Towards Greater Energy Efficiency in Latin America and the Caribbean:

Progress and Policies

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Towards Greater Energy Efficiency in Latin America and the Caribbean:
Progress and Policies

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Summary

Energy efficiency has been gaining more attention, both nationally and globally, as a means to reduce energy costs, meet the energy demands of growing populations, and at the same time reduce greenhouse gas emissions, especially in the context of climate change. It is at the core of the 7th of the Sustainable Development Goals (SDGs) Agenda, under "Affordable and Clean Energy", where the global rate of energy efficiency improvement is aimed to double by 2030.

Energy efficiency is of particular relevance in the case of Latin American and the Caribbean (LAC), a region where demand for energy services is expected to double by 2040, where there is considerable inequality in terms of affordability of energy services and where the energy sector is still considerably reliant on subsidies. As such, it can bring about substantial environmental, economic and social benefits.

Traditionally, energy efficiency has been measured by looking at energy intensity; i.e. the amount of final energy consumption over final economic output. In that case, LAC outperforms over regions of the world by ranking itself second, right behind Europe. However, the interpretation of this finding is misleading, as in the case of LAC, lower energy intensity is not necessarily synonym to higher energy efficiency. Rather, this report discusses that this could be due to a low use of domestic appliances or poor service affordability in the case of households, a lower use of technology, or a less intensive use of energy in industrial production, bearing in mind that LAC's economies are not as industrialized as other developing regions to start with.

The next questions that then come to mind are the following: What can be done in LAC in order to improve energy efficiency? What are the national and the regional constraints and challenges? How much progress has been made, and what remains to be done? This note is an attempt to address these questions by presenting a fresh regional outlook and proposing a common energy efficiency policy agenda through a conceptual framework that supports the implementation of energy efficiency programs in LAC.

The conceptual framework around energy efficiency policy design consists of four major steps: (1) Law and regulation, (2) Types of incentives, (3) Targets, and (4) Governance and support. The first step consists of implementing a Law on energy efficiency with a well-defined goal and having at least one entity to regulate it. The second step includes incentives to be initiated to support the policy. These can be mandatory performance standards, and market-, price- or information-based. Step three is about setting specific targets in terms of the sector of the economy that will be affected by the policy, the physical object on which the focus is and the unit of measurement that will be then used to assess the impact of the policy. Finally, the government needs to provide support, which it can do through auction programs, financing schemes and technical assistance, to cite a few examples.

We apply this framework to the case of LAC in order to assess the progress that has been made so far in terms of energy efficiency policy in the region, and where there is still room for improvements in achieving greater energy efficiency. The area where most progress has been made is the legal and regulatory one. When looking at information-based incentives, most LAC countries also seem to have been participating actively in energy audits and labelling of appliances. In terms of targets, energy efficiency policies that are already implemented show well-defined targets. In other areas, however, energy efficiency policy remains

weak. Mandatory codes and standards are only enforced by three countries, the same applies to obligation schemes, and Brazil is the only country with an auction program aimed at energy efficiency, to give some examples. Governance and support are also lacking.

One important conclusion from our findings is also the unbalance in terms of energy efficiency policy across the different sub-regions in LAC, when assessed through our conceptual framework. Indeed, the poster boys in the region seem to be Brazil, Mexico, Colombia, Chile and Uruguay, while countries in Central America and the Caribbean seem to be lagging behind.

Several policy recommendations made to contribute to the design of successful energy efficiency policies emerge from the analysis. First, we suggest to centralize energy efficiency laws and to complement them with quantifiable national targets. Second, more mandatory codes and obligation schemes need to be implemented, energy audits should be encouraged, and appliances labelling made universal and compulsory. With respect to targets, the private, residential and energy-intensive sectors deserve more attention. The last national initiatives recommended are to provide technical assistance and encourage auctions. From a regional viewpoint, we suggest creating more regional agencies and common frameworks, to make energy audits compulsory for larger companies, to harmonize minimum energy standards and labelling, and to reinforce dialogue between the different actors.

Introduction

Energy efficiency occurs when the same product or service is provided with less energy use, allowing to save costs while reducing emissions of CO2 gases and other pollutants. It has become one of the key mechanisms to improve power system efficiency, and it has been reinforced as the "first fuel" by G7 countries at the Kitakyushu Energy Ministerial Meeting in 2016. The improvement of efficiency in the power system can be driven by better generation, transmission, distribution and consumption. Looking at the consumers' side, this can be achieved via two main mechanisms: (a) demand management load (changing the moment when consumers use the energy); and (b) energy efficiency (using the same service/comfort with lower energy consumption).

The potential of energy efficiency is however not being fully exploited, as measures are frequently hindered by various market failures in different structures of developed and emerging economies. The implementation of energy efficiency programs developed will not be sufficient on their own to by-pass these economic barriers, as they depend on the countries' legal and regulatory frameworks, selection of measurement methodologies, and level of commitment of the domestic decarbonization strategy, to name a few.

In the context of Latin American and the Caribbean (LAC), a lot remains to be done in terms of energy efficiency improvements. This is especially true in light of the demand for energy services that is expected to double by 2040, and as LAC is a resource-rich region, where the energy-intensive extractives industries make an important economic contribution (Yepez-Garcia et al., 2018). When energy efficiency is measured by looking at energy intensity (i.e. the ratio between the level of final energy consumption and measure of output), LAC ranks second in the world in terms of lowest energy intensity, right behind Europe. While some people could believe that this implies that LAC has high levels of energy efficiency, it is more likely due to a low number of appliances or poor services affordability in the case of households, or to a lower use of technology or less intensive use of energy in industrial production. In other words, showing low energy intensity does not necessarily imply high energy efficiency, at least not in the case of LAC.

In spite of a common agenda for LAC to enhance energy efficiency, energy efficiency incentives have been heterogeneous across the region. Countries such as Costa Rica, Mexico and Brazil, which for some time now have been consolidating their institutional and regulatory frameworks to support energy efficiency activities, have implemented successful programs in this area (Gerarden et al., 2017). In contrast, progress has been slower in other LAC nations. A study on the progress of energy efficiency programs in 2017 found that several countries in LAC made good progress in terms of energy efficiency programs with respect to labelling, enactment of energy efficiency laws, the creation of specific agencies or units responsible for the subject, or the incorporation of energy efficiency plans into the general planning process of the energy sector[1]. However, even if several industries decreased their energy intensity, energy-intensive industries are still lagging behind when it comes to implementing energy efficiency programs (Sanchez et al., 2017).

The present report aims to inform policymakers and specialists on what are the choices available in the design of energy efficiency promotion through a conceptual framework. It seeks to give them a broad overview of the current situation by comparing LAC to the rest of the world, by comparing LAC countries to one another and also by looking at the different industries within LAC. After overviewing what has already been done in LAC in terms of energy efficiency

[1] For some examples of national and regional targets of energy efficiency, see annexes I, II and III in Sanchez et al., 2017.

improvements, it suggests national and regional initiatives to continue enhancing energy efficiency in the region.

The rest of the report is divided into three main sections. The first section provides an overview of energy efficiency in LAC by reviewing the different measurement indicators of energy efficiency, highlighting why it matters in LAC, analysing energy intensities at the regional, national, industrial and residential levels, and seeking to provide an explanation to the dichotomy between energy intensity and energy efficiency in LAC. Section 2 presents a conceptual framework through which to understand the progress in energy efficiency policy that has been achieved so far in LAC. The final section presents some policy recommendations and their limitations by suggesting both national and regional initiatives to promote energy efficiency.

A. OVERVIEW OF ENERGY EFFICIENCY IN LAC

This section gives an overview of energy efficiency in LAC to understand the trends and where the region stands internationally. It starts by describing the different measurement indicators of energy efficiency and justifying our choice and highlights why energy efficiency and its policy are important for LAC. When comparing LAC to other world regions, LAC stands out as the region with the lowest energy intensity. When comparing LAC countries and different economic sectors, energy intensity shows to be heterogeneous. We also discuss why showing low energy intensity does not necessarily imply high energy efficiency.

1. Defining Energy Efficiency

Energy efficiency is an intuitive concept and has been at the top of the agenda of policymakers. However, building an indicator to measure it and to track policies is challenging[2]. The absence of detailed data, methodological obstacles to aggregate data and the missing information at the macro-level are some of the main challenges. In the absence of a unique approach, there are several methodologies that are utilized, and that can be grouped into two different groups: top-down versus bottom-up approaches. Table 1 presents and contrast these two perspectives.

Table 1: Indicators to measure energy efficiency[3]

Method	Indicator	Description
Top-down	Energy Intensity	The ratio of energy consumption over national income, i.e. energy input in an economic output process.[4]
	Energy Intensity Decomposition	Break down of macro-level energy intensity into sectoral intensity, e.g. industrial, commercial, residential. Also decompose the 'true' efficiency from economic and structural effects. Often use Laspeyres/Divisia index[5].

[2] Refer to Filippini & Hunt (2015) for a discussion on the theoretical basis and parametric empirical approaches used to measure energy efficiency from an economic perspective.

[3] Other indicators depending on the sector analysed (i.e. commercial, residential, buildings etc.) can be found in Forsström et al. (2011), and indicators measuring alternative energy efficiencies (e.g. energy physical efficiency, energy thermodynamics efficiency, energy utilization efficiency etc.) can be found in Wei and Liao (2016).

[4] See VividEconomics (2013), Rajbhandari and Zhang (2017) and Wei and Liao (2016), to cite but a very few examples of energy efficiency defined as energy consumption per unit of GDP/output.

[5] See Reddy and Ray (2010), and Torrie et al. (2018) for examples of case studies on India and Canada, respectively, that use the decomposition analysis.

Method	Indicator	Description
	Energy Use per capita	Energy consumption per person is often used as an indicator of efficiency, especially for developing countries[6].
Bottom-up	Productive Efficiency	Measured by the input price ratio. Implies the cost effectiveness of an input combination to achieve certain energy services[7].
	Willingness to Pay	Identified by the elasticities of randomized trial for energy efficient investment, mostly in residential households[8].
	Engineering Approach	Based on technical parameters of equipment/appliances, and assumption of counterfactual level of usage. Can include technology-level information, such as life cycle and cost, and could even include technology evolution[9].

Source: Own elaboration

The main advantage of the top-down energy intensity indicator, including all decomposition levels (national, sectoral and product levels), is the simplicity of data and the straightforward economic intuition. It is widely used among regulators and policy-makers to monitor the efficiency gains for countries and cities. It is also probably the most commonly used indicator in the current literature on energy efficiency. On top of this, the top-down approach usually means a long time series of available data, so that the evolution or trends of energy efficiency status is trackable.

It is also the preferred measure in the ECLAC's Database on Indicators of Energy Efficiency[10] (ECLACa, 2019). For instance, for comparison between countries, the BIEE looks at primary energy intensities by measuring the total energy consumption over GDP converted at purchasing power parities (PPP), in order to reflect differences in general price levels between countries. This is also the measurement we use below when comparing energy intensity in LAC against other world regions. In its Market Report Series on Energy Efficiency for 2017, the International Energy Agency (IAE) distinguishes between "energy intensity" and the "efficiency effect' to measure energy efficiency (IAE, 2017:130). It defines the former as "the measure of the amount of energy used to produce a unit of output", and the latter as "the amount of energy used per unit of activity". This definition is nonetheless not entirely accurate, since a given country with a low energy intensity does not necessarily have high efficiency, e.g. a small service-based country with a temperate climate would certainly have a much lower intensity than a large industry-based country in a very cold climate, even if energy is more efficiently consumed in this country compared to the first (IIEA, 2014:19). The report makes the observation that if energy intensity is low, it can be due to improvements in energy efficiency, but not only, as it can also be due to a shift from energy-intensive industries towards less intensive service sectors (Ibid., 2017:17). For this reason, they suggest a decomposition analysis to measure energy efficiency. Details about the data and indicators used to measure the "efficiency effect" based on the IEA decomposition analysis can be found in Appendix 1. We rely on these energy efficiency indicators in our subsequent analysis when we compare sectors.

[6] See research report by Forsström et al. (2011) where they refer as this indicator as the "energy efficiency of communities".
[7] One key paper that looks at energy efficiency and productive efficiency is that by Schurr (1982).
[8] See Kinoshita (2018) and Kowalska-Pyzalska (2019) for examples of households studies that use this indicator.
[9] See Energy Efficiency Indicators: Fundamentals on Statistics (IEA, 2014: 33).
[10] *BIEE- Base de Indicadores de Eficiencia Energética.*

On the contrary, the bottom-up approaches focus on the adjustment of resources from the supply side of the economy. Requiring detailed data availability at end-use level, the first two approaches (i.e. productive efficiency and willingness to pay) aim to capture energy efficiency with the microeconomic theory of production and avoid the over-simplicity of the macro demand side's point of view. The third approach of the bottom-up grouping focuses on the technical accuracies, while some price and behavioral effects are usually neglected, causing a gap between actual energy efficiency saving and estimated results, or the so-called "energy efficiency gap". When there is not sufficient end-use level information, analysts rely more on a top-down approach based on macroeconomic elements and research by putting together household spending and energy consumption (IEA, 2014: 33).

Moreover, considering how climate change impacts from extreme events and disasters can threaten the economy and welfare, it becomes necessary to mainstream emission measurements in energy efficiency analysis. These measurements include CO2 emissions from production and use of energy, per capita, and per unit of GDP.. While this report does not include emission intensities due to the lack of available good quality statistics, these stand as a relevant measurement for future discussions in order to obtain a broad landscape of energy efficiency analysis (not just from the perspective of the economic production factors, but also from an environmentally sustainable perspective).

To have a diagnostic for all member countries in LAC, based on data availability, a top-down approach of energy intensity analysis is performed for both economy-wide and sectoral levels. We acknowledge that energy intensity is only a proxy for measuring energy efficiency and that it has its limitations. These are that a low energy intensity might not simply be reflecting energy efficiency, as it also depends on other factors. These are the structure of the economy, the type of industry base, the exchange rate, the country's size, climate, behavior and the affordability of energy services (OECD/IAE, 2014:17).

Finally, it is worth raising the issue of the lack available good quality data across LAC countries to effectively analyse and model energy efficiency. The current statistical efforts are not enough from a regional perspective, as there is a necessity to strength technical and institutional capacities, as well as the application of standard methodologies for easy updating and comparability across countries (IDB, OLADE and ECLAC, 2017).

2. Why Energy Efficiency Matters in LAC

The promotion of energy efficiency policies has been discussed in several regional fora and national development agendas of LAC countries. Since 2015, it has become more relevant due to the implementation of the 2030 Agenda and the Sustainable Development Goals (SDGs), and especially the SDG n°7 "Affordable and Clean Energy". The latter seeks to ensure energy access in an economical, reliable, and modern way for all, and identifies energy sustainability as a key factor for the fulfilment of the rest of the SDGs. Indeed, the SDG n°7 has a specific target (7.3): "By 2030, to double the global rate of improvement in energy efficiency"; thereby reaffirming the economic, social and environmental benefits that more energy-efficient economies can generate (United Nations, 2019).

In the Forum of the Countries of Latin America and the Caribbean on Sustainable Development (2017), LAC governments have reaffirmed their commitment to the 2030 Agenda, stressing that it is people-centred, universal and transformative. In the field of energy, governments discussed the need to prioritize governance mechanisms that support low-carbon projects and greater energy efficiency for the region. Nevertheless, the region shows that energy efficiency is not yet a priority issue for the energy sector (ECLACa, 2019). While countries such as Mexico

and Brazil have consolidated their institutional and regulatory frameworks for supporting energy efficiency activities for several years, with successful programs in this area, most of the remaining LAC countries' progress has been slower (IDB, OLADE and ECLAC, 2017). The growing demand for energy and the effects of climate change makes it necessary for countries to rethink their energy system. As a result, countries have discussed the importance of implementing energy efficiency measures, even before implementing renewable energy programs, in order to face the growing demand for energy by the population (ECLACa, 2019).

The need to implement energy efficiency policy in LAC has three main drivers: (1) it is an efficient mechanism to deal with the pent-up demand on electricity services in LAC; (2) it is an efficient tool to deal with the challenges imposed by climate change, as energy efficiency measures are among the most cost-effective actions to reduce emissions, and (3) it can ensure more and better affordability of energy services for households (IEA, 2017; Jimenez and Yepez-Garcia, 2019). Some progress has already been made in promoting energy efficiency policies. In recorded cases of crisis situation, efficiency was incorporated as a permanent component of energy policies and planning, for example by including energy saving and efficient strategies (IDB, OLADE, and ECLAC, 2017). In addition, some regional programs have emerged addressing policy recommendations and best practices for more effective results. These include the Regional Program of Energy Efficiency Indicators for LAC (BIEE) led by UN-ECLAC, and the program for Latin America and the Caribbean for Energy Efficiency led by OLADE.

Energy efficiency is particularly relevant in LAC because of how households are affected by the lower level of services and affordability. Indeed, while LAC countries show much lower energy intensity compared to developed countries, this is not the result of higher energy efficiency. To give an example, the household use of electricity equipment of the 5th decile of the Brazilian population (i.e. the middle-class) is lower than the first decile in France. Paradoxically, the electricity consumption of the highest decile in Brazil (i.e. the richest) is higher than the highest decile in France, indicating significant inequality in terms of access in Brazil (Grottera et al., 2017). One of the causes of this pent-up demand is the problem of services affordability in LAC, and a key consequence is the relation between economic growth and increase in demand.

As such, energy efficiency is the tool to decouple the increase of household well-being from an expected strong increase in LAC energy demand. The other side of the same problem is that energy efficiency may also increase services affordability (as you can have the same service using a low amount of energy, or you can have more/better services for the same amount of energy). Energy efficiency alone can deliver substantial economic, environmental and social benefits (OECD/IEA, 2012)[11]. It is a great opportunity for LAC where there is demand for better affordability of energy services and restriction in the use of subsidies. In this context, governments have incentives to find a better way to deal with affordability, increasing the well-being resulting from energy services and avoiding large undefined subsidies. Moreover, energy efficiency as a tool to improve energy services minimizes environmental impact.

