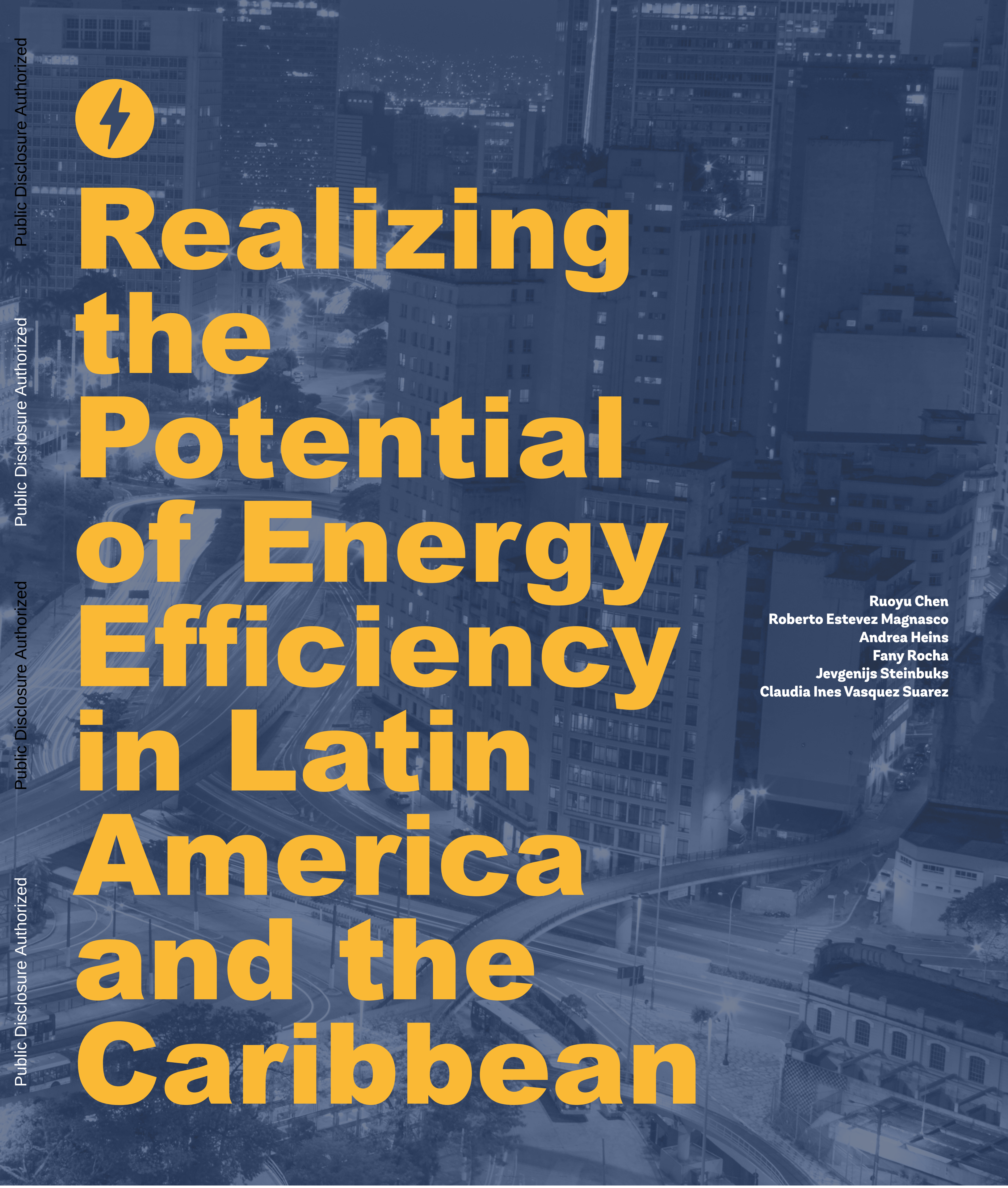

Realizing the Potential of Energy Efficiency in Latin America and the Caribbean

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ESMAP is a collaborative effort of the World Bank and 24 partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy. ESMAP's analytical and advisory services are fully integrated with the World Bank's country financing and energy policy dialogue. ESMAP works to accelerate the energy transition required to ensure access to affordable, reliable, sustainable, and modern energy for all, consistent achieve Sustainable Development Goal 7 (SDG7). It helps to shape strategies and programs to achieve the World Bank Group's Climate Change Action Plan targets

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Abstract

Realizing the Potential of Energy Efficiency in Latin America and the Caribbean responds to the urgent need to relaunch the energy efficiency agenda on the continent in the context of post-COVID recovery, the challenges of climate change mitigation, and high energy prices. The report assesses the current state of energy efficiency policies and measures in the region, identifies key challenges and drivers for improvement, and proposes ways forward. Starting with a high-level review of how energy efficiency policies have evolved in the region over the past two decades, the report proceeds to disaggregate broad trends into discrete efficiency improvements and changes in economic activity. It then identifies key drivers of energy intensity reductions at the sector level. Finally, it provides recommendations on policy instruments to support energy efficiency improvements.

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Executive Summary

Energy efficiency is a critical but underutilized resource throughout Latin America and the Caribbean. Investing in it should be an integral part of every country's energy policy. Countries that have consistently invested in energy efficiency over the last decades have seen lower consumer costs, a more reliable energy supply, less volatile energy prices, and lower emissions of greenhouse gases (GHG) (IEA 2022). Energy efficiency improvements are necessary for sustainable economic development because they help reduce the economic and environmental costs of producing goods and services and shrink their overall carbon footprint. As noted by the International Energy Agency's (IEA) Global Commission for Urgent Action on Energy Efficiency, success depends on whole-of-government responses to align actions across economic sectors, engage public support and participation, and dismantle barriers (IEA 2020a).

On average, improvements in Latin America and the Caribbean (LAC) have been modest, with energy demand projected to increase significantly in coming decades. Though some countries have taken measures to improve energy efficiency, those measures have been unevenly and consistently implemented. Energy efficiency remains underutilized in the region because of technical, financial, and policy barriers.

Successful implementation of energy efficiency programs requires long-term and holistic engagements on all these fronts. But government actions in the region have lacked sustainability and have been unable to attract private financing to invest in energy efficiency initiatives or reduce the risks associated with projects (Loureiro et al. 2021). There is now an urgent need to relaunch the energy efficiency agenda across the continent in the context of post-COVID recovery, the challenges of climate change mitigation, and high energy prices.

This report assesses the current state of energy efficiency policies and measures in the region, identifies key regional challenges and drivers for improved energy efficiency, and proposes ways forward. Starting with a high-level review of how the policies throughout the region have evolved over the past two decades, the report then pinpoints key regional policy levers that drive improvements. Specifically, the report applies the Fisher decomposition method (Boyd and Roop 2004) to disaggregate broad trends in energy trends into discrete efficiency improvements and changes in economic activity. It then analyzes which policy instruments are most likely to reduce the energy intensity of key sectors. Finally, it provides recommendations on policy instruments to support energy efficiency improvements in the region.

The rest of the world significantly outpaced the region's modest improvements in energy intensity

The region's economies have become less energy intensive in recent decades. Since 2005, there has been a decoupling of energy variables from changes in GDP, with GDP growing faster than energy supply and consumption from 2005 to 2019 (figure ES.1). These trends indicate that the region's economies have become less energy intensive. In fact, the region's energy intensity is lower than that of all other world regions except the European Union.

However, improvements in energy intensity in the region have stagnated, while those of the rest of the world have accelerated. In recent decades, the United States and the European Union reduced their energy intensity by around 2 percent and 1.8 percent per year, respectively.[1] In contrast, the indicator for LAC oscillates at practically constant values in the same period, with an average annual reduction of 0.5 percent, far below the 4 percent per year between 2020 and 2030 needed to fulfill net-zero GHG reduction objectives, according to the IEA's *World Energy Outlook 2020* (IEA 2021a).

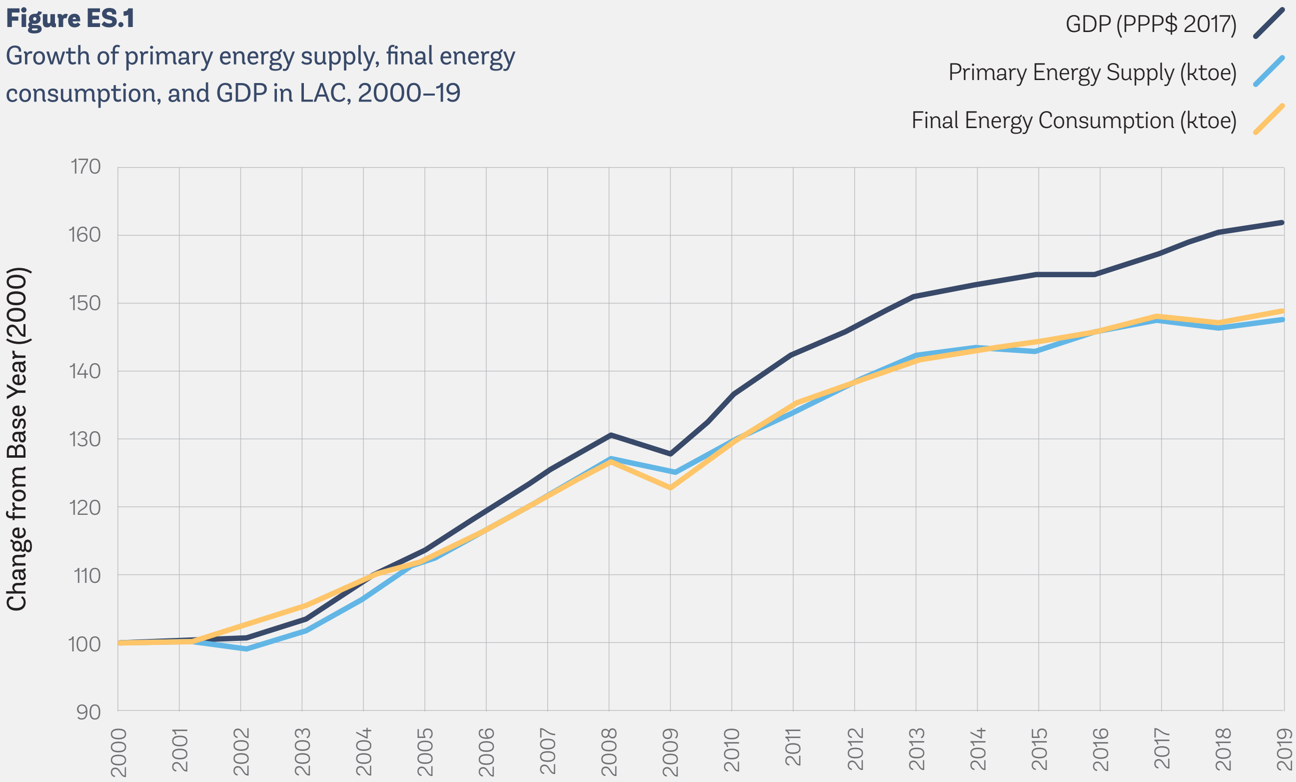
Low energy intensity in the region does not necessarily imply high energy efficiency. It also reflects the underutilization of household appliances, a lack of affordable residential energy services, and less use of technology. The use of energy in industrial production is also less intensive, as LAC's economies are not as industrialized as those of other developing regions (IDB 2019).

Sectoral energy intensity indicators have varied widely from country to country. The variations have evened out at the regional level, with aggregate values across the residential, manufacturing, and services sectors showing relatively small changes. Colombia and Peru show consistent energy intensity reductions in the three sectors. Chile, Mexico, and Argentina display reductions in two of the three sectors, while Brazil and other countries of the region have increased their energy intensity overall. Countries with a higher share of energy-intensive industries show higher energy intensity. Greater access to appliances in the residential sector also results in greater energy intensity (unless those appliances are energy efficient).

Under favorable economic conditions, energy demand in LAC could increase significantly with greater affordability and penetration of appliances. If that happens, energy intensity will stabilize or even increase. For example, under the right economic conditions, households would be able to purchase additional appliances, which, absent energy efficiency policies, would push up the residential sector's energy intensity.

1 World Bank data, https://datos.bancomundial.org/indicador/EG.EGY.PRIM.PP.KD

Figure ES.1
Growth of primary energy supply, final energy consumption, and GDP in LAC, 2000–19



Source: WBG, based on Latin-American Energy Organization (OLADE) and World Bank database.
Note: Total energy supply comprises final energy consumption, non-energy consumption, and consumption and losses of the energy sector.

The region needs to overcome many barriers to greater energy efficiency

Commonly acknowledged barriers to energy efficiency are low energy prices, low exposure to energy supply shocks, legacy assets operating past their design life, and obstacles to the uptake of technology. The latter might include impediments to technology transfers, such as limits on trade with certain countries or financial barriers that limit the government and the private sector's capacity to invest in updated technologies. In addition, lack of coordination and prioritization of policy measures across sectors, lack of policy stability, and lack of capabilities to implement and control policy implementation are also important barriers.

Energy efficiency policies, which are notoriously difficult to approve and implement, are effective if they are well-targeted to specific sectors and sensitive to the local context. However, their implementation is often limited by several factors, including information gaps, the high up-front cost of investments, and the diffuse nature of benefits, low visibility, and challenges in measuring results. For example, inadequate prioritization in a very energy-intensive economy might erroneously focus on tackling insulation of the existing building stock as the first measure to be implemented. Actually, other steps (such as improving labeling and standards for appliances and vehicles) can be more immediate, effective, and efficient.

Many of the programs developed in the region have been based on international grants or technical assistance and were not sustained over time despite their good results (ECLAC 2021). International cooperation primarily seeks to achieve a quick knowledge transfer and seldom yields programs that are self-sustaining without an enabling environment. Although most of these programs include a government-financed capacity-building component, local governments do not always provide continuity and scale up the implemented measures.

Lack of financing has also hampered advances in energy efficiency. Based on Latinobarometer's 2018 survey, 71 percent of households in the region would be willing to spend money on appliances that allow them to lower their electricity bill, but 22 percent of them said that they did not have the resources to cover the cost of the appliances (IDB 2019).

The lack of information on the impacts of implemented policies and measures has delayed the uptake of energy efficiency measures in the region. For example, lack of awareness was a significant impediment for energy efficiency policies in the Argentinean electricity sector (Recalde and Guzowski 2012). Improved information on impact would provide an opportunity to evaluate and disseminate results and share best practices among countries, enabling the industrial and commercial sectors to implement successful measures without public support.

Energy demand policies and regulatory reforms can significantly improve the region's energy efficiency

Over the past four decades, LAC countries have implemented various energy efficiency policies and measures. Eleven countries have adopted national legislation; six others have a bill under discussion. Since 1985, twenty-two LAC countries have implemented almost 300 measures and programs, with the implementation rate rising after 2007. Using information from ECLAC's Base of Energy Efficiency Indicators (ECLAC 2021) and the IEA's policies database, the World Bank compiled a database of policies and programs in LAC countries. That information was supplemented with additional measures from official country websites to cover countries that do not appear in the IEA and BIEE databases and those that appear but whose information is incomplete. It should be borne in mind, however, that well-structured and comparable information on implementation and effectiveness is hard to find, and information presented at the national level may mask significant regional discrepancies.

Countries in the region have taken different approaches to energy efficiency planning. Some have approved a national plan or strategy.[2] In these, the policies and measures have focused on (i) energy labeling systems and minimum energy performance standards (MEPS); (ii) national energy efficiency planning; (iii) incentives and mandates for the private sector; (iv) building codes; (v) incentives and mandates for the public sector; and (vi) financing mechanisms.

Improvements in energy efficiency regulations related to planning and access to financing have the potential to reduce energy intensity and improve sectoral energy efficiency. Countries with weak regulatory policies could significantly improve their energy efficiency if they implemented better policies and raised their score on the Regulatory Indicators for Sustainable Energy (RISE) to that of the leading country (Mexico in 2019, the last year for which updated indicator values were obtained).

For example, Argentina, Dominican Republic, Guatemala, and Peru—where energy efficiency policies are suboptimal—have the potential to achieve additional reductions of 6 to 8 percent in their energy intensity index and additional improvements of 6.5 to 9.5 percent in their sectoral energy efficiency. Improving RISE scores to Mexico's levels in countries with somewhat better regulatory policies, such as Brazil, Chile, Colombia, and Ecuador, could produce additional declines of 2 to 3.5 percent in their energy intensity index and additional improvements of 2.5 percent to 4 percent in their sectoral energy efficiency. The average energy intensity and sectoral gains in energy efficiency resulting from strengthening regulatory policies in the region are estimated at 2.3 percent (figure ES.2) and 2.7 percent and (figure ES.3), respectively.

2 In Argentina, Guatemala, and the Dominican Republic the plans are still under parliamentary discussion.

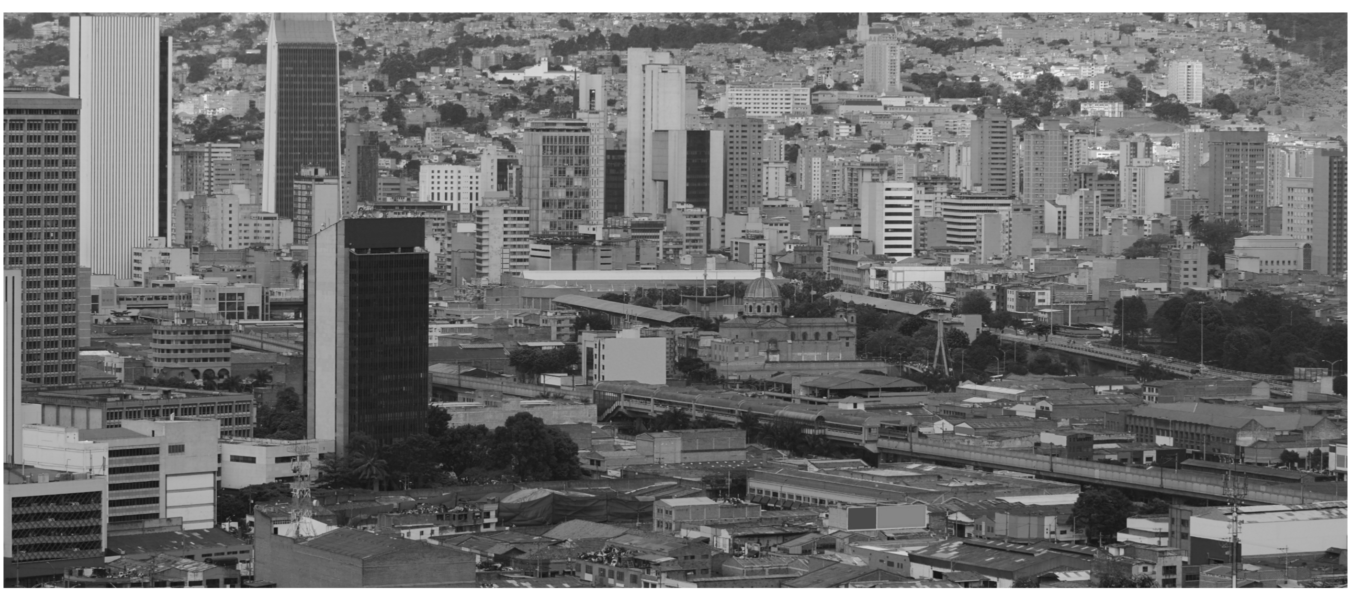
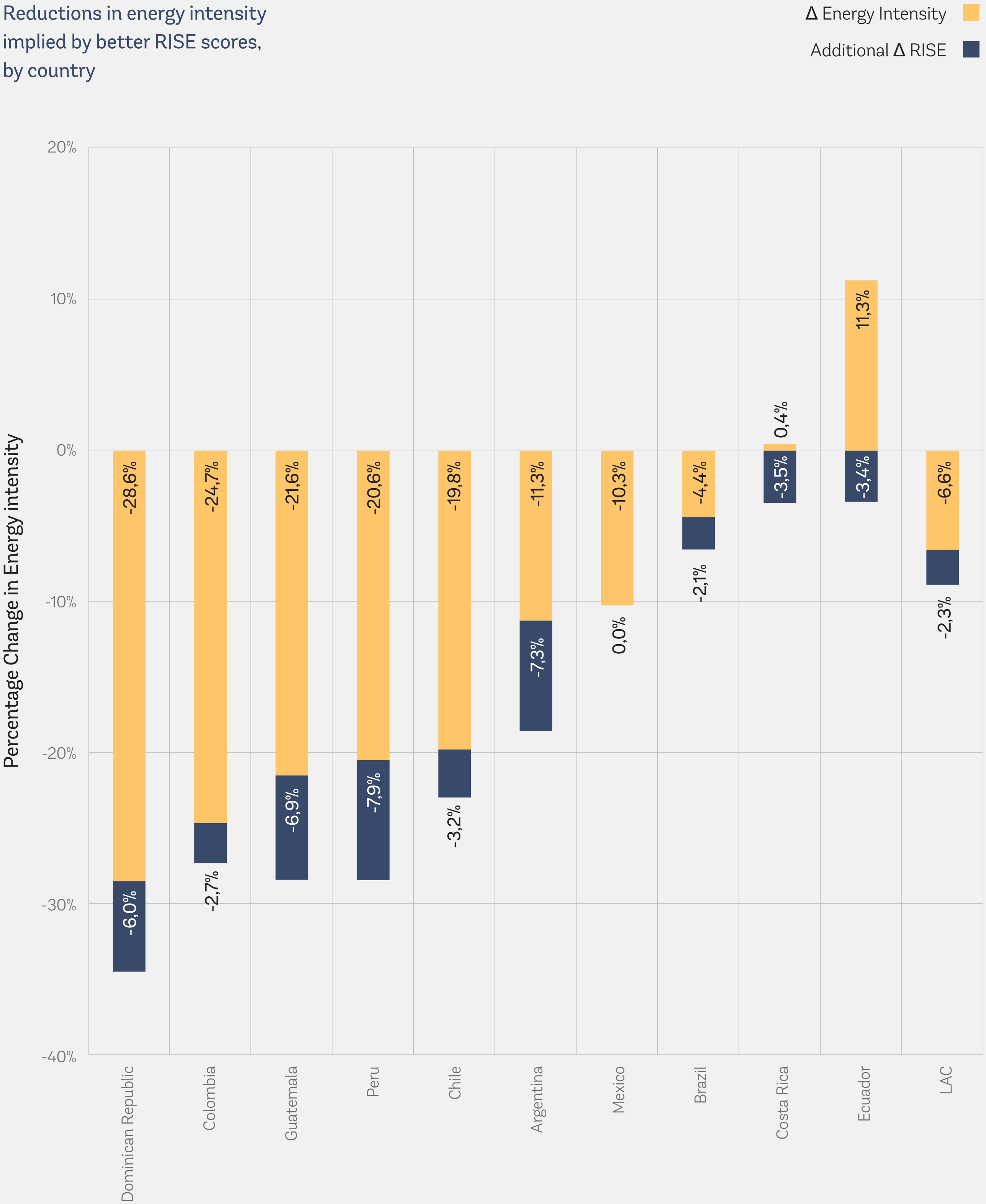
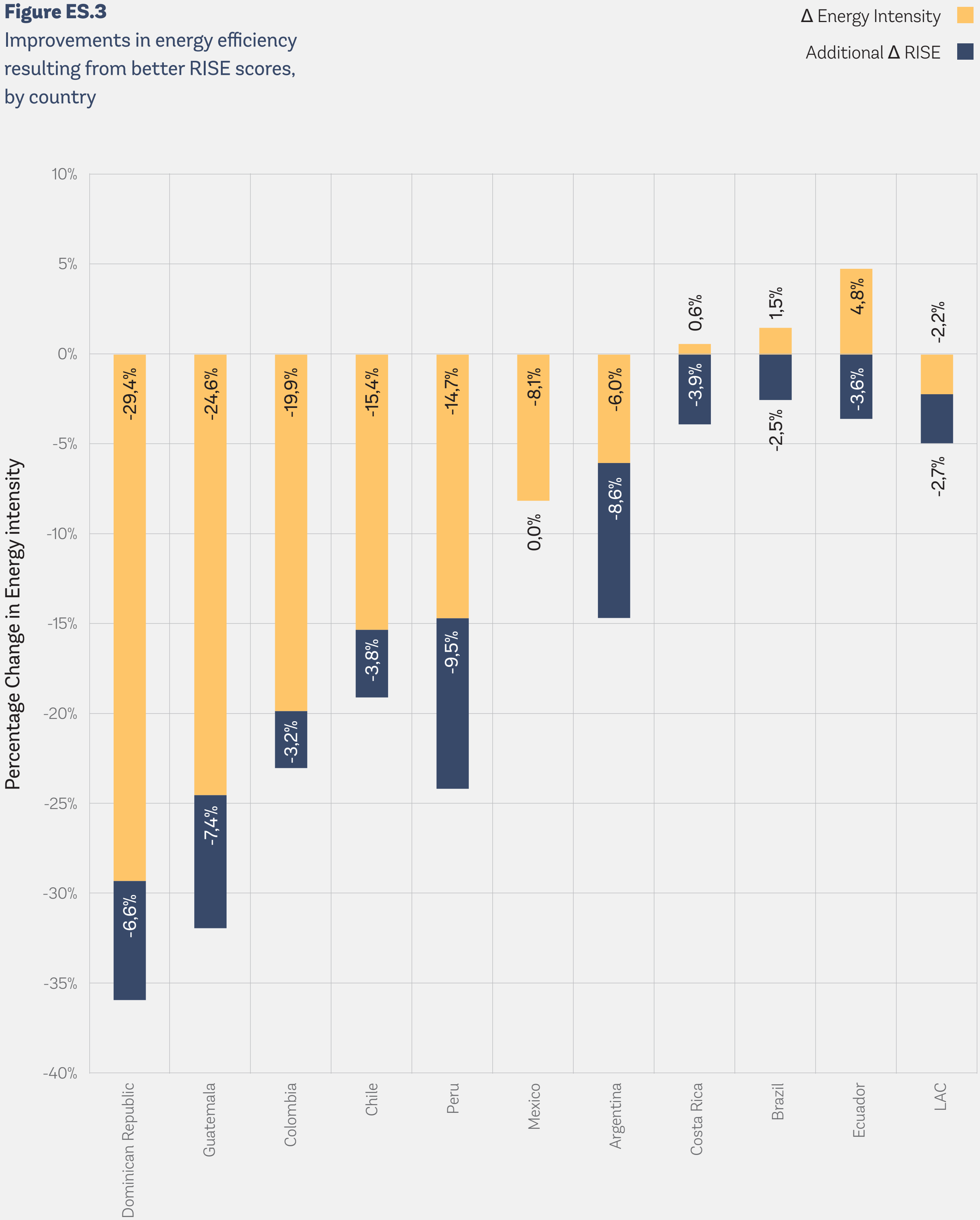


Figure ES.2
Reductions in energy intensity implied by better RISE scores, by country



Source: WBG' estimates based on counterfactual regression analysis using OLADE, UN data, Penn World Tables, IEA.
Note: Yellow bars show the baseline changes in energy intensity of ten largest LAC countries between the first year and the last year of available data. Blue bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country for 2019 RISE EE scores. RISE scores have been periodically updated, and we used the version available at the time of the analysis.

Figure ES.3
Improvements in energy efficiency resulting from better RISE scores, by country



Source: WBG' estimates based on counterfactual regression analysis using OLADE, UN data, Penn World Tables, IEA.
Note: Yellow bars show the baseline changes in energy intensity, due exclusively to energy efficiency improvements, of ten largest LAC countries between the first year and the last year of available data. Blue bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country for 2019 RISE EE scores. RISE scores have been periodically updated, and we used the version available at the time of the analysis.

