     | 8     |
| Location       | Building              | % Savings reached | % Minimum required | Difference |
|----------------|-----------------------|-------------------|--------------------|------------|
|                |                       | Energy | Water | Energy | Water | Energy | Water |
| Valledupar     | Armonía               | 36     | 42    | 25     | 20    | 11     | 22    |
|                | Verona                | 27     | 30    | 25     | 20    | 2      | 10    |
| Villavicencio  | Balcones de la Colina | 40     | 40    | 45     | 20    | -5     | 20    |
|                | Sinsonte              | 31     | 33    | 25     | 25    | 6      | 8     |
|                | Batara                | 26     | 31    | 25     | 25    | 1      | 6     |

Social Housing (VIS)

| Location       | Building              | % Savings reached | % Minimum required | Difference |
|----------------|-----------------------|-------------------|--------------------|------------|
|                |                       | Energy | Water | Energy | Water | Energy | Water |
|                | Mirador del Joboque   | 32     | 35    | 20     | 10    | 12     | 25    |
| Pasto          | Sotavento             | 25     | 23    | 20     | 10    | 5      | 13    |
|                | Torres del Cielo      | 21     | 39    | 20     | 10    | 1      | 29    |
| Quindío        | Tacurumbí             | 30     | 32    | 15     | 15    | 15     | 17    |
|                | Colinas del Norte     | 24     | 28    | 15     | 15    | 9      | 13    |

Table 4 Percentage of savings by LEED

| Location       | Building              | % Savings reached | % Minimum required | Difference |
|----------------|-----------------------|-------------------|--------------------|------------|
|                |                       | Energy | Water | Energy | Agua | Energy | Water |
|                |                       | Energy | Water | Energy | Water | Energy | Water |
|                |                       | Hotel   |       | Office |       |        |       |
| Bogotá         | W hotel               | 47     | 43    | 20     | 25    | 27     | 18    |
|                | Terra 100             | 21     | 54    | 20     | 25    | 1      | 29    |
|                | Virrey                | 37     | 34    | 20     | 25    | 17     | 9     |
|                | Aloft                 | 24     | 30    | 20     | 25    | 4      | 5     |
|                | Green Loop            | 43     | 37.6  | 30     | 30    | 13     | 7.6   |
|                | Elemtento             | 40     | 60    | 30     | 30    | 10     | 30    |
|                | Alpina                | 21     | 40    | 30     | 30    | -9     | 10    |
|                | Bavaria               | 24     | 74    | 30     | 30    | -6     | 44    |
|                | Coca Cola             | 20     | 20    | 30     | 30    | -10    | -10   |
|                | Panoramic             | 22     | 42    | 30     | 30    | -8     | 12    |
|                | Banco Gnb            | 32     | 59    | 30     | 30    | 2      | 29    |
|                | Sudameris             | 32     | 59    | 30     | 30    | 2      | 29    |
|                | Torre 3               | 21     | 50    | 30     | 30    | -9     | 20    |
| Medellín       | Ruta N                | 34     | 72    | 30     | 30    | 4      | 42    |
|                | Bancolombia           | 30     | 40    | 30     | 30    | 0      | 10    |
|                | ISagen                | 25     | 80.9  | 30     | 30    | -5     | 50.9  |

| Location       | Building              | % Savings reached | % Minimum required | Difference |
|----------------|-----------------------|-------------------|--------------------|------------|
| Cajicá         | Homecenter            | 55     | 70    | 25     | 25    | 30     | 45    |
| Pitalito       | Gran Plaza            | 21     | 39    | 40     | 15    | -19    | 24    |
|                | San Antonio           | 19     | 24    | 30     | 15    | 2      | 10    |
| Manizales      | Homecenter            | 25     | 52    | 25     | 25    | 0      | 27    |
The savings percentages achieved for both EDGE and LEED methodologies are mostly above the values required by the resolution. Those values that are below the threshold do not imply a contradiction in what determines a sustainable construction, since obtaining EDGE or LEED certifications includes other quantifiable items and allow to achieve the certification.

In the case of EDGE methodology, in the 95 projects with data provided (which corresponds to 47% of the certified projects), 24% do not meet the reduction percentage for energy, 12% for water consumption, and 6% for both. For LEED methodology, in the 20 projects analyzed (representing nearly 9% of the certified projects), only 45% do not meet the reduction percentage for energy, 5% for water, and 5% for both; ratifying what was initially mentioned: Over 50% of the data for both methodologies and all sectors, meet and exceed the percentage of reduction in consumption for water and energy.

Some focused efforts have been made in the country's densest urban centers since 2016, making strategies and advancing their implementation since 2018. CCCS shows the results of the Bogotá implementation of BEA program in other cities, promoting incorporation of new municipalities and builders in the program, looking to ensure the effective monitoring of the resolution. This presentation has been made through forums and meetings highlighting the opportunities and incentives from the national government and the commercial financial sector, which offers sustainable construction.

However, while the Colombian government seeks to go towards the development of sustainable buildings, where water and energy savings tend to establish an economic, social, and environmental balance; although the guidelines of Resolution 0549 are an advance, in the context of sustainable construction, it is ineffective because this regulation is not mandatory for all new buildings (only for

| Location   | Building         | % Savings reached | % Minimum required | Difference |
|------------|------------------|-------------------|--------------------|------------|
|            |                  | Energy Water      | Energy Agua        | Energy Water |
| Bucaramanga| Homecenter       | 33 45             | 35 45              | -2         | 0          |
|            | NO Social housing (NO VIS) | | | | |
| Barranquilla| Viverdi         | 23 51             | 45 20              | -22        | 31         |

Tables 3 and 4 show the contrasts of savings percentages achieved instead of those proposed according to the climate zone (table 2). In these tables, columns 2 and 3 show the energy and water savings percentages achieved by the certified projects, respectively, then columns 4 and 5 show the minimum savings percentages required to comply with the climate zone, and finally columns 6 and 7 show the differences between the first two groups of data. Negative values represent percentages in deficit compared to the minimum required as stated in Resolution 0549 and positive values represent percentages in excess compared to the minimum established.

Some of the most populous municipalities such as the city of Bogotá and Medellín, widely presented in Table 3 and 4, have implemented plans and/or strategies to ensure or facilitate the implementation of the measures established in Resolution 0549 through the BEA program (Building Efficiency Accelerator), which is a public-private partnership that converts global experience into action to accelerate the implementation of local government policies and programs for building efficiency [26]. In Bogota, through this strategy, they seek to ensure 20% savings in energy consumption and 30% in all new buildings in the city [27]. In Medellín and its metropolitan area "Valle de Aburrá" the program aims to develop business models that accelerate the implementation of comprehensive sustainability solutions in existing buildings in this major urban center in conjunction with the accompaniment of public policies for sustainable construction that focus on new construction[28]. Both strategies coordinate in conjunction with the CCCS. Cali and Montería have recently joined the program[29].

6. Conclusions

After this analysis of the data on sustainable and certified buildings, some of these certifications do not present complete information to contrast with the percentages raised by Resolution 0549.

The savings percentages achieved for both EDGE and LEED methodologies are mostly above the values required by the resolution. Those values that are below the threshold do not imply a contradiction in what determines a sustainable construction, since obtaining EDGE or LEED certifications includes other quantifiable items and allow to achieve the certification.
public buildings) or existing buildings in the process of rehabilitation. Additionally, lack of effective verification in applying the minimum saving percentages by builders is a blind spot in the regulation.

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