One additional aspect worth mentioning is that in the context of LAC, a region that consumes 4 times more energy per capita than OECD countries, energy efficiency can contribute to the expansion of the level of services for unmet needs, instead of focusing on the replacement of equipment. This is because households, offices, and public buildings and spaces in LAC do not count with the same level of comfort as developed countries to start with, in terms of building insulation, AC, and public lighting, to cite a few. As such, the role energy efficiency can play there is not necessarily one of saving energy costs, but rather

[11] The work of Ravillard et al. (2019) shows the positive results on affordability of energy efficiency policy in Peru.

of improving access to energy services and their affordability, increasing production, and overcoming energy poverty (Sanchez et al., 2017:74-5).

The Nationally Determined Contributions (NDCs) announced as part of the Paris Agreement in 2016 defined energy efficiency measures to achieve the mitigation targets. While most of the countries showed their intention to improve energy efficiency, far fewer have specified new energy efficiency policies, and only a handful have set specific targets for energy demand, intensity or efficiency. In most cases, when NDCs refer to energy efficiency, they mention either existing policies and funding, or areas of focus for future efficiency improvements.

The building sector emerged as the target sector for energy efficiency. Energy efficiency is also generally more prominent in submissions from developing countries and emerging economies. Although almost all countries have some energy efficiency policies or goals in place, there is still scope to strengthen energy efficiency policies and measures in NDCs. Concerted efforts to achieve the goals in NDCs could help catalyze action on energy efficiency, which is often needed regardless of climate change mitigation. For instance, Argentina is the poster child of a country that has made investments in energy efficiency fundamental in order to meet the targets it has set in the NDCs (Cadena et al., 2019). In addition to country-level action, thousands of states and cities, and hundreds of private sector actors have made climate change mitigation commitments that include energy efficiency actions.

Therefore, energy efficiency is the main tool to reach both social and environmental objectives: moving to low-emission fuels, decarbonizing the structure of economic output and maintaining affordable services. Moreover, energy efficiency can be deployed quickly, and it can be considered as a kind of energy resource that all countries possess in abundance (IEA, 2017). LAC needs to accelerate its progress towards improved energy efficiency to unlock environmental and social benefits. It is a key opportunity for leapfrogging in a region where the demand for energy services is expected to double by 2040 (Yepez-Garcia et al., 2018). To this extent, energy efficiency can improve the power system efficiency and increase end-user welfare.

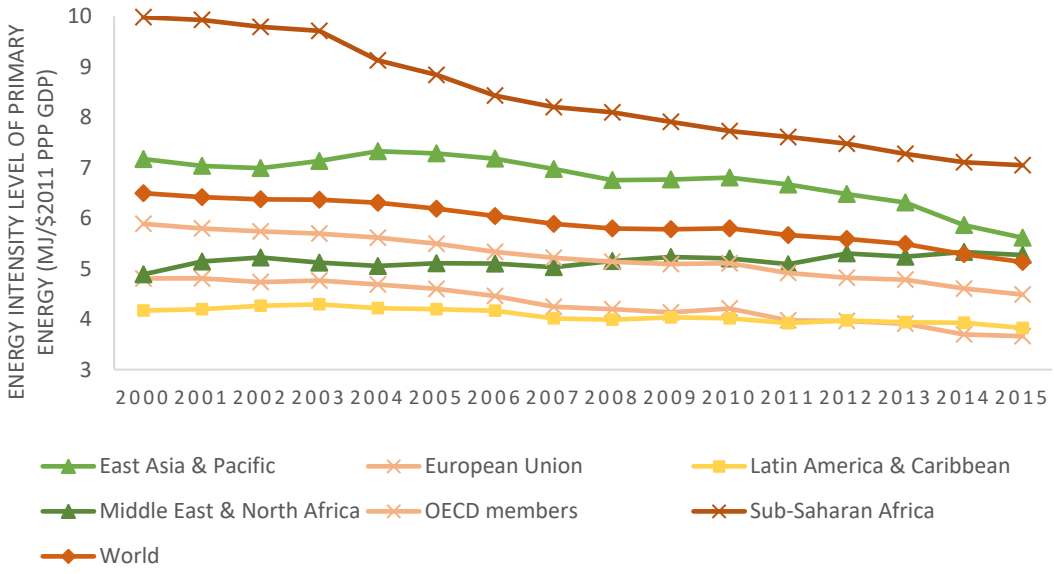
3. Energy Efficiency Outlook in LAC

This section presents an analysis of available indicators to evaluate LAC's energy efficiency trends and structure. It is divided into three parts. First, we review the entire economy from an aggregate approach in order to assess the overall situation of the region. Second, we analyze industrial sectors. The third part focuses on the household sector, considering per capita consumptions of energy, and data on the low use of energy appliances. Each part of the analysis presents comparisons of LAC with other world regions and between LAC countries.

a) Aggregate

When using energy intensity as a proxy for energy efficiency, LAC indicators stand between countries where the energy consumption of transportation and generation is typically high, e.g. the U.S., and very energy efficient economies, e.g. Japan. As shown in Figure 1, energy intensity in LAC is 30% lower than global intensity level and 20% lower than OECD countries.

Figure 1: Energy Intensity Progress in Major Regions around the World, 2000-2015



Source: IDB elaboration based on World Bank Development Indicators

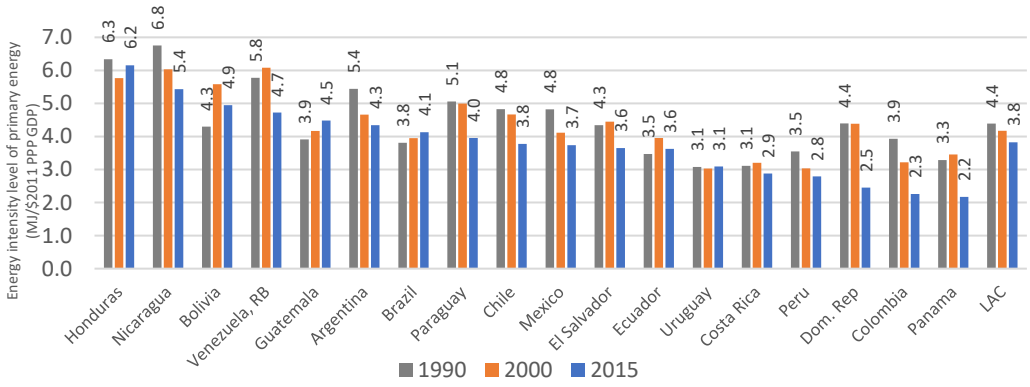
Even if low, the energy intensity trend in LAC is relatively stable, standing out from the rest of the world where it is decreasing. This means that it was already low to start with, unlike other regions where a decrease since the early noughties can be seen. In 2016, global energy intensity decreased by 1.8%, with an annual average rate of 2.1% since 2010. It is expected to decrease by 2-2.6% per year in the coming years, in order to achieve the NDC (National Determined Contributions) targets and the 2-degrees greenhouse gas emission requirement (IEA, 2017). Meanwhile, LAC has been trapped in an "intensity" bottleneck since 2007, as it has been keeping an intensity level around 4 MJ/USD[12], with an annual change oscillating around ±1%.

While at first sight LAC seems to be doing well in terms of energy efficiency, based on the energy intensity indicator, the latter can be misleading. A low level of energy intensity can be the result of a low level of appliances (and low level of development/comfort), or the result of efficient appliances. Two points are particularly important to consider when thinking about LAC: 1) the low level of energy intensity does not mean a high level of service efficiency (for instance, if compared to OECD countries), 2) energy efficiency programs may not decrease the energy intensity of some consumers, but increase the level of energy services.

Doing a zoom into LAC countries (Figure 2), data shows that from 1990 to 2015 almost every country decreased its energy intensity, except Bolivia, Guatemala, Brazil and Ecuador. This is due to the fact that the energy consumption of these countries increased more than their GDP, suggesting that their economies are more energy-intensive than in 1990 (based on the definition of energy intensity outlined above). Countries showing significant intensity decreases in this period are the Dominican Republic, Colombia, Panama and Mexico. Looking at tendencies by period, data shows that economies in the region reveal particularly lower levels of energy intensity during 2010-15 (annual average rate), compared to 1990-2000 and 2000-10. One explanation could be reflecting the outcome of the energy transition programs implemented during this period, along with the experienced economic growth, which in most cases was driven by less energy-intensive sectors. This will be further detailed in the next section.

[12] US Dollar is using constant 2011 value with PPP adjusted for all countries and regions.

Figure 2: Energy intensity progress in LAC by countries, 1990-2015



Source: IDB elaboration based on World Bank Development Indicators

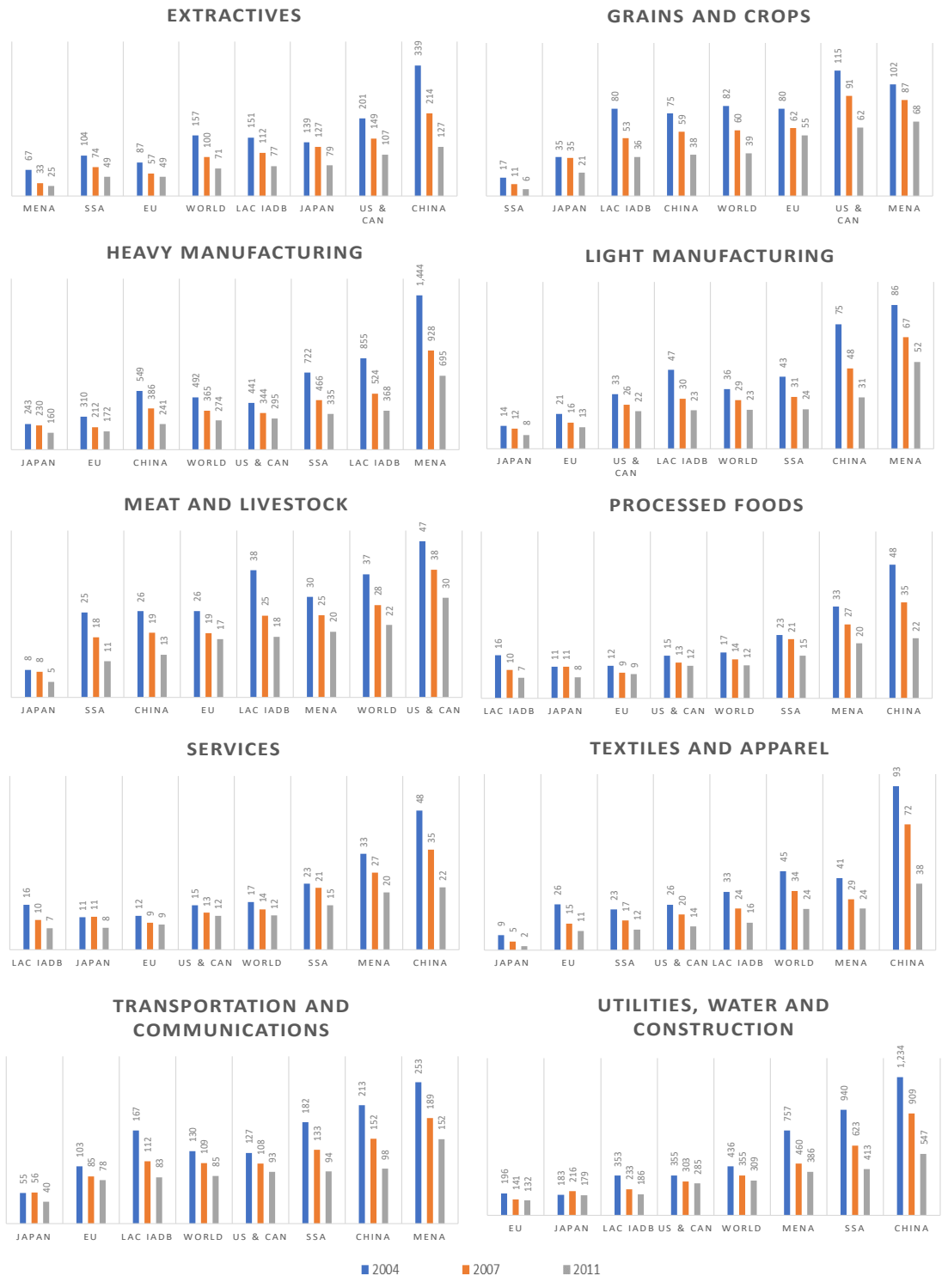
b) By industry

In order to better understand the energy intensity by industry, we use data from the Global Trade Project Analysis (GTAP) to calculate energy intensity indicators for 9 industries (Figure 3). We carry out the comparison by type of industry across countries in different regions.

We observe improvements over the years in the energy intensity indicator for all industries in all regions. In almost every industry sector, LAC's energy intensity is slightly smaller than the average of the World indicator, except in industries that are most intensive in energy (i.e. extractives and heavy manufacturing), where LAC displays higher intensity than the world and other regions.

The services sector in LAC has the lowest energy intensity, compared to the other countries and regions. It may be related to the lower use of technology and appliances, and not necessarily to higher energy efficiency. In fact, several studies on the region have reported the lag in innovation and technology adoption in LAC compared to other regions of the world (IDB, 2010; Dutz et al., 2018;), including in the case of the services sector (Rubalcaba, 2013).

Figure 3. Energy intensity indicator by industry across countries and regions, 2004, 2007, 2011
(toe-$ output)



Source: IDB elaboration based on GTAP data.

It is essential to look at specific industries when investigating energy intensity in the LAC region, as the latter varies considerably across the different sectors of the economy and as there is great heterogeneity across countries (Jimenez & Mercado, 2014).

To better understand how energy intensity is related to economic sectors and industries, this report breaks down the economy-wide efficiency into subsectors.

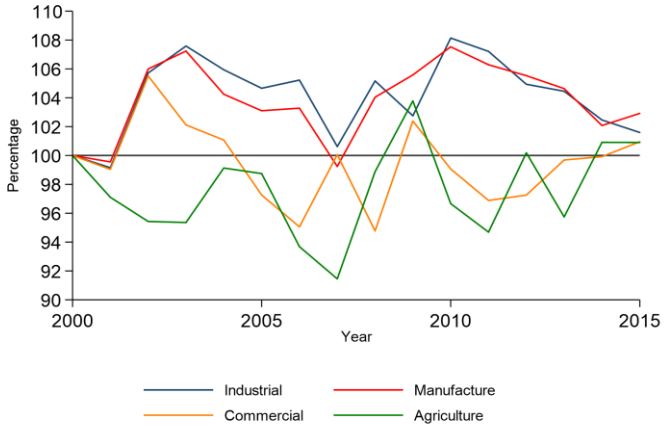
Drawn from a study by the IEA (2016), energy consumption can be divided into the following sectors: Industrial, Commercial, Agriculture, Transport, and others. The Industrial[13] and Commercial[14] sectors combined consist of 50% of the national income of the region. Following the IEA (2014), a disaggregation of energy use, and the corresponding efficiency changes, is depicted using the formula below:

$$E = \sum_i^n \left(A \cdot \frac{A_i}{A} \cdot \frac{E_i}{A_i} \right) = A \sum_i^n (S_i \cdot I_i) \qquad (1)$$

where E represents the energy use, while i indicates the given sector (industrial, commercial, residential, etc.), A is the activity effect that represents the volume of an economy, e.g. value-added in manufacturing, commercial sector, or population in the residential sector, S is the structural effect representing the proportion of subsector i in the whole economy, and I is the energy intensity, i.e. the energy use per unit of activity. Figure 4 shows the evolution of energy intensity in different sectors based on this methodology.

During the past 15 years, LAC countries have undergone multiple recessions and recoveries with fluctuations in energy use and national income. Compared to the efficiency level in 2000, both the industrial and commercial energy intensity remained at the same level with a slight increase in energy intensity in 2015. Industrial energy intensity dropped twice along the period, while commercial energy intensity showed higher decreases. Two other series are included for reference: manufacture, as a subsector of industrial, mapped similar trends as industrial efficiency changes. However, it is not possible to observe a clear pattern in LAC's energy intensity evolution. We next look at energy intensity in industrial and commercial sectors by country.

Figure 4: Energy intensity by industry in LAC, 2000-2015 (base year 2000)

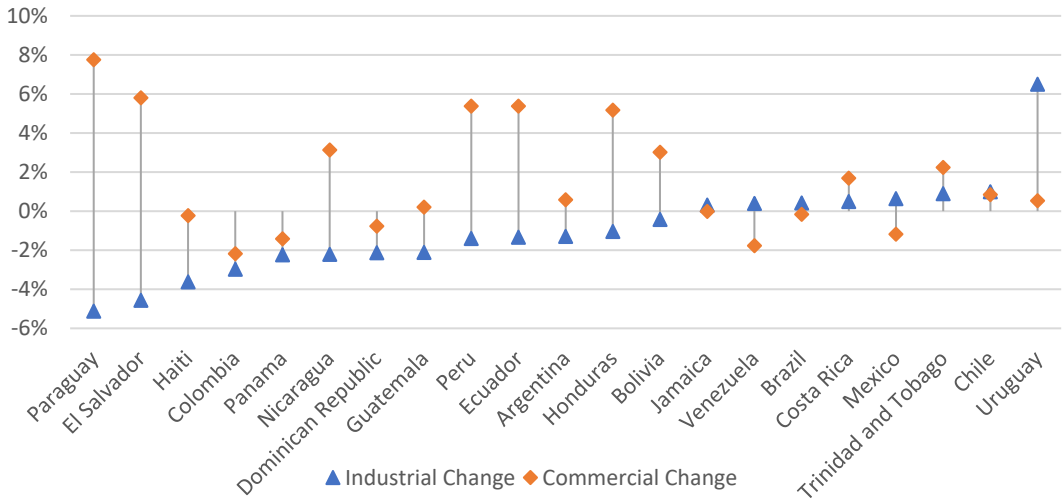


Source: IDB elaboration based on IEA Energy Balance Statistics and UN Stats[15]

To compare the energy intensity evolution for all LAC countries, an annualized change rate of energy intensity decrease is presented for both the industrial and the commercial sectors during the period 2000-15 in Figure 5. Negative values indicate a decrease of energy intensity (which can indicate an energy efficiency improvement), while positive values indicate an increase of energy intensity. Here again, energy intensity is used as energy consumption of the sectors over sectors' economic output.