Improvements in energy efficiency resulting from phasing out energy subsidies and reforming regulatory regimes can bring substantial energy savings. Counterfactual simulations based on econometric analysis show considerable combined savings for the countries of the region, with smaller and poorer economies of Central America and the Caribbean experiencing the largest relative savings. For example, energy reforms could save up to an estimated 13.38 percent of total energy consumption in Haiti, 9.93 percent in El Salvador, and 8.5 percent in Honduras. Argentina and Bolivia would also see significant energy savings from energy reforms (9.73 percent and 9.45 percent, respectively). These savings would be even larger when accounting for energy security and environmental benefits.

Steps to improve energy efficiency in the region

Exploiting synergies between sustainable programs, technology transfer, financing, and adequate energy pricing will be essential to realize the region's energy efficiency potential. Based on the IEA's bottom-up scenarios (IEA 2021a), considerable improvements in the region's energy intensity are possible, from 1.1 percent to 2.3 percent annual reductions through 2040. These scenarios mark a clear upside compared with the region's paltry improvement trend over the past 20 years (around 0.5 percent per year).

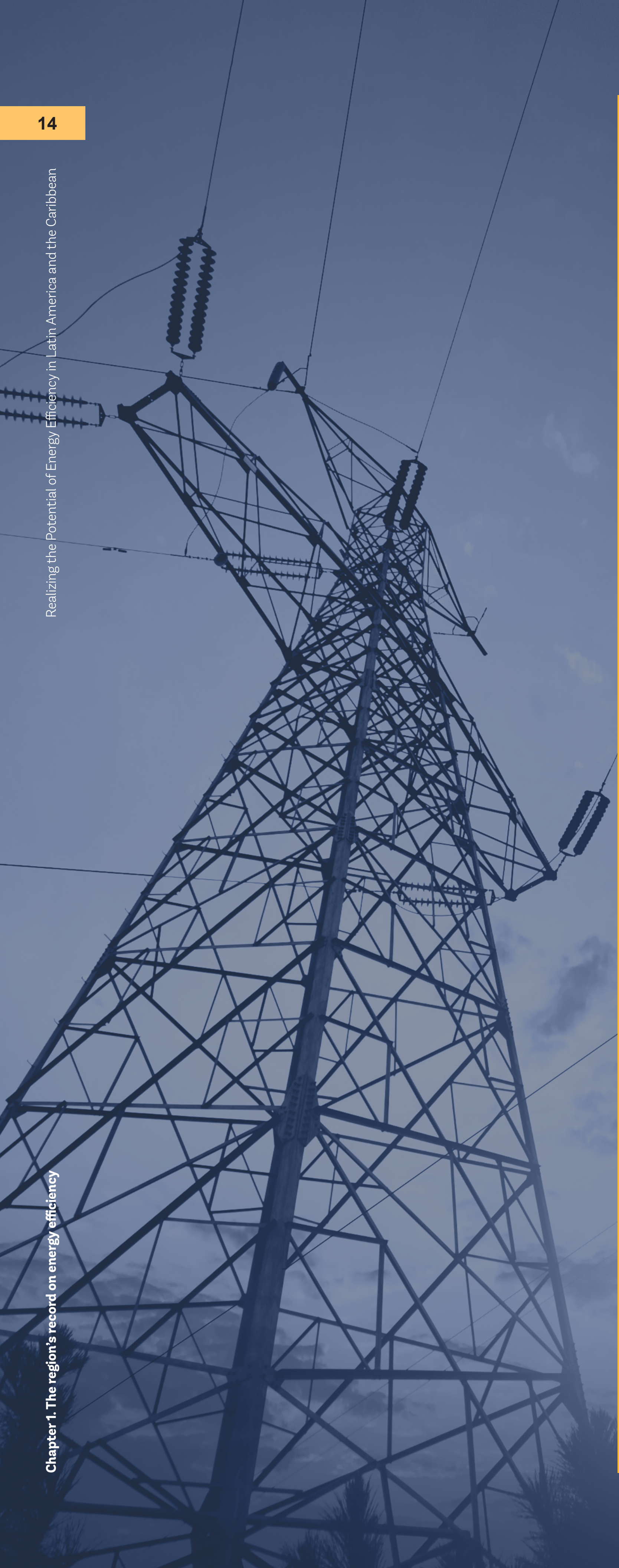
There is an urgent need for sustainable and well-financed policies and programs that focus on efficient technology integration complemented by a just phase-out of energy subsidies. Energy efficiency policies in the region have shown mixed results depending on the country and sector, with more policies and measures often not translating into consistent improvements in energy efficiency and final energy intensity. National and local governments should take advantage of existing programs and improved capacities to set up long-term programs and scale up the measures already implemented. Their focus should be on enhancing technology transfer, improving the sustainability of programs, improving access to financing, and reducing energy subsidies while ensuring that vulnerable social groups are protected.

Incentivizing the integration of the most efficient technologies in various sectors can be done by establishing special tax schemes to promote efficient technology uptake (either in the form of tariffs or taxes that are removed or lowered for efficient technology or, conversely, in the form of increased tariffs or taxes for inefficient technology). Other drivers include better access to information on the impact of improved technologies and offers of concessional financing for select investments. Particularly for the industrial and commercial sectors, programs should be designed so that their sustainability and scaling are backed by co-financing from the private sector. Improved frameworks for monitoring and reporting of the results and impacts of energy efficiency measures would enable the private sector to understand options and implement successful measures without the need for public support.

Wider access to financing is effective—but only under certain conditions. For example, energy efficiency investments require an adequate enabling environment characterized by clear information, trusted parties that can provide needed services, and essential equipment and material, all of which can be hard to come by. To ensure their presence, national governments must implement clear long-term plans and streamlined procedures to support investments (IEA 2022).

LAC countries must continue to reduce energy subsidies while protecting vulnerable populations. Energy subsidies directly affect how energy is used and the choice to acquire efficient technologies. Although the currently high energy prices make subsidy reduction difficult, they also offer an opportunity to establish frameworks that will allow subsidies to be phased out automatically as soon as prices drop.

Finally, the importance of coordinated government actions and a comprehensive and integrated approach to address the multiple challenges to energy efficiency implementation cannot be understated. Success with energy efficiency depends on the actions of policymakers responsible for energy, industry, housing, transport, and finance, as well as the equivalent actors at the subnational and local levels.



1

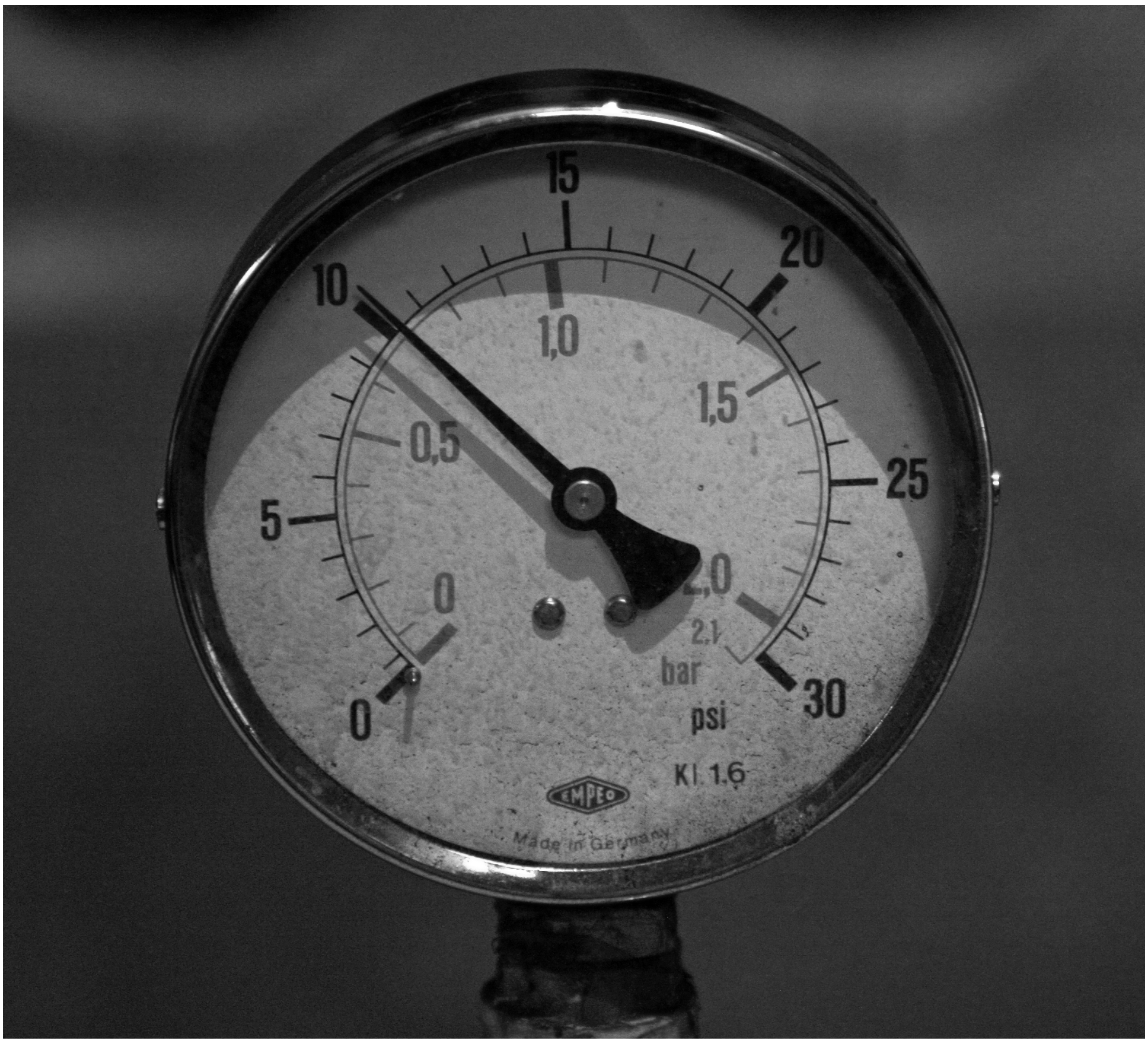
The region's record on energy efficiency

Energy efficiency improvements in Latin America and the Caribbean (LAC) are not keeping pace with growth in energy demand, which is projected to grow substantially in coming decades. Though some countries have taken measures to improve energy efficiency, those measures have been unevenly and consistently implemented.[3] There is an urgent need to revisit the energy efficiency agenda in the continent and relaunch it in the current context of post-COVID recovery and high energy prices.

The objective of this report is to take stock of current energy efficiency policies and measures in the region, identify key regional challenges and drivers for improvement, and propose some ways forward.

The report begins with a review of how energy efficiency policies in the region have evolved over the last two decades. It then proceeds to identify key policy levers that drive improvements in energy efficiency across the region. Specifically, the report applies the Fisher decomposition method (Boyd and Roop 2004) to disaggregate broad trends in energy intensity into discrete efficiency improvements and changes in economic activity. It subsequently analyzes which policy instruments would have the largest effects in reducing sectoral energy intensities. The report concludes with recommendations for policy instruments to support energy efficiency improvements in the region.

3 LAC includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and the Bolivarian Republic of Venezuela.



Why should the region's countries be concerned about energy efficiency?

Investing in energy efficiency should be an integral part of every country's energy policy. Countries that have consistently invested in energy efficiency over the last decades have seen lower consumer costs, a more reliable energy supply, less volatile energy prices, and lower emissions of greenhouse gases (GHG) (IEA 2022). Energy efficiency improvements are necessary for sustainable economic development because they help reduce the economic and environmental costs of producing goods and services and shrink their overall carbon footprint. As noted by the International Energy Agency's (IEA) Global Commission for Urgent Action on Energy Efficiency, success depends on whole-of-government responses to align actions across economic sectors, engage public support and participation, and dismantle barriers (IEA 2020a).

However, despite its great potential, energy efficiency remains underutilized in the region because of technical, financial, and policy barriers. Successful implementation of energy efficiency programs requires long-term and holistic engagements on all these fronts. But government actions in the region have lacked sustainability and have been unable to attract private financing to invest in energy efficiency initiatives or reduce the risks associated with projects (Loureiro et al. 2021).[4]

At the country and regional level, the evolution of energy efficiency can be inferred from trends in total energy supply, final energy consumption, and GDP.[5] Figure 1.1 shows that primary energy supply and total final energy consumption grow at similar rates.[6] Since 2005, there has been a decoupling of energy variables from changes in GDP, with GDP growing faster than energy supply and consumption from 2005 to 2019. These trends indicate that the region's economies have become more energy efficient.

4 Owing mainly to a lack of commercial and financial sector experience with EE projects, it is difficult to obtain statistical data on the actual energy and cost savings achieved by implemented energy efficiency projects. There is also a lack of statistics on sector default rates (Loureiro et al. 2021).

5 Primary energy supply includes final energy consumption, non-energy consumption, and consumption and losses of the transformation sector (or energy sector).

6 During this period some LAC countries experienced changes in their power generation mix that affected energy supply but not necessarily final energy consumption. However, in the regional aggregated values, these variations are compensated for, such that both variables show a similar evolution.

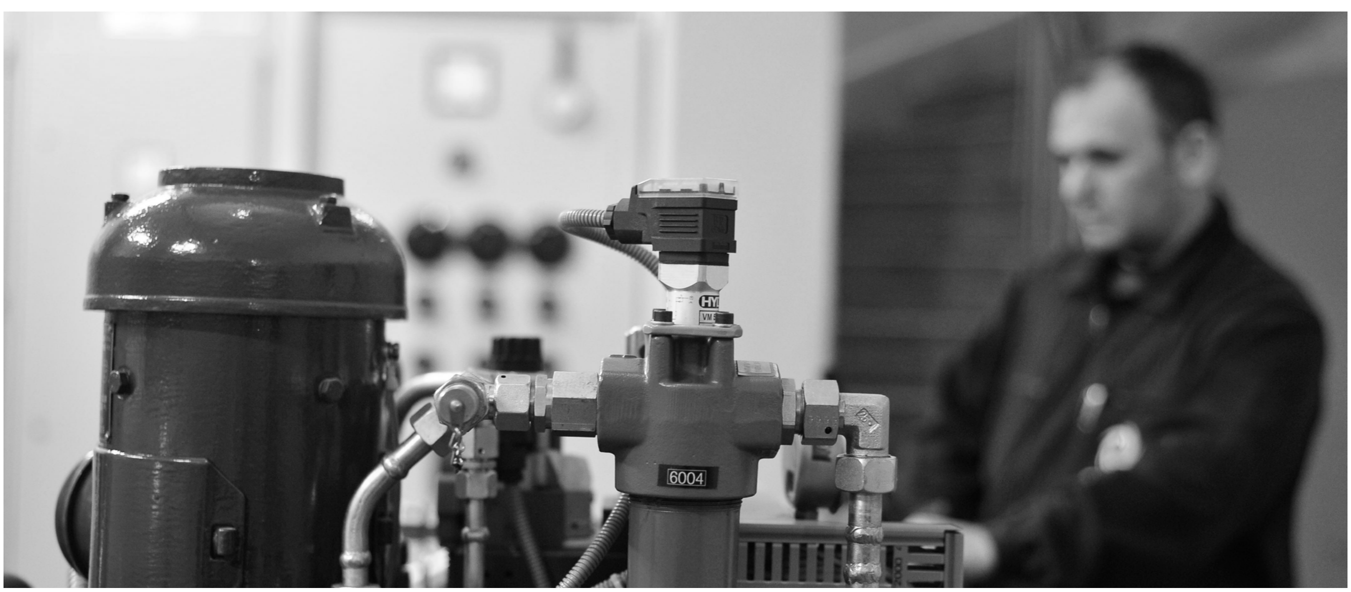
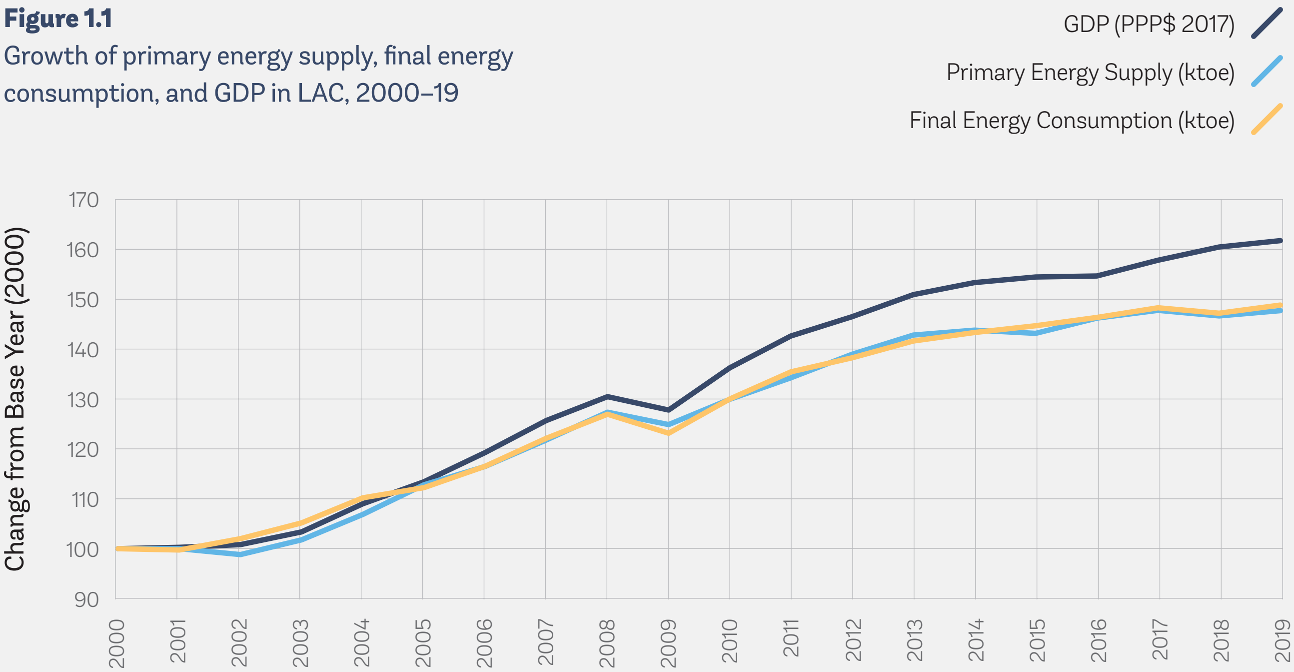


Figure 1.1
Growth of primary energy supply, final energy consumption, and GDP in LAC, 2000–19



Source: WBG, based on Latin-American Energy Organization (OLADE) and World Bank database.
Note: Total energy supply comprises final energy consumption, non-energy consumption, and consumption and losses of the energy sector.

Owing to general equilibrium effects and structural changes, energy efficiency is difficult to measure and track across an entire economy. It is usually measured as improvements in energy consumption for specific processes or services. Given these measurement problems, trends can be gauged by changes in both primary and final energy intensity, defined as the ratio of output to energy. While energy intensity is a crude indicator of energy efficiency, it can provide some macro-level guidance on how energy efficiency has developed over time by controlling for observed structural changes.

Main barriers to energy efficiency

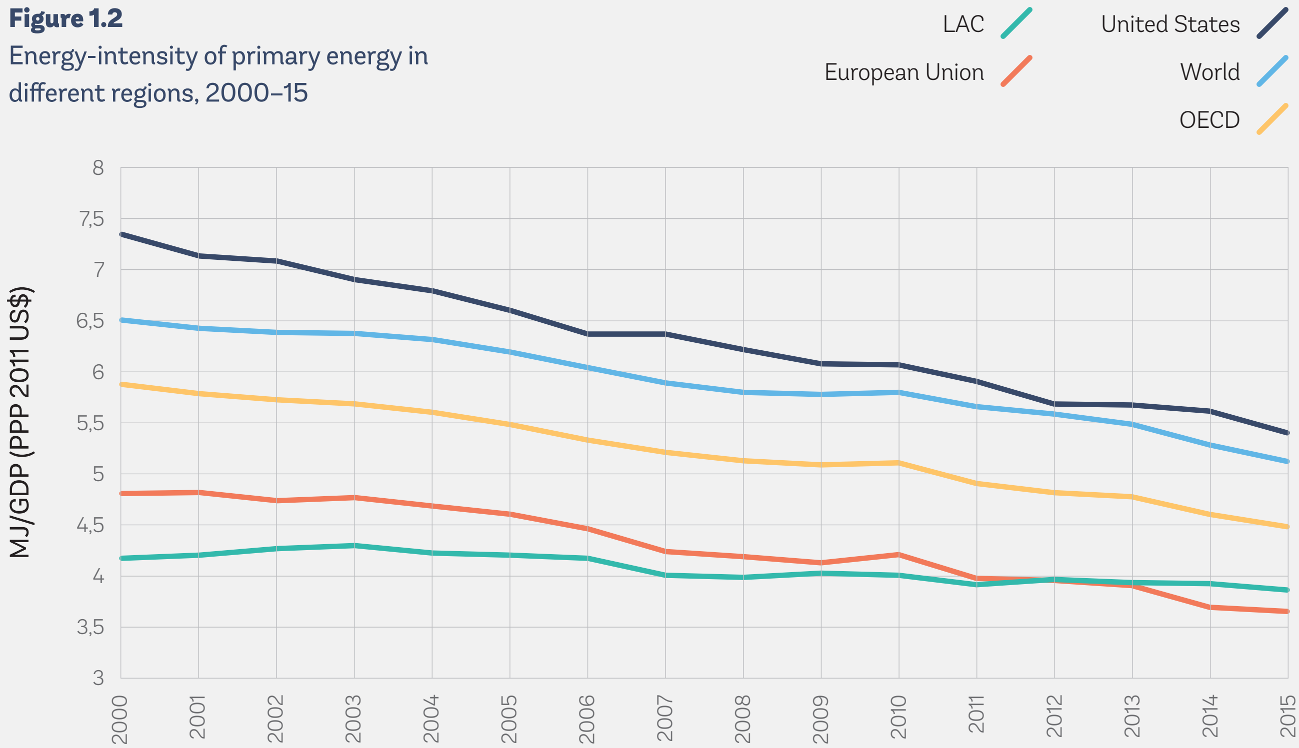
Commonly acknowledged barriers to energy efficiency are low energy prices, low exposure to energy supply shocks, legacy assets operating past their design life, and obstacles to the uptake of technology. The latter might include impediments to technology transfers, such as limits on trade with certain countries or financial barriers that limit the government and the private sector's capacity to invest in updated technologies. In addition, lack of coordination and prioritization of policy measures across sectors, lack of policy stability, and lack of capabilities to implement and control policy implementation are also important barriers. For example, inadequate prioritization in a very energy-intensive economy might erroneously focus on tackling insulation of the existing building stock as the first measure to be implemented. Actually, other steps (such as improving labeling and standards for appliances and vehicles) can be more immediate, effective, and efficient.

Is the region energy efficient?

Energy intensity is lower in LAC than in all other world regions except the European Union (figure 1.2), but improvements in the region have stalled, while the rest of the world has reduced its energy intensity significantly. The European Union, the countries of the Organization for Economic Co-operation and Development (OECD), the United States, and the world as a whole have shown much more progress in lowering their energy intensity than have the LAC countries. In the 2000–15 period, the United States reduced its energy intensity by around 2 percent per year, and the European Union and the OECD by around 1.8 percent per year.[7] By contrast, the indicator for LAC oscillates at practically constant values in the period, with an average annual reduction of 0.5 percent. According to the IEA's *World Energy Outlook 2020* (IEA 2021a), this reduction is considerably below the 4 percent per year between 2020 and 2030 needed to fulfill net-zero GHG reduction objectives (IEA 2021a).

7 World Bank Data, https://datos.bancomundial.org/indicador/EG.EGY.PRIM.PP.KD

Figure 1.2
Energy-intensity of primary energy in different regions, 2000–15



Source: WBG, based on World Bank Database, World Development Indicators.

Low energy intensity in the region does not necessarily imply high energy efficiency. It also reflects the underutilization of household appliances, a lack of affordable residential energy services, and less use of technology. The use of energy in industrial production is also less intensive, as LAC's economies are not as industrialized as those of other developing regions (IDB 2019). With energy demand projected to increase in the region owing to greater affordability and penetration of appliances (figure 1.3). If that happens, energy intensity is likely to stabilize or even increase. This is so because, under favorable economic conditions, households would be able to purchase additional number of appliances which, absent energy efficiency policies targeted to the sector, would mean an increase in the residential sector's energy intensity.

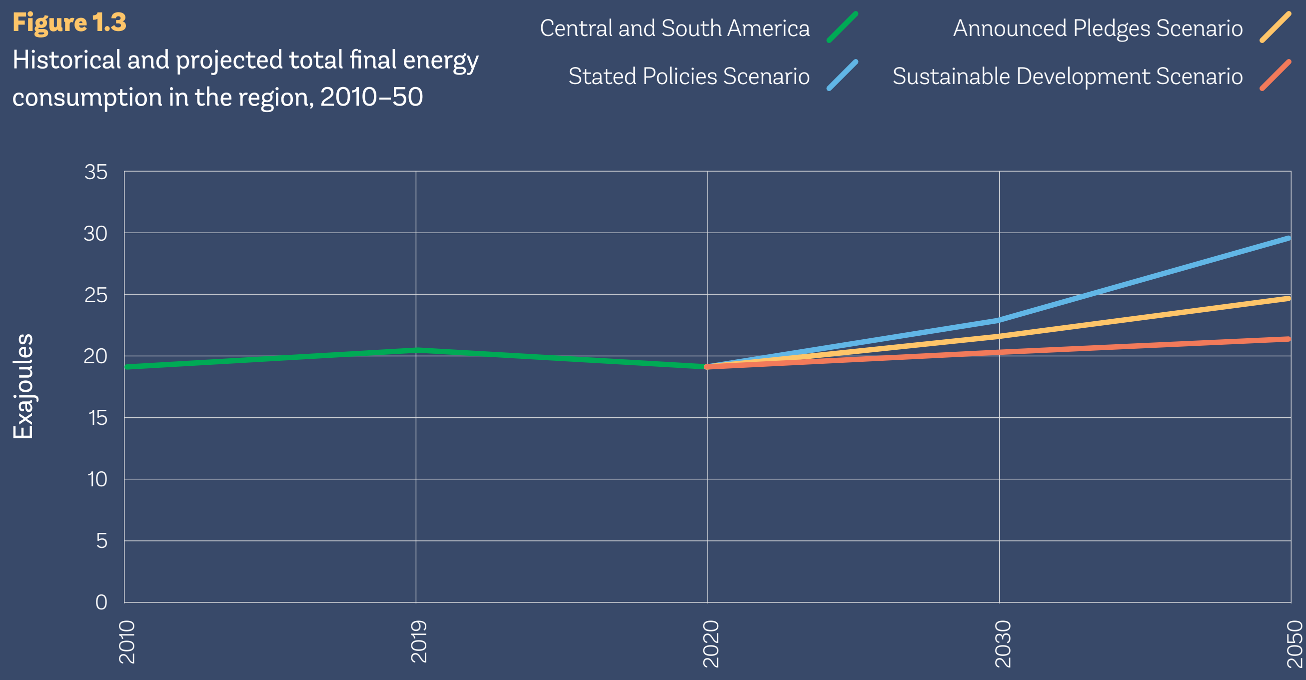
Though most countries in the region have energy efficiency policies, they appear to have little impact on the energy intensity index. However, their effects are difficult to isolate owing to the combined effects of other variables, such as access to equipment and technology, economic structures, the power generation mix, economic crises, the climate, habits of consumption, and general economic development.

Final energy intensity is dropping slowly in LAC, with an average annual change of around −0.4 percent (figure 1.4). Although final energy intensity changes at a rate similar to that of final energy supply, using the energy intensity indicator based on final consumption allows us to remove the impact of variations in the transformation sector[8] and those caused by nonenergy consumption, leaving only energy consumption from the residential, industrial, services, transportation, agriculture and fishing, and construction sectors. Between 2000 and 2019, the cumulative reduction was around 8 percent, with no consistent annual reduction.

Trends in final energy intensity in the region show an irregular decreasing trend between 2000 and 2019 (figure 1.4). Although countries present different realities, the average is shaped chiefly by changes in the region's economic composition (marked by a reduction in the industrial share of GDP) and an average improvement in the energy efficiency of the region's residential and services sectors. In addition, irregularities can be largely explained by the effect of economic instability in the region over the years studied and changes in the population's access to energy-consuming appliances (which increased per-capita energy use).

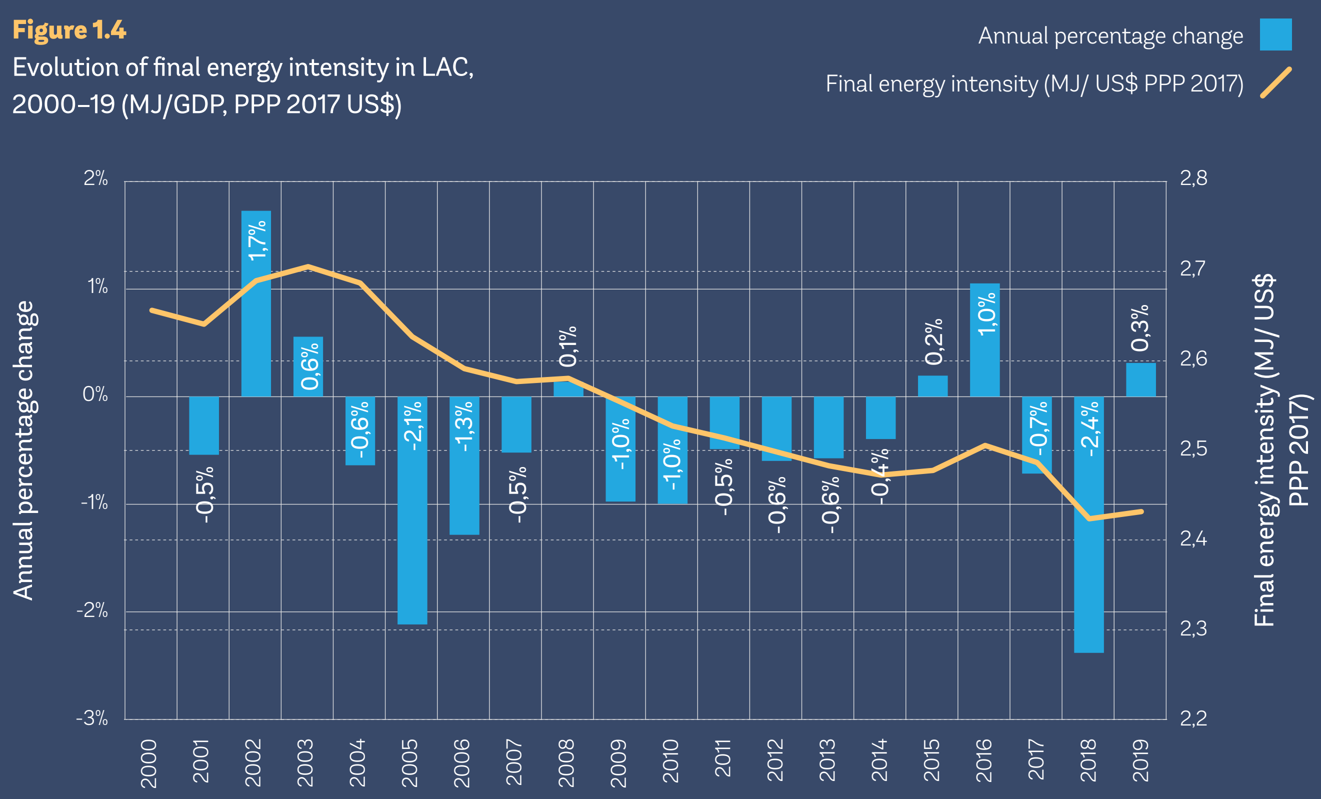
8 The "transformation sector" is understood as activities that result in the transformation of primary energy forms into secondary energy forms (for example, a coal power plant transforming energy in coal into energy in an electric current). This concept s closely linked to that of Final Energy , which is the primary or secondary energy that is directly used by socio-economic sectors, and does not include losses due to the intermediate processes (transformation, transmission, transport, distribution and storage losses).

Figure 1.3
Historical and projected total final energy consumption in the region, 2010–50



Source: WBG, based on IEA 2021a and World Bank Indicators.
Note: The scenarios are described in IEA's *World Energy Outlook 2020* (IEA 2021a). The scenarios are discussed in greater detail in the last section of this chapter of the report.

Figure 1.4
Evolution of final energy intensity in LAC, 2000–19 (MJ/GDP, PPP 2017 US$)



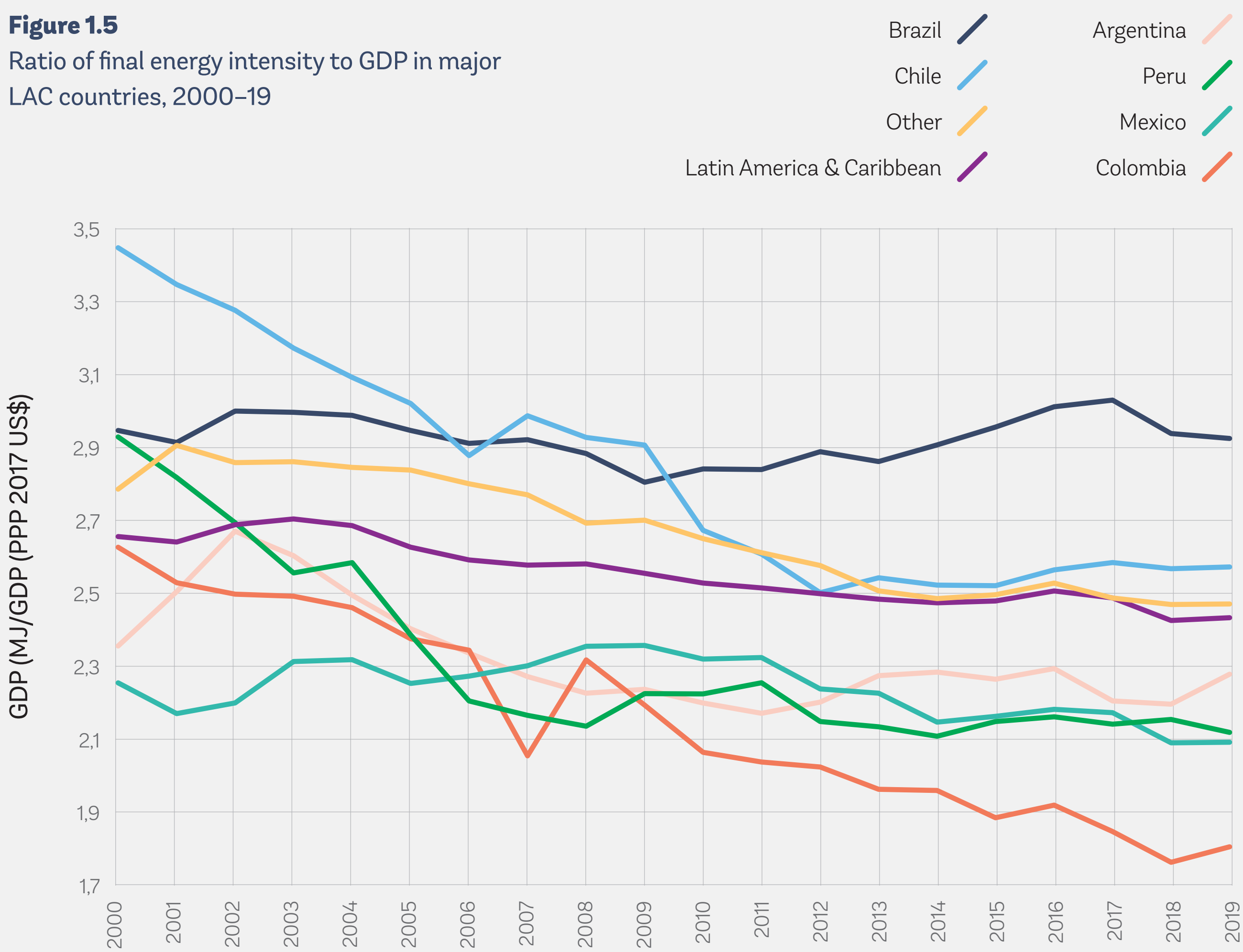
Source: World Bank, based on OLADE and World Bank database.

The evolution of energy intensity shows wide differences across LAC countries. Colombia, Peru, and Chile show the fastest reduction in energy intensity (figure 1.5). However, all three showed considerably greater improvement in the 2000–10 period than in 2010–19. Argentina and Brazil saw a change in the growth trend between the 2000–10 and 2010–19 periods, initially lowering energy intensity and later increasing it. Mexico, in contrast, initially showed an upward trend that was later reversed, leading to consistent reductions. The "Other LAC countries" category exhibited more reduction in the period 2010–19 period. Within this group, Costa Rica, the Dominican Republic, Guyana, Honduras, Nicaragua, Panama, Paraguay, and Suriname improved their energy intensity between 2000 and 2019. In the Dominican Republic, Guyana, Panama, and Suriname, the improvement exceeded 40 percent; in Honduras, Nicaragua, and Panama, 20 percent; and in Paraguay and Costa Rica, 10 percent.

Sectoral energy intensity indicators have varied widely from country to country (figure 1.6). However, the variations have evened out at the regional level, with aggregate values across residential, manufacturing, and services sectors showing relatively small changes. Colombia and Peru show consistent energy intensity reductions in the three sectors. Chile, Mexico, and Argentina display reductions in two of the three sectors, while Brazil and other countries of the region have increased their energy intensity overall. Countries with a higher share of energy-intensive industries show higher energy intensity. Greater access to appliances in the residential sector also results in greater energy intensity (unless those appliances are energy efficient).

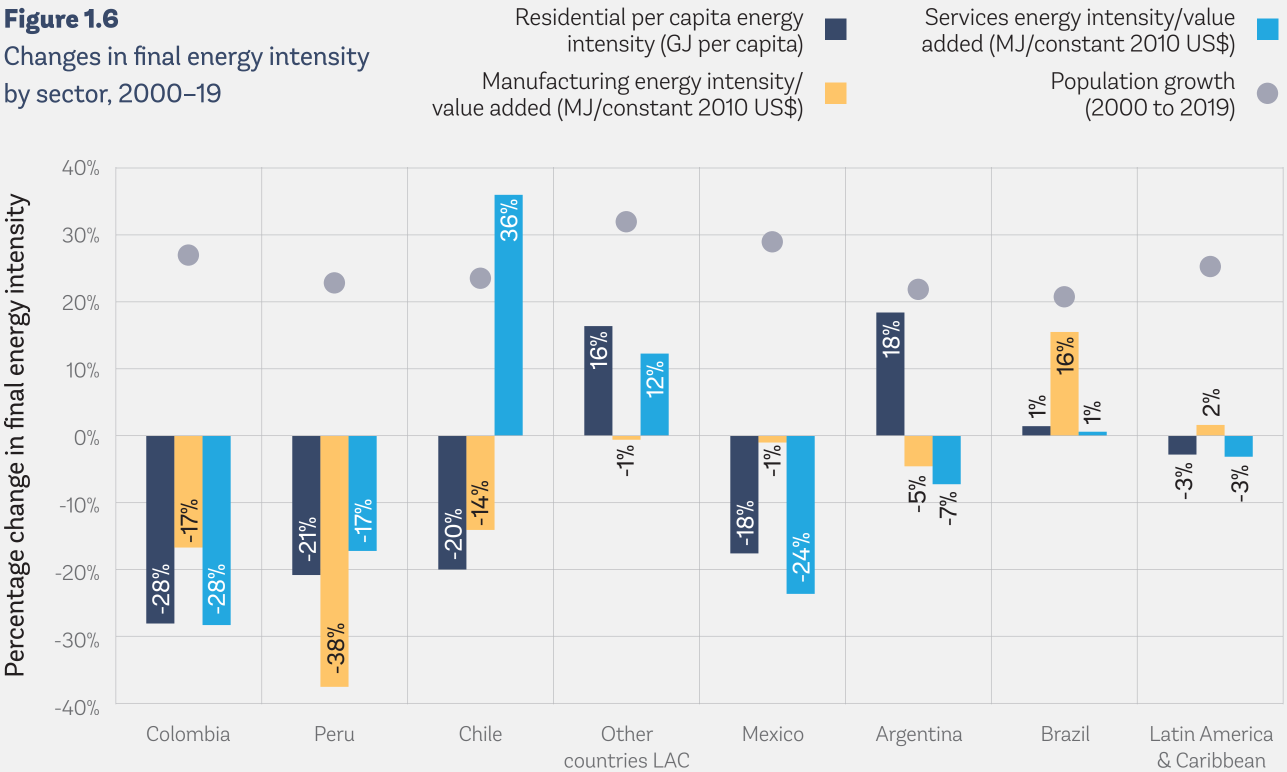
Reductions in energy intensity for the residential and manufacturing sectors in Colombia and Peru could be attributed to improvements in energy efficiency. These improvements could potentially be driven by increased uptake of more efficient technology, resulting in lower intensity per capita and as a share of value added, respectively.

Figure 1.5
Ratio of final energy intensity to GDP in major LAC countries, 2000–19



Source: WBG, based on OLADE and World Bank database, change in energy intensity over time.

Figure 1.6
Changes in final energy intensity by sector, 2000–19



Source: WBG, based on OLADE and World Bank database.

Institutional context, regulation, and policies

Evolution of energy efficiency policy implementation in the region

Over the past four decades, LAC countries have implemented various energy efficiency policies and measures. Eleven countries have adopted national legislation; six others have a bill under discussion. Since 1985, twenty-two LAC countries have implemented almost 300 measures and programs, with the implementation rate rising after 2007. Using the aggregated indicators proposed in the document "*Indicadores de Políticas Públicas en Materia de Eficiencia Energética en América Latina y el Caribe*" (ECLAC-GTZ, 2010), the information from ECLAC's Base of Energy Efficiency Indicators (BIEE)[9] (ECLAC 2021) and the IEA's policies database (IEA 2020b), the World Bank compiled a database of policies and programs in LAC countries. This information was supplemented with additional measures from official country websites to cover countries that do not appear in the IEA and BIEE databases and those that appear but whose information is incomplete. It should be borne in mind, however, that well-structured and comparable information on implementation and effectiveness is hard to find, and information presented at the national level may mask significant regional discrepancies.

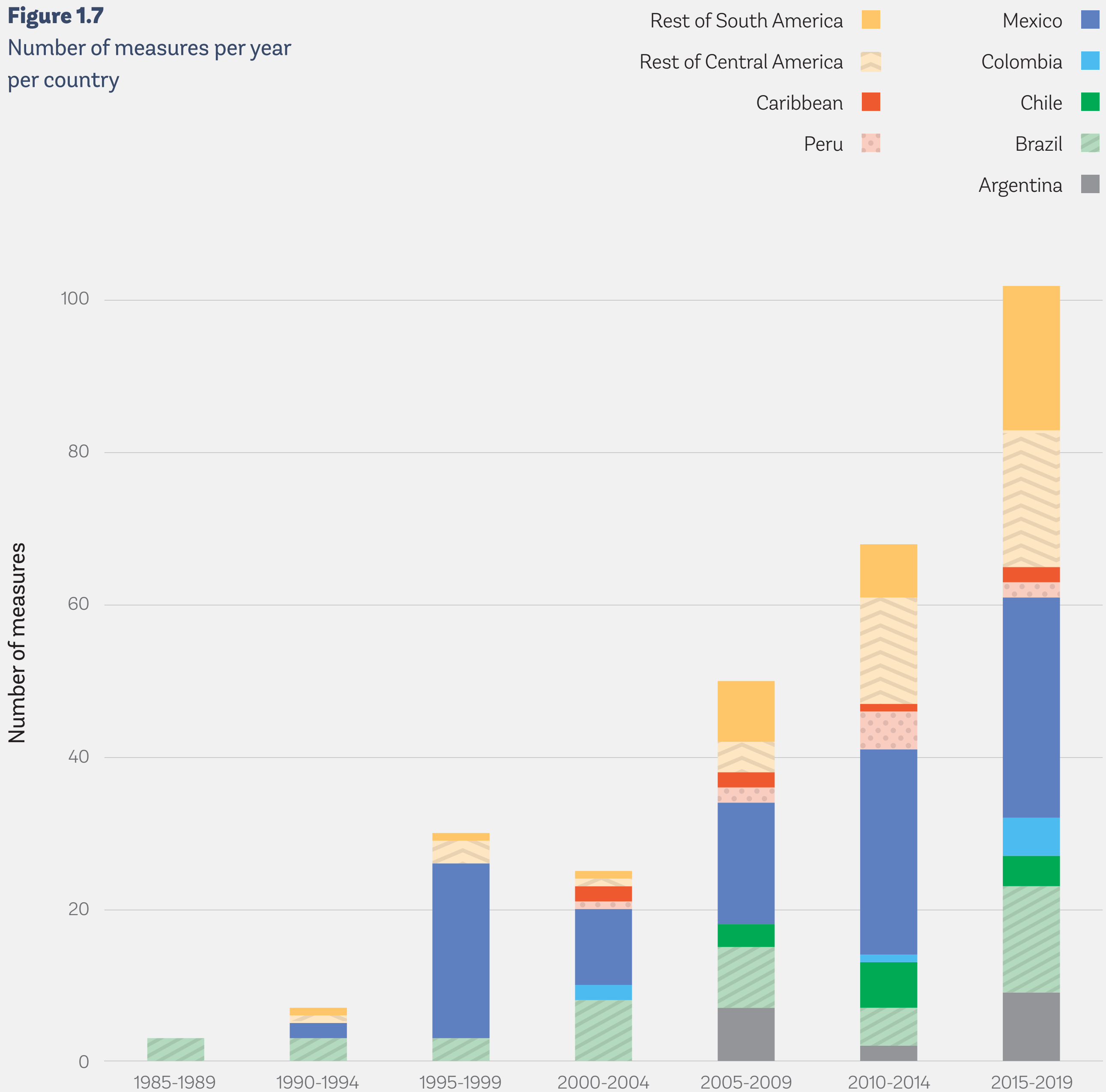
Countries in the region have taken different approaches to energy efficiency planning. Some have approved a national plan or strategy.[10] In these, the policies and measures have focused on (i) energy labeling systems and minimum energy performance standards (MEPS); (ii) national planning; (iii) incentives and mandates for the private sector; (iv) building codes; (v) incentives and mandates for the public sector; and (vi) financing mechanisms.

Energy efficiency policies and actions in Colombia, Brazil, Mexico, Argentina, Chile, and Peru have shown increased momentum but wide differences (figure 1.7). Some countries have shown regular actions and efforts since 1985 (Brazil) and 1993 (Mexico) while others exhibit sporadic activity. Since 2007 growth in adopted measures has been strong across the region.

9 https://biee-cepal.enerdata.net/en/

10 In Argentina, Guatemala, and the Dominican Republic the plans are still under parliamentary discussion.

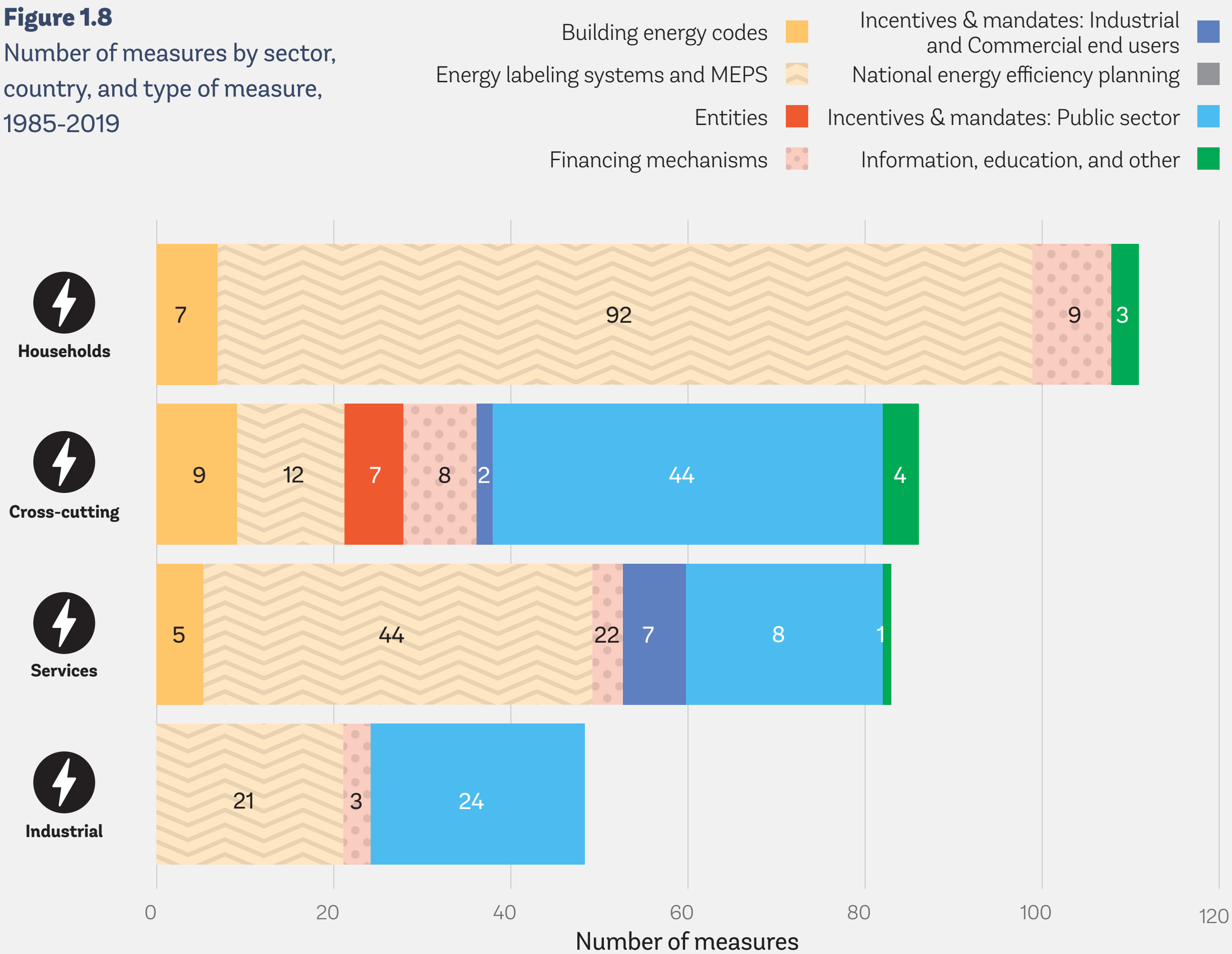
Figure 1.7
Number of measures per year per country



Source: WBG, based on the aggregation of policy databases (BIEE, ECLAC, IEA).
Note: Only measures for which a starting year was documented are accounted for.

There are also wide variations by sector in the types and quantity of policies implemented 1.8). Energy labeling systems and MEPS are the measures most frequently implemented, followed by national energy efficiency plans, and incentives and mandates. There are 111 measures for the residential sector; 84 measures for the services, commercial, and public sectors; 48 for the industrial sector; and 86 identified as "cross-cutting" (affecting three or more sectors). Most measures were aimed at households or across all sectors, the latter implying the importance of cross-cutting approaches to address the multiple challenges of implementation. "Energy labeling and MEPS measures were the most common across all sectors, especially in residential and services sectors, due mainly to the large number of labeling measures implemented for household appliances. Figure A.27 in the Appendix shows energy efficiency policies and regulations per country, across the LAC region, and provides further detail on this regard.

Figure 1.8
Number of measures by sector, country, and type of measure, 1985-2019



Source: WBG, based on aggregation of policy databases (BIEE, ECLAC, IEA).
Note: "Entities" refers to government, quasi-government or private body that can implement certain types of Energy Efficiency policies (e.g., establishing and enforcing regulations) or execute other functions (e.g., delivery of Energy Efficiency goods and services), such as a national energy efficiency agency.

Energy efficiency policies are notoriously difficult to approve and implement. They are effective if they are well-targeted to specific sectors and take into account the local context. Their implementation is often limited by several factors, including information gaps, high up-front cost of investments and diffuse nature of benefits, low visibility, and challenges in measuring results.

The implementation of energy efficiency measures needs to account for policy complexities across sectors. In 2007 and 2008 a drought caused a 30 percent reduction in the available water for hydroelectric generation in Chile, where hydroelectric generation represented 40 percent of electricity generation in the country. The drought threatened deep electricity shortages in the country. Despite this challenge, the country was able to avoid electricity interruptions by implementing a comprehensive short-term package of quick measures targeting low-hanging fruit. The measures implemented included private-public information campaigns on the importance of saving energy and how to do it; a program to distribute energy-efficient lighting; and short-term rationing.[11]

11 Sources for this paragraph and the next: https://www.cne.cl/wp-content/uploads/2016/07/AnuarioCNE2015_vFinal-Castellano.pdf; https://web.archive.org/web/20190507004819/http://antigua.cne.cl/noticias/energia/electricidad/2-gobierno-y-empresas-electricas-lanzan-campana-de-energia-ahorra-ahora; https://www.emol.com/noticias/nacional/2008/08/03/315898/gobierno-lanza-nueva-campana-para-fomentar-ahorro-y-buen-uso-de-la-energia.html.

Once the emergency had passed, the government sought to build on the success of the public information campaigns and maintain the gains by putting in place long-term financing for energy efficiency investments and offering financial incentives for conservation actions that built on the information campaigns to stimulate sustained energy savings.

The full and consistent implementation of energy efficiency polices in the region has also been hampered by lack of policy stability over time. As constraints to effective implementation of policies tend to be specific to each country, no single barrier can be easily addressed across the region, and there is no one-size-fits-all solution. An example of a long-term targeted policy measure is Mexico's program of voluntary agreements for energy efficiency (box 1.1). Two others are described in box 1.2.

Measures aimed at providing financial incentives were the most often discontinued by far; these were followed by measures designed to support energy efficiency entities, capacity building, energy efficiency programs, and information on energy efficiency (figure 1.9). It is worth mentioning that "EE entities" refers to government, quasi-government or private bodies that can implement certain types of Energy Efficiency policies (e.g., establishing and enforcing regulations) or execute other functions (e.g., delivery of Energy Efficiency goods and services), such as a national energy efficiency agency or decentralized entity, a special purpose public fund, a unit mandated to promote EE under a ministry, etc.