[13] Industrial sector consists of Manufacturing Mining and Construction.
[14] Commercial sector consists of Public services and Commercial uses.
[15] In LAC the national income by Industrial, Commercial and other sectors in 2000 were respectively 35%, 15% and 49 %, in 2015 it was 30%, 16% and 54%.

Figure 5: Annual change in industrial and commercial energy intensity in LAC countries,
2000-2015



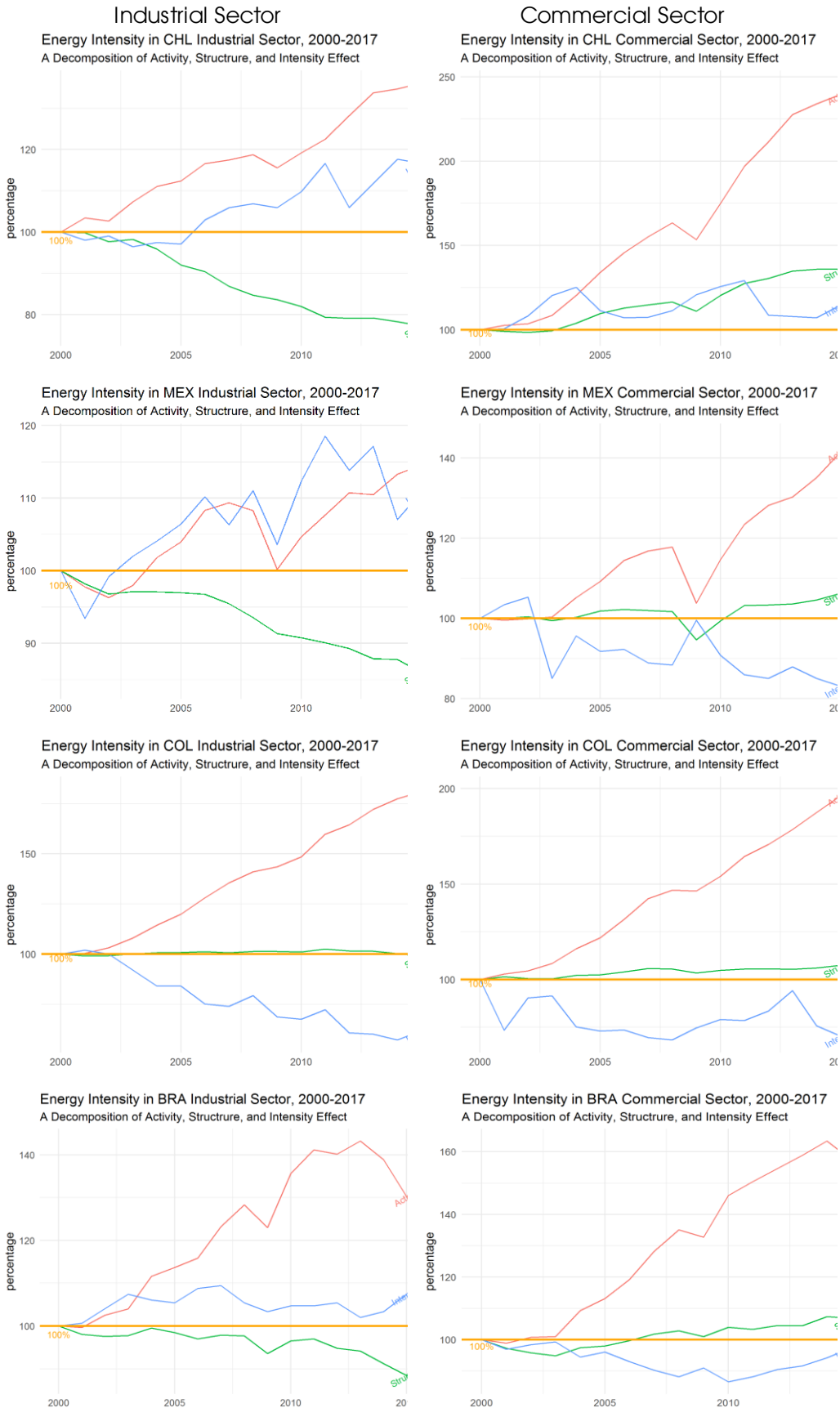
Source: IDB elaboration based on IEA Energy Balance Statistics and UN Stats

Colombia, the Dominican Republic, Haiti and Panama are the only 4 countries that experienced some decrease in energy intensity in both industrial and commercial sectors over the past 15 years. It does not mean, however, that these countries have become more efficient. It simply means that the industrial production has become less intensive in its use of energy. One important shift in LAC economies that may impact the level of energy intensity is the composition of the economy. Industrial energy intensity tends to be much higher than commercial, as shown in Figure 5, because of energy-intensive industries such as extractives, heavy manufacturing and utilities (including water and construction).

To better understand the relation between energy intensity in commercial versus industrial consumption, Figure 6 shows the detailed analysis of energy intensity using decomposition analysis for the LAC countries with the highest GDP. These countries are Chile, Mexico, Colombia and Brazil. It is helpful to glimpse into the activity, structure, and energy intensity effect of each economy (Ang, 2006; IEA, 2016).

Based on the methodology described in Equation (1), the activity effect defines the size of national income in the sector and the structure effect defines the change of proportion of that sector in terms of the whole economy. We observe a shift towards a service-oriented economy along with a fade-out of industrial GDP. The only variations are in Mexico's energy intensity improvement. One explanation can be the effects of the Energy Transition Law policies which will be detailed in the next section (i.e. public lighting and energy efficiency certificate projects).

Figure 6. Energy intensity in Brazil, Chile, Mexico and Colombia, 2000-2014 (base year 2000)



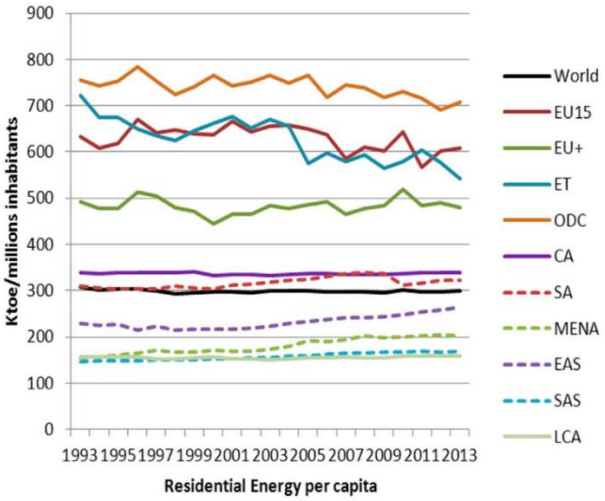
Source: IDB elaboration based on IEA Energy Balance Statistics

c) For households

To analyze households, we build a proxy for energy intensity. Most studies measure residential energy efficiency by looking at energy (or electricity) consumed per capita or per unit of appliance or per square feet of occupied housing units (IEA, 2016; Horta, 2010; Forrstrom et al., 2011; OECD/IEA, 2014). We, however, consider the ratio of energy consumption over the monetary value of appliances purchased at market prices.

We chose this measurement for comparability purposes, and also to give a different perspective on energy efficiency in the region compared to other indicators. For instance, Figures 7 and 8 show energy intensity measured by looking at residential consumption per capita and per GDP at PPP, respectively, in LAC compared to other world regions. Based on both figures, LAC stands out as the region with the lowest residential energy intensity. In the case of energy intensity measured by consumption per capita, South Asia evolves closely with LAC over time. When looking at consumption per GDP at PPP, it is Middle East and North Africa that is closest to LAC. The differences between these two figures also show that based on the measurement of energy intensity, conclusions can vary.

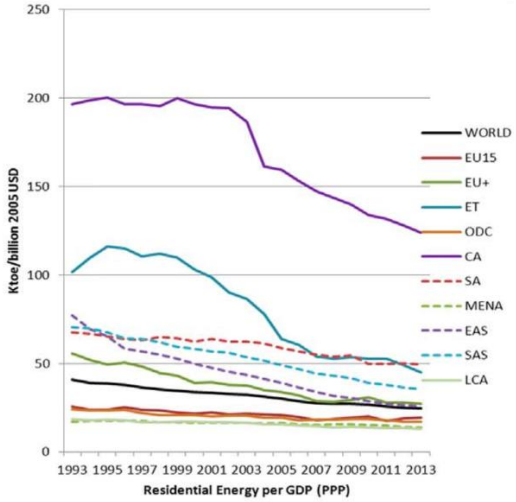
Figure 7. Residential energy per capita consumption trends (1993-2013) in world regions[16]



Source: Pablo-Romero et al. (2017)

[16] EU+ stands for New European Union members, ET for Economies in Transition, ODC for other Developed Countries, CA for Central Africa, SA for Southern Africa, MENA for Middle East and North Africa, EAS for East Asia, SAS for South Asia and LCA for Latin America and the Caribbean.

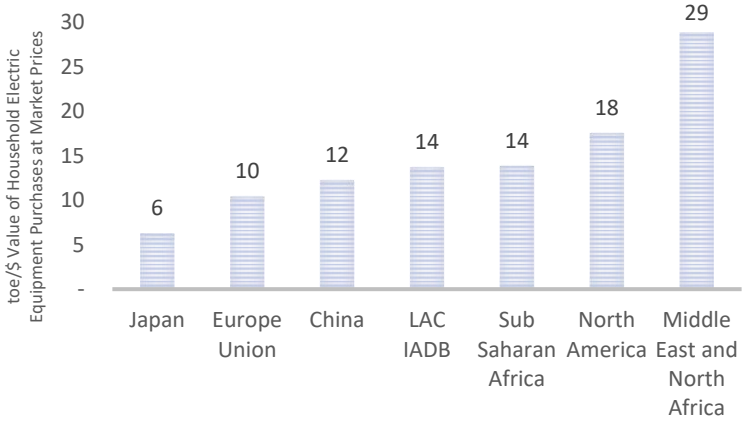
Figure 8. Residential energy consumption per GDP (PPP) trends (1993–2013) in world regions and economies by per capita GNI in 2013



Source: Pablo-Romero et al. (2017)

An alternative measurement to household energy intensity is presented in Figure 9, which shows a different picture, where energy intensity is measured by looking at energy consumption over the monetary value of household purchases of electric equipment at market prices. This approach, based on GTAP data from input-output tables, reveals that LAC households have higher energy intensity than Japan, the European Union and China, but lower than North America, the Middle East and North Africa. This is different from the findings in the two preceding figures. This analysis reveals two important observations. First, it shows the importance of the choice of measurement for energy intensity when analyzing energy efficiency. Second, it confirms the hypothesis mentioned above that low energy intensity in LAC (measured with traditional indicators of intensity) is not due to energy efficiency patterns, but might in part be due to the low use of energy appliances that reflects lower energy intensities.

Figure 9. Household energy intensity by region, base year 2011 (toe/$ value of household electric equipment purchases at market prices)[17]



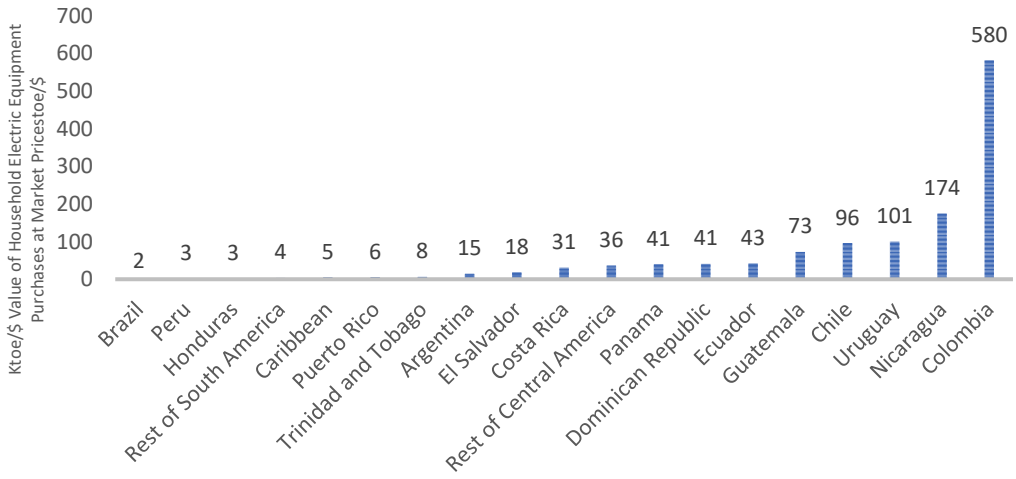
Source: Own elaboration based on GTAP data 2015

The same analysis in Figure 9 is applied to Figure 10. When looking at LAC countries, most of them present low ratios of energy consumption in electronics with respect to the monetary value of these purchases (Figure 10). Indicators for

[17] The household energy use corresponds to the household energy product consumption and the consumption of household energy imports, while the value of household electric equipment corresponds to household expenditures on electric equipment.

Brazil, Peru and the Caribbean countries show the lowest indicators in the region, whereas countries like Uruguay, Paraguay, Jamaica and Venezuela show a relatively large value for the energy intensity indicator.

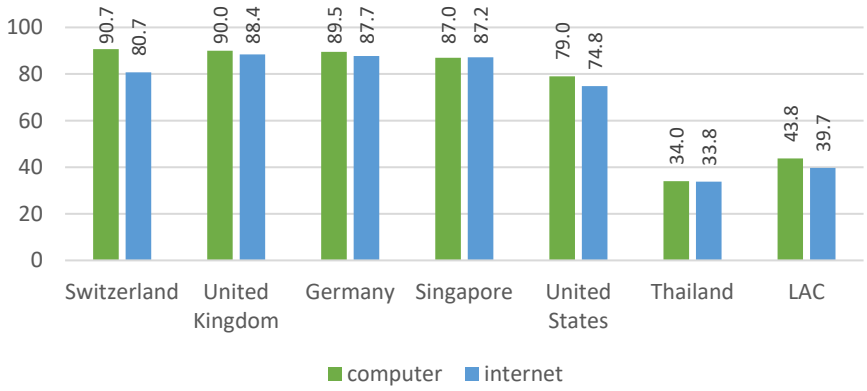
Figure 10. Household energy intensity by country, base year 2011 (Use of Energy (Ktoe)/ $ value of household electric equipment purchases at market prices



Source: Own elaboration based on GTAP data 2015

Other evidence supporting this hypothesis can be seen by measuring the percentage of households that own appliances. Figure 11 shows the percentage of households with access to a computer and internet in LAC compared to some developed countries. For instance, European countries, such as Switzerland, the United Kingdom and Germany show higher rates than LAC. This suggests that LAC has relatively lower access to electric equipment than other regions. This could explain lower uses of energy.

Figure 11. Percentage of households with a computer and internet, 2014[18]



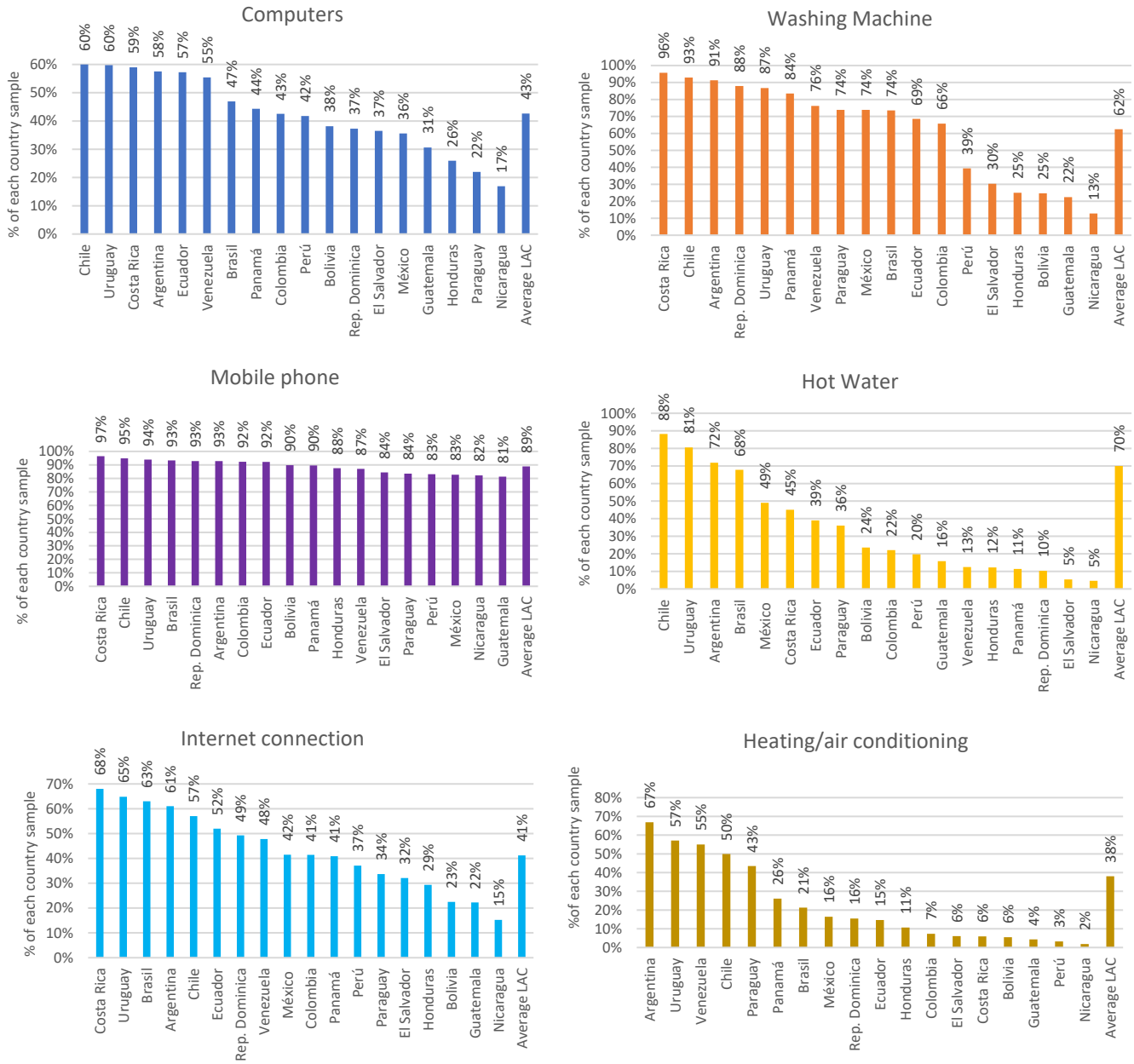
Source: ECLAC data, UN data, and World Telecommunication Indicators Data

Based on comparable energy data available from the Latinobarometro[19] database for 2018, Figure 12 presents a zoom into LAC countries, by including and disaggregating other relevant energy appliances. Our analysis estimates show

[18] Available data for LAC countries (2014), Switzerland (2014 and 2010), UK (2014 and 2013), Germany (2014 and 2013), Singapore (both 2013), United States (both 2012), Thailand (both 2014).
[19] It is an annual public opinion survey that involves some 20,000 interviews in 18 Latin American countries. It observes the development of democracies, economies and societies, using indicators of attitude, opinion and behaviour. In the field of energy, the interviewees were asked whether they own appliances. The survey is carried out only in urban zones.

that appliances to which LAC households have the least access are heating and air conditioning (38%), internet connection (41%), and computers (43%). Meanwhile, the highest accesses are to mobile phones and hot water, with 89% and 70%, respectively. Another finding is that in almost every access to appliances, Central American countries show the lowest percentages of the region[20], where also poverty rates are the highest in the region, and where GDP per capita is lower too (ECLAC, 2019b:82; ECLACc, 2019).