Box 1.1

Mexico's voluntary agreements for energy efficiency

Mexico's program of voluntary agreements (VAs) for energy efficiency, mandated under the country's energy transition law, was launched in 2019. VAs are implemented by the Secretariat of Energy, through the Commission for the Efficient Use of Energy (CONUEE), a decentralized national-level energy efficiency entity created by law in 2008. CONUEE's main objective is to promote energy efficiency and act as a technical body for the sustainable use of energy.

CONUEE signs VAs with companies that consume significant amounts of energy consumption. Under the agreements, the companies commit to cutting the energy intensity of their activities and to measuring the impacts of their efforts. The participants must specify the goal that they pledge to reach over the term of the agreement; CONUEE provides technical support to help them achieve that goal. The technical assistance provided includes support in setting goals; a methodology for energy audits (both for setting a baseline and for verification of goals); a technical and cost-benefit analysis of proposed energy efficiency actions; and potentially supporting an ISO 50.001 certification. Starting from a single agreement in 2019, CONUEE has signed VAs with 14 of the largest companies in Mexico, including Nestlé, Grupo Bimbo, Audi México, Bio Pappel Scribe, Cementos Fortaleza, Flex, Nemak, Vitro, and Ternium.

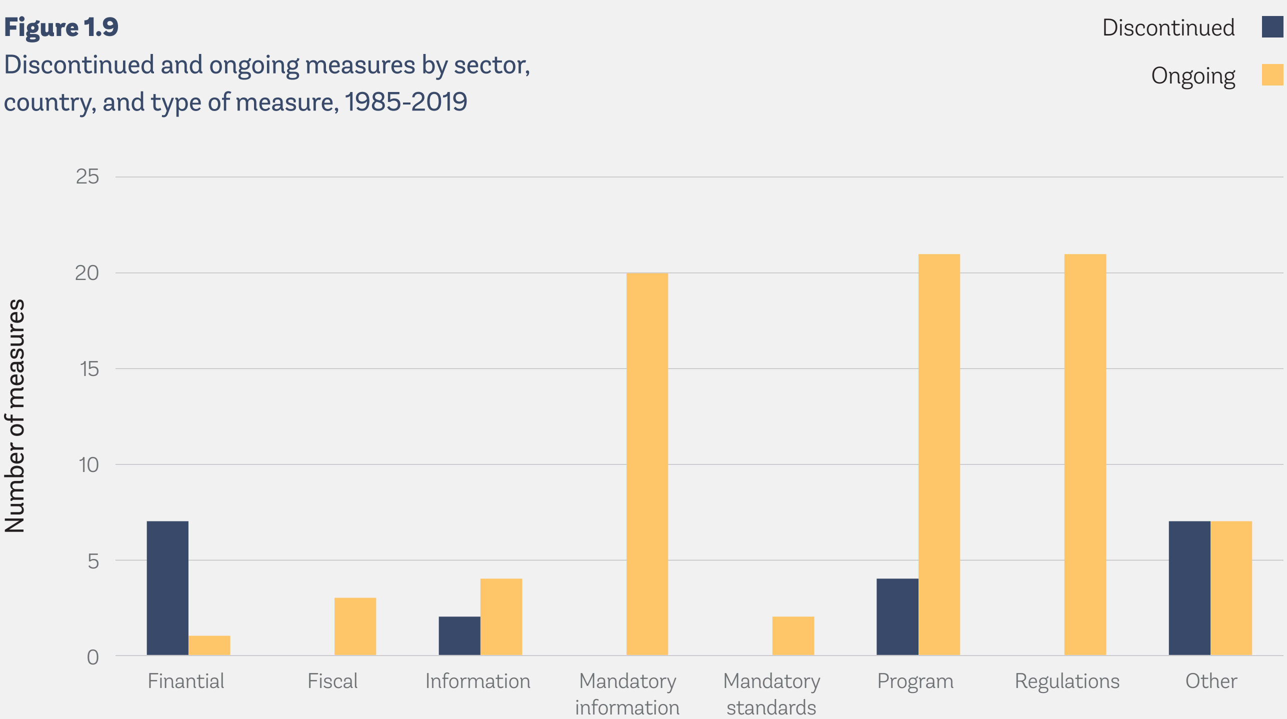
Source: Mexican Government, Energy Secretariat (SENER), CONUEE, n.d.

Box 1.2
Mexico's EE Labelling and MEPS

An energy labeling system and MEPS in Mexico are examples of an energy efficiency policy sustained over time. Started in 1995, the Mexican Official Energy Efficiency Standards (NOM-ENER) are mandatory. They include the technical specifications to be met by the equipment (minimum efficiency values or maximum energy consumption), the test methods, the conformity assessment method, and the respective energy efficiency label. CONUEE leads the standardization process and includes a Regulatory Impact Analysis, containing the estimated energy savings associated with each standard. 33 NOM-ENERs have been published, covering equipment from the residential, commercial, and industrial sectors, and the updating process for these standards is continuous.

Source: Mexican Government, Energy Secretariat (SENER), CONUEE, n.d.

Figure 1.9
Discontinued and ongoing measures by sector, country, and type of measure, 1985-2019



Source: WB team, based on ECLAC (2021) and review of public webpages of LAC countries.
Note: "Other" includes support for energy efficiency entities, awareness raising, and capacity building.

Many of the programs developed in the region have been based on international grants or technical assistance and were not sustained over time despite their good results (ECLAC 2021). International cooperation primarily seeks to achieve a quick knowledge transfer and seldom yields programs that are self-sustaining without an enabling environment (box 1.3). Although most of these programs include a government-financed capacity-building component, local governments do not always provide continuity and scale up the implemented measures. Programs dependent on public budgets are often intermittent owing to economic and socio-political crises and lack of long-term planning of energy policies. Box 1.4 presents an example of a well-designed program that has faced implementation challenges related to an inflexible regulatory framework and insufficient capacity at the municipal level.

Box 1.3
Argentina's energy efficiency program funded by the Global Environment Facility

The energy efficiency program in Argentina funded by the Global Environment Facility (GEF) is an example of a well-targeted program financed by an international grant that achieved some success during implementation but could not maintain its momentum after grant financing was exhausted. The program's objective was to increase energy efficiency and reduce emissions of greenhouse gases. This was to be achieved by providing targeted financial resources aimed at removing the regulatory, financing, and information barriers to activities and investments in energy efficiency and energy conservation.

The program helped Argentina's national government improve its capabilities to set energy efficiency standards, conduct labeling, prepare regulations, and provide SMEs with access to finance for investments in energy efficiency. It resulted in 20 sets of norms and standards, issued 19 labels for appliances, initiated an energy efficiency law project, and funded energy efficiency investments for 13 SMEs.

Nonetheless, the SME financing facility ceased operations not long after the end of the GEF project for lack of additional commitments from the government and a stable local implementing counterpart. The program might have been more sustainable had it focused on building technical capacity in the implementing partner and in helping the partner build a solid institutional structure.

Source: IBRD Extranet-Projects and Operations-Project detail-P090119.

Box 1.4
Mexico's PRESEMEH program

The ongoing PRESEMEH program in Mexico is an example of a well-designed program that has faced implementation challenges owing to insufficient municipal capacity barriers and the lack of a sufficiently flexible regulatory framework.

The program's objective is to promote energy efficiency in Mexico's municipalities and other eligible public facilities through energy efficiency investments in the public sector and to contribute to strengthening the enabling environment for energy efficiency. The project supports capacity development and institutional strengthening, while also providing financing for energy efficiency investments that will be partially repaid from anticipated energy savings. The principal implementing actor is FIDEE, a public-private financing facility, that has a sustainable financing stream based on a tax collected as a percentage of the electricity tariff. The main advantage of FIDEE as an implementer is that it is able to contract directly for works, instead of relying on municipalities, which might have limited capacity to handle the contracting.

The remaining challenges are related to municipalities' capacity for developing projects and submitting repayments to FIDEE's revolving fund. The latter problem is due to the lack of a regulatory framework flexible enough to accommodate an innovative financing mechanism.

The main lessons learned to date are related to the need to (i) ensure flexibility to adapt instruments in time, and (ii) create concentrated capacity in a single implementing agency, especially when local (municipal) capacity is limited. At the start of a program, subsidies or concessional financing (such as the concessional loan FIDEE obtained from the World Bank) can help stir initial participation. In addition, long-term sustainability and certainty come from the fact that FIDEE has a stable (albeit smaller) revenue stream to sustain its own operations. Even when the World Bank project ends, the implementing agency will be able to generate new projects.

Source: WBG team; and IBRD Extranet-Projects and Operations-Project detail-P149872.

Sanctions related to noncompliance with regulations on labeling programs or energy performance standards are applied by 10 countries in the region. Fines are adjusted to a macroeconomic indicator (in most cases linked to the country's basic salaries), which helps maintain the operational value of sanctions despite macroeconomic variations.

Lack of financing has also hampered advances in energy efficiency. Based on Latinobarometer's 2018 survey, 71 percent of households in the region would be willing to spend money on appliances that allow them to lower their electricity bill, but 22 percent of them said that they did not have the resources to cover the cost of the appliances (IDB 2019).

The lack of information on the impacts of implemented policies and measures has delayed the uptake of energy efficiency measures in the region. For example, lack of awareness was a significant impediment for energy efficiency policies in the Argentinean electricity sector (Recalde and Guzowski 2012). Improved information on impact would provide an opportunity to evaluate and disseminate results and share best practices among countries, enabling the industrial and commercial sectors to implement successful measures without public support. The lack of reliable information on the impacts of energy efficiency policies and programs limits comparability and is a barrier to their replication across countries and sectors. It also misses the sizeable potential efficiency gains that could be achieved through behavioral changes like promoting maximum heating and minimum cooling temperatures in homes. Recent research shows that behavioral barriers can indeed be addressed by increasing awareness of energy efficiency benefits, such as by promoting energy audits in the building sector (Bagaini et al. 2020).

RISE scores and energy efficiency policies

RISE—Regulatory Indicators for Sustainable Energy—is a set of indicators intended for use in comparing the policy and regulatory frameworks that countries have put in place to support the achievement of Sustainable Development Goal 7 on universal access to clean and modern energy (World Bank 2021). The third edition of the report (ESMAP 2020) captures policies and regulations that enhance sustainable energy in the form of 30 indicators distributed among four pillars: access to electricity, clean cooking, renewable energy, and energy efficiency.

As RISE scores seek to achieve a homogenous and comparable scoring system, it is hard to capture all nuances and differences in energy efficiency policies between countries and between sectors in each country. Also, scores sometimes do not reflect the country's updated policy landscape, or they rely heavily on the *enactment* of regulation for scores, without being able to assess if and how these policies are actually *implemented* on the ground. These measurement issues notwithstanding, the RISE scores are the best available measure to benchmark advances in energy efficiency policy and action among countries and sectors.

Notwithstanding their limitations, RISE scores are the best available benchmarks of energy efficiency policies and actions among countries and sectors and are thus taken as a reference framework for this analysis. The following categories of policy indicators are considered: (i) national planning; (ii) specific energy efficiency entities, incentives, and mandates for the private sector (industrial and commercial end users); (iii) incentives and mandates for the public sector; (iv) financing mechanisms; (v) MEPS; (vi) energy labeling systems; and (vii) building energy codes.

The areas of national planning and entities are closely interdependent and are fundamental enablers to develop, implement, and sustain long-term policies to promote energy efficiency. These policies help coordinate multiple actors, ensure sustainability of policies and programs, provide clarity on objectives and tools, channel concessional financing, and enable information exchanges.

Incentives and mandates for the private sector (industrial and commercial end users) are common elements of most national energy efficiency plans. The industrial and commercial sectors include most large individual consumers. In many cases, initiatives cover both sectors with incentives such as specific energy-saving targets, compliance with mandatory audits, and the obligations to implement energy management systems, among others.

Incentives and mandates for the public sector usually hinge on a combination of initiatives. These comprise energy-saving obligations in buildings, control and monitoring mechanisms, and mandatory guidelines for the purchase of products and services with certain energy efficiency characteristics. In addition, they sometimes include provisions for public budget regulations to allow public entities to retain the energy savings they achieve through energy efficiency.

Financing of policy instruments and financial incentive schemes to eliminate or reduce barriers to energy efficiency are key policy elements. Financial tools have shown good results in many countries, where they ensure the development of a market for energy-efficient goods and services. However, despite the critical need for financing, the current regional context is expected to further restrict access to financing for such investments, mostly due to a sharp slowdown in growth in the region, contracting fiscal space, inflationary pressures, and exchange rate volatility. The most commonly used financing instrument is a trust (a specific fund targeted to achieve a policy goal). Other mechanisms for promoting investments are tax exemptions, tariff preferences, and awards for excellence. Sixty-nine percent of the countries analyzed included aspects related to this topic (Argentina, Brazil, Colombia, Dominican Republic, Ecuador, Guatemala, Nicaragua, Panama, Peru, Uruguay, and Venezuela), but the combination of mechanisms that each country uses to encourage investments and financing for the development of energy efficiency are different.

Energy labeling systems provide reliable information to consumers on the energy efficiency of products, while MEPS help displace the most inefficient equipment from the market. Product labeling and minimum energy efficiency standards are key to allow industry and consumers to make economic choices when purchasing appliances and equipment. They also help to support oversight of large consumers' compliance with standards for processes, services, and products.

There is little financial incentive for builders to pay the additional capital costs required for more efficient buildings. Building codes attuned to energy efficiency address this barrier by setting minimum energy efficiency standards for building technologies and design elements that may include the building envelope, HVAC systems, and lighting, among others.

The evolution of overall RISE energy efficiency scores in the region shows consistent improvements. Over the past decade all LAC countries have improved their RISE scores for the overall energy efficiency policies. Scores have improved in the region across all energy efficiency subindicators. The subindicators showing the largest improvement at the regional level are those dealing with national planning, entities, and energy labeling systems.[12]

The evolution of RISE scores in the largest countries of the region differs from that in the rest of the region (figure 1.10). Compared to 2010 the largest LAC countries reported a notable improvement in energy labeling systems. There was a certain level of progress in the other areas, such as financing mechanisms and entities. Other countries had a general improvement in the areas of entities, national planning, and incentives and mandates for the public sector. Over the period 2010 to 2019, the largest countries made moderate progress in the categories of entities, financing mechanisms, and energy labeling systems, while in the rest of the region, only financing mechanisms stands out. Policies for building energy codes were little changed in either of two country categories.

Although each country's characteristics, priorities, and performance on these indicators is different, it is relevant to highlight the importance of making progress in the areas of national planning and entities since these are indispensable for the development of long-term policies to promote energy efficiency.

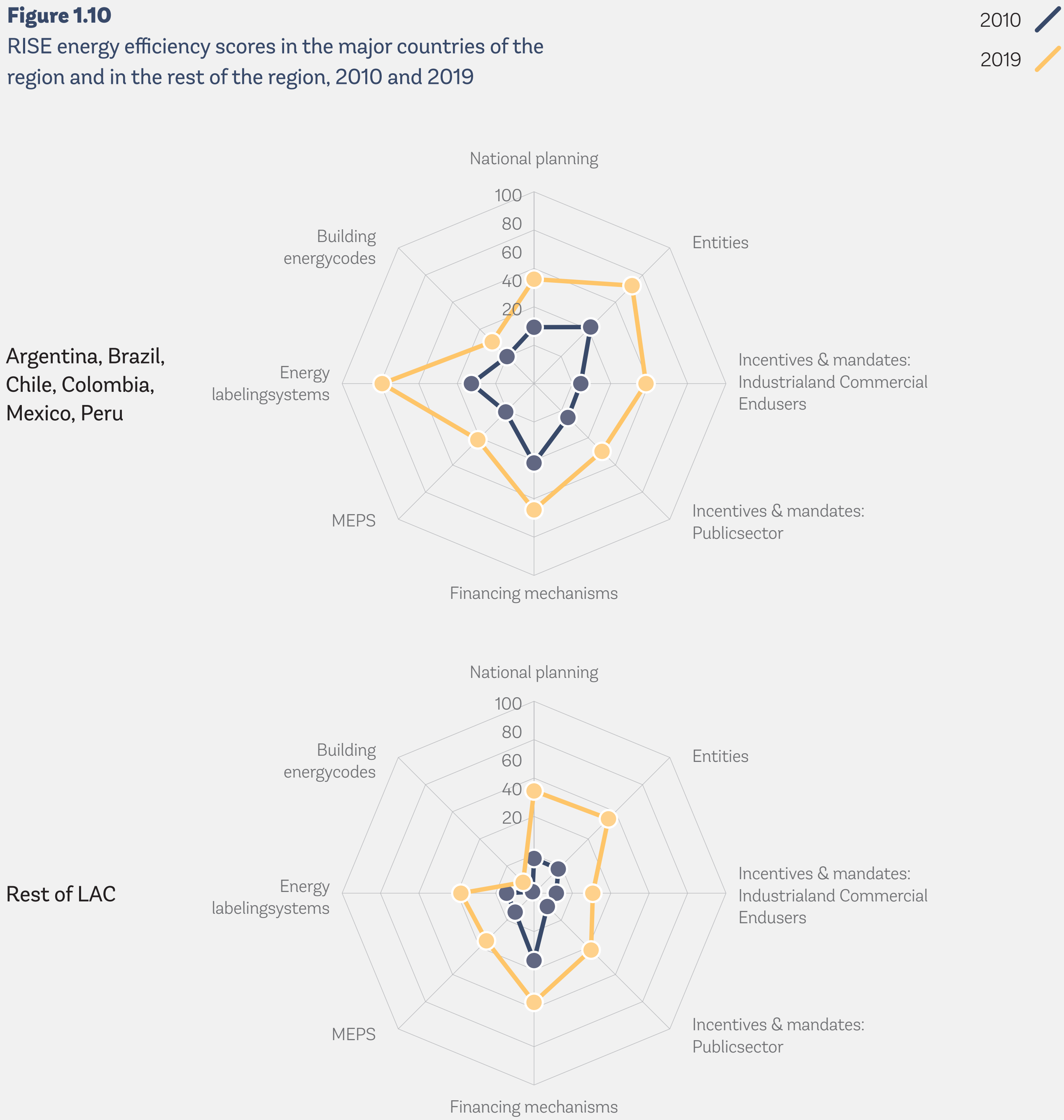
12 To ensure that all countries in the benchmark exercise were comparable, we used the IEA energy dataset, which included 19 LAC countries. Cuba and Venezuela are not included because they are considered outliers. Suriname and Trinidad and Tobago are not included because they lack household consumption data, which is needed for the disaggregation of the residential sector. Barbados is not in the IEA dataset. RISE covers EE policies in every sector, including utilities and transport.

According to RISE, all LAC countries show some increase in the quantity and scope of energy efficiency policies implemented in the past decade (figure 1.11). Mexico ranks first, followed by Panama, Brazil, and Costa Rica; with Panama showing the largest absolute score increase for the group.

RISE scores are moderately well correlated with records of energy efficiency actions implemented in countries (figure 1.12). Using information from ECLAC's Base of Energy Efficiency Indicators (BIEE) (ECLAC 2021) and the IEA's policies database (IEA 2021b), it was possible to compile a database of energy efficiency policies and programs in LAC countries. This information was supplemented with additional measures from official country websites, as noted previously. Together these sources were used to construct an extended database of cumulative policies and actions. Figure 1.12 was constructed based on this information.

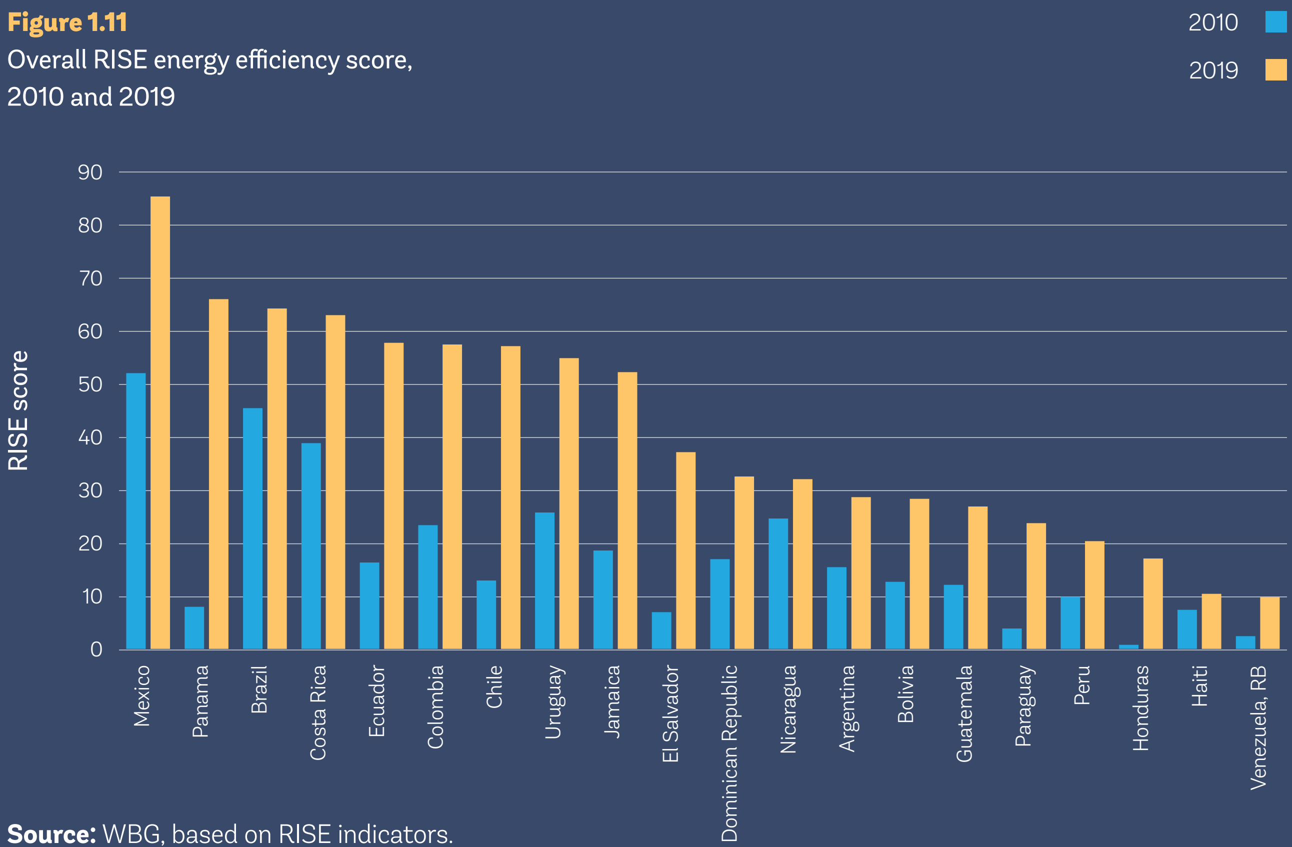
Figure 1.10

RISE energy efficiency scores in the major countries of the region and in the rest of the region, 2010 and 2019



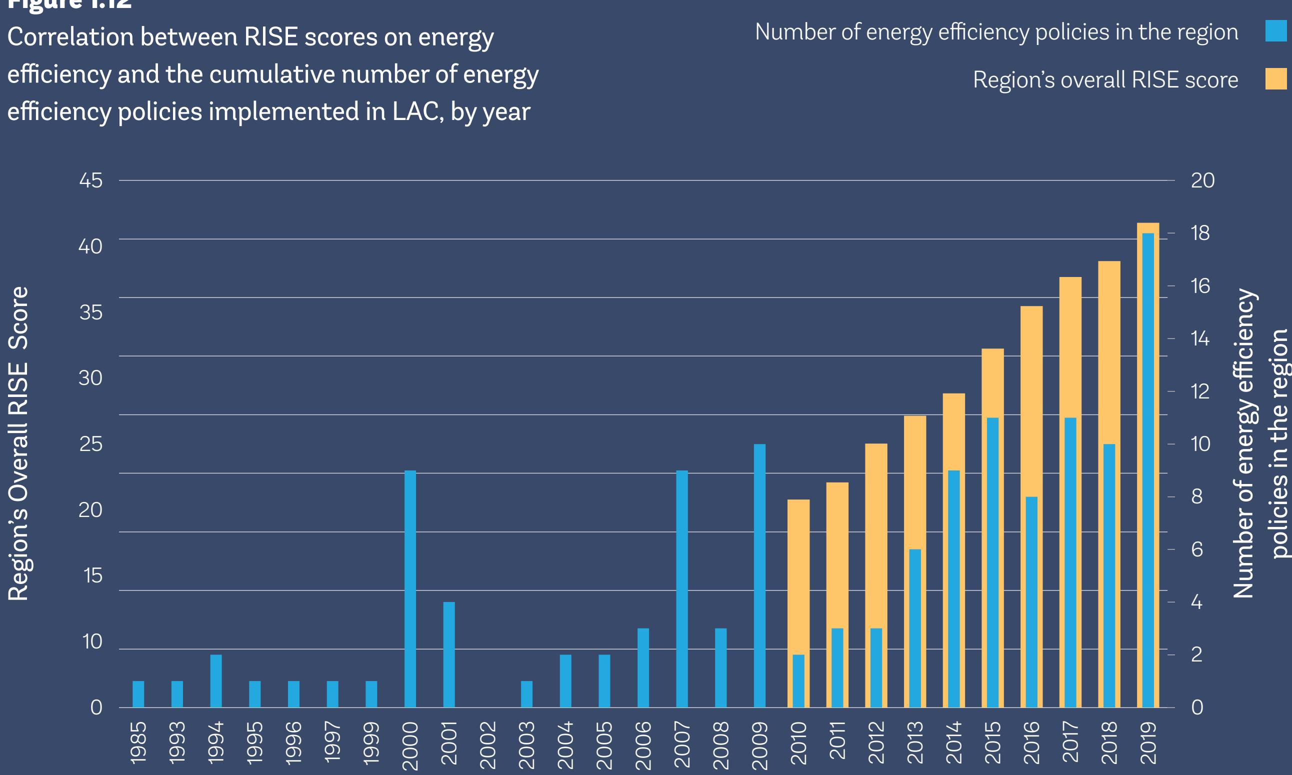
Source: WBG, based on RISE indicators.

Figure 1.11
Overall RISE energy efficiency score, 2010 and 2019



Source: WBG, based on RISE indicators.

Figure 1.12
Correlation between RISE scores on energy efficiency and the cumulative number of energy efficiency policies implemented in LAC, by year



Source: RISE, BIEE, IEA.

Energy efficiency potential in the region

The projections developed in *World Energy Outlook 2020* (IEA 2021a) are used to estimate the potential for energy efficiency in LAC. The analyzed scenarios are:

- The Stated Policies Scenario (STEPS) reflects the latest announced policy intentions and targets, insofar as they are backed up by detailed measures for their realization.

- The Sustainable Development Scenario (SDS) models an increment in energy efficiency and low-carbon energy policies and investment on top of what is assumed in the STEPS scenario. The SDS puts the energy system on track to achieve the Paris Agreement goal, as well as energy access and air quality goals. The assumptions on public health and the economy are the same as in STEPS.

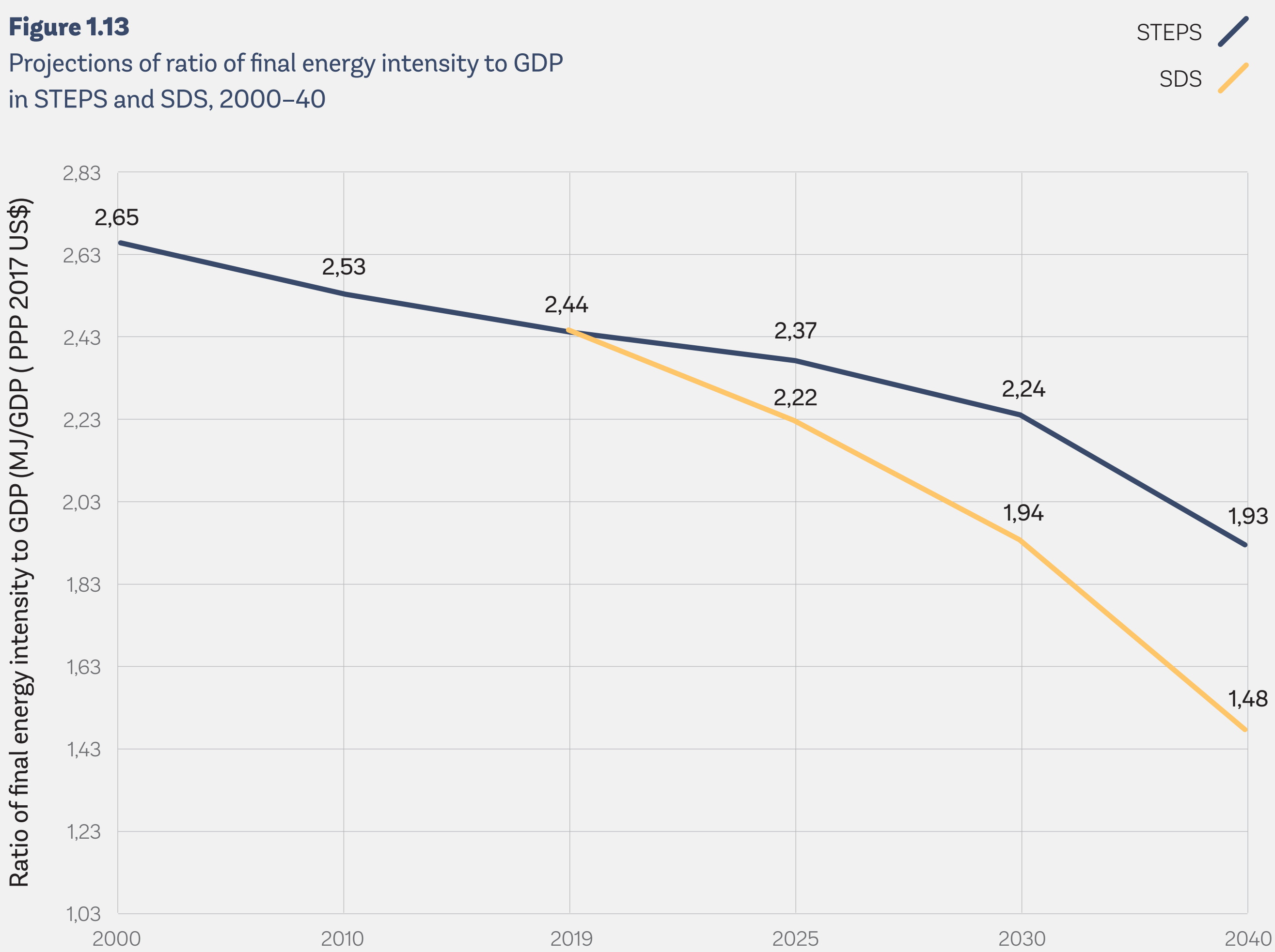
The scenarios suggest that the right energy efficiency measures can reduce cumulative global CO_2 emissions by up to one-third by 2030. In other words, energy efficiency measures account for one-third of the cumulative CO_2 emission reductions between STEPS and SDS. Figure 1.13 shows the projection for the region, calculated for the country group "Central and South America" (as defined by IEA).[13] The projections of the expected evolution of energy intensity for the countries in the group are applied to the reported regional energy intensity for the "LAC region" (as defined by OLADE[14]). The goal is to analyze the potential of energy efficiency measures to accelerate achievement of the SDG targets for the same set of countries.

The SDS scenario projects a more pronounced decrease in energy intensity, with a larger impact in the short term, as a result of an intensification of energy efficiency policies. The scenario foresees that the post-Covid-19 recovery will be accompanied by energy efficiency measures, achieving an annual improvement of 1.5 percent between 2019 and 2025. This implies continuing the measures already developed while implementing new policies with a higher impact on energy intensity. Further acceleration of the improvement in energy intensity is expected between 2025 and 2030 (at an annual rate of improvement of 2.7 percent) and between 2030 and 2040 (with an annual rate of improvement of 2.6 percent). This scenario marks a clear upside compared to the region's improvement trend over the last 20 years (around 0.5 percent each year). As shown in the figure, there is still room for improvement between the region's expected energy intensity based on current policies (STEPS scenario) and what could be achieved with policies aimed to keep global warming at a level "well below" 2°C (SDS scenario).

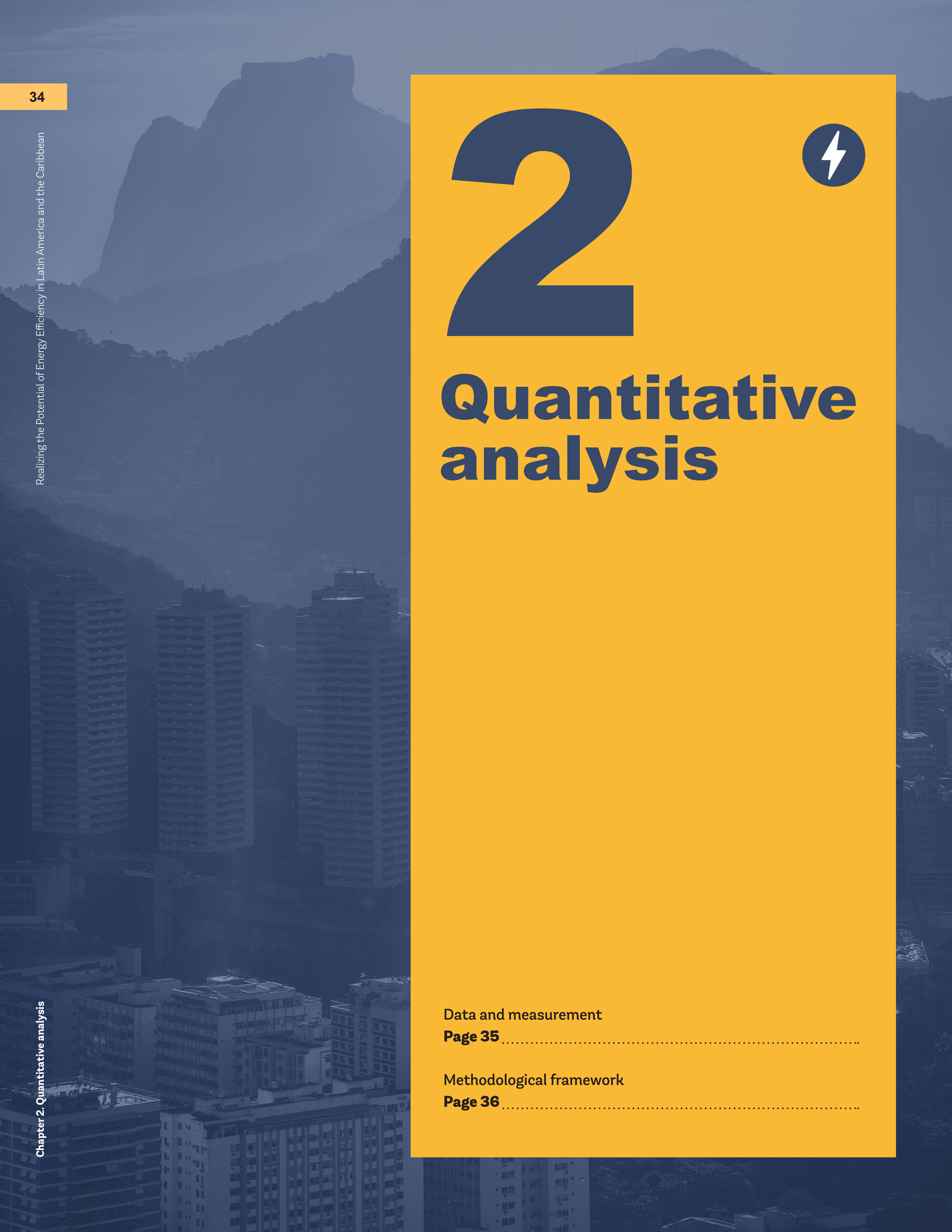
13 In the IEA's scenarios, Central and South America includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Bolivarian Republic of Venezuela (Venezuela), and other Central and South American countries and territories.

14 For OLADE's estimations, LAC countries include Argentina, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Granada, Guatemala, Guyana, Honduras, Haiti, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, República Dominicana, Suriname, Trinidad y Tobago, Uruguay, Venezuela.

Figure 1.13
Projections of ratio of final energy intensity to GDP in STEPS and SDS, 2000–40



Source: WBG, based on IEA 2020.
STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.



2 Quantitative analysis

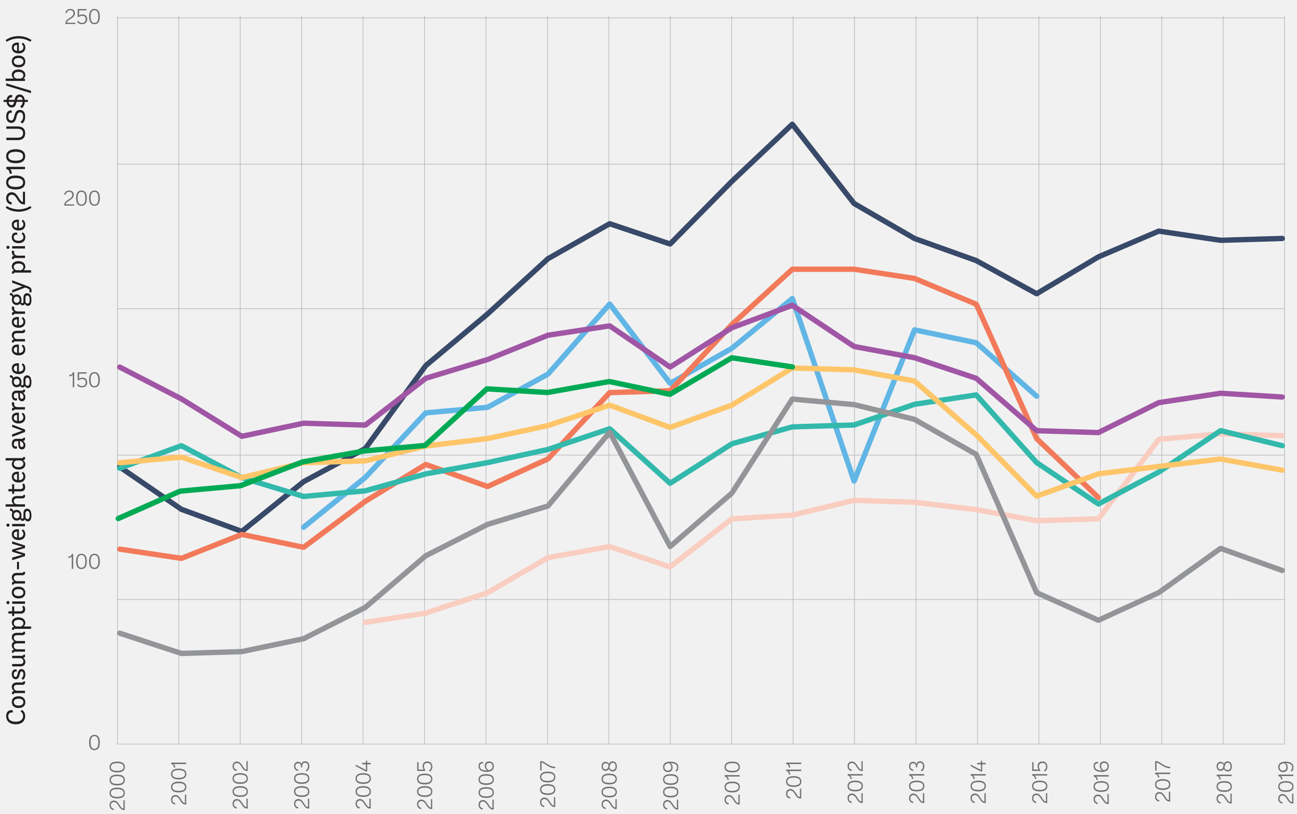
Data and measurement

The data used in the quantitative analysis come from variety of sources, including the IEA, the International Monetary Fund (IMF), OLADE, Penn World Tables, and the World Bank's Open Data and RISE databases for the period 2000–19. The variables of interest include final energy consumption, energy prices and value added, GDP, population, labor, capital stock, investment, exchange rates, heating and cooling degree days, and regulatory indicators. The energy consumption and value-added indicators are disaggregated into four sectors (agriculture and mining, manufacturing, services, and residential), while all other indicators are at the country level.

Energy prices and consumption are calculated based on series for electricity, gasoline, diesel, fuel oil, kerosene, LPG, and natural gas. Interpolation and extrapolation methods were used to fill gaps in the price series. The final energy end-use price is calculated as a consumption-weighted average for each country. Energy subsidies are calculated using a price-gap approach.

Real energy price growth in the LAC region has been modest and, on average, has tracked the world energy price (figure 2.1). However, trends have varied significantly across the region. Prices grew faster than the regional average in some larger economies, such as Brazil, Chile, and Colombia. In Argentina, they have also increased but remain well below the regional average. They remained stagnant or even decreased in Mexico, Peru, and smaller countries.

Figure 2.1
Evolution of energy prices in LAC, 2000–19



Source: EIA, OLADE, based on authors' calculations.
Note: Owing to limited data availability, the consumption-weighted average energy price for each country is computed using final energy consumption of gasoline, diesel, kerosene, LPG, natural gas, and electricity due. The world energy price is proxied by the Brent crude oil spot price.

Methodological framework

The methodological framework of quantitative analysis involves three stages: (i) Fisher decomposition of energy intensity index; (ii) econometric analysis of energy intensity drivers, and (iii) counterfactual simulations of energy efficiency policies. The first stage separates actual changes in energy efficiency within each sector of the economy from changes in the economy's industrial structure. The second stage identifies key factors affecting energy efficiency. The third quantifies the extent to which energy policies can improve energy efficiency in LAC countries. (A more extensive treatment of the report's methodology appears in the appendix.)

Fisher decomposition analysis separates the aggregate energy intensity index into the index in each sector and the activity index of changes in the productive structure of the economy. It aids in understanding whether changes in a country's average energy intensity are driven by sectoral improvements in energy efficiency or merely reflect the changing composition of the economy. It also helps identify policies that can better target specific sectors of the economy. Mathematical details of the Fisher decomposition method are shown in the appendix. The methodological advantage of the Fisher method is that it is exact. It allows for accurately calculating the difference between current energy consumption and energy consumption that would have occurred had energy efficiency or the activity component of the energy intensity index remained at the 0 level (time t_0).

The decomposition is performed based on a sample of LAC countries for which sector-level data were available for the agriculture, manufacturing, services, and residential sectors over the period 2005–18. Unfortunately, data limitations prevent a more granular decomposition, even though there is a considerable variation in energy intensity within economic subsectors.[15]

The econometric analysis involves estimating regressions for panel data to determine the effects of energy prices and policies on the energy intensity index and its activity and efficiency components. Each energy policy proxied by the

15 For example, the mining sector tends to be more energy intensive than the agriculture sector, and there is considerable variation in energy intensity across manufacturing industries.

RISE subcomponent is included in a separate regression to avoid problems of co-linearity. The control variables include heating and cooling degree days that account for variation in energy demand under different climate conditions. The capital-labor ratio and the squared capital-labor ratio variables control for potential impacts of capital intensity on energy intensity. The investment-to-capital ratio variable indirectly controls for different energy intensities of the capital stock vintages. The population growth variable controls for potential effects of adding infrastructure for energy efficiency and intensity in slow-growing versus fast-growing countries. The time trend and the squared time trend variables control for the rate of technological progress. All variables except the time trend and population growth rate are converted to natural logarithms and carry elasticity interpretations.

Although caution is warranted in interpreting the estimated effects of energy policies, the potential for endogeneity bias is likely to be small. Energy prices are determined by trends in the global commodity market and are plausibly exogenous. However, estimated coefficients for energy policies may be confounded by unobserved factors (such as country-specific capabilities to implement these policies through different stages) that are also correlated with outcomes. While this bias cannot be fully eliminated, it is effectively reduced by adding control variables, time and country fixed effects, and lagged values of policy variables.

In addition, bias may be created by omitting policies from the estimated regressions. This bias appears to be negligible, as the magnitude of estimated coefficients seemed little changed when all policies were added in the regression. Since the analysis is based on a sample of LAC countries, its results are not generalizable to other countries with different income and development levels, production structures, and rural-urban ratios.

Counterfactual simulations use the estimated parameters to quantify the extent to which policies affect improvements in energy efficiency. Two policies are considered. The first is the elimination of fossil fuel subsidies leading to an increase in end-use energy prices. The second is the change in energy efficiency regulations captured by RISE scores. Specifically, the simulations analyze a scenario where all LAC countries improve their RISE scores to the level of the best-performing economy.

3

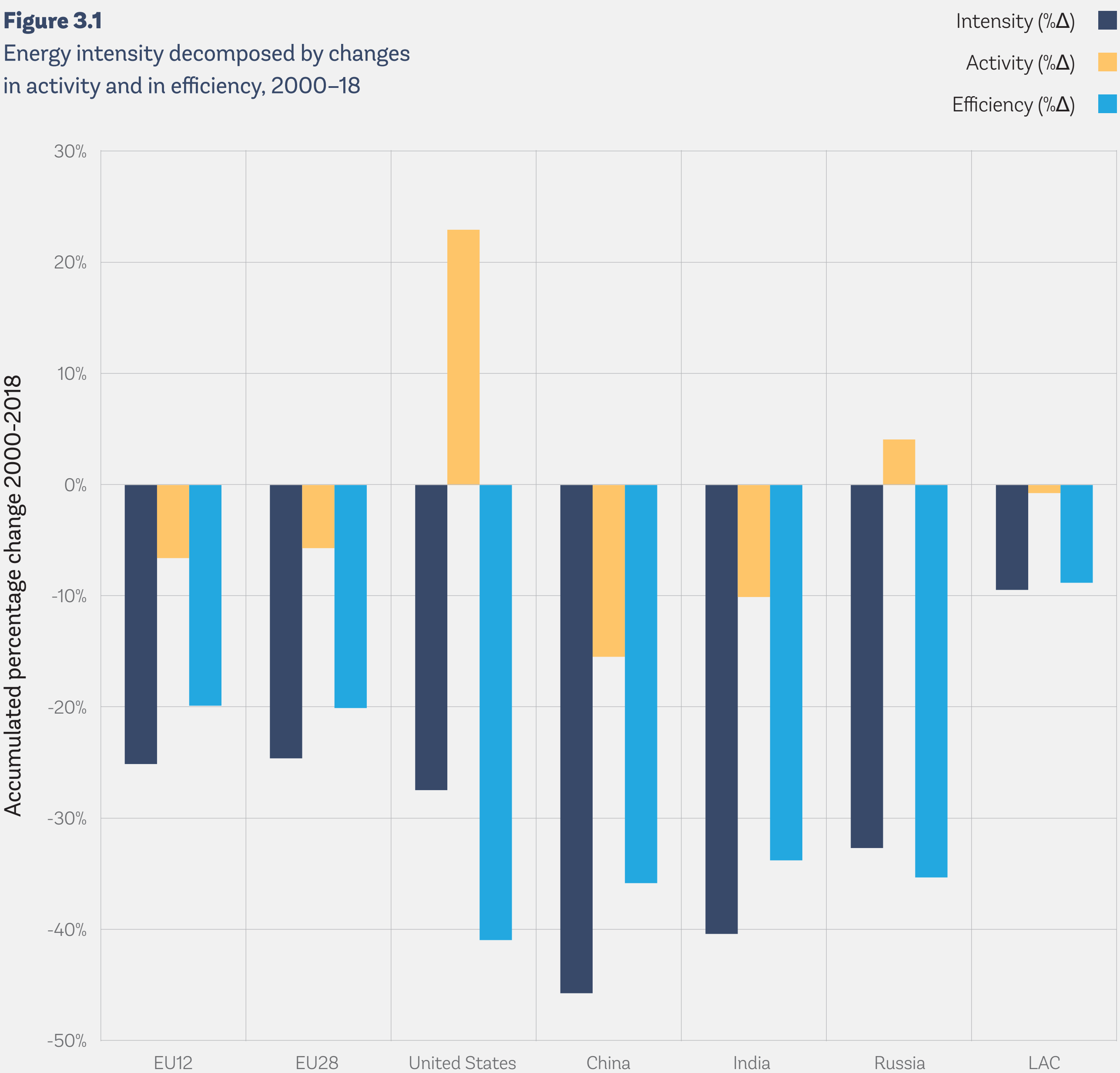
Results of the Fisher decomposition analysis

When compared to the United States, China, India, Russia, and the European Union (average), the LAC region stands out for the slow rate at which it is reducing its energy intensity (figure 3.1). Shifts to more energy-efficient sectors of the economy and improvements in sectoral energy efficiency have contributed to a decline in the energy intensity index in China, India, and the European Union. In the United States and Russia, improvements in sectoral energy efficiency have been partially offset by the reallocation of economic activity to more energy-intensive sectors. In the countries of the regions, reductions in energy intensity were due to sectoral improvements in energy efficiency; there was no change in the industrial structure.

Changes in energy intensity, economic composition, and sectoral indices of energy efficiency in the region reveal significant heterogeneity among the LAC countries. Guyana had the largest reduction in its energy intensity index (42.8 percent) over the 2006–2018 period, while Jamaica had the largest increase between 2000 and 2018 (17.6 percent). Among the major countries of the region, Colombia achieved the largest reduction in energy intensity (24.7 percent), followed by Peru (20.6 percent), Chile (19.8 percent), Argentina (11.3 percent), Mexico (10.3 percent), and Brazil (4.4 percent).

Figure 3.1

Energy intensity decomposed by changes in activity and in efficiency, 2000–18

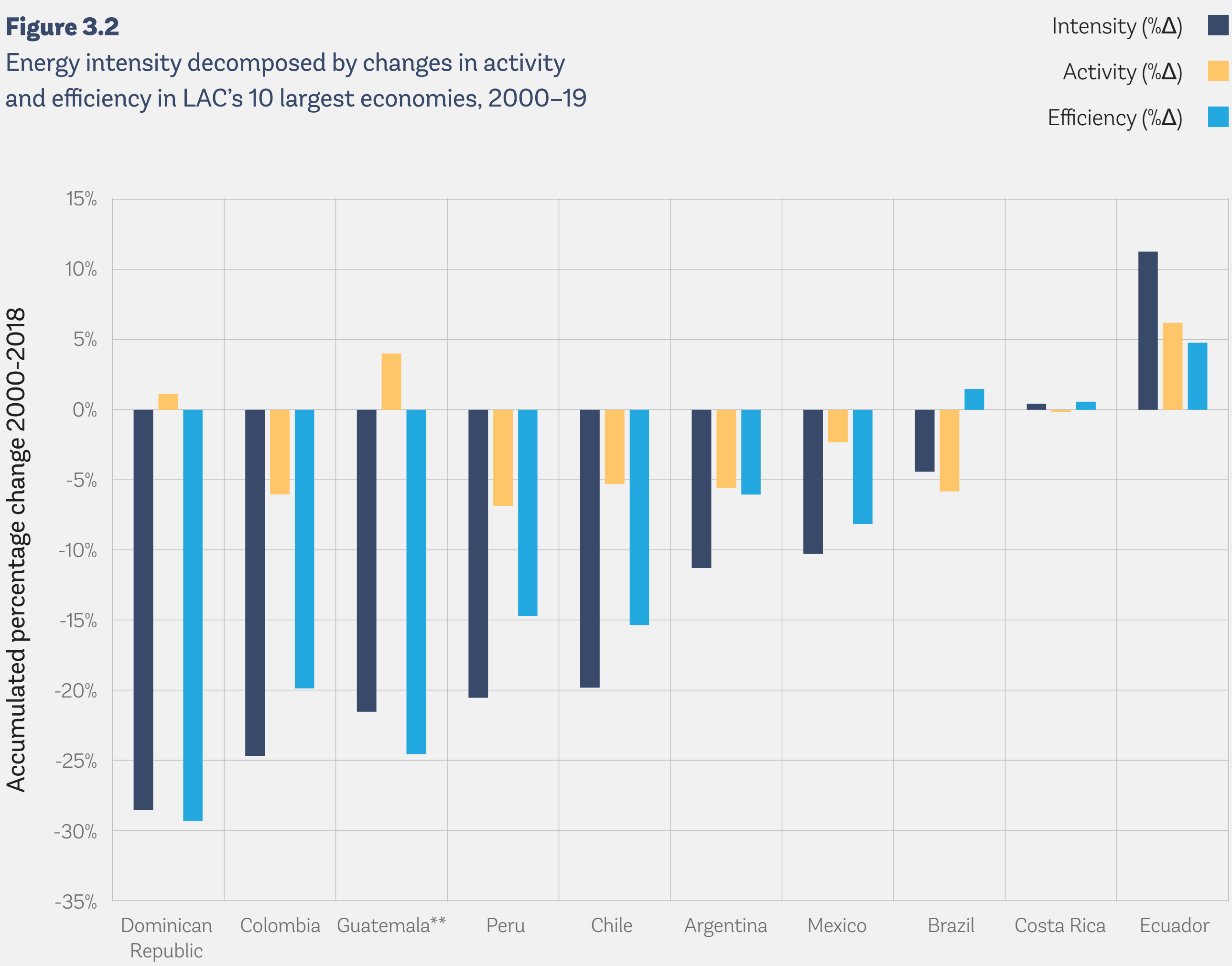


Source: WDI, IEA.

What have been the drivers of changes in energy intensity?

There are different sources of changes in energy intensity across LAC countries (figure 3.2). In the five major economies of the region, the shift in economic activity toward less energy-intensive industries has played a major role in Brazil, reducing the energy intensity index of the Brazilian economy by 5.8 percent. In contrast, in Chile, Colombia, Mexico, and Peru, improvements in the sectoral energy efficiency index were more prominent. These yielded reductions of between 6 and 19.9 percent in the overall energy intensity index. In Argentina's case, the improvements in both indexes are roughly equal. Costa Rica shows almost no change on all indicators, and Ecuador displays a noteworthy increase in energy intensity, driven both by changes in the composition of economic activity and by reductions in energy efficiency. Most of the largest economies seem to be undergoing structural changes in their industrial structures, with resources shifting from more to less energy-intensive industries.

Figure 3.2
Energy intensity decomposed by changes in activity and efficiency in LAC's 10 largest economies, 2000–19



Source: OLADE, UN data. Note: For Guatemala, Fisher Decomposition is performed using only three industries, manufacturing, services, and residential. For the other countries, agriculture and mining are also included.
Note (**): The OLADE does not report energy consumption data of the agricultural and mining sector (ISIC A–C) for Guatemala. Therefore, Fisher Decomposition for this country does not include the agricultural and mining sector.

Econometric analysis and results

Regression results show the importance of energy prices and regulatory policies in explaining changes in energy intensity in the region. Higher energy prices help to lower energy intensity owing to improvements in sectoral energy efficiency, though some of these improvements are offset by a higher energy intensity of economic activity. Improvements in energy efficiency regulations led to improvements in energy intensity and sectoral indices of energy efficiency while having no statistically significant effect on the energy intensity of economic activity. When looking at the regional (LAC) level, national planning, governance, and financing mechanisms appear as the most salient regulatory policies achieving reductions in energy intensity and improving sectoral energy efficiency.