Figure 12. Percentage of people surveyed that owns energy appliances and equipment in LAC by countries, 2018



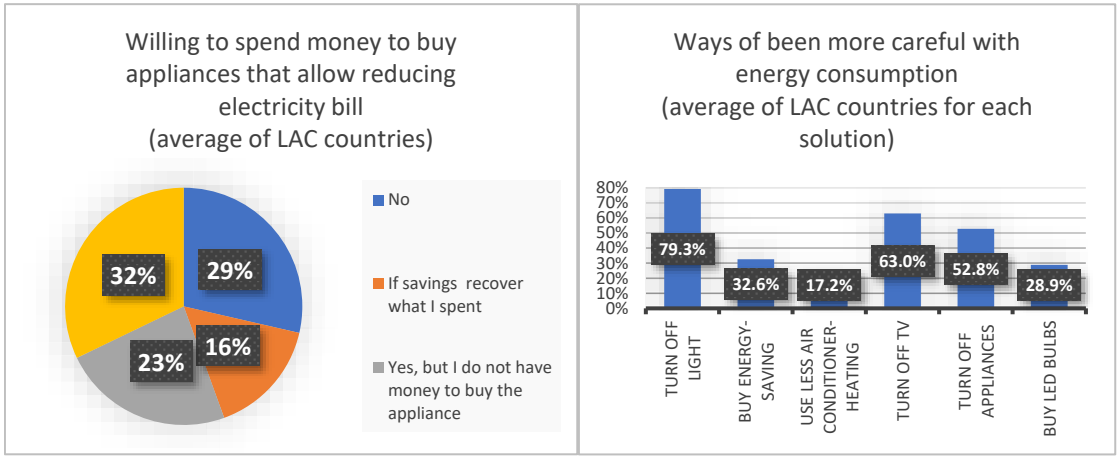
Source: Own elaboration based on Latinobarometro Data 2018

Note: LAC measures are calculated by doing a simple average of the country's information. The Latinobarometro database uses similar number of observations for each country sample.

[20] This is limited to Honduras, El Salvador, Nicaragua and Guatemala.

Using the same Latinobarometro database, indicators that can support the evaluation of households' behavior on energy consumption and efficiency are presented in Figure 13. On the left-hand panel, responses to the question on whether households are "willing to spend money to buy appliances that allow reducing their electricity bill" show that on average one household out of two in LAC would be willing to make this purchase for this purpose. A remaining 16% would agree but does not have the money to buy the appliance. The rest disagrees.

Figure 13. Behavioral indicators of LAC households on energy efficiency



Source: Own elaboration based on Latinobarometro Data 2018

Note: LAC measures are calculated by doing a simple average of the country's information. Latinobarometro Database uses similar amount of observations for each country sample.

The right-hand panel of Figure 13 shows that the most popular responses to the question on "ways of being more careful with energy consumption" rates are to turn off lights, turn off the TV, and turn off appliances. These behavioural indicators suggest that to support energy efficiency patterns within the households, it is necessary to improve affordability and energy-saving habits.

While energy intensity in LAC is low and has remained low during 2000-15, factors other than energy efficiency have affected this trend, implying that there is still room for improvement in energy efficiency policy. The next section will provide a conceptual framework through which the progress made in energy efficiency in LAC can be assessed. Later we make some policy recommendations.

B. UNDERSTANDING ENERGY EFFICIENCY THROUGH A CONCEPTUAL FRAMEWORK

In order to assess energy efficiency policy, we elaborated a conceptual framework. This conceptual framework is used as a benchmark against which to assess the progress that has been made in energy efficiency policy in the region so far. It consists of several steps that are mutually reinforcing and that have been grouped under four headings: Law and regulation (I), Types of incentives (II), Targets (III), and Governance (IV) and Support (V). Figure 14 below illustrates the conceptual framework. Each heading has sub-headings with different areas to consider.

Law and Regulation (I) include setting a well-defined goal or objective (i) through a Law on energy efficiency, adding to the Law a detailed action plan (ii) on how to meet the objectives, along with deadlines, and in parallel having one or more entities (iii) to regulate the process. Then, different types of incentives (II) can be implemented, to promote energy efficiency improvements. These can either be mandatory performance standards (i), price-based (ii), market-based (iii) or information-based (iv). It is possible to combine different types of incentives.

To design energy efficiency policy requires to define specific targets (III). In this case, targets are non-numerical, in the sense that they are not a percentage reduction of carbon dioxide emissions or a percentage increase in energy efficiency, for instance. Targets are the sector, the object and the unit to which the policy is directed. The sector (i) is that of the economy, the object (ii) refers to the appliance or equipment and the unit (iii) is the measurement used to evaluate the impact of the policy.

Two other dimensions necessary for the successful implementation of a policy on energy efficiency are governance (IV) and support (V). They ensure a smooth implementation of the policy through several mechanisms. In terms of governance these are enforcement (i), providing direct contracts (ii), calling for projects with available funds (iii), and auction programs (iv). Support mechanisms include financing schemes (iv), tariff structures (iii) and technical assistance. The timing of support (i) and whether it is multi-sectoral (ii) , meaning coming from many fronts, is also crucial for the success of energy efficiency policy design. The remaining part of this section looks at each heading in details to provide a theoretical understanding, followed by a practical approach with a description of the progress made in each area in LAC countries.

1. Law and Regulation

The first step to create an enabling environment for energy efficiency policy is to establish a legislation or action plan (I.iii), with or without a determined energy efficiency target (I.i). Then it is to regulate this action plan. A delegation of setting the strategy, executing policy and programs, and ex-post monitoring, is common to share amongst ministers, regulatory and independent third-party organizations. We refer to the latter as energy efficiency entities (I.ii).

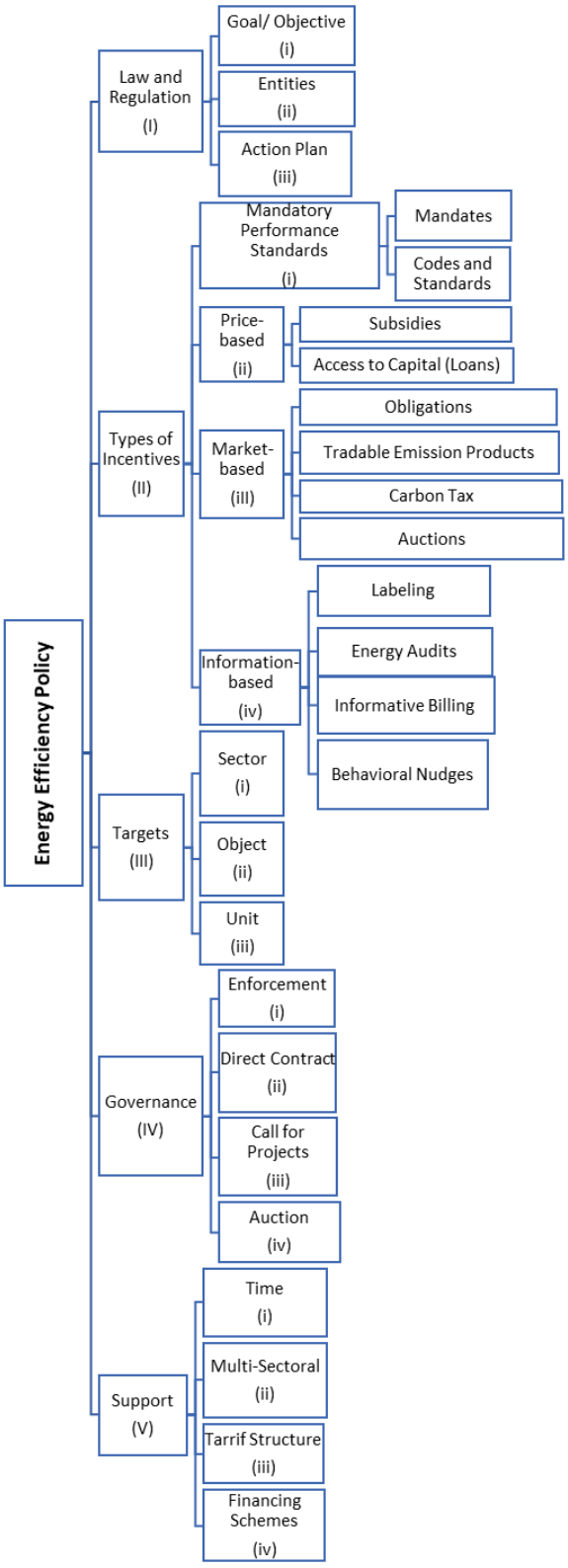
a) Energy Efficiency Law

When mapping energy efficiency legislation progress, all LAC countries have devoted substantial efforts to incorporate energy efficiency into a legal framework, though their legal strength vary. Since the region's first Energy Efficiency Law establishment in Costa Rica in 1994, LAC has been progressing actively to strengthen the legal framework on energy efficiency. As per Figure 15, by 2017, 10 out of 26 IDB member countries had consolidated their institutional

and regulatory frameworks by implementing a law on energy efficiency. Another 7 countries are currently undergoing the preparation and/or congress discussion for a national law, while the rest of the countries do not include energy efficiency in major national laws, though they have similar goals in their energy planning or non-energy laws or policies. The length of the bar for each country in Figure 15 is an approximate representation of the time frame that energy efficiency law implementation required or requires.

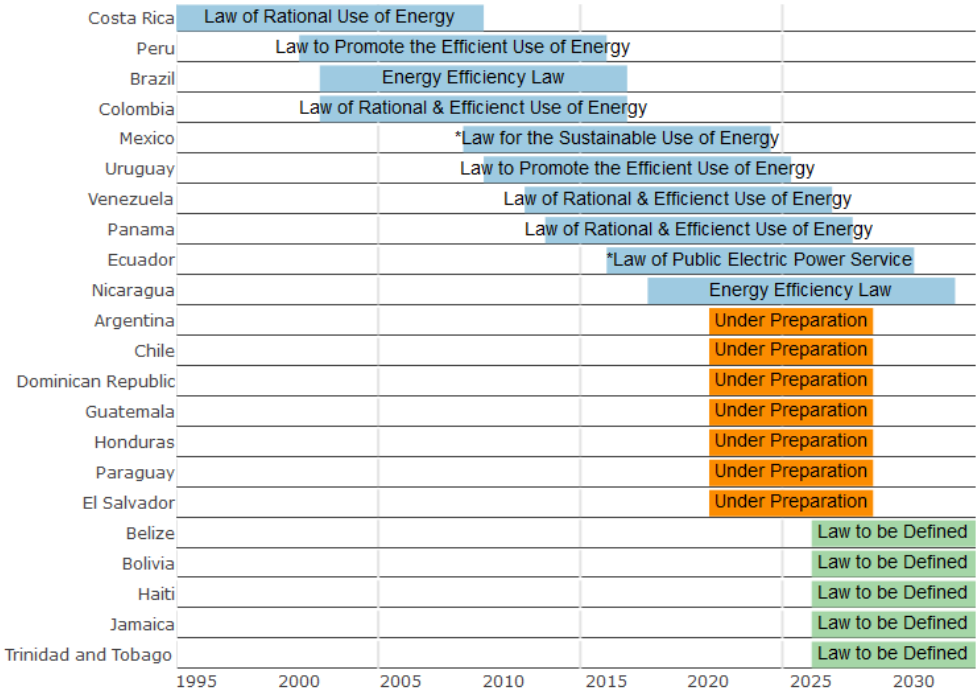
Compared to the international scene, LAC has progressed in its energy efficiency legal framework timely. For instance, China only established its legal framework in 2008, and France in 2005. However, to fully utilize the legal binding of the legal framework, countries also depend on the implementation and monitoring of the tools and projects, which can be done with the support of energy efficiency entities, which we review next.

Figure 14. Conceptual framework



Source: Own elaboration

Figure 15. Timeline of energy efficiency legal framework in LAC



Source: Own elaboration based on IEA Energy Efficiency Database, Bloomberg New Energy Finance Policy Database and CEPAL BIEE database

b) Energy efficiency entities

Once the energy efficiency law is implemented, national entities are essential to develop and implement programs, projects and standardization on energy efficiency. They help set the strategy and standards, regulate the activities, verify compliance and contribute to the labeling, financing and training, amongst others. They are thus necessary to the success of energy efficiency policy.

As an example, a regulatory facility is usually established to foster the realization of the energy efficiency Law. This is also an effective way to extend legal power to the implementation of policies and projects. In LAC, the average time taken from the enforcement of energy efficiency Law to the establishment of regulation is two years. With a strong push from their governments, Brazil, Uruguay and Mexico managed to establish both legal and regulatory frameworks in the same year.

Mexico's regulatory framework is an interesting case study. Since 1990, there is a public institution responsible for the regulation and planning of the national energy efficiency strategy. Moreover, there is a private non-profit trust fund, FIDE, that has financial resources and technical and operational capacity to implement energy efficiency projects and programs. These have contributed to the creation of a market for equipment, services and financing for energy efficiency, as well as supported the effective implementation of energy efficiency standards mainly in high consumption equipment, such as electric motors, electrical appliances and lighting equipment, amongst others.

Table 2 below provides an overview of energy efficiency entities in LAC. The entities have also been classified into Ministry or Secretariat, Regulatory agencies, Public agencies and Private independent organizations. By observing the delegation of

energy efficiency entities, two interesting patterns emerge. One the one hand, the role of setting an energy efficiency strategy and regulating market participants tend to be the duty of public and governmental agencies. On the other hand, the role of designing energy efficiency standards, implementing tools, and carrying out monitoring and evaluation, in some countries, are delegated to private non-profit entities.

Appendix 2 summarizes findings from Table 2 by indicating whether for each country and each task related to the regulation and monitoring of energy efficiency law there exists an entity, captured by a "yes" versus "no" response. Then the last line of the table sums the total of different entities performing tasks for each country. The country with the highest number of different entities that regulate and monitor energy efficiency law is Colombia with five different entities, while the countries with the lowest number of entities, which is only one, are Nicaragua, Dominican Republic, Guatemala and Haiti.

Energy efficiency policy and programs usually involve multiple parties and are led by a public entity. The following observations have been drawn from the literature on this matter:

- Public organizations tend to have more of an incentive for multi-tasking than private firms (Williamson, 1985).
- A task that is performed with a more accurately observed outcome would have come from a higher-powered incentive, because the outcome is a good indicator of the effort one wants to motivate (Dixit, 1997).
- Activities that are more difficult to measure, such as innovation, will suffer a relative disadvantage (Holmstrom and Milgrom, 1991).
- Another attribute of government and public organizations is that they must respond to multiple requests, or "principals". This means that the interaction of principals and the un-isolatable duties will lead to the moral hazard of agencies and be followed by a low-powered incentive for administration.

In sum, there are many missing links between energy efficiency entities and energy efficiency in LAC. Amongst them, two factors are mostly related with LAC's political environment. One of them is the need to establish an efficient regulatory delegation of energy efficiency tasks. The second one is to provide measurable and monitorable incentives to pass on energy savings to industries and end-consumers. What these findings reveal is that while energy efficiency entities are key to monitor and implement tools and projects in view of supporting the energy efficiency law, they are not sufficient on their own to promote energy efficiency improvements. Instruments can be used to complement them. We turn to these now.