Higher energy prices are associated with lower energy intensity and higher sectoral energy efficiency. Table 2.1 shows that a 1 percent increase in energy prices is associated with a 0.16 percent decrease in the economy-wide energy intensity index. This coefficient can also be interpreted as the price elasticity of energy intensity. Table 2.2 shows that a 1 percent increase in energy prices is associated with a 0.20 percent decrease in the sectoral energy efficiency index. Table 2.3 shows that a 1 percent increase in energy prices is associated with a 0.04 percent increase in the economic activity component of the energy intensity index.

These findings suggest that higher energy prices produce a decline in the index as sectoral energy efficiency improves. However, this effect is partially offset by a "rebound effect" (such as higher energy consumption in response to improvements in energy efficiency), leading to the reallocation of some economic activity to the more energy-intensive industries. [16]

16 For more details on the rebound effect, see Sorrell (2007).

Table 2.1. Link between RISE scores, energy intensity index, and energy price

	(1)	(2)	(3)	(4)	(5)
Energy price	-0.16***	-0.16***	-0.16***	-0.15***	-0.19***
RISE EE scores		-0.08***			
RISE EE scores $_{t-1}$			-0.07***		
RISE EE scores $_{t-3}$				-0.07***	
RISE EE scores $_{t-5}$					-0.08***
N	319	319	300	262	224
R-square	0.71	0.75	0.77	0.81	0.84
Country and year FE	Yes	Yes	Yes	Yes	Yes

Note: Control variables include levels and squared terms of the capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of a time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank

Table 2.2. Link between RISE scores, energy efficiency, and energy price

	(1)	(2)	(3)	(4)	(5)
Energy price	-0.20***	-0.20***	-0.20***	-0.18***	-0.22***
RISE EE score		-0.09***			
RISE EE scores $_{t-1}$			-0.08***		
RISE EE scores $_{t-3}$				-0.07***	
RISE EE scores $_{t-5}$					-0.08***
N	319	319	300	262	224
R-square	0.72	0.75	0.78	0.81	0.84
Country and year FE	Yes	Yes	Yes	Yes	Yes

Note: Control variables include levels and squared terms of the capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of a time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank.

Table 2.3. Link between RISE scores, economic activity, and energy price

	(1)	(2)	(3)	(4)	(5)
Energy price	0.04***	0.04***	0.04**	0.03*	0.03**
RISE EE score		0.01*			
RISE EE scores $_{t-1}$			0.01		
RISE EE scores $_{t-3}$				0.00	
RISE EE scores $_{t-5}$					-0.00
N	319	319	300	262	224
R-square	0.75	0.75	0.78	0.83	0.88
Country and year FE	Yes	Yes	Yes	Yes	Yes

Note: Control variables include levels and squared terms of the capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of a time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank.

Energy efficiency regulatory policies reduce energy intensity and improve sectoral energy efficiency. In various model specifications, improvements in RISE energy efficiency scores consistently show reductions in the energy intensity index and improvements in sectoral energy efficiency. A 1 percent increase in score results in a 0.08 percent reduction in the energy intensity index and sectoral index. There is no statistically significant effect of regulatory policies on the economic activity component of energy intensity scores. The effects of regulatory policies, measured by RISE scores, remain stable over time. Higher RISE scores from three or five years ago have a statistically significant and negative relationship with the economy-wide energy intensity index and sectoral index.

Better national planning, strong energy efficiency policy, regulation and implementation capacity at all government levels, and improvements in financing mechanisms all help to lower energy intensity and promote sectoral energy efficiency. Tables 4.4 through 4.6 show that improvements in national planning scores, the scores of energy efficiency entities, and financing mechanism scores yield negative and statistically significant effects on the energy intensity and sectoral indices. A 1 percent increase in score results in a 0.01 to 0.02 percent reduction in the two indices. These changes do not appear to have any effect on the industrial composition of the economy.

Table 3.4. Link between national planning RISE score, energy intensity, and energy price

	Energy intensity	Efficiency Index	Activity Index
Energy price	-0.17***	-0.21***	0.04***
RISE scores: national planning	-0.02***	-0.02***	-0.00
N	319	319	319
R-square	0.72	0.73	0.75
Country and year FE	Yes	Yes	Yes

Note: Dependent variables are the Fisher energy intensity, energy efficiency, and activity indices, respectively. Control variables include levels and squared terms of the capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank.

Table 3.5. Link between the RISE score of energy efficiency entities, energy intensity, and energy price

	Energy intensity	Efficiency Index	Activity Index
Energy price	-0.15***	-0.20***	0.04***
RISE scores: EE entities	-0.02***	-0.01**	-0.00
N	319	319	319
R-square	0.73	0.73	0.75
Country and year FE	Yes	Yes	Yes

Note: Dependent variables are Fisher energy intensity, energy efficiency, and activity indices, respectively. Control variables include levels and squared terms of the capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of a time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank.

Table 3.6. Link between financing mechanism RISE scores, energy intensity, and energy price

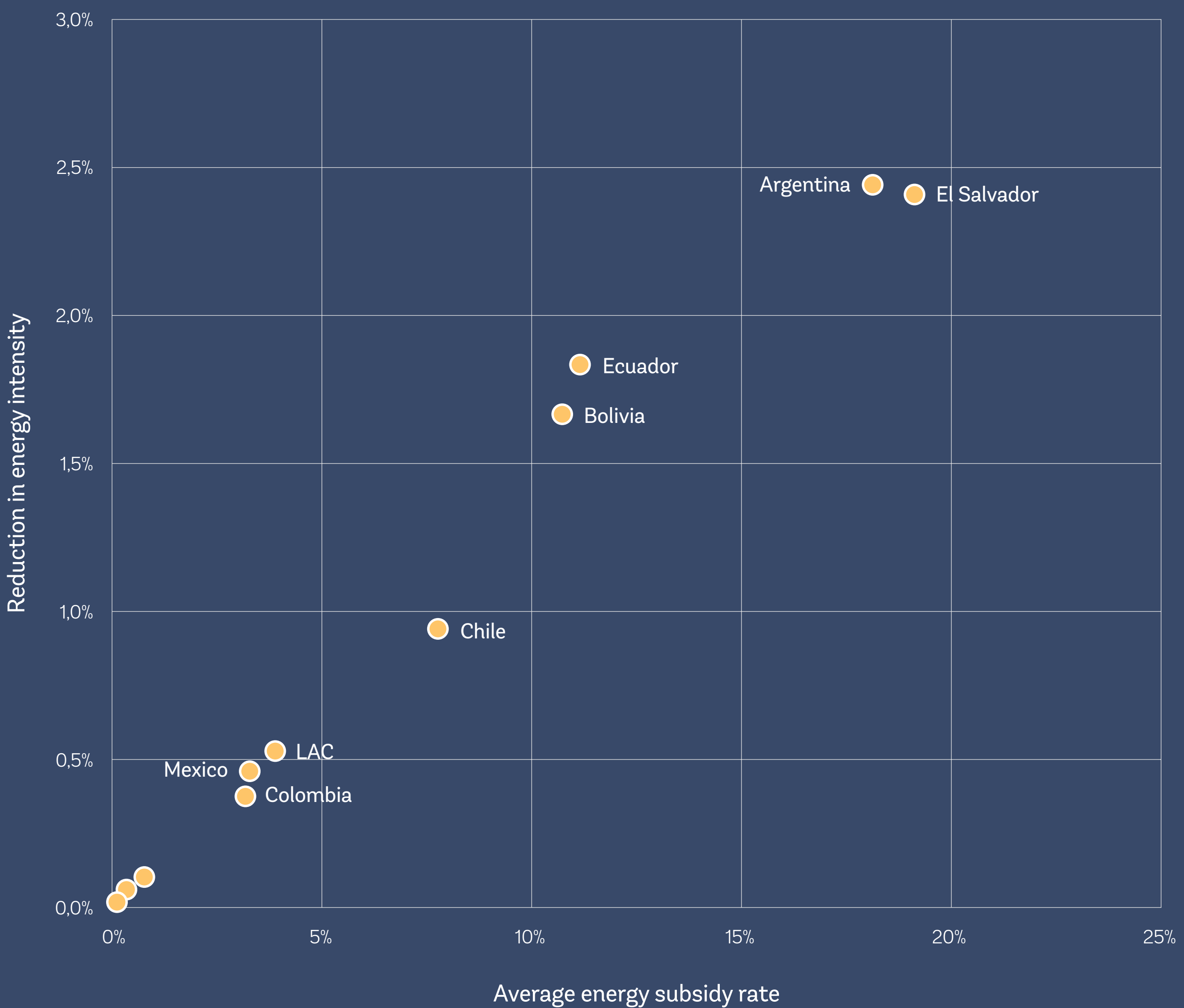
	Energy intensity	Efficiency Index	Activity Index
Energy price	-0.15***	-0.19***	0.04***
RISE scores: financial mechanism	-0.02***	-0.02***	0.00
N	319	319	319
R-square	0.72	0.73	0.75
Country and year FE	Yes	Yes	Yes

Note: Dependent variables are Fisher energy intensity, energy efficiency, and activity indices, respectively. Control variables include levels and squared terms of capital-labor ratio, investment to capital ratio, population growth rate, cooling degree days (CDD), heating degree days (HDD), and levels and squared terms of a time trend. All variables are in natural logarithms except for population growth rates and time trends.
FE = Fixed Effects.
Source: OLADE, UN data, Penn World Tables, IEA, World Bank.

Counterfactual simulations and results

Eliminating energy subsidies has a large potential for reducing energy intensity in LAC countries (figures 3.3 and 3.4). From the perspective of investors, energy subsidies lower the commercial feasibility of energy efficiency projects by increasing their payback period. This reduces the attractiveness of the investments, as their value relative to alternative investments drops. Counterfactual simulations reveal that countries with large energy subsidies, such as Argentina, Bolivia, Ecuador, and El Salvador, can achieve a 1.7 to 2.5 percent reduction in their energy intensity index and 2 to 3 percent improvements in their sectoral energy efficiency. Phasing out fossil fuel subsidies in countries with moderate subsidization, such as Chile, Colombia, and Mexico, can result in a 0.4 to 1 percent decline in the energy intensity index and 0.5 to 1.3 percent improvements in their sectoral energy efficiency. The average gains resulting from eliminating subsidies in the entire region are estimated at 0.5 for energy intensity and 0.7 percent for sectoral energy efficiency.

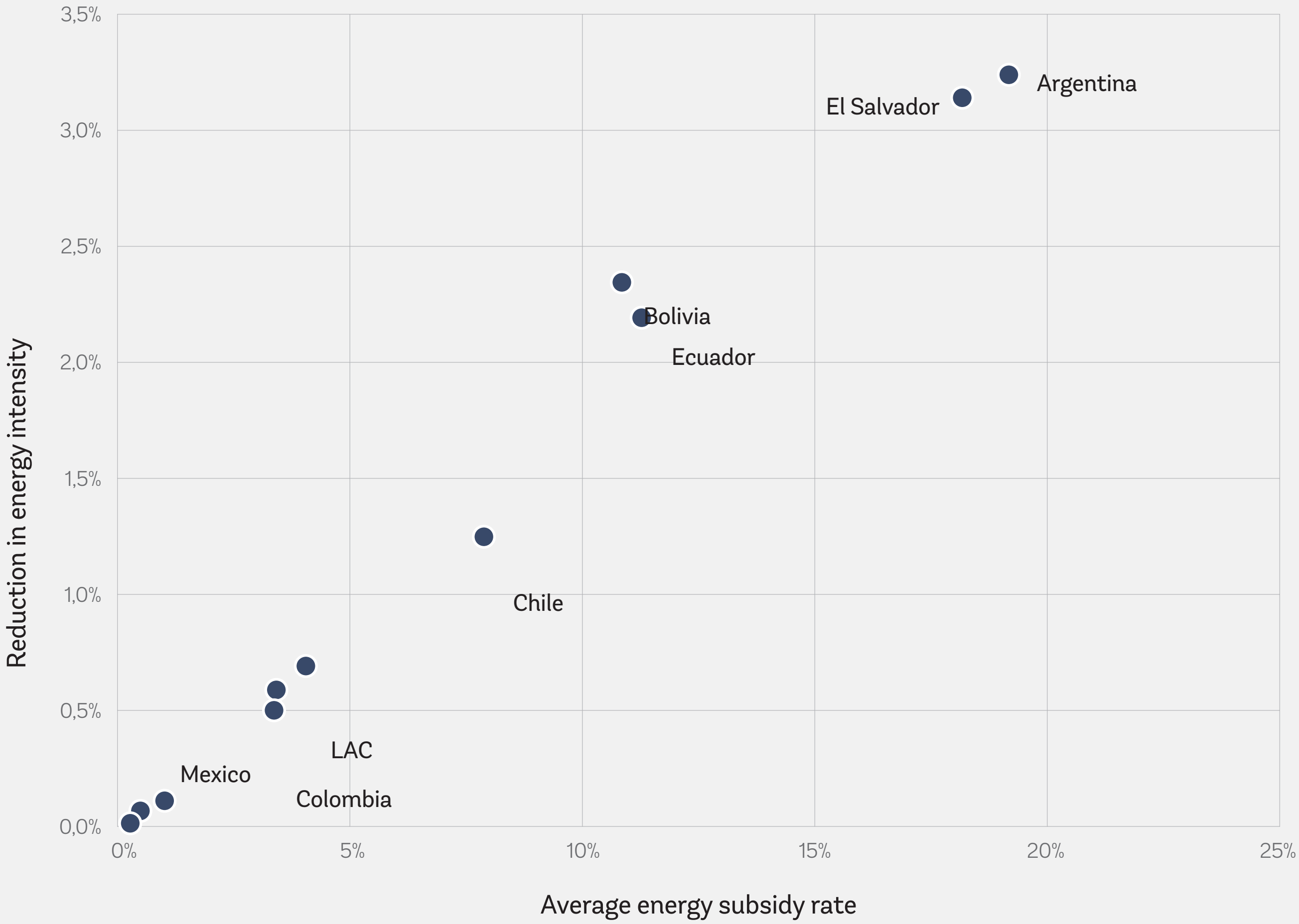
Figure 3.3
Projected reductions in energy intensity from eliminating subsidies



Source: WBG, based on IEA Fossil Fuel Subsidies Database, IMF Getting Energy Prices Right Database, and OLADE.

Figure 3.4

Projected reductions in energy intensity from improved energy efficiency and elimination of subsidies



Source: Authors' estimates based on IEA Fossil Fuel Subsidies Database, IMF Getting Energy Prices Right Database, and OLADE.

Strengthening energy efficiency regulations, particularly with respect to financing, planning, and energy efficiency entities, can significantly improve the prospect of reducing energy intensity and raising sectoral energy efficacy (figures 3.6 and 3.7).

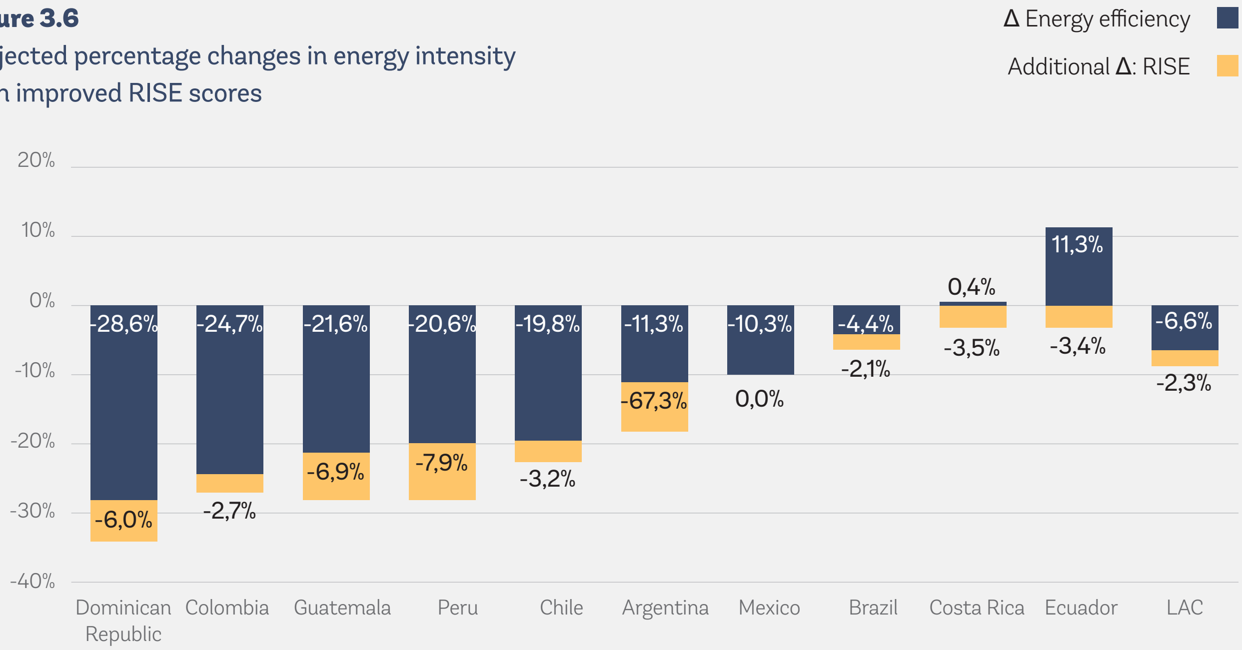
Countries with weak regulatory policies would have achieved much better energy efficiency if they had implemented more pertinent policies and boosted their RISE score to that of the leading country (such as Mexico in 2019)[17]. With the right mix of regulatory policies, Argentina, Dominican Republic, Guatemala, and Peru could achieve additional declines of 6 to 8 percent in their energy intensity index and additional 6.5 percent to 9.5 percent improvements in their sectoral energy efficiency.

Raising RISE scores to Mexico's levels in countries with moderate energy efficiency regulatory policies, such as Brazil, Chile, Colombia, and Ecuador, would bring additional declines of 2 to 3.5 percent in their energy intensity index and 2.5 to 4 percent additional improvements in sectoral energy efficiency.

The average energy intensity and sectoral gains in energy efficiency resulting from strengthening regulatory policies across the entire region are estimated at 2.3 percent and 2.7 percent, respectively.

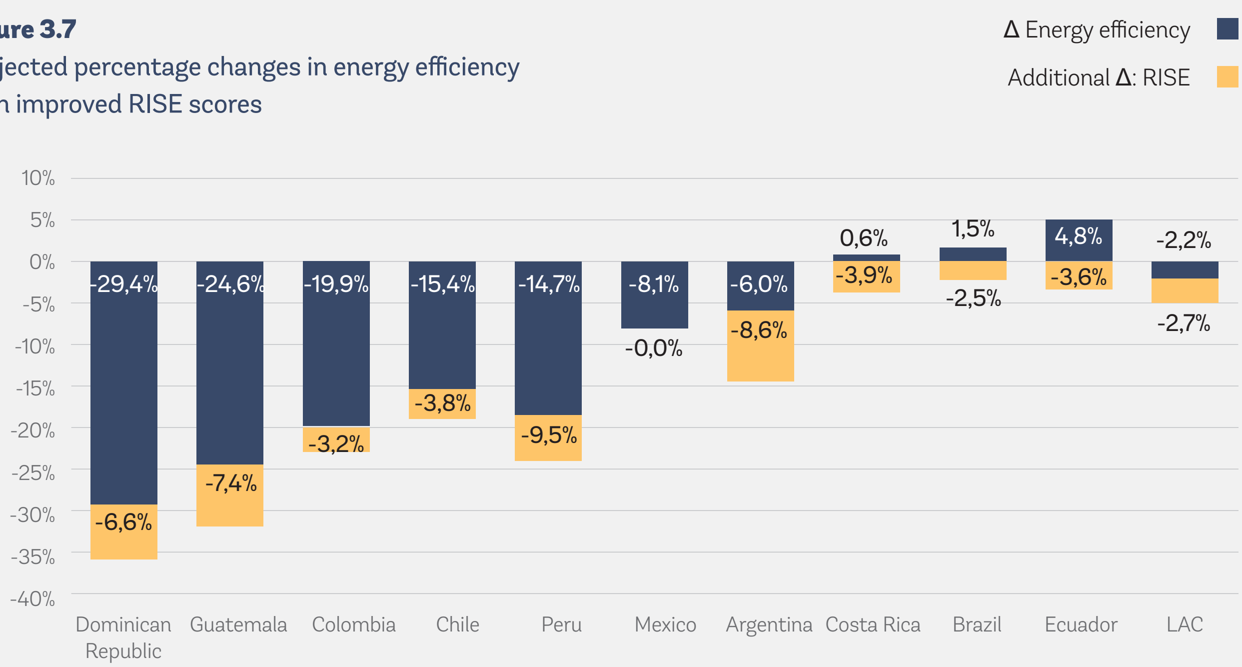
17 Mexico has a high RISE score in the three policy areas identified as of higher potential (financing, planning, and energy efficiency) due to the fact that it has put I place a large number of such policies, but this does not imply that that implementation of these policies is fully effective, nor that there is no additional space for further improvements.

Figure 3.6
Projected percentage changes in energy intensity with improved RISE scores



Source: Authors' estimates based on OLADE, UN data, Penn World Tables, IEA.
Note: Yellow bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country. Blue bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country for 2019 RISE EE scores. RISE scores have been periodically updated, and we used the version available at the time of the analysis.

Figure 3.7
Projected percentage changes in energy efficiency with improved RISE scores

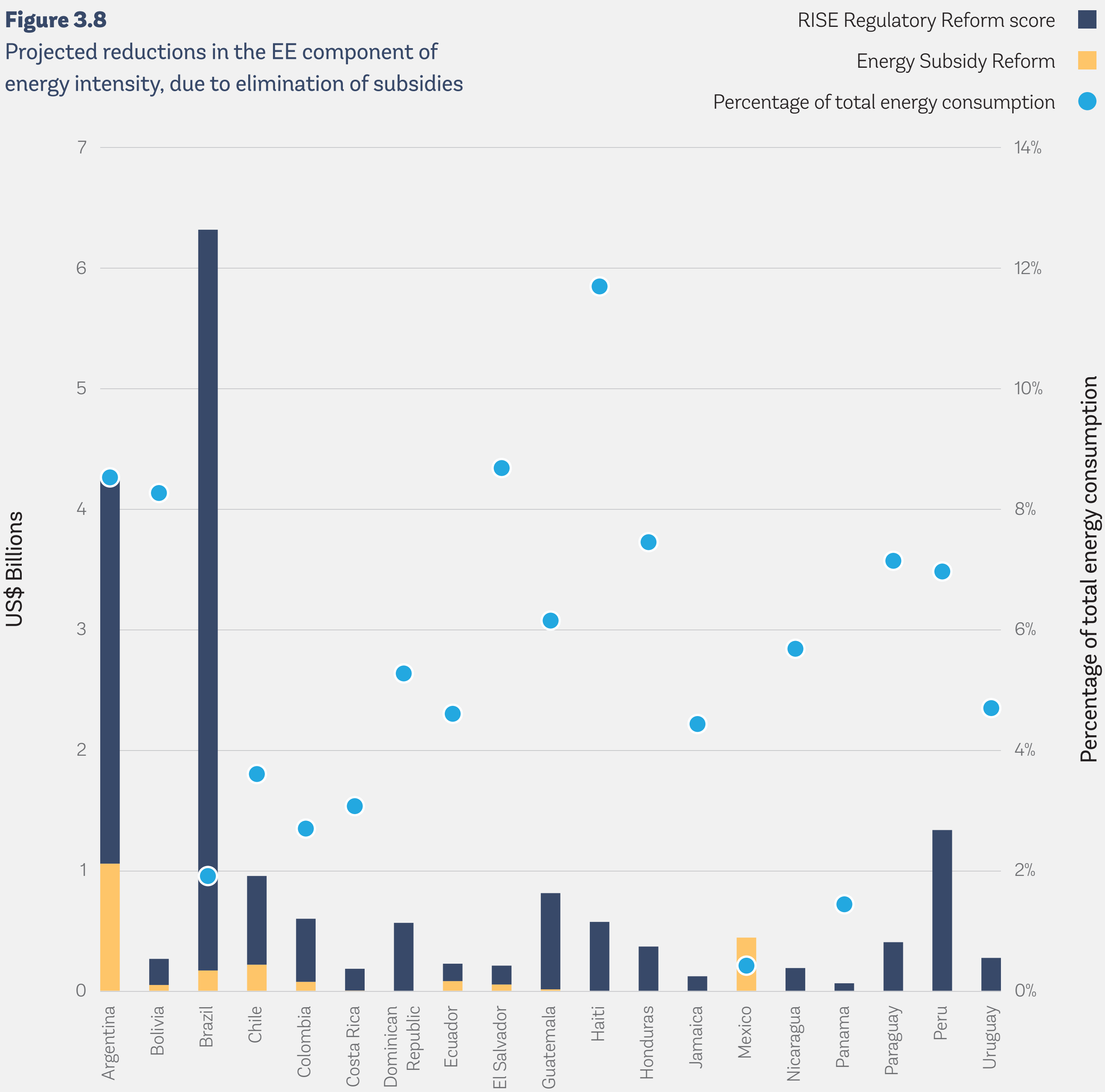


Source: Authors' estimates based on OLADE, UN data, Penn World Tables, IEA.
Note: Yellow bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country. Blue bars show additional energy intensity reductions if each country had raised their RISE score to that of the leading country for 2019 RISE EE scores. RISE scores have been periodically updated, and we used the version available at the time of the analysis.

Energy efficiency improvements from energy subsidies and regulatory reforms offer significant energy savings (figure 3.8). Combined, these savings vary from US$61 million in Panama to US$6.3 billion in Brazil, with smaller and poorer economies of Central America and the Caribbean experiencing the largest relative savings. For example, energy reforms could cut up to 13.38 percent of total energy consumption in Haiti, 9.93 percent in El Salvador, and 8.5 percent in Honduras. Argentina and Bolivia would also see significant energy savings from energy reforms (9.73 percent and 9.45 percent, respectively). These savings would be even larger if energy security and environmental benefits were accounted for.

Figure 3.8

Projected reductions in the EE component of energy intensity, due to elimination of subsidies



Source: Authors' estimates based on IEA Fossil Fuel Subsidies Database, IMF Getting Energy Prices Right Database, OLADE, UN data, Penn World Tables, and IEA.

Note: Yellow bars show simulated changes in the value of energy consumption resulting from elimination of energy subsidies, blue bars show additional energy savings if each country had raised their RISE score to that of the leading country, and purple markers show total energy savings as a percentage of total baseline energy consumption.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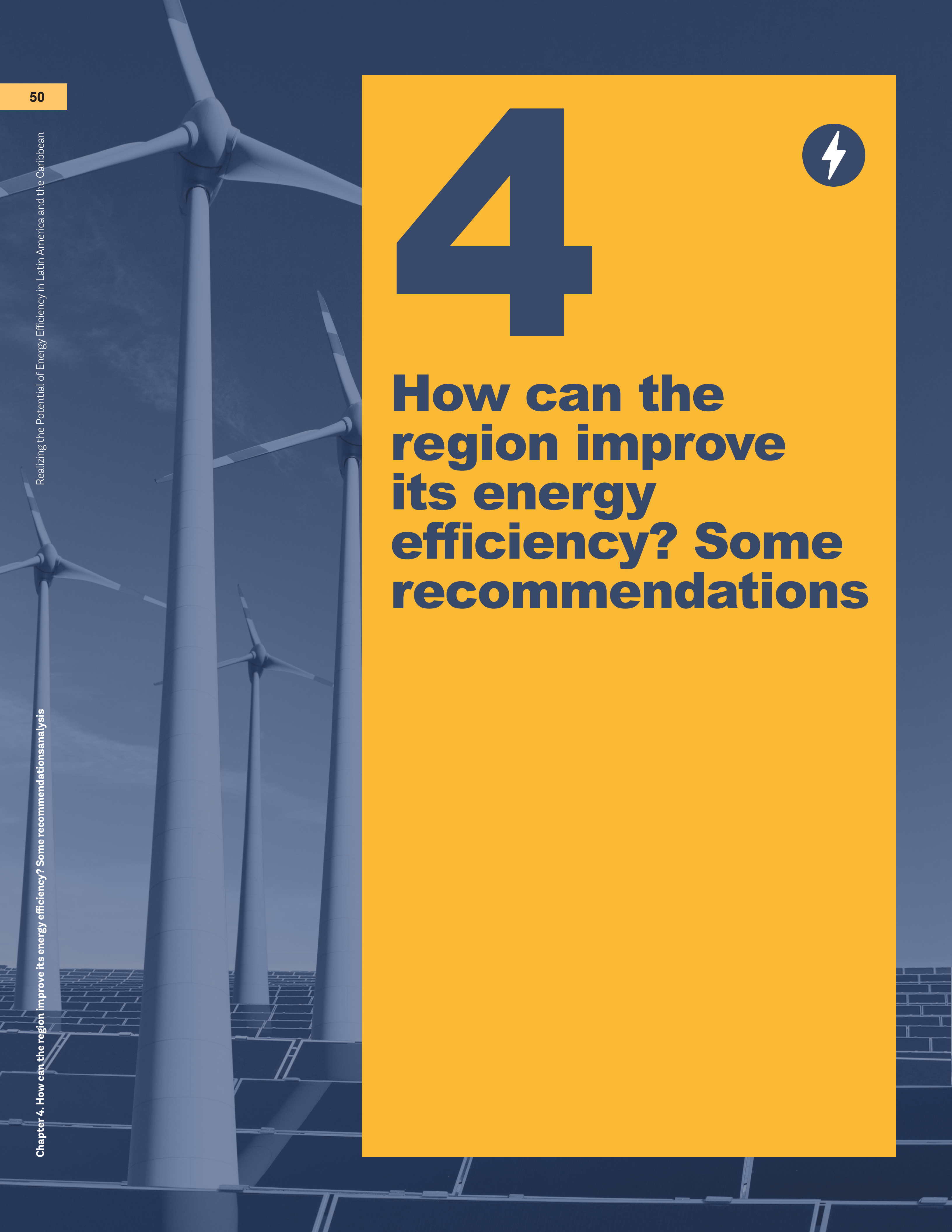


4

How can the region improve its energy efficiency? Some recommendations

Exploiting synergies between sustainable programs, technology transfer, financing, and adequate energy pricing will be essential to realize the region's EE potential. Based on the IEA's bottom-up scenarios (IEA 2021a), considerable improvements in the region's energy intensity are possible, from 1.1 percent to 2.3 percent annual reductions through 2040. These scenarios mark a clear upside compared with the region's paltry improvement trend over the past 20 years (around 0.5 percent per year).

There is an urgent need for sustainable and well-financed policies and programs that focus on efficient technology integration complemented by a just phase-out of energy subsidies. Energy efficiency policies in the region have shown mixed results depending on the country and sector, with more policies and measures often not translating into consistent improvements in energy efficiency and final energy intensity. National and local governments should take advantage of existing programs and improved capacities to set up long-term programs and scale up the measures already implemented. Their focus should be on enhancing technology transfer, improving the sustainability of programs, improving access to financing, and reducing energy subsidies while ensuring that vulnerable social groups are protected. Using Mexico's RISE scores as a benchmark, counterfactual simulations of the effect of improved energy efficiency governance in each country demonstrate notable reductions in their energy intensity of between 2.5 percent and 7.9 percent, depending on the country.

Incentivizing the integration of the most efficient technologies in various sectors can be done by establishing special tax schemes to promote efficient technology uptake (either in the form of tariffs or taxes that are removed or lowered for efficient technology or, conversely, in the form of increased tariffs or taxes for inefficient technology). Other drivers include better access to information on the impact of improved technologies and offers of concessional financing for select investments. Particularly for the industrial and commercial sectors, programs should be designed so that their sustainability and scaling are backed by co-financing from the private sector.

Better information on the impacts of existing energy efficiency measures would help accelerate the uptake of technology by the private sector. Improved frameworks for monitoring and reporting of results and impacts of energy efficiency initiatives would enable the private sector to implement successful measures without public support.

Financing and incentives facilitate investments in more efficient technology. When adequately designed, financial incentives are flexible (that is, they can be adapted to various purposes and sectors) and easy to implement. They are usually effective in increasing the likelihood of firms investing in energy efficiency projects or carrying out energy audits to better understand their current energy consumption (Brutscher and Ravillard 2019). Outside the region, Italy's "Superbonus" program provides an example: it finances residential energy efficiency investments with a tax credit of 110 percent the value of the investment. The measure was launched in 2020 and has already resulted in investments for more than €20 billion (IEA 2022).[18] In the region, actions linked to financial incentives have correlated with improvements and increased private investments in energy efficiency (Anderson and Newell 2004; Blok 2004).

Wider access to financing is effective—but only under certain conditions. For example, energy efficiency investments require an adequate enabling environment characterized by clear information, trusted parties that can provide needed services, and essential equipment and material, all of which can be hard to come by. To ensure their presence, national governments must implement clear long-term plans and streamlined procedures to support energy efficiency investments (IEA 2022).

LAC countries must continue to reduce energy subsidies while protecting vulnerable populations. Energy subsidies directly affect how energy is used and the choice to acquire efficient technologies. Although the currently high energy prices makes subsidy reduction difficult, they also offer an opportunity to establish frameworks that will allow subsidies to be phased out automatically as soon as prices drop. Counterfactual simulations show that some LAC countries can leverage the elimination of fossil fuel subsidies to achieve significant reductions in their energy intensity (between 0.5 percent and 2.5 percent depending on the country). As an example, Argentina showed a 37.7 percent increase in residential energy intensity between 2000 and 2016, fueled by a combination of greater numbers of (nonefficient) household appliances and highly subsidized residential tariffs.[19] However, a 44 percent reduction in subsidies between 2015 and 2016 (ECLAC 2021) brought a 16 percent drop in residential energy intensity between 2016 and 2018.

Finally, the importance of coordinated government actions and a comprehensive and integrated approach to address the multiple challenges to EE implementation cannot be understated. Success with energy efficiency depends on the actions of policymakers responsible for energy, industry, housing, transport, and finance, as well as the equivalent actors at the subnational and local levels.

18 https://www.governo.it/it/superbonus.

19 Per capita energy consumption in the residential sector is high for Argentina, likely due to energy consumption for heating due to colder weather.

References

Anderson, S., and R. Newell. 2004. "Information Programs for Technology Adoption: The Case of Energy-Efficiency Audits." Resource and Energy Economics 26 (1): 27 –50. 10.1016/j.reseneeco.2003.07.001.

Bagaini, A., F. Colelli, E. Croci, and T. Molteni. 2020. "Assessing the Relevance of Barriers to Energy Efficiency Implementation in the Building and Transport Sectors in Eight European Countries." The Electricity Journal 33 (8): 106820. https://doi.org/10.1016/j.tej.2020.106820.

Blok, K. 2004. "Improving Energy Efficiency by Five Percent or More per Year?" *Journal of Industrial Ecology* 8 (7): 87–99. https://doi.org/10.1162/1088198043630478.

Boyd, G. A., and J. M. Roop. 2004. "A Note on the Fisher Ideal Index Decomposition for Structural Change in Energy Intensity." *The Energy Journal* 25 (1): 87–102.

Brutscher, P-B, and P. Ravillard. 2019. "Promoting Energy Audits: Results from an Experiment," EIB Working Paper 2019/06, European Investment Bank, Luxembourg. https://ideas.repec.org/p/zbw/eibwps/201906.html.

CONUEE (Comisión Nacional para el Uso Eficiente de la Energía). n.d. https://www.gob.mx/conuee.

ECLAC. 2021. "Policy and Measures." Base de Información de Eficiencia Energética (BIEE). https://biee-cepal.enerdata.net/en/measures/search.

ECLAC and GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). 2010. *Indicadores de Políticas Públicas en Materia de Eficiencia Energética en América Latina y el Caribe*. Santiago, Chile: ECLAC.

ESMAP. 2020. *Regulatory Indicators for Sustainable Energy: Sustaining the Momentum*. Washington, DC: World Bank.

IDB (Inter-American Development Bank). 2019. *Towards Greater Energy Efficiency in Latin America and the Caribbean: Progress and Policies*. New York, NY: IDB. https://publications.iadb.org/publications/english/document/Towards_Greater_Energy_Efficiency_in_Latin_America_and_the_Caribbean_Progress_and_Policies.pdf.

IEA (International Energy Agency). 2020a. *Recommendations of the Global Commission for Urgent Action on Energy Efficiency*. Paris: IEA. https://www.iea.org/reports/recommendations-of-the-global-commission-for-urgent-action-on-energy-efficiency.

IEA. 2020b. *Energy Efficiency Indicators: December 2020 Edition: Database Documentation*. Paris: IEA.

IEA. 2021a. *World Energy Outlook 2020*. Paris: IEA.

IEA. 2021b. "Policies Database." IEA, Paris. https://www.iea.org/policies?topic=Energy%20Efficiency.

IEA. 2022. "Accelerating Energy Efficiency: What Governments Can Do Now to Deliver Energy Savings." IEA, Paris. https://www.iea.org/commentaries/accelerating-energy-efficiency-what-governments-can-do-now-to-deliver-energy-savings.

Loureiro, T., C. Pozza, F. D. Mexis, S. Olivero, C. D. Csiky, and A. Bogi. 2021. "Integration of Finance in Energy Efficiency." *Environmental Science Proceedings* 11 (1): 7. https://doi.org/10.3390/environsciproc2021011007.

Recalde, M., and C. Guzowski. 2012. "Boundaries in Promoting Energy Efficiency: Lessons from the Argentinean Case." *International Journal of Hydrogen Energy* 37 (19): 14725–29.

Sorrell, S. 2007. *The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings from Improved Energy Efficiency*. London: UK Energy Research Centre (UKERC).

World Bank. 2021. "World Bank Data." https://data.worldbank.org.

World Bank. 2021. "RISE—Regulatory Indicators for Sustainable Energy." https://rise.esmap.org/.

Appendix A

A.1. Note on data sources

The findings of this Report are based on original research by authors of the Report using a dataset of 56 countries (23 LAC countries, and 33 benchmark countries/ regions), 20 years, and 1,239 observations, coming from nine original sources.

Data on final energy consumption by industry across 23 Latin American and Caribbean countries are provided by the Latin American Energy Organization (OLADE). Data on sector-specific energy consumption in benchmark countries and regions—the European Union, the United States, China, India, and the Russian Federation—are obtained from the International Energy Agency (IEA). The time period is wide: 2000–19. Time frames and data availability vary by country.

Economic sectors in Latin America and the Caribbean are defined in accordance with OLADE. The economy is thus divided into four ISIC 2-digit industries (ISIC Rev. 3):

- Agriculture and mining (ISIC A–C)
- Manufacturing (ISIC D)
- Services (ISIC 41, 50–93)
- Residential (rural and urban households)[20]

A fifth, residual, sector (called Other Sectors) absorbs the remainder of final energy consumption and economic activities. Note that statistics on final energy consumption are limited by the small number of categories used in this method.

Value added by industries: For the agriculture and mining, manufacturing, and services industries, we measure the size of economic activity by industry based on value-added data, obtained from national accounts published by the United Nations. For the residential sector, we measure economic size using household consumption. For benchmark countries, the value added by industry and household consumption comes from the World Bank's World Development Indicators (WDIs).

Macroeconomic variables: Data on key macroeconomic variables such as GDP, household consumption, population, capital stock, investment, and exchange rates are obtained from the Penn World Table (v10.0) for the period 1950–2019.

Weather: Yearly weather variables, such as heating degree days (HDDs) and cooling degree days (CDDs) for the years 2000–21, are obtained from the Weather for Energy Tracker database maintained by the IEA and the Euro-Mediterranean Center on Climate Change (CMCC).

Energy prices and consumption by source, including for electricity and hydrocarbons such as gasoline, diesel, fuel oil, kerosene, liquefied petroleum gas, and natural gas, are obtained from OLADE. OLADE provides two energy price series, one for 2000–19 with data gaps, and another, updated, series for 2014–20. The two series were combined and harmonized to create an energy price series covering the 2000–19 period with the fewest data gaps possible. Energy prices were then extrapolated to fill the series. Finally, we calculated a consumption weighted average energy price for each country by incorporating the energy consumption data series provided by OLADE.

Energy subsidies are obtained from two data sources: the IEA Fossil Fuel Subsidies Database and the International Monetary Fund (IMF) Fossil Fuel Subsidies by Country and Fuel Database. The degree of data availability differs across the two sources. The magnitude of energy subsidies also differs. We use the IEA data whenever possible as they provide more conservative estimates of energy subsidies. The IEA data are available for 2010–20 for seven countries in our study: Argentina, Bolivia, Colombia, Ecuador, El Salvador, Mexico, and Trinidad and Tobago. For the remaining countries of Latin America and the Caribbean (LAC), we use IMF data, which are available for 2015–25. The drastically different methodologies used by the IEA and IMF in estimating energy subsidies make it difficult to compare the two data sets.

20 The "Residential" sector is not an ISIC industry. According to OLADE's Energy Statistics Manual 2017: "The end-use sectors are classified according to the traditional division of economic sectors and the ISIC (International Standard Industrial Classification), version 3. It also includes the residential sector, which is not an economic activity."

Table A.1. Data sources

Source	Data type	Details
OECD and IEA	Final energy consumption by industry	Data on 23 LAC countries in 2000–19 (OECD), and on benchmark countries and regions (IEA).
OLADE	Definition of economic sectors in LAC countries	Four sectors of focus: agriculture and mining, manufacturing, services, and residential.
	Energy prices and consumption by source	Data on major energy sources—electricity, gasoline, diesel, fuel oil, kerosene, liquefied petroleum gas, natural gas—in 2000–19.
IEA	Energy subsidies	Estimates of energy subsidies in 2010–20 in LAC are obtained from two data sources using very different methods to estimate subsidies, making it difficult to compare data across them.
IMF		
Penn World Tables	Macroeconomic variables	Data on key macroeconomic variables in 1950–2019, such as GDP, household consumption, population, capital, investment, and exchange rates, are obtained from the Penn World Table (v10.0).
RISE Database	RISE energy efficiency scores	Time period, 2010–19.
UN data	Value added by sector	Time period varies by country.
World Bank WDI		
IEA/CMCC	Weather	Yearly weather variables in 2000–21, such as heating degree days and cooling degree days, are obtained from the Weather for Energy Tracker database

Note: CMCC = Euro-Mediterranean Center on Climate Change; GDP = gross domestic product; IEA = International Energy Agency; IMF = International Monetary Fund; LAC = Latin America and the Caribbean; OECD = Organisation for Economic Co-operation and Development; OLADE = Latin-American Energy Organization; RISE = Regulatory Indicators for Sustainable Energy; UN = United Nations; WDIs = World Bank World Development Indicators.

Table A.2. Selected countries and regions

Country/region	Time period	Energy intensity (%)	Economic activity (%)	Energy efficiency (%)
EU12	2000–18	-25.2	-6.6	-19.9
EU28	2000–18	-24.7	-5.7	-20.2
United States	2000–18	-27.6	23.1	-41.1
China	2000–18	-45.9	-15.5	-36.0
India	2000–18	-40.6	-10.1	-33.9
Russia Federation	2000–18	-32.8	4.1	-35.5
Latin America and the Caribbean	2000–18	-9.5	-0.7	-8.8
Guyana	2006–18	-42.8	-25.2	-23.6
Belize	2001–18	-35.9	-9.2	-29.4
Dominican Republic	2000–13	-28.6	1.1	-29.4
Honduras*	2000–19	-27.9	6.2	-32.1
Colombia	2000–16	-24.7	-6.0	-19.9
Guatemala*	2001–18	-21.6	4.0	-24.6
Peru	2000–11	-20.6	-6.9	-14.7
Chile	2003–15	-19.8	-5.3	-15.4
Panama	2007–19	-19.8	-11.5	-9.4
Nicaragua	2006–19	-12.9	-7.1	-6.2
Argentina	2004–19	-11.3	-5.6	-6.0
Mexico	2000–19	-10.3	-2.3	-8.1
Haiti*	2005–18	-9.5	-11.5	2.3
El Salvador	2000–16	-5.4	-1.0	-4.4
Paraguay*	2000–17	-4.8	-11.3	7.3
Brazil	2000–19	-4.4	-5.8	1.5
Grenada	2000–18	-4.2	0.0	-4.2
Trinidad and Tobago*	2000–15	-3.3	-14.1	12.6
Suriname	2006–18	-1.0	0.4	-1.4
Costa Rica	2000–14	0.4	-0.2	0.6
Barbados*	2006–19	4.6	-18.9	28.9
Bolivia	2000–18	4.7	-9.3	15.4
Ecuador	2000–19	11.3	6.2	4.8
Jamaica	2000–18	17.6	-4.7	23.4
Uruguay	2000–19	27.5	-8.0	38.6

Note (*): The OLADE does not report energy consumption data of the agricultural and mining sector (ISIC A–C) from Honduras, Guatemala, Haiti, Paraguay, Trinidad and Tobago, and Barbados. Therefore, Fisher Decomposition for these countries does not include the agricultural and mining sector.

A.2. Results

Result 1: Fisher decomposition analysis

The report applies the Fisher decomposition method (Boyd and Roop 2004) to disaggregate broad trends in energy trends into discrete efficiency improvements and changes in economic activity.

The Fisher Ideal Index is a perfect decomposition with no residual term, which means that it can perfectly explain the changes in energy intensity compared to a base period. In addition, according to Boyd and Roop (2004), the Fisher Ideal index satisfies all four axioms of the index number theory, namely, factor reversal, positivity, time reversal, and quantity reversal.

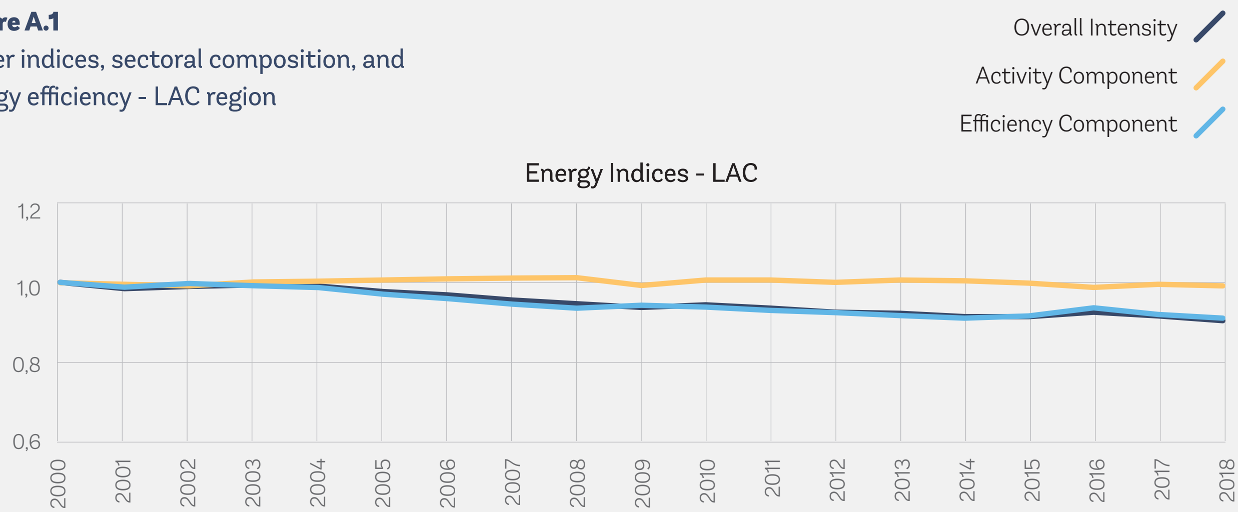
In application to energy, the Fisher Ideal index decomposes changes in aggregate energy intensity into an activity (or composition) component, measuring the shifting of economic activities across sectors (e.g., from industry to services), and an efficiency component, which measures the changes in energy efficiency within each sector.

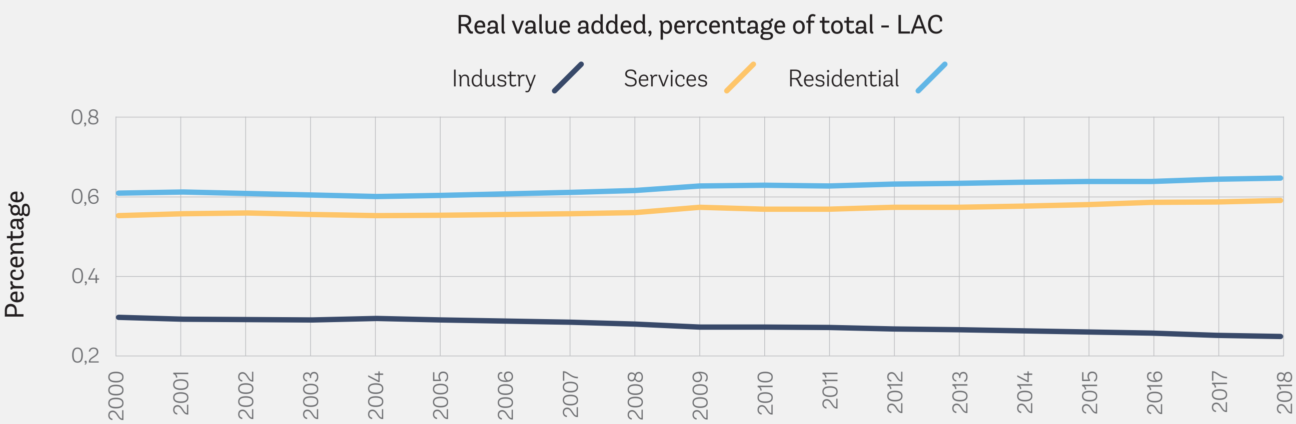
Technically, the Fisher Ideal Index is calculated as the geometric mean of the Laspeyres Index and the Paasche Index. The former hold constant economic activities (or composition) or efficiency at the base period ($t = 0$) levels, and the latter hold constant economic activities or efficiency at the end-period ($t = T$) period levels.

LAC region

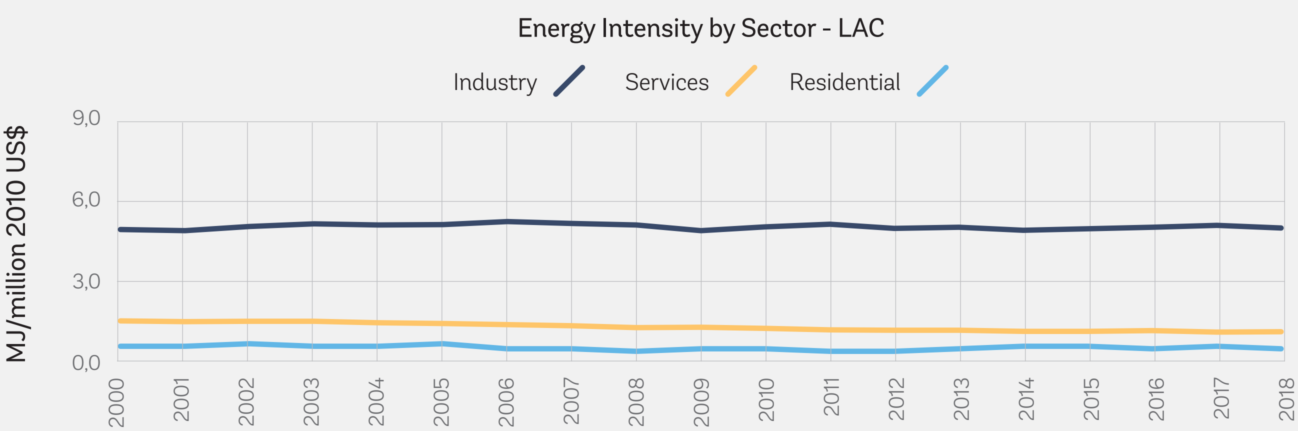
In the LAC region, the economic weight of the industrial sector is clearly shifting over time to both the services and residential sectors. Energy efficiency (EE) is not improving in the industrial and services sectors but is so in the residential sector, backed by successful EE policies.

Figure A.1
Fisher indices, sectoral composition, and energy efficiency - LAC region





Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

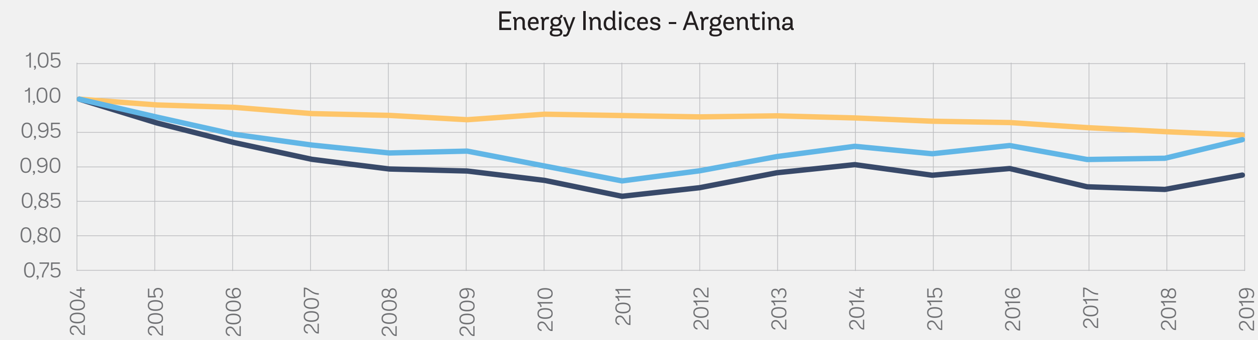


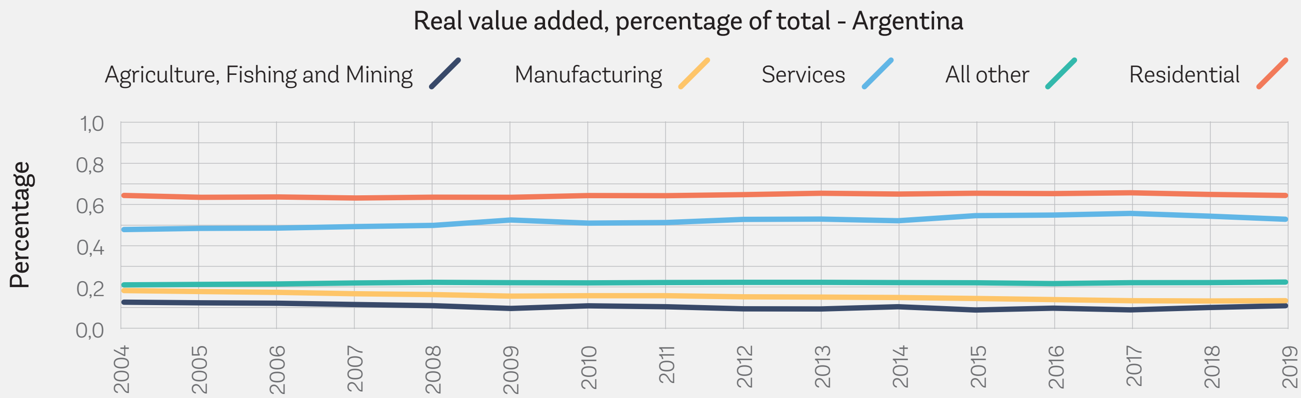
Note : Industry (ISIC C-F), Services (ISIC G-Q)

LAC countries

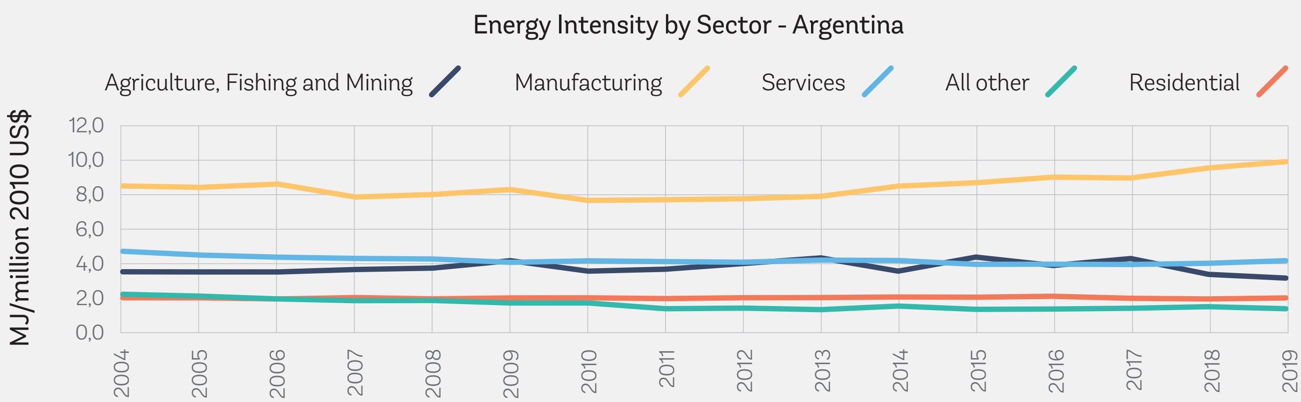
Argentina's improvement in energy intensity can be mostly attributed to changes in economic composition, a shift away from manufacturing, and increased efficiency in the services sector.