Table 2. Energy efficiency entities in Latin American and Caribbean countries[21]

Are there governmental and/or independent bodies dedicated to:	Brazil	Mexico	Bolivia	Ecuador	Honduras	Chile	Nicaragua	Colombia	Argentina	Peru	Venezuela	Dominican Republic	Guatemala	Haiti
1. Setting EE strategy?	MME	SENER	ME	MEER	SERNA	ME	MEM	MME	MEM	DGEE	MPPEE	MEM	MEM	MTPTC/ BME/Ed H
2. Setting EE standards?	INMETRO	CONUE E	IBNORCA	ARCONEL	SERNA	ME	MEM	ICONTEC	MEM	DGEE / OGPP /DGH	MPPEE	No	No	No
3. Regulating EE activities of energy suppliers?	ANEEL	CONUE E	CNDC	ARCONEL	SERNA	No	No	No	No	No	MPPEE	No	No	No
4. Regulating EE activities of energy consumers?	ANEEL	CONUE E	CNDC	ARCONEL	SERNA	No	No	No	No	No	MPPEE	No	No	No
5. Certifying compliance with equipment EE standards?	PROCEL	EMA	IBNORCA	INEN	OHN	SEC	MEM	SIC/ DIAN	MEM	MINE M	SENCAME R	No	No	No
6. Certifying compliance with building EE standards?	PROCEL	EMA	GBC	INEN	OHN	MIN VU	MEM	MVCT	No	No	No	No	No	No
7. Selecting and/or approving third party auditors tasked with certifying EE standards?	PROCEL	EMA	GBC/ IBNORCA	OAE	No	SEC	MEM	CNA	OAA	MINE M	No	No	No	No
8. Voluntary EE labeling	PROCEL	FIDE												

[21] There exist important programs of communication, dissemination and awareness, however, we do not have enough data to specify and classify it.

9. Financing EE programs and projects		FIDE												
10. EE Training		FIDE, CONUEE, CFE												

Ministry/ Secretariat	Regulatory Agency	Public Agency	Private Independent Organization

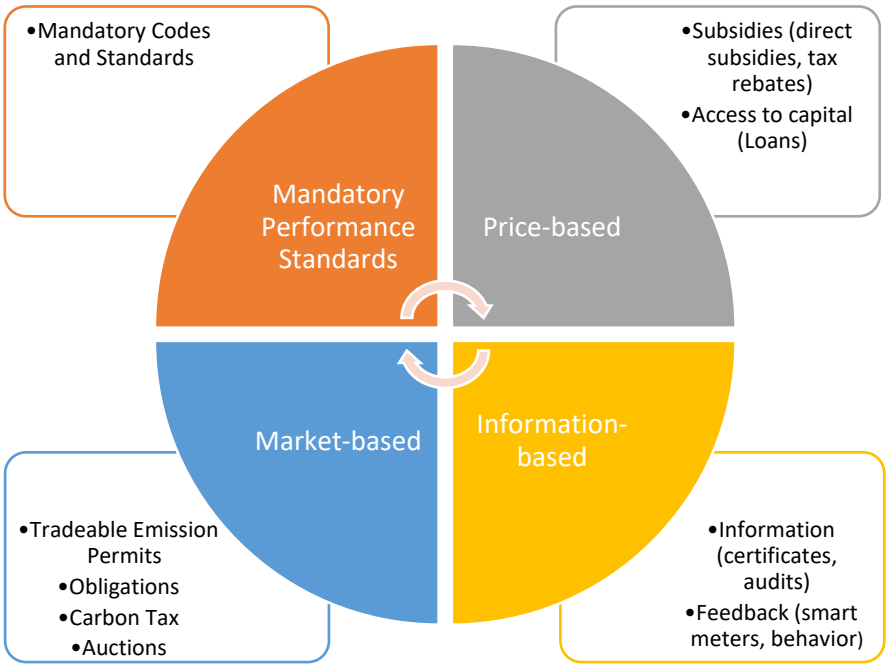
Source: Own elaboration based on IDB SER Energy Database and World Bank RISE Database (2017)

(Note: The ownership of each entity is indicated as the color coding below. Public Agencies include all other public agencies besides ministry-level, such as Superintendent, National Commission, General Direction etc. All entities' acronyms can be found in Appendix 3)

2. Types of Incentives

After implementing a law and establishing regulation, the next step is to select a type of incentive (II) or a portfolio of incentives, to meet energy efficiency targets. To put some structure in the selection of incentives, 4 categories targeting different aspects of the economy are presented in Figure 16: (i) Mandatory Performance Standards; (ii) Price-based; (iii) Market-based; and (iv) Information-based. Each incentive can be initiated on its own, but it is not mutually exclusive. We review each of them in more details in the following sections.

Figure 16. An overview of types of incentives



Source: Own elaboration based on Wiese et al. (2017)

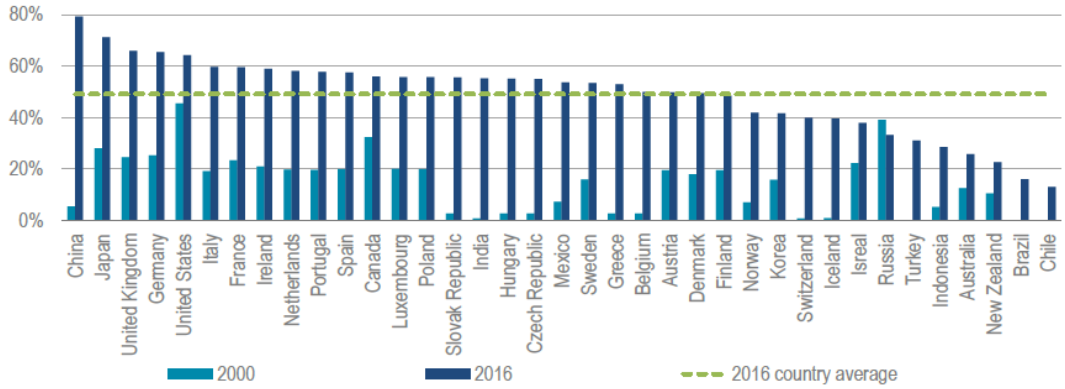
a) Mandatary Performance Standards

Regulatory instruments consist of mandatory codes and standards on energy efficiency. These are widely applied instrument due to their predictability and low financing cost. If these were to be broken down into counterparts in different sectors, they would be building energy codes on efficient energy use over building's lifecycle in the construction sector; Minimum Energy Performance Standards (MEPS) on appliances and industrial equipment in the industrial sector; and fuel economy standards on public and private transportation in the transport sector; to cite but a few examples.

The IEA (2017) reports that three countries in LAC have a coverage potential from mandatory codes and standards[22]. These are Mexico, Brazil and Chile. Thanks to the improvement of the fuel economy in Mexico, as well as retirement, renewal, expansion and the stock turnover, the potential coverage of mandatory codes in Mexico is slightly above the 2016 country average (see Figure 17). Brazil and Chile appear on the very right hand-side of the figure, with less than 20% coverage and no evidence for mandatory codes and standards in 2000.

[22] When a policy is enforced, the applicable energy uses are said to be "covered".

Figure 17. Coverage potential of existing mandatory codes and standards



Note: The dotted green line in the chart is the arithmetic (unweighted) country average (mean) of coverage potential across the 37 countries.

Source: IEA (2017)

In terms of MEPS, Argentina, Chile, Ecuador and Mexico have implemented them for bulb lighting, Chile Ecuador and Mexico for domestic electrical equipment, and Argentina, Mexico and Haiti (still in progress as of 2017) for AC. In Mexico, these are also applied to industrial refrigeration and heating (Sanchez et al. 2017).

b) Price-based

In terms of price-based instruments, these are tax and subsidies, frequently applied at end-user or product level, and access to capital via loans. Financial incentives such as tax rebates and direct subsidies can provide direct stimulus for energy efficiency needs from the end-user side, while subsidies to promote R&D or investments in new facilities can motivate the manufacture's side. These incentives intend to motivate energy efficiency investment that requires huge up-front cost. In reality, price-based instruments are usually impaired by "human" factors that do not participate in the ex-ante engineer simulations, namely rebound effects and free rider effects. We return to these effects in the last section of this report.

One financial incentive that has received acknowledgement is the feebate system. It was first adopted in France on vehicle fuel economy in 2008. The rules are that less polluting cars benefited from a price reduction of up to 1,000 euro, whereas the most polluting ones were subject to a taxation of 2,600 euro (D'Hautefeuille et al., 2014). According to the World Bank (2015), the new instrument resulted in an immediate drop of 7 grams of CO2 per kilometer for new vehicles.

In general, feebate is a combination of a tax for the "bad" (i.e. inefficient appliances) and a subsidy for the "good" (i.e. efficient ones). The design of the instrument is self-sufficient in financing in most of the European cases. Chile is the first mover in LAC who is actively considering taking advantage of the feebate tool. The Mario Molina Center in Chile and the Chilean Ministry of Transport and Telecommunications are still in the review process of a feebate on vehicles, and it is estimated that the incentive and disincentive system will imply a 5% reduction of CO2 emissions from the total national vehicle fleet recorded in 2014. A Chilean Auto Fuel Economy Label Based was developed for the national market and adopted in 2013 following a feebate proposal[23].

[23]More information can be found on: https://www.fiafoundation.org/transport/gfei/autotool/approaches/economic_instruments/fee_bate.asp#Chile

Other examples of price-based instruments include the use of financial incentives in a IDB-funded program in Barbados (see Box 1), or the subsidizing of thermal reconditioning of homes as part of the 2010 Energy Efficiency Agency in Chile (Copenhagen Centre on Energy Efficiency[24], 2015). In Argentina, a Fund was created in 2009 specifically for energy efficiency investments, where SMEs are provided low interest loans for energy efficiency projects[25]. In Brazil, the 2013 Inova Energy Program can cover up to 90% of accepted projects costs related to energy efficiency, and up until 2017, the INOVAR-Auto Incentive Program was adding 30% to the Industrial Products Tax for all light duty and commercial vehicles that would not comply with specific energy efficiency requirements.[26]

Another example of a price-based instrument that is a bit different, as it used tax for the "good", is that implemented by Guyana, where in 2012 the value-added tax on imports of machinery and equipment used to obtain, generate or use energy from renewable sources was brought down to zero[27] (CCEE, 2015).

[24] Henceforth CCEE.
[25] IEA Policy and Measures Databases: Argentina.
[26] IEA Policy and Measures Databases: Brazil.
[27] More details can be found in Appendix 4.

Box 1: Barbados-public sector intelligent energy program, PSSEP, IDB funded

The Sustainable Energy Investment Program I is a US$10 million loan to the government of Barbados approved in December 2010 by IDB. The objective of the project was to promote the increased use of renewable energy) and the implementation of energy efficiency measures through the design and implementation of the Sustainable Energy Investment Program, also known as the "Smart Fund", a Government initiative comprising a package of financial instruments and technical assistance to support investments in renewable energy and energy efficiency. Ultimately, the project helped to reduce Barbados' fossil fuel dependency and promote sustainable energy supply, as well as carbon emission reductions.

The results of the program are twofold. On the one hand, energy saving was achieved, thanks to energy efficiency technologies in public lighting and buildings:

- Electricity was saved through retrofits (energy efficient public lights and energy efficient equipment in public buildings) and through energy efficiency application funded by the program. At the completion of project, the energy savings was of 3,105 MWh, meaning that the amount of MWh generated in energy savings exceeded the original target (500 MWh).
- The new renewable energy funded through the Smart Fund (MW installed distributed RE generation capacity) reached 1.9 MW, far exceeding the original target of 1 MW.

On the other hand, consumers have responded by changing appliances or installing solar panels in the event of electricity bill doubling. A GeoPoll survey in Barbados in 2018 found that people responded by mainly buying more efficient appliances (26%) or by installing solar panels (29%) in the event of the electricity bill doubling.

People's responses to doubling electricity bill

	Total		Male		Female	
	Count	Percentage	Count	Percentage	Count	Percentage
Cold/short showers	98	15%	28	13%	70	16%
Buy efficient appliances	167	26%	50	24%	117	27%
Reduce cooling	62	10%	17	8%	45	10%
Buy solar panel	185	29%	83	40%	102	24%
Buy solar heaters	38	6%	13	6%	25	6%
Nothing	212	33%	56	27%	156	36%

Source: Own elaboration based on a GeoPoll survey (2018). GeoPoll is the world's largest mobile survey platform, where people are asked questions directly on their mobile phones without any phone plan or internet access as pre-requirements. The database includes information about the respondents' demography and location.

c) Market-based

There is growing interest in the role that markets can play in delivering cost-effective efficiency gains and reducing the need for direct government expenditure (IEA, 2017). By implementing market-based instruments, such as obligations, auctions, tradable emission products and carbon tax, regulators can guide the outcome of the policy instrument, e.g. energy savings or conservation. How to properly design a market-based instrument appears to be the biggest challenge for regulators. This is particularly relevant for the case of LAC, considering the structural and cultural differences with advanced economies. Besides obligations and auctions

Table 3 shows a framework developed by the IEA (2017) that contributes to the design of market-based instruments with a special focus on obligation schemes.

Features included are the fuel types and sectors, the lifetime of measures, the savings' calculation, the parties involved and the tradability of savings. These are all presented in the left column, while possible options are on the right-hand side. Options are ranked from the most frequent to the least frequent one in terms of number of appearance in obligation schemes.

Other aspects that are key to the design of market-based instruments, but that cannot be quantified easily and that hence have been excluded from this design are: 1) who the key actors in energy efficiency are and whether they are independent; 2) how the evaluation, monitoring and verification process is done, and whether they are guided by independence, transparency or on-site inspections; 3) which target should be set between energy savings, emission reduction and energy conservation, and which base year should be selected; 4) whether there should be any penalties to foster compliance; and 5) what the balance of cost recovery of utilities and welfare of low-income households is.

Table 3: Framework showing key features of market-based instrument design

Features	Options (ranking left to right: most frequent to least)				
1. Fuels	Electricity	Electricity, Gas	Electricity, Thermal Energy, Process Fuels	Electricity, Gas, District Heating	All Fuels
2. Sectors	All except Transport	All sectors	Residential		
3. Lifetimes of measures	Lifetime savings	Annual savings	Annual and peak savings	Annual peak savings	Cumulative first year savings
4. Savings calculation	Deemed savings	Custom savings	Metered savings		
5. Obligated parties	Distribution company	Energy suppliers	Dedicated entity		
6. Tradability of savings	Horizontal and vertical	Horizontal	None		

Source: Own elaboration based on IEA (2017)

This framework is useful to create an obligation scheme, as it forces to think about all features. It is also useful to assess existing obligation schemes. We have used it to assess the case of Brazil and of the Energy Efficiency Obligation Program[28]. This scheme has been in force since 1998 and was updated in 2017. Its features correspond to the shaded boxes in Table 3. Up until 2016, Brazil and Chile were the only two countries in LAC to have an obligation scheme (Lees and Bayer, 2016). It was then joined by Uruguay, when the Ministry of Industry, Energy and Minerals put in place an energy efficiency Obligation that became effective in 2016[29].

In terms of auction programs directed at improving energy efficiency, Brazil serves as a textbook example. It mulled the adoption of a pilot energy efficiency auction project in Roraima, the only state not connected to the National Interconnected System (SIN), which depends on expensive energy imports. The aim is to diminish the initial amount of power consumption during the program. Companies would be competing against each other in reducing a percentage of that amount for the lowest price. The winning companies would then become a new sort of market agent entering the Brazilian market, known as a "consumption reduction agent".

[28] Please refer to https://www.iea.org/policiesandmeasures/pams/brazil/name-147345-en.php for more details on the program.

[29] Please refer to https://www.iea.org/policiesandmeasures/pams/uruguay/name-166298-en.php for more details on the obligation.

The whole program would incentivize companies to carry out different energy efficiency projects, such as replacing household bulbs and appliances[30].

d) Information-based

Information-based instruments are designed to address asymmetric information problems and the behavioral patterns that lead to market inefficiency. The main instruments are (i) energy audits, which tailor ad hoc periodic services to raise awareness of energy consumption; (ii) certificate and labels, designed for building and residential appliances; and (iii) feedback incentives, using advanced technology and behavioral theories to nudge end-user consumption, as well as informative billing. This type of policy instruments is supplement to all aforementioned instruments, and is closely related to demand management and the ancillary services.

Several countries in LAC have supported the performance of energy audits. For instance, in 2005, Honduras started the Program for Energy Efficiency in the Industrial and Commercial Sector, in which one of the tasks was to perform 17 energy audits (CCEE, 2015). In Nicaragua, through the Development of Energy Efficiency Program that ran during 2007-2011, energy audits were carried out in major companies in the sectors of industry, trade and services. In Guatemala, it was an integral part of the 2009 Non-Reimbursable Technical Cooperation Agreement between the National Electrical Energy Commission and the IDB (Ibid.).[31] Another example is that of Mexico, where the Energy Sector Management Assistance Program (ESMAP) supported detailed energy audits in six municipalities, including street lighting, municipal buildings' energy use, and water and wastewater (Salmeri et al., 2017).

The labelling of appliances has also been used extensively as an energy efficiency initiative in LAC. As of 2017, it was implemented in almost all LAC countries, except in Bolivia, El Salvador and Dominican Republic where it was still in progress then. For the Andean region, except Bolivia, it was launched in 2003 as part of a regional initiative called Normalization and Labelling of Energy Efficiency. In Chile, it came with the creation of the Energy Efficiency Agency in 2010. In Paraguay, it was an integral part of the 2011 National Committee for Energy Efficiency (CCEE, 2015). Countries with the most labels are Mexico and Uruguay, where these apply to domestic electric equipment, vehicles, industrial refrigeration, AC, heating, and bulb lighting. In Mexico, the list also includes buildings, while in Uruguay it includes public lighting (Sanchez et al., 2017).

Labelling is however not mandatory in all countries and can cover different household appliances and equipment. For instance, in Santa Lucia it is voluntary for fluorescent and incandescent lamps, whereas in Nicaragua it is compulsory for refrigerators. It is not always aligned with the same existing labelling program either. While Costa Rica and Panama are aligned with Mexican labelling standards, the rest of LAC is aligned with either the EU or the US existing labeling programs (Braungardt and Gothern, 2017).