Figure A.2
Fisher indices, sectoral composition, and energy efficiency - Argentina



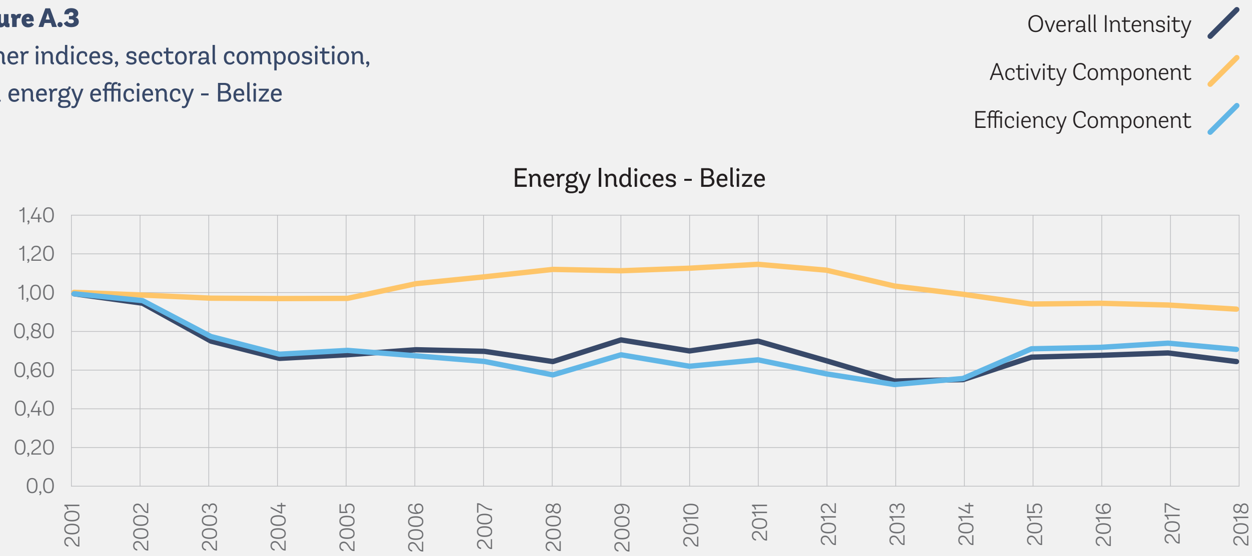


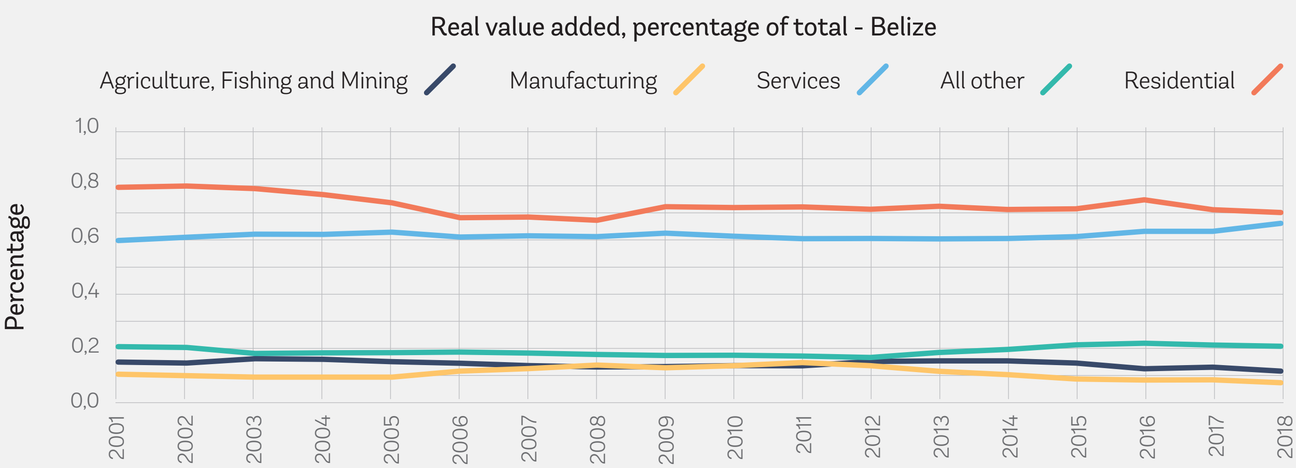
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



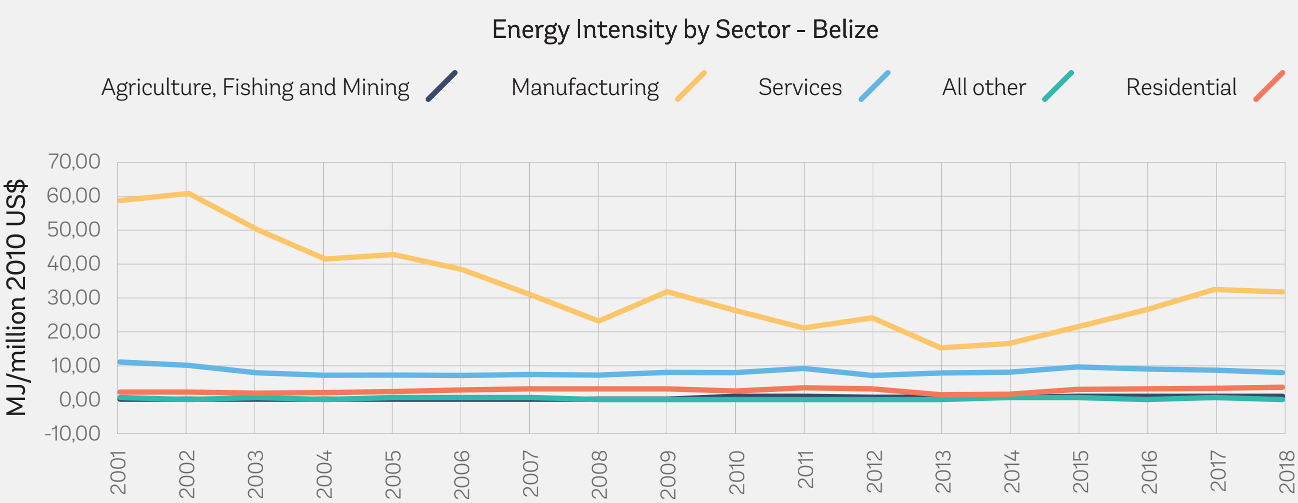
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.3
Fisher indices, sectoral composition, and energy efficiency - Belize



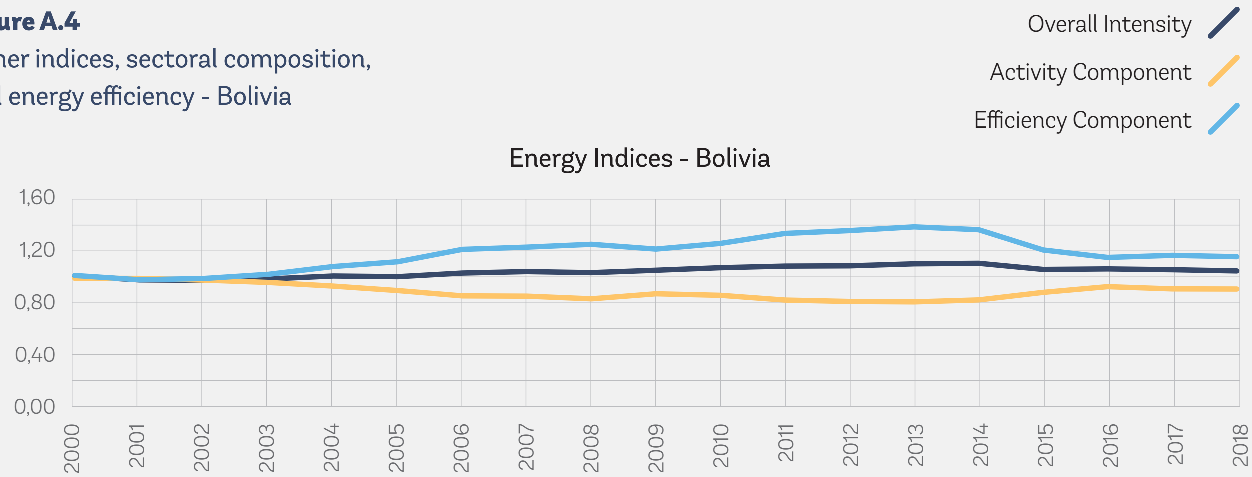


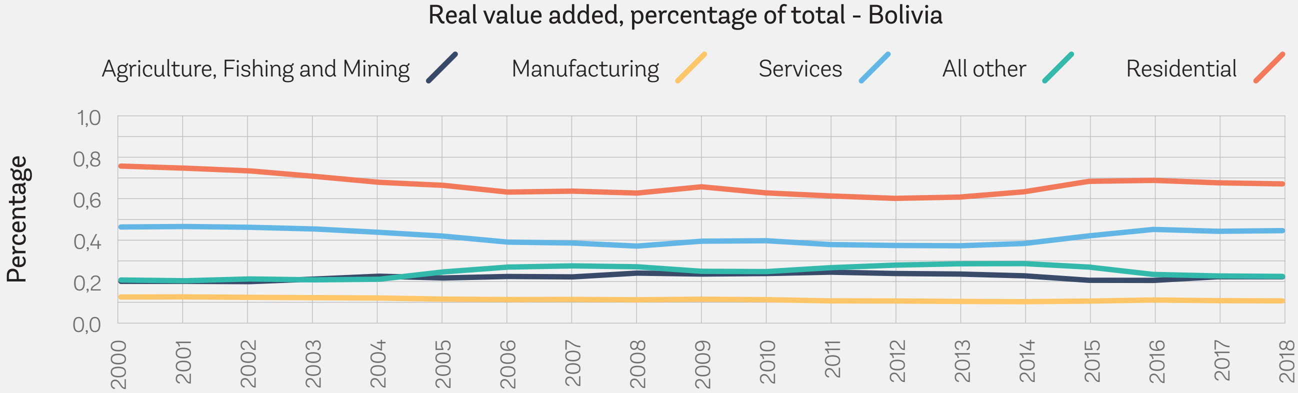
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



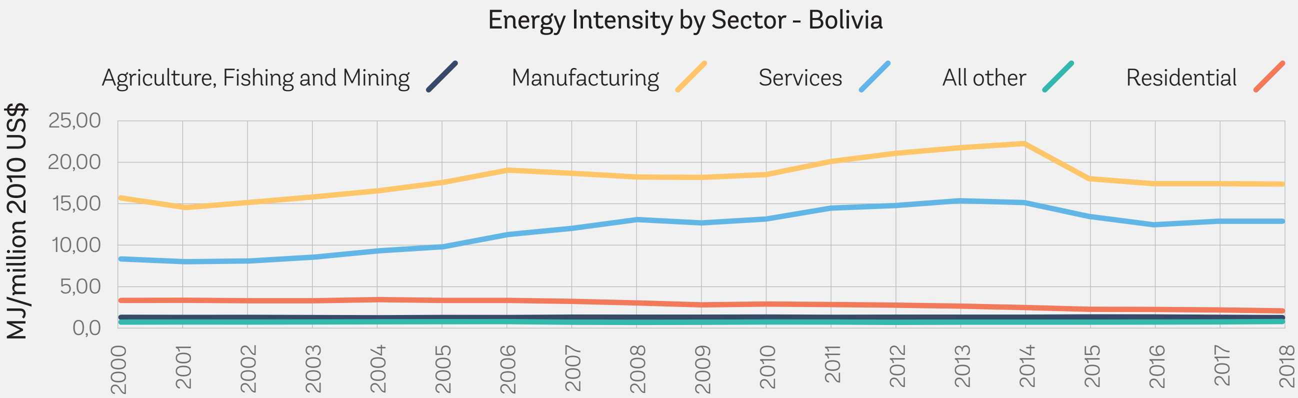
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.4
Fisher indices, sectoral composition, and energy efficiency - Bolivia





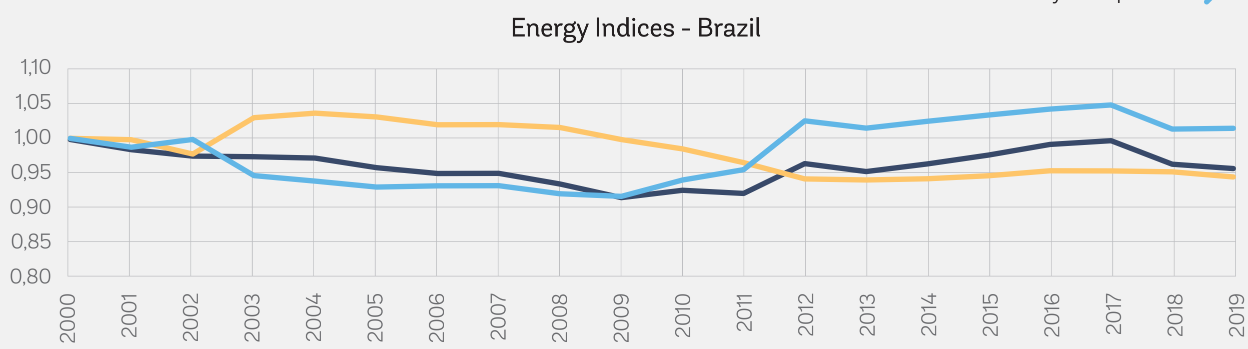
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

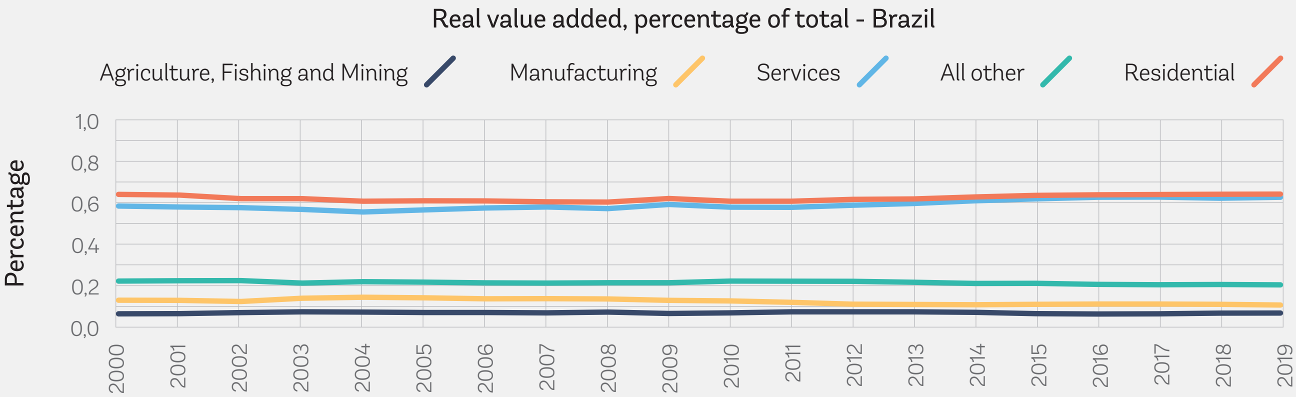


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

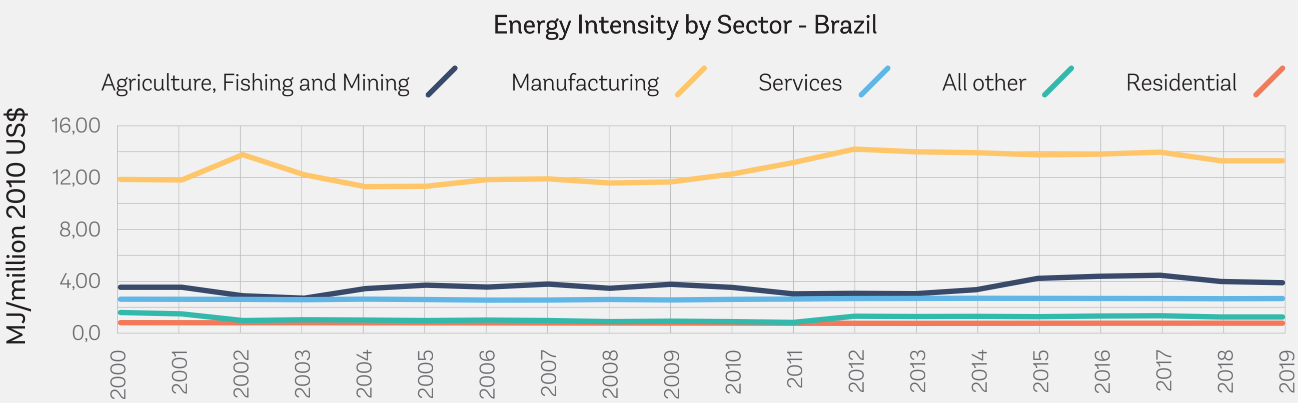
In the case of Bolivia, data on the energy consumption of the construction sector (ISIC rev.3, F) were also available. Thus, the sectors used in the Fisher decomposition include agriculture and mining, manufacturing, construction, services, and residential.

Figure A.5
Fisher indices, sectoral composition, and energy efficiency - Brazil





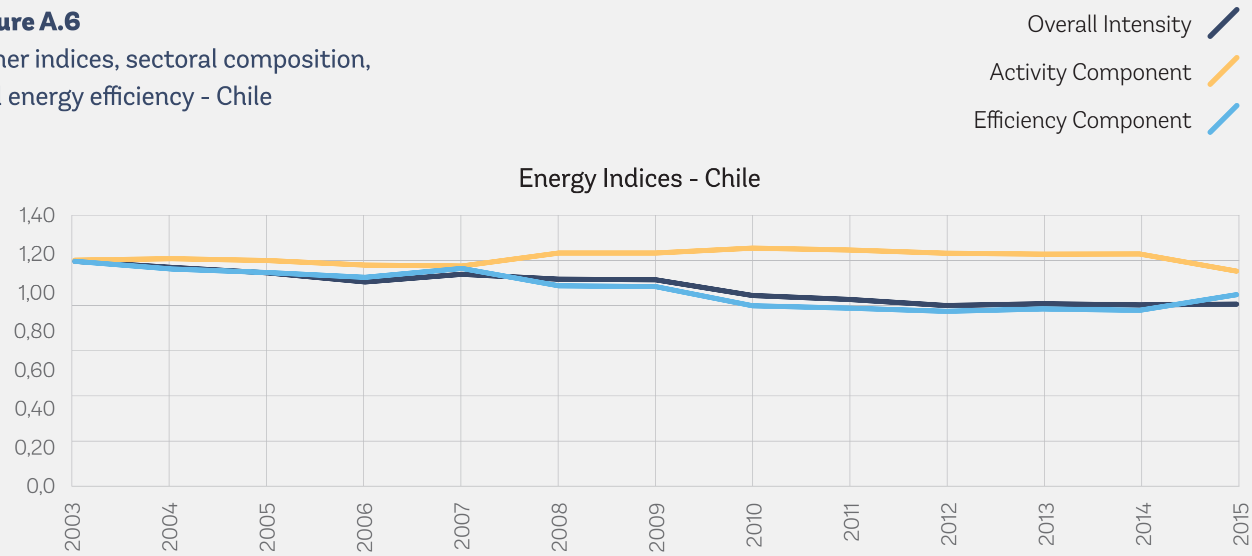
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

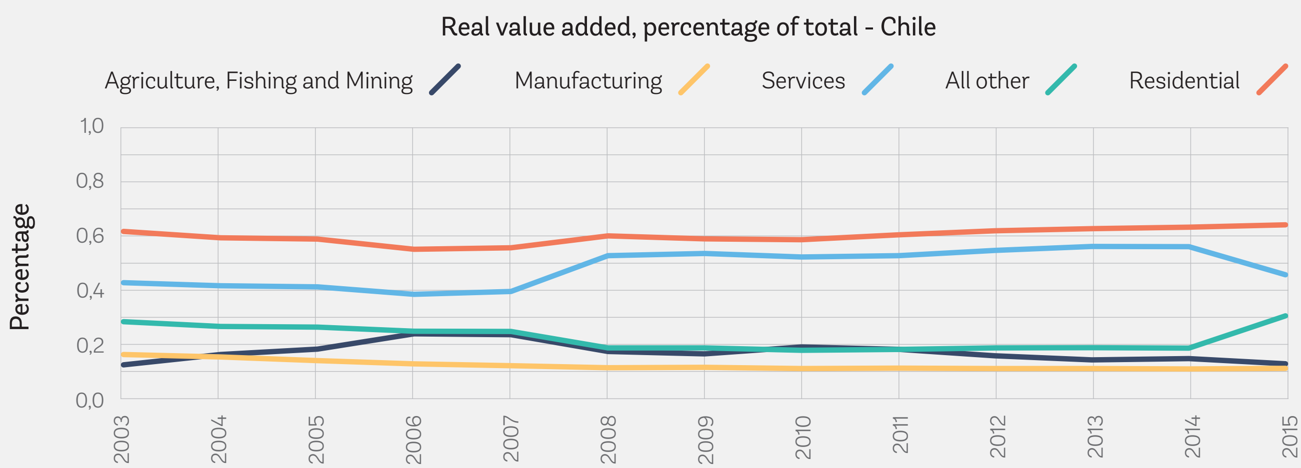


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

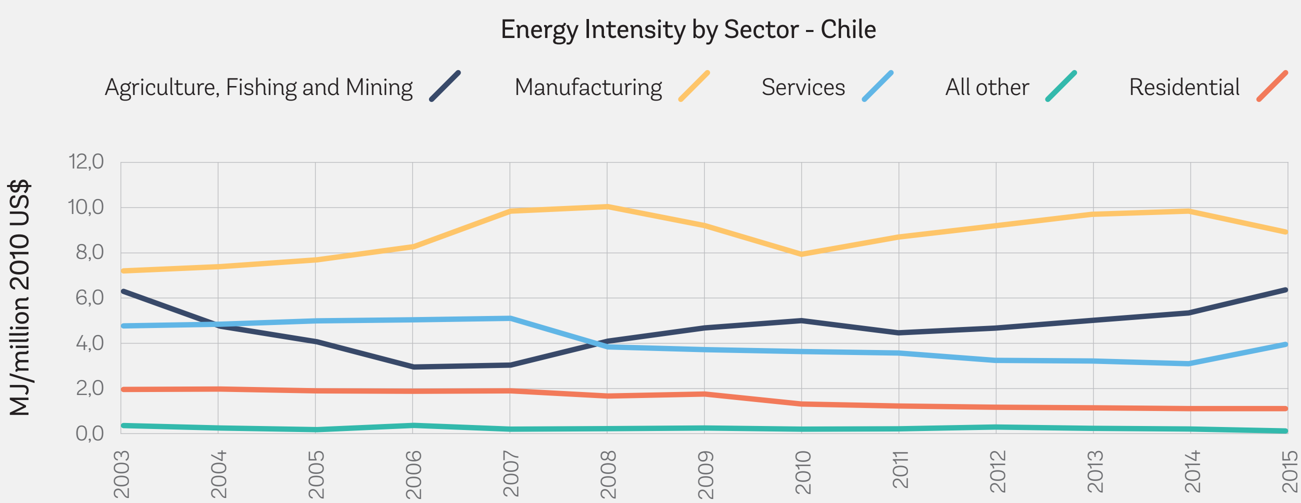
In Brazil the reduction in energy intensity due to the reduced relative economic weight of the manufacturing sector has been offset by that sector's decreased energy efficiency, alongside the decreased efficiency of the agriculture and mining sector.

Figure A.6
Fisher indices, sectoral composition, and energy efficiency - Chile



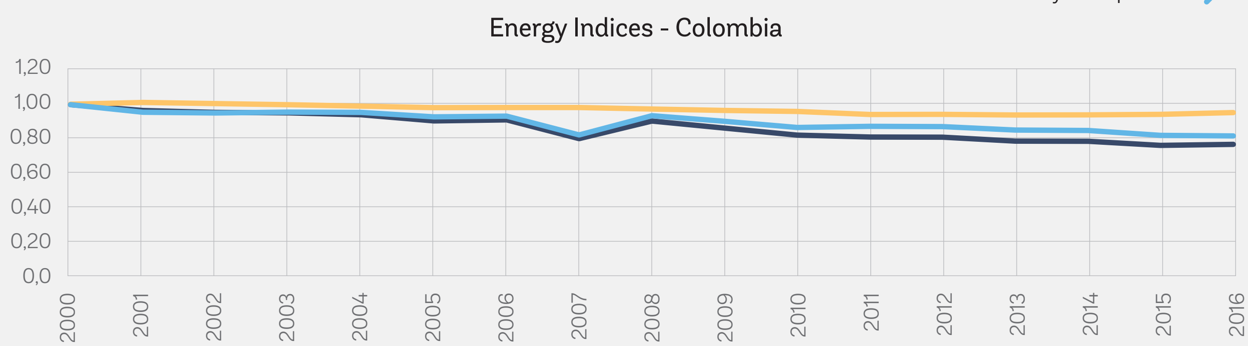