Another type of information-based instrument that might not be as obvious as those mentioned above is linked to education. Indeed, informing householders, public administration staff or younger generations about energy efficiency initiatives is also part of the policy agenda, as it raises awareness. In Panama, between 2010 and 2013, over 100,000 students in the country were given presentations and were involved in discussions about energy efficiency (CCEE, 2015). In Argentina, the 2010 Program for Rational and Efficient Use of Energy in

[30] More information can be found there : https://www.bnamericas.com/en/news/brazil-studies-possible-energy-efficiency-auctions

[31] More details can be found in Appendix 4.

Public Buildings included a section on addressing the lack of knowledge on the energy usage of national public buildings. This Program was preceded by the 2007 National Program for Rational and Efficient Use of Energy that also included focusing on education and increasing awareness on energy consumption, though it was directed to other sectors of the economy[32].

3. Targets

For energy efficiency policy to be successful, targets (III) need to be defined. Targets encompass three aspects. These are the sector, the object and the unit. Defining the economic sector helps limit the coverage of the policy. The sector (i) can be residential, commercial, industrial, utilities, public, building-related or transport. The object (ii) has to do with the equipment or appliance that is targeted. Defining the object can also help define the sector. For instance, if the object is refrigerator, the targeted sector is residential. Other objects include vehicles, lighting, air conditioning, other appliances and supply-side objects. Finally, defining the unit (iii) helps measure the success of the policy. It depends on the object. The unit can be energy intensity, energy use, energy saving or emissions.

These targets will help classify most energy efficiency policy designs that are already in force and identify effective policy designs to guide energy efficiency policy implementation in specific sectors of the economy. For example, to push for an energy efficiency obligations program, most countries chose to go economy-wide, except for the transport sector, whereas some countries went with residential consumption, and other countries, like China, started with the heavy manufacturing industrial sector.

One type of energy efficiency policy targeting a specific object in a specific sector with a defined unit to measure the effect that has been widely applied in LAC is the replacement of light bulbs (i.e. the object) in households (i.e. the residential sector), where consumption (i.e. the unit) is used to measure the policy effect. For instance, between 2008 and 2009, Bolivia replaced nine million incandescent light bulbs, saving between 92 and 100MW of electricity during peak hours (CCEE, 2015). Other countries that also launched initiatives or programs to replace traditional light bulbs with energy-saving light bulbs are Chile, Costa Rica, the Dominican Republic, Ecuador, Guyana, Nicaragua and Uruguay (Ibid.) Peru also joined the "club", though more recently. Box 2 below looks into details at the Peruvian case study and the incandescent light bulbs with power-saving light bulbs, as part of the National Energy Plan for 2014-15.

Another type of energy efficiency policy also targeting households is that of clean cooking, where the traditional cooking stoves are replaced by energy-efficient or solar cooking stoves, and where the unit of measure to assess the policy effect is the carbon footprint, the time spent cooking and health (in the longer term). One example is that of Guyana, where 507 solar cooking stoves were distributed, five energy-efficient wood stoves were built and explained, and two bio-digesters were installed in five communities under the Energy Access at Community Level for Millennium Development Goals[33]. Other countries that have led initiative to promote clean cooking are Peru, with the FISE program created by the Government in 2012, and Honduras, with the 2014 initiative by the Ministry of Finance, amongst others (Barnes et al., 2018; Sanz and Calzada, 2018).

[32] IEA Policies and Measures Databases: Argentina.
[33] More details can be found in Appendix 4.

Box 2: The case study of efficient lightning policy in Peruvian households

In the past fourth years, the Peruvian Ministry of Energy and Mines developed the National Energy Plan 2014-2015 with the objective of improving energy indicators by 2025. The plan included the replacement of energy bulbs in the households with an estimated savings of $80 million of energy costs and the substitution of 2.5 million incandescent and 1.5 million incandescent bulbs to power saving bulbs and LED light bulbs, respectively, along with other energy efficiency measures. The program of substitution of incandescent bulbs to energy saving bulbs was implemented, as well in government and public buildings. The country is also part of the Global Efficient Lighting Strategy. The Efficient Lighting Strategy of Peru is a GEF-funded project, "Lighting Market Transformation in Peru", led by the Peruvian Ministry of Energy and Mines with support from the UNEP-GEF.

4. Governance and support

Governance (IV) is the next step for the implementation of energy efficiency policies. How the regulators and agencies organize the application and selection of participants will alter the incentive of participants to contract and bind. These regulators also play a role in enforcing the contract (i), direct or indirect (ii), that is set up. Calls for projects (iii) can also create incentives, especially when there is funding available and a type of reward to compensate the project. Another element of governance (and of market-based incentive, as shown above), is auction (iv), which is becoming a trend in most developing countries for its efficient price discovery process. In the field of energy efficiency, the only auction program that we are aware of is that of Brazil described above. For other fields, such as that of renewables, almost all countries in LAC have auction programs. Auction programs have proven to be a successful form support coming from the government.

Support (V) from other sectors (.ii) matters for energy efficiency policy implementation. How to adjust discounting and expectations (i) about the future is crucial to incentivize energy efficiency investment. For instance, the tariff structure (iii), whether dynamic or flat, can change the consumer's behavior towards energy efficiency programs. Financing schemes (iv) also matter and can have a considerable influence in both the private and the residential sectors.

Another example of support is via technical assistance in energy efficiency investments. For instance, this was provided for investments in renewable energy and energy efficiency implementation in Barbados in 2010 under the Sustainable Energy Investment Program I (see Box 1 above). In Uruguay, funding for technical assistance was an integral part of the Uruguayan Trust Savings and Energy Efficiency (FUDAEE) that emerged from the 200 Law on the Efficient Use of Energy (CCEE, 2015).

It was not possible to cover all existing energy efficiency policies in LAC in this section, though we attempted to give a good overview and relevant examples. Table 4 below shows the concentration of energy efficiency policies in all LAC countries according to the type of policy and the initiative, as well as the coverage of policies across LAC countries. Six types of policy have been identified. These are economic instruments, information and education, policy support regulatory instruments, research, deployment and development, and voluntary approaches. Each type of policy then has several initiatives, including a category for 'others' that do not fall under the ones presented[34].

[34] The categorization of types of policy and initiatives has been done according to that of the IRENA webpage. Initiatives also have sub-categories, but we did not enter into as much details. Much information about this categorization can be found on their website.

This table serves the purpose of synthesizing information that is otherwise harder to gather and compare. It allows us to make some vertical comparison by country between the different policy types and initiatives, as well as some horizontal comparison between countries. We can observe that energy efficiency policies are concentrated in economic instruments, and more specifically in fiscal or financial incentives, followed by policy support, where strategic planning is dominant. Policies are less concentrated in voluntary approaches, and information and education.

In terms of coverage, the number of policies is the highest for Mexico, followed by Colombia and Brazil. The countries with the least number of energy efficiency policies are Antigua and Barbuda, and Suriname, *ex aequo*, followed by Barbados and Dominican Republic, also *ex aequo*. It is worth noting the heterogeneity in terms of energy efficiency policies and of success stories. For instance, Brazil and Mexico stand out from other LAC countries as they have consolidated institutional structures for energy efficiency, a stable legal framework, financing mechanisms and have an important record of successful initiatives having been implemented, compared to the rest of the region (ECLAC, 2013).

It is worth mentioning that some of the examples given in the analysis above, for instance energy audits, do not appear in Table 4. This could allegedly be because the examples of energy audits we cited were small initiatives part of a program with a limited coverage. To this extent, Table 4 and the analysis above should be considered as complements to one another. Based on the findings of this section we use our conceptual framework to make some policy recommendations in terms of energy efficiency improvements.

Table 4. Overview of number of energy efficiency policies by country and by policy type and initiative

POLICY TYPE / INITIATIVE		COUNTRIES																								
		Antigua and	Argentina	Barbados	Belize	Bolivia	Brazil	Chile	Colombia	Costa Rica	Dominican Republic	Ecuador	El Salvador	Guatemala	Guyana	Honduras	Mexico	Nicaragua	Panama	Paraguay	Peru	Suriname	Uruguay	Venezuela	TOTAL BY MEASURE	TOTAL BY TYPE
Economic instruments	Direct investment		2			1	2	4	4	2					2		9			3	3	1		1	34	149
	Fiscal/financial incentives	1	7	2		5	8	1	3	2	1	2	2	3	2	5	7		4	2	8		13	2	81	
	Market-based instruments		4		2		2		1				2	3			2		5		2				23	
	Other							1	2				1					6			1				11	
Information and education	Advice/ aid in implementation						1	1									1								3	13
	Information provision						1										3				1			1	6	
	Performance label																								0	
	Professional training and qualification																						1		1	
	Other																1	1				1			3	
Policy support	Institutional creation		3	1	1	1	2		3	1			1		1	1	2			3	1				21	119
	Strategic planning	1	3	1	1	7	2	1	12	8		3	3	4	1	3	8	3	1	1	5	1	1	2	72	
	Other		1			1	3	1	6	1	1						3	6			1		2		26	
Regulatory instruments	Auditing																								0	106
	Codes and standards					1	1	2	5			1					9			3	1		3		26	
	Monitoring																								0	
	Obligation schemes						1	1	3			1									1		1		8	
	Other mandatory requirements		1				2										2	1							6	
	Other	1			3	1	4	3	5	2	1	1	2	4		7	5	2	8	1	7		9		66	
Research, Development and Deployment	Demonstration project							1						1			1				1				4	17
	Research program					1	1				1			1			2				1		1		8	
	Other						1										2	2							5	

Voluntary approaches	Negotiated agreements (public-private sector)																								0	3
	Public voluntary schemes																	1							1	
	Unilateral commitments																								0	
	Other								1									2							2	
TOTAL		3	21	4	7	18	31	16	45	16	4	8	11	16	6	16	57	24	18	13	33	3	31	6		

Source Own elaboration based on IEA/IRENA Joint Policies and Measures database (2018)

Nota Bene: if one policy fits under different types, then it has been counted for each type. If a policy fits different sub-categories of initiatives, then it was only accounted one for that initiative. For example, the 2007 Biofuel Promotion Laws in Argentina included several fiscal/financial incentives, such as grants and subsidies, and tax relief, but we only counted it as one policy in the "fiscal/financial incentives" initiative category.

C. POLICY RECOMMENDATIONS AND LIMITATIONS

We saw in the previous section that considerable progress had been made in terms of energy efficiency policy, especially in terms of energy efficiency Law and labelling of appliances, amongst others, with particularly successful stories in Brazil, Mexico and Uruguay. However, progress is heterogeneous across countries and across type of policies and initiatives, and much more can be done. This section will focus on policy recommendations at both national and regional levels through the lens of our conceptual framework, inspired by international experience. We conclude this section by presenting limitations.

1. National Initiatives

a) Law and Regulation

- Laws implemented early on, with no dependence on them to take initiatives

As we saw, 10 out of 26 LAC countries have implemented energy efficiency laws, starting with Costa Rica in 1994. In 7 other countries it is under preparation and in 5 countries the law is still to be defined. In terms of implementing energy efficiency law, LAC is lagging behind compared to other regions in the world. Even if the current wave of energy efficiency as a result of climate policies and targets started after the 90s, many countries started energy efficiency promotion earlier in the context of energy serving in order to respond to the Oil Crisis hit in 70s (for example, Japan established the first energy conservation law in 1979).

Countries still preparing the law should accelerate the process and those that are still defining it should learn from other existing energy efficiency laws in the region and make it a priority, as the process before a law comes into force is long. In addition, preparing an energy efficiency law will inform the government about the energy efficiency situation and areas that require the most attention.

However, it is worth bearing in mind that the mere existence of a law does not guarantee the success of a national energy efficiency program, and *vice versa*. An energy efficiency program depends on numerous socio-economic-financial and technological variables, which, in addition, change significantly depending on the country analyzed. In fact, many countries that do not have an energy efficiency law have been able to carry out numerous actions related to this topic. As such, implementing an energy efficiency law is a step forward, as it gives stability. In the case where it is absent, this should not be seen as an obstacle to progress in other areas of energy efficiency.

- Consistent and centralized energy efficiency laws

The energy efficiency law should remain consistent throughout its decision process. It often happens that during the passage through the parliamentary committees that are incumbent on the analysis of a draft energy efficiency law, the original text undergoes variations of form and, sometimes, substance, altering the text and sometimes also the spirit of the original design (Feng, et al. 2018).

To ensure a successful implementation of the law, the decision to adopt it should also be centralized, as in countries with a federal political structure, with each province's autonomy to adhere or not to national law, the effective impact of having an energy efficiency law can be much less than in a centralized country

(Cutz, Masera, Santana, & Faaij 2017). In the case of Argentina, for example, each province is "invited" to adhere to national law; with no obligation to do so.

- Laws accompanied by quantifiable national targets

Based on global experience, countries with more aggressive energy efficiency goals also tend to set up quantifiable national targets on top of energy efficiency law, such as the US, EU, and China. Examples are the US targets on energy saving, the EU's target on energy consumption reduction, and China's target on energy intensity improvement. Currently, LAC countries seldom establish targets to facilitate law enforcement, and thus lack proper evidence to set up *ex post* a monitoring framework on energy efficiency. The main model in the region is Brazil, where a *National Electricity Conservation Program* (PROCEL) is managed by Electrobras, and the majority of funding is coming from governmental sources. PROCEL produces an annual report on energy efficiency results tracking in order to achieve the electricity consumption reduction target of 10% by the year 2030. This goes hand in hand with Brazil's Ten-Year Energy Expansion Plan, the PDE, which has higher energy efficiency as one of its central components (Jimenez and Yepez-Garcia, 2019).

b) Types of incentives

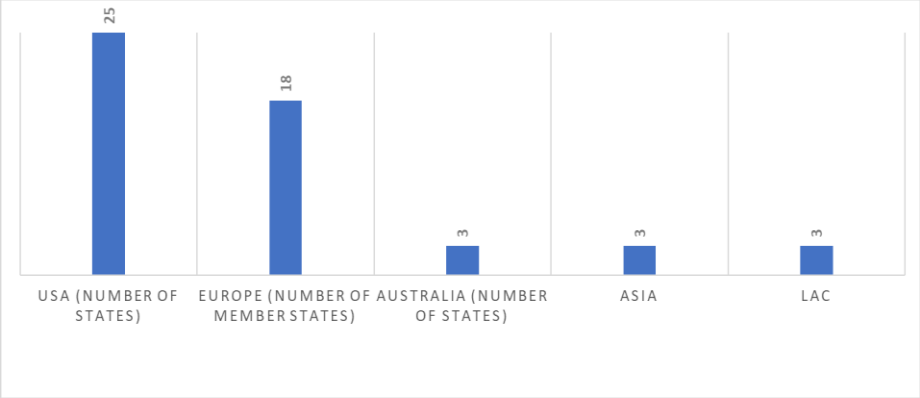
- Mandatory codes with a higher coverage and extended to more LAC countries

Mandatory codes as a type of incentive for energy efficiency policy in LAC should have a higher energy consumption coverage percentage and should be applied to more LAC countries. In 2016, mandatory energy efficiency policy instruments covered 31.5% of the world's energy consumption, with a 1.4% percentage increase compared to 2015. However, more than 30% of the current total coverage is accounted for by China (IEA, 2017). Except Mexico that has a higher than average coverage for the year 2016, it remains below Russia, Korea, Turkey and Indonesia in Brazil and Chile.

- More obligations schemes

In terms of market-based instruments directed to energy efficiency, LAC is slightly behind global development. In 2005, only 13 market-based instruments were in force, all of them being obligation schemes. Brazil was the only LAC country, others being 7 U.S. States, 4 European countries and South Korea. By 2016, the number quadrupled, with then 52 market-based instruments being active, out of which 48 were obligations and 4 auctions. Uruguay and Chile are the only LAC countries adding two obligation schemes to the global advancement. As of May 2019, there were 52 energy efficiency obligation schemes worldwide, with the USA States ahead covering almost 50% of them, followed by EU Member States and Australia (Figure 18). LAC stands at the same level as Asia, with obligation schemes in three countries: Brazil, Chile and Uruguay.

Figure 18. Energy efficiency obligation schemes worldwide (as of 2019)



Source: UNIDO, Statistical databases

- Higher use of financial incentives, especially in the private sector

As a price-based instrument, financial incentives are easy to implement, can have specific targets in terms of object and sector, and are usually efficient in increasing the probability that firms invest in energy efficiency projects (Anderson and Newell, 2004; Blok, 2004) or carry out energy audits (Brutscher and Ravillard, 2019). Particularly attention should be given to the private sector in the case of LAC.

- Encouraging energy audits

With respect to information-based instruments, energy audits should be further promoted, as they can boost investments in energy efficiency improvements projects (Backlund and Thollander, 2015; Schleich et al., 2015; Murphy, 2014; Kalantzis and Revoltella, 2019). As we just mentioned, financial instruments can be used to incentivise households and firms to carry them out. Some examples on policies promoting energy audits in EU and non-EU countries can be found in Appendix 5. These include free audits or programs covering over 50% of the audits' costs, or applicable to a maximum amount of energy audit costs. In terms of national incentives directed at energy audits, LAC is lagging behind, compared to the rest of the world. As mentioned above, to the best of our knowledge, there are only a few examples of such policies in LAC, and the existing ones have either been targeting a few companies or have been short-term.

- Mandatory labelling applied to all appliances

Another information-based instrument that can contribute to energy efficiency is labelling. Having the labelling of appliances made mandatory would help consumers be aware of the energy use of their equipment and consequently raise awareness. This is particularly true in the case of households. Labelling should also be applied to all household appliances that are used on a daily basis, and not restricted to only a few. So far, many labelling initiatives have been taken in LAC countries, but these could be reinforced if they were made compulsory and extended to cover all appliances.

c) Targets

- Putting more emphasis on the private sector

While we showed above that considerable progress has already been made so far in LAC in terms of energy efficient lightning policy, where the sector (i.e. residential), the object (i.e. light bulbs) and the unit (i.e. consumption), are well

defined, there are some key economic sectors that have been ignored in energy efficiency policy-making in LAC, and the public has been given more attention than the private.

It is possible that the governmental bodies in charge of promoting energy efficiency activities and projects are putting more emphasis on the sector of public buildings - long postponed in this matter -, in residential buildings - by efficiency standards and energy labeling for envelopes - in cities efficient -subsidized within the environmental issues, in public lighting and transport, which still represents an unexploited deposit of fuel savings (Koengkan, 2018). Many countries are also privileging government energy efficiency programs in the public sector over the private sector.

- Targeting the most energy-intensive sectors

An example of sectors that have not received as much policy attention as it deserves are energy-intensive industries, despite the fact that they are a significant contributor to the industry energy use, including greenhouse gas emissions. For instance, Iron and Steel, Chemicals, Food and Paper take up 72% of total industrial consumption in Brazil. In spite of being moderate contributors to domestic economic growth, these heavy energy industries are usually the biggest energy consumers. Few energy efficiency programs target them specifically.

Except in some isolated cases, little importance has been given to the implementation of energy efficiency programs in the energy transformation sector (oil refineries and thermal power generation plants) (Feng, et al. 2018). These actions seem to have been left to the goodwill or specific interest of the companies, public or private, without being part of a strategic decision of the state.

Although the mining sector is critical due to its importance and its high energy intensity (in Chile, Argentina, Peru and Bolivia, mainly), in general terms it is neither being given the relevance it should have in the energy efficiency plans, nor is there much interest in the implementation of energy efficiency programs for the upstream sector in hydrocarbons (oil and/or natural gas exploitation fields, oil and natural gas conditioning plants, cryogenic plants for the separation of natural gas components, etc.) (Fontaine et al., 2019).

- Incentivizing energy efficiency policies in the residential sector

While the previous section showed the numerous energy efficiency programs targeting households that have already been launched in LAC, it is worth bearing in mind that incentives for households to embrace energy efficiency programs or adopt energy efficiency policies are not as clear and straightforward as for the industrial, commercial and transport sectors (Jimenez and Yepez-Garcia, 2019). This is because households tend to be more exposed to credit constraints and information asymmetries, while individuals are more prone to demonstrate behavioral bias (Ibid.). To this extent, it might be necessary to further incentivize households to take initiatives in energy efficiency improvements.

- Defining the right object

It is necessary that energy efficiency policy be focused solely on what it targets, which is energy efficiency improvement. For example, in many countries energy efficiency has been promoted under non-mandatory initiative, and in some the emergence of a global concern for the impact of climate change had a negative impact on the institutionalization of energy efficiency programs, as it concentrated mostly on mitigation policies (emission reduction). For instance, there are certain

dependencies that in the 80s and early 90s had a function almost exclusively oriented to the rational and energy efficiency, which were then subsumed within dependencies with interference in the area of the environment (for example, Guatemala) (Feng, et al. 2018).

In addition, it is striking that after reviewing energy efficiency programs currently in force in the countries, none of them explicitly highlights the promotion of energy cogeneration - understood as the joint generation of heat and electricity from a single energy source, primary energy source especially in the industrial sector and secondarily in the commercial sector (in the latter, only applicable to large installations) (Fontaine et al., 2019). Real changes in energy source utilization are being carried out much more by technological advances than by changes in the behavior of consumers, regardless of the sector.

There are also no explicit programs aimed at improving the combustion process in boilers and industrial furnaces, a significant energy source of opportunities for improvement in the use of energy (Koengkan, 2018), and to date most energy efficiency policies have been concentrated on electricity, instead of looking at cooking, for which roughly 80 million people in the region perform using solid fuels (Barnes et al., 2018:56-7). Indeed, in Haiti, Guatemala, Honduras and Nicaragua, over half of the households use wood, charcoal and other biomass fuels to cook, burning these inefficiently using traditional stoves. As Barnes et al. point out, "LAC needs to address the household cooking fuel issue through a strategy that promotes both modern cooking fuels (e.g., LPG and electricity) and the design and dissemination of clean-burning, fuel-efficient solid fuel–fired stoves" (Ibid.).

- Allowing for some flexibility in the target's response

A systematic pattern can be identified according to global trends, that can inspire energy efficiency policy-making in LAC. Instruments that enforce a certain target of energy efficiency or savings, as performance standards and energy efficiency obligations, are more likely to cause a mitigating interaction with other instruments, as they do not increase effectiveness implemented in combination. On the other side, instruments that provide flexibility regarding how a sector or target group responds to a certain instrument, e.g. energy taxes or information measures, are more likely to have a reinforcing effect in combination (Braathen, 2007).

d) Governance and support

- Providing technical assistance

The lack of LAC policy interventions led to a lack of regional experience, which stimulates the need for governments to provide technical assistance to companies or households willing to go ahead with energy efficiency improvements projects. Technical assistance can be combined with a financial incentive or support for energy audits, to cite a few examples.

- Encouraging auctions

Auctions are a policy instrument used to achieve energy savings by setting highly attractive prices and overcoming deadweight effects often attributed to financial support. As far as we know, Brazil is the only LAC country where auction has taken place to support energy efficiency policy. Switzerland is the poster-boy of auction programs, with the Swiss Energy Efficiency Auction that reported to have awarded over 100 million Swiss Francs to projects and programs, which have saved 5.5 TWh of electricity savings in the country (Radgen et al., 2016). The Brazilian imitative and the success story of the Swiss case can encourage other LAC countries to also implement auctions.

2. Regional Initiatives

Another way to look at energy efficiency policy is from a regional perspective. Up to 2015, the existing regional initiatives were:

- Base Indicators for Energy Efficiency (BIEE) launched by Economic Commission for Latin America and the Caribbean (ECLAC) in 2011
- Technical Coordination Group (TCG) consisting of ECLAC, Dredging, Environmental and Marine Engineering NV (DEME), one European expert (specialist on ODYSSEE) and National Coordinators
- LAC-EE Network (i.e. public-private non-profit initiative) since 2011
- Energy and Climate Partnership of the Americas (ECPA) since 2009

And sub-regional initiatives included:

- Caribbean Community (CARICOM) Energy Program
- The Caribbean Sustainable Energy Program, an EU-funded Initiative
- 4E Program for Renewable Energy and Energy Efficiency in Central America
- The Regional Program in Energy Efficiency for Industrial and Commercial Sectors in Central America (PEER) implemented by UNDP and funded by Global Environment Facility (GEF)

To the best of our knowledge, no other regional initiative has concretized since the ones mentioned in the list above, and as the list for sub-regional initiatives reveals, these have been concentrated in the Caribbean region and Central America, with no sub-regional program in the Southern Cone or Andean region.

- Creating more regional agencies and frameworks

The EU has an interesting regional experience that may help regional initiatives benefit from some lessons. The EU's Energy Service Directive had set an energy saving target of 9% in 2006, a 20% reduction of CO2 gas emissions target by 2020 was launched in 2009 and in 2012 an Energy Efficiency Directive was created. The 2012 Energy Efficiency Directive offers a set of binding incentives to help the EU reach its objectives in terms of energy consumption, amongst which figure a compulsory audit for large companies and national incentives to push SMEs to also carry them out. A 20% energy efficiency target by 2020 is also on the agenda. More recently, the 2030 Climate and Energy Framework has been adopted, building on the 2020 target, to aim for 30% of energy efficiency by 2030. This latest initiative includes national incentives for SMEs to undergo energy audits. While LAC cannot be compared to the EU fully, as the former is a region and the latter an official union, one could still argue that the geographical proximity between LAC countries and similar institutional, historical and economic patterns between some of them (e.g. sectors based on natural resources) can facilitate the creation of regional incentives with common targets to promote energy efficiency. In addition, as far as we know, LAC is the only region in the world after the EU where the project regional integration is already fairly well developed, thanks to the creation of regional and sub-regional agencies, trade agreements and alliances. This should facilitate the creation of new regionals agencies and frameworks.

- Making energy audits for large companies compulsory for all countries

Drawing from the argument that energy audits can boost investments in energy efficiency improvements (Backlund and Thollander, 2015; Schleich et al., 2015; Murphy, 2014; Kalantzis and Revoltella, 2019), one regional initiative that could be taken is to make energy audits compulsory for large companies in LAC countries. This is the case in the EU, where energy audits and management became an

integral part of the 2012 Energy Efficiency Directive under Article 8 (Torregrossa, 2015; Brems et al., 2016). The latter states that large enterprises in all EU countries are required to be subject to an energy audit by 5 December 2015 and at least every four years thereafter (Hirzel et al. 2016). Large firms are particularly targeted as they also usually the most energy-intensive ones and more financially stable than small or medium ones.

- Harmonizing minimum energy standards and labelling

Based on the analysis above, we saw that labelling was neither harmonized across countries nor was it based on the same standards. One regional initiative could be to have minimum energy standards and labelling harmonized. Indeed, there is a strong emphasis to support, throughout the region, the development of energy efficiency standards for energy-consuming equipment and elements. Energy labeling systems to inform users will promote a rational purchase decision (balanced between initial cost and operating cost over the life of each equipment) (Fontaine et al., 2019). Less emphasis has been placed on the development of minimum energy efficiency standards, which should constitute a more advanced step in the optimization of energy source utilization. The existence of MEPS (minimum energy performance standards) would gradually eliminate the most inefficient equipment and elements in terms of energy source utilization from the market (Timilsina, & Shrestha, 2009). It seems that energy efficiency programs in this area have decreased in intensity (Cutz, Masera, Santana, & Faaij 2017). The exception is the sustained attempt in several LAC nations to promote the implementation of energy management systems based on ISO 50001 and derived standards (Silva, et al. 2018).

- Reinforcing dialogue

One last policy recommendation at the regional level is to reinforce dialogue between LAC countries in order to share experience, learn from one another and create a common agenda with mutual support to reach energy efficiency targets. This is particularly the case for LAC countries with similar ecosystems that face the same environmental challenges. There can be some knowledge and expertise sharing, as well as research initiatives and projects pulling together different actors to design energy efficiency policy and define its target, and later evaluate its effect and learn lessons from the results. The dialogue can take place via the organization of forums, conferences or networking, amongst others.

3. Limitations

All the policy recommendations presented above do not come without their limitations. Two obstacles to the desired outcome can be identified in the literature. One of them is the free-rider effect, where actors would have carried out the investments or taken the measures without the existence of the policy or initiative, and the other one is the rebound effect, where making energy more efficient can actually stimulate consumption.

a) Free-rider effect

In this specific context of energy efficiency policy, the free-rider effect takes place when the initiative or measure would have been carried out regardless of the policy implemented[35]. One example reported in the literature is that where companies would have carried out an energy audit even without the existence of

[35] This definition slightly differs from the more traditional economic decision where someone would benefit from a good without paying for it.

a government measure to subsidize energy audit programs (Thollander et al., 2007; Fleiter et al. 2012). Even though to carry out a full evaluation of an energy efficiency policy would require to have a measurement of the free-rider effect, this is usually hard to estimate (Backlund and Thollander, 2015). One way to measure it *ex ante* is through contingent valuation choice experiments, and *ex post* with some analysis of the results on a treatment group that would have benefited from the measure versus a control group that would not have benefited from it. The failure to account for the free-rider effect when evaluating the impact of an EE policy would result in an overestimation of its effectiveness (Olsthoorn et al., 2017).

b) Rebound effect

The rebound effect refers to the phenomenon that consumers increase their energy consumption rather than the expected energy conservation based on an energy efficiency policy. One common explanation is consumers' behavioral change after the acknowledgment of the energy efficiency product. Now that new appliances and new technologies would be more energy efficient, it may induce consumers to be less price responsive due to the implicit price reduction on energy, and therefore consume more energy, therefore canceling out the expected conservation effects.

Another aspect worth bearing in mind when thinking about the rebound effect as an obstacle is the fact that energy consumption patterns vary between developed and developing countries. Someone living in a developed country with a highly developed economy will tend to consume more energy than someone living in a non-industrialized and poor country. For instance, LAC countries have a lower energy consumption per capita compared to OECD countries. The consumption behavior is also different. Developing countries are willing to consume more energy, as they associate energy consumption with quality of living. The focus is therefore not necessarily on reducing energy consumption, but rather on promoting energy consumption with greater energy efficiency, in the case of LAC.

Let us consider a few examples of the rebound effect in developed countries. In the United States, for instance, the introduction of energy efficiency technologies allowed monetary cost reductions and reductions of environmental damages associated with energy production and consumption. Several programs were implemented in the use, the introduction of new technologies and business models. However, some critics of the energy efficiency programs emerged. In the U.S., some authors found that the investments are significant relative to the energy savings, relating energy efficiency programs with the rebound effect: the fact that improving energy efficiency may save less energy than expected due to a backfire in energy use (Gillingham et al., 2015). While some newer studies found no evidence for the rebound effect as a result of energy efficiency programs in some states, there seems to be some agreement elsewhere on the relatively high cost of investments relative to energy savings (Fowlie et al., 2018).

In the same direction, an explanation of why energy efficiency technologies were not adopted, even if they are thought to reduce financial cost and contribute to emissions reductions, was reviewed in the literature on the benefits of the "energy-efficiency gap" and addressed with the arguments of the presence of market failures that prevent investors to adopt new and more efficient technologies, behavioral explanations, and possible measurement errors in the energy efficiency indicators (Gerarden et al., 2017). Gillingham et al., (2015) pointed out the difficulties of estimating the rebound effect because of a lack of evidence of market responses to energy efficiency policies. The most common approach to estimate the rebound effect is to estimate the fuel price or operating cost elasticities of demand. However, the cost of these estimates are zero-cost breakthrough and policy-induced improvement effects. There is a wide range of

rebound effect estimates for the U.S. The figures are around 0 to 50 percent for refrigeration, and up to 30% for transportation and heating (Freire-González, 2016, 2017). Table 5 shows some examples of rebound effects in other countries found in the literature.

Table 5. Synthesis of rebound effects found in the literature

Study	Type of Elasticity	Estimated Value
Atakhanova et al. (2007)	Kazakhstan short-run elasticity of electricity demand, 1994-2003	-0.128
Athukorala et al. (2010)	Sri Lanka short-run elasticity of total elasticity demand, 1960-2007	-0.16
Ben Sita et al. (2012)	Lebanon short-run elasticity of gasoline demand, 2000-2010	-0.623
Crotte et al. (2010)	Mexico short-run elasticity of gasoline demand, 1980-2006	0 to -0.15
Halicioglu (2007)	Turkey short-run elasticity of electricity demand, 1968-2005	-0.33 to -0.46
Iwayemi et al. (2010)	Nigeria short-run elasticity of gasoline demand, 1976-2006	-0.25
Jamil et al. (2011)	Pakistan short-run elasticity of total electricity demand, 2000s	-0.07
Lin et al. (2013)	China medium-run elasticity of gasoline demand, 1997-2008	-0.196 to -0.497
Nahata et al. (2007)	Russia short-run elasticity of electricity demand, 1995-2000	-0.165 to -0.28
Ramanathan (1999)	India short-run elasticity of gasoline demand, 1972-1993	-0.21
Sene (2012)	Senegal short-run elasticity of gasoline demand, 1970-2008	-0.12

Source: Gillingham K., Rapson D., Wagner, G. (2015)

It is however worth noting that the rebound effect does not apply to all measures, as there are also some passive initiatives that can be taken, such as thermal insulation or refrigerators, which cannot be manipulated by energy users. Policies linked to lighting also have a minimum rebound effect, and rebates on industrial and commercial equipment do not generate rebound effects either.

Also, seeing a rebound effect as a result from an energy efficiency measure could mean that the program is not working, but it could also mean it has a positive effect, as it is avoiding the increase in the demand (it is allowing consumers to have more/better services for the same amount of energy).

In sum, we need to keep in mind that the baseline in LAC countries is different to that in the developed world. For example, replacing existing equipment with more efficient equipment in a public building in a developed country will not have the same results as in a LAC country. This is because it is likely that the target public building will not have the required energy services to meet the users' comfort level in the first place. Therefore, on top of replacing the old equipment with energy efficiency equipment, it will also be necessary to add new equipment in unserved parts of the building, meaning that the overall energy use of the building is likely to remain unchanged, but that the quality of the service will increase significantly. This example demonstrates the importance of targeting energy efficiency in policy-making in LAC.

Concluding Remarks

The importance of energy efficiency in LAC is unquestionable. Its implementation can bring significant benefits to meet the energy demand of growing populations through using better and less energy resources, reducing energy costs, which supports many aspects of economic productivity, improving energy consumption habits, and decreasing the production of emissions. It can also contribute to the development of the energy sector by expanding services for unmet needs.

Although, at the global level LAC is in 2nd place behind Europe in terms of energy intensity, which misguidedly leads us to think that LAC has an efficient progress, this report finds that this may be due to the lag in innovation and technology adoption in LAC industries and services compared to other regions of the world, and the low use of domestic appliances or poor service affordability in the case of households. However, when comparing industry intensities that are most intensive in energy, LAC shows higher intensity than other regions, while in services sector it is the lowest. This suggests that low energy intensity in LAC depends also on the structure of the economies, mainly based on services sector with relatively less use of energy than other regions. We also noted considerable heterogeneity when disaggregating the economy by sector or comparing LAC countries with one another.

While some efforts have been made to improve energy efficiency in LAC, there is still room for improvement in many areas. By using a conceptual framework, the present work has sought to contribute to the existing research that has been done on energy efficiency in LAC. The focus here has been on policy and its design more specifically, through a regional lens.

The conceptual framework consisted of four major steps: (1) Law and regulation, (2) Types of incentives, (3) Targets, and (4) Governance and support. The first step was about implementing a Law on energy efficiency with a well-defined goal and having at least one entity to regulate it. The second step included incentives to be initiated to support the policy. These could be mandatory performance standards, and market-, price- or information-based. Step three was about setting specific targets in terms of the sector of the economy that would be affected by the policy, the physical object on which the focus was and the unit of measurement that would then be used to assess the impact of the policy. Finally, the government needed to provide support, which it could do through auction programs, financing schemes and technical assistance, to cite a few examples.

Our analysis has shown that there is considerable disparity in terms of the progress that has been made across LAC. For instance, out of 26 IDB members, 10 have implemented an energy efficiency law, 7 have the law under preparation and for the remaining 5 countries, the law is yet to be defined. With respect to entities that supervise, monitor or regulate energy efficiency, the only task that is covered by at least one entity per country is that of setting an energy efficiency strategy. In terms of entities setting standards, all countries have at least one entity completing this task, except Dominican Republic and Guatemala. The country with the most entities responsible for energy efficiency is Colombia, while those with the least are all in Central America.

When looking at incentives, the only countries found to have some coverage potential in their mandatory codes and standards, meaning that the policy is enforced, are Mexico, Brazil and Chile. Price-based and market-based incentives also seem to have been privileged by Brazil and Chile, in comparison to other LAC countries. Indeed, these two countries, later joined by Uruguay, are the only ones that have an obligation scheme, and Brazil stands alone in terms of auction

programs directed at energy efficiency. With respect to information-based incentives on audits or labelling, policies are more balanced across the region, with most countries participating. In terms of targets, energy efficiency policies directed at energy-saving lighting or clean cooking have proved to be well-targeted in terms of sector, object and unit. Finally, while the coverage and depth of governance and support are harder to evaluate, they seem to only have been applied in a few cases in LAC.

Our last section has offered some policy recommendations, at both national and regional levels. At the national level, we suggest implementing the energy efficiency law early on, to have it centralized and to complement it with a quantifiable national target. We also recommend broadening and deepen mandatory codes, to spread obligation schemes, create more financial incentives, especially in the private sector, to support energy audits and make appliances labelling universal and mandatory. In terms of targets, the private, energy-intensive and residential sectors deserve more attention. The final national recommendation is to provide technical support and to encourage auction programs. At the regional level, we suggest creating more regional agencies and common frameworks, to make energy audits compulsory for larger companies, to harmonize minimum energy standards and labelling and to reinforce dialogue between the different actors.

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Appendices

A1. Data and Indicators included in the IEA decomposition analysis

Sector	End-use/sub-sector	Activity	Structure	Efficiency
Residential	Space heating	Population	Floor area / population	Temperature-corrected energy / floor area
	Water heating	Population	Occupied dwellings / population	Energy / occupied dwelling
	Cooking	Population	Occupied dwellings/ population	Energy / occupied dwelling
	Space cooling	Population	Floor area / population	Temperature-corrected energy / floor area
	Lighting	Population	Floor area / population	Energy / floor area
	Appliances	Population	Appliance stock/ population	Energy / appliance unit
Passenger transport	Passenger car; bus; rail; domestic aviation	Passenger kilometre	Share of passenger-kilometres by mode	Energy / passenger-kilometre
Freight transport	Freight road transport; rail; domestic shipping	Tonne kilometre	Share of tonne-kilometres by mode	Energy / tonne-kilometre
Manufacturing	Food; textiles; wood; paper and printing; chemicals; rubber; non-metallic minerals; basic metals; machinery; transport equipment; furniture/other manufacturing	Value added	Share of value added	Energy / value-added
Services	Services	Value added	Share of value added	Energy / value-added
Other industries	Agriculture; construction	Value added	Share of value added	Energy / value-added

Source: IEA, Energy Efficiency Indicators, 2016

A2. Energy Efficiency (EE) Entities and Energy Intensity

Are there governmental and/or independent bodies dedicated to:	Brazil	Mexico	Bolivia	Ecuador	Honduras	Chile	Nicaragua	Colombia	Argentina	Peru	Dominican Republic	Guatemala	Haiti
1. Setting EE strategy?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Setting EE standards?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
3. Regulating EE activities of energy suppliers?	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
4. Regulating EE activities of energy consumers?	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
5. Certifying compliance with equipment EE standards?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
6. Certifying compliance with building EE standards?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
7. Selecting and/or approving third party auditors tasked with certifying EE standards?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Number of Entities	4	3	4	4	2	3	1	5	2	2	1	1	1

Source: IDB elaboration based on IDB SER Database and World Bank RISE project

A3. List of acronyms of energy-related entities in LAC

Brazil
MME- Ministry of Mines and Energy
INMETRO- National Institute of Methodology, Standardization and Industrial Quality
ANEEL - Brazilian Electricity Regulatory Agency
PROCEL- National Program for Energy Efficient Use of Petroleum and Natural Gas Derivatives

Mexico
SENER- Secretariat of Energy
CONUEE- National Commission for the Efficient Use of Energy
EMA- Mexican Accreditation Entity
FIDE- *Fideicomiso* For Energy Saving
CFE- Federal Electricity Commission

Bolivia
ME- Ministry of Energy
IBNORCA- Bolivian Institute for Normalization and Quality
CNDC- National Electricity Transmission Commission
GBC- Green Building Council

Ecuador
MEER- Ministry of Electricity and Renewable Energy
ARCONEL- Agency of Regulation and Control of Electricity
INEN- Ecuadorian Service of Normalization
OAE- Ecuadorian Accreditation Organization

Honduras
SERNA- Secretary of Natural Resources and Environment
OHN- Honduran Organism of Normalization

Chile
ME- Ministry of Energy
SEC- Superintendency of Electricity and Fuels
MINVU- Ministry of Housing and Urbanism

Nicaragua
MEM- Ministry of Energy and Mining

Colombia
MME- Ministry of Mines and Energy
ICONTEC- Colombian Institute of Technical Norms and Certification
SIC/DIAN- Superintendency of Industry and Commerce/ Colombian Tax and Customs National Authority
MVCT- Ministry of Housing, City and Territory
CNA- National Accreditation Council

Argentina
MEM- Wholesale Electrical Market
OAA- Argentine Organism of Accreditation

Peru

DGEE- General Directorate for Energy Efficiency
OGPP/DHG- General Office for Planning and Budget
MINEM- Ministry of Energy and Mining

Venezuela
MPPEE- Ministry for Popular Power for Electrical Energy
SENCAMER- National Autonomous Service for Standardization, Quality, Metrology and Technical Regulations

Dominican Republic
MEM- Ministry of Energy and Mining

Guatemala
MEM- Ministry of Energy and Mining

Haiti
MTPTC/ BME/EdH- Ministry of Public Works, Transports and Communications/ Office of Mining and Energy/Electricity of Haiti

Source: own elaboration

A4. Examples of Energy Efficiency Initiatives in LAC

Energy Efficiency Initiatives in LAC
Bolivia successfully implemented the replacement of incandescent bulbs with CFLs. During 2008 and 2009, nine million incandescent light bulbs were replaced, generating savings in peak hours of between 92 and 100 MW. From 2011 to 2012, replaced ten million efficient light-bulbs, the estimated savings were 82 MW during peak hours.
Chile in 2010 created the Energy Efficiency Agency, implementing various projects in the areas of industry and mining, transportation and the commercial, residential and public sectors. Specific programs include the replacement of incandescent bulbs with CFLs, mandatory labeling of household appliances and light duty vehicles, energy efficiency labelling, subsidies for thermal reconditioning of homes. Energy efficiency has also been incorporated into the educational curriculum.
Costa Rica lead the implementation of energy efficiency programs in 1990s. The electric utilities have introduced programs to promote the use of CFLs, the Costa Rican Institute of Energy (ICE) and the National Power and Lighting Company (CNFL) implemented programs to reduce power consumption and peak load demand. In 2008, ICE launched the "three for the price of two" CFLs promotional campaign. The objective was to achieve a reduction of 30MW in energy demand in the National Electrical System (SEN) and to avoid investment of approximately USD 30 million in new power plants over the useful life of this kind of lamp. In 2010, CNFL launched a campaign to provide free CFLs to households, which resulted in the distribution of over 700,000 lamps.
Ecuador, under the Programs for the Normalization and Labelling of Energy Efficiency in equipment, the country created fifteen mandatory Technical Regulations (RTEs) that establish minimum performance standards and energy efficiency labelling for household electrical equipment such as CFLs, and for home appliances. The project to replace incandescent bulbs with CFLs is another example of a successful initiative that enabled the replacement of sixteen million bulbs in over two million households, small businesses and public institutions. The Efficient Street Lighting Project facilitated the replacement of 65,000 mercury vapor lamps by sodium vapor and induction lamps.
Guyana, in 2012, the Government set value-added tax (VAT) at zero, making the following products fully exempt from import duties: machinery and equipment for obtaining, generating and using energy from renewable energy sources, including solar panels, solar lamps, deep-cycle batteries, solar generators, solar water heaters, solar cookers, DC solar refrigerators, DC solar freezers, DC solar air conditioners, wind turbines, water turbines, power inverters, CFLs and light emitting diode (LED) lamps. The Guyana Energy Agency (GEA) assisted the Office of the Prime Minister in the promotion and distribution of 507 solar cooking stoves, the construction and demonstration of five energy-efficient wood stoves and the installation of two bio-digesters in five communities under the Energy Access at Community Level for Millennium Development Goals (MDG) Achievement in Hinterland Area Project, a UNDP Project. To conserve energy, GEA's engineers, with support from the Ministry of Public Works and Work Service Group (WSG), replaced a series of photocells in street lamps with the objective of removing some 2,000 defective photocells. The Guyana Manufacturing Services Association (GMSA) and the IDB implemented an action with the objective of assisting local companies, especially in the manufacturing and service sectors, to make the most efficient use of their energy applications and simultaneously employ the most effective methods of energy conservation. With the support of GIZ, ECLAC implemented a project entitled "Reducing the Carbon Footprint in the Caribbean through the Promotion of Energy Efficiency and the Use of Renewable Technologies".
Honduras

The Program for Energy Efficiency in the Industrial and Commercial Sectors (PESIC), started in 2005. The main tasks carried out under this program were the establishment of the Project Financing Fund (FOPESIC) and performance of seventeen energy audits, which involved the investment of US$ 1 million. In 2008 the use of incandescent bulbs in the public sector was eliminated. The program replaced four million incandescent bulbs with CFLs in the residential sector in 2009. Education programs in energy efficiency were introduced and developed in primary schools.
Nicaragua Under the program "Development of Energy Efficiency in Nicaragua" (2007-2011), energy audits were conducted in major companies in the industry, trade and services sectors, as well as support tasks for the implementation of pilot projects. As part of the program, in the rural sector a Stoves Project was developed, benefiting four thousand households in fourteen communities across the country. In addition, CFLs lamps in the residential sector were distributed, mostly for free or at a reduced price; the replacement of conventional lighting technologies and the introduction of efficient air-conditioning units in government buildings; and a demonstration project for water heating with thermal solar energy in hospitals.
Panama The National Secretariat of Energy (SNE) has implemented energy efficiency programs in the departments and agencies of the Public Administration, resulting in savings of up to US$ 45 million in the period 2009-2014. Since the beginning of the Regional Program on Energy Efficiency (PEER) in Panama (2005/2011), annual savings of US$ 836,000 and 5,218 MWh per year were recorded for power consumption, because of an estimated initial investment of US$ 1.5 million. In the period 2010-2013, energy efficiency presentations and discussions were held in different schools in the country for students at primary, secondary and university levels, having reached more than 100,000 students nationwide.
Paraguay One important step was the creation of the National Committee for Energy Efficiency (CNEE) in accordance with Executive Order N° 6377/11, responsible for the preparation and implementation of the National Plan for the Efficient Use of Energy. This is coordinated by the Deputy Minister of Mines and Energy of the Ministry of Public Works and Communications. The initial actions included the preparation and approval of standards for labelling, including general requirements, air conditioners, refrigerators, freezers and combined equipment.
Uruguay The Energy Efficiency Project (2005-2012) was funded by a grant from GEF through the World Bank, the Public Utility (UTE) and the Ministry of Industry and Mines (MIEM). This nationwide project improved the understanding of energy efficiency across the economy. Upon completion of the project, nearly US$ 23 million had been invested, ten ESCOs were in operation, 250 actors had been trained in energy efficient practices, cumulative energy savings had been made amounting to 559 ktoe, 1.4 million tons of CO2 had been saved, more than 45 national energy efficiency standards had been approved, and over two million CFLs had been delivered to the population under the "Full Lights" plan ("A todas luces"). Implementation of National Energy Efficiency Awards (editions 2009 to 2014) in recognition of the efforts made at the national level by different companies and institutions

Source: CCEE (2015)

A5. Summary of national policy incentives to promote energy audits in EU and non-EU countries

Country	Firms targeted	Instrument	Type of instrument
EU			
Austria	Large & SMEs	Regional programme	Financial
Belgium (Flanders)	Large SMEs	Audit covenant Self-scan for SMEs	Voluntary Voluntary
Belgium (Wallonia)	Large	Subsidies for energy audits	Financial
Bulgaria	SMEs Large & SMEs	Energy Efficiency and Green Economy Programme Industrial Energy Efficiency Targets for industrial energy enterprise owners	Financial Voluntary
Croatia	Large & SMEs	Subsidies for energy audits (of EUR 6,600 only until 2015)	Financial
Denmark	Large & SMEs SMEs	Energy saving obligation targeting energy companies Subsidy for energy audits and implementation of energy saving measures	Financial Financial
Finland	Large & SMEs	Voluntary Energy Efficiency Agreement	Voluntary
France	SMEs	Energy efficiency support	Financial
Germany	SMEs SMEs Large & SMEs Large & SMEs Large & SMEs	Energy Consulting Programme (financial support for detailed energy audits, up to 80% of funding of eligible costs) Eco tax cap for manufacturing industry Special equalisation scheme[36] BAFA support programme for cross-cutting technologies Energy efficiency networks[37] (including conducting energy audits)	Financial Financial Financial Financial Information
Italy	SMEs	Call for co-funding of Regional programmes (50% level of support with a grant to cover energy audit costs)	Financial
Luxembourg	Large & SMEs Large & SMEs Large & SMEs	Mandatory energy audits for energy-intensive companies Funding scheme for energy audits in energy-intensive companies (up to 40% of the audit costs with a limit of EUR 30,000) Voluntary agreement on industrial energy efficiency	Regulatory Financial Voluntary
Malta	SMEs Large & SMEs Large & SMEs	Malta Enterprise Scheme (co-financing of energy audits by national funds) ERDF Energy Grant Scheme[38] Programme from MHRA (Malta Hotels and Restaurants Association) [39]	Financial Financial Voluntary
Netherlands	Large & SMEs	Long Term Agreements	Voluntary

[36] Only applies to companies with an electricity consumption of less than 5 GWh.
[37] Only applies to companies with energy costs above EUR 500,000.
[38] Ran during 2007-2013, currently not accepting further applications. At the time of publication, a new scheme was planned under the new EU Funding Period 2014-2010.
[39] Under preparation at the time of publication.

Poland	Large & SMEs	Energy/electricity supply audit of an enterprise[40] (subsidy of 70% of the eligible audit costs)	Financial
Portugal	Large & SMEs	Refund of energy audit costs[41] (50% of the audit costs refunded, with a maximum of EUR 750)	Financial
Slovakia	Large & SMEs	SlovSEFF (Slovak Sustainable Energy Finance Facility) III programme	Financial
Sweden	SMEs SMEs	Energy audit vouchers[42] (subsidy of 50% of the audit costs, with a maximum of EUR 5,500) Support scheme for energy efficiency investments (companies with <50 employees can apply for funding of up to 70% of the total project costs, while medium-sized companies can obtain funding of up to 60% of the eligible costs, conditional on having carried out an energy audit)	Financial Financial
Non-EU			
China	Large & SMEs	Top-10,000 programme[43] (includes compulsory energy audit and rewards if energy saving projects are successfully implemented and exceed a minimum savings threshold of 147 TJ)	Regulatory
Japan	SMEs	Free Energy Audit	Financial
Switzerland	Large & SMEs Large & SMEs Large	Canton de Vaud audit programme Voluntary target agreements Reimbursement of network charge[44]	Financial Voluntary Financial
United States	SMEs	Industrial Assessment Centers (IACs) (free energy audits for manufacturers only conducted by university engineering students)	Information
Australia	Large & SMEs	National Greenhouse and Energy Reporting Act (compulsory energy audit if regulator suspects firms that operate facilities with more than 25 kt of greenhouse gas emissions (GHG) per year not to be respecting the obligatory purchase of "carbon units", which are tradable permits for each tonne of GHG emitted)	Regulatory
India	Large & SMEs	Energy Conservation Act (ECA) (compulsory energy audit to nine energy-intensive sectors)	Regulatory
South Africa	Large & SMEs	National Energy Efficiency Leadership Network (EELN)	Voluntary
Turkey	Large & SMEs	Energy Efficiency Law	Voluntary

Source: Brutscher and Ravillard (2019)

[40] For SMEs it only applies to companies with an energy consumption > 20 GWh per year.
[41] Only applies to companies with an annual energy consumption of less than 1000 toe/year.
[42] Companies eligible for support are those involved in the primary production of agricultural products with at least 100 livestock units and all other companies with a final energy demand exceeding 0.3 GWh/year.
[43] The programme addresses the largest 1,000 energy-intensive companies consuming each more than 5.275 TJ/year, and representing in total about 33% of China's energy demand.
[44] Applicable only if companies have electricity costs equivalent to at least 10% of their gross value added, if they meet all eligibility requirements, if the refund amount is at least CHF 20,000 per year and if the company signs a target agreement with the federal government to increase energy efficiency. Additionally, 20% of the refunded tax amount has to be invested in less cost-effective measures that are not an integral part of the target agreement.

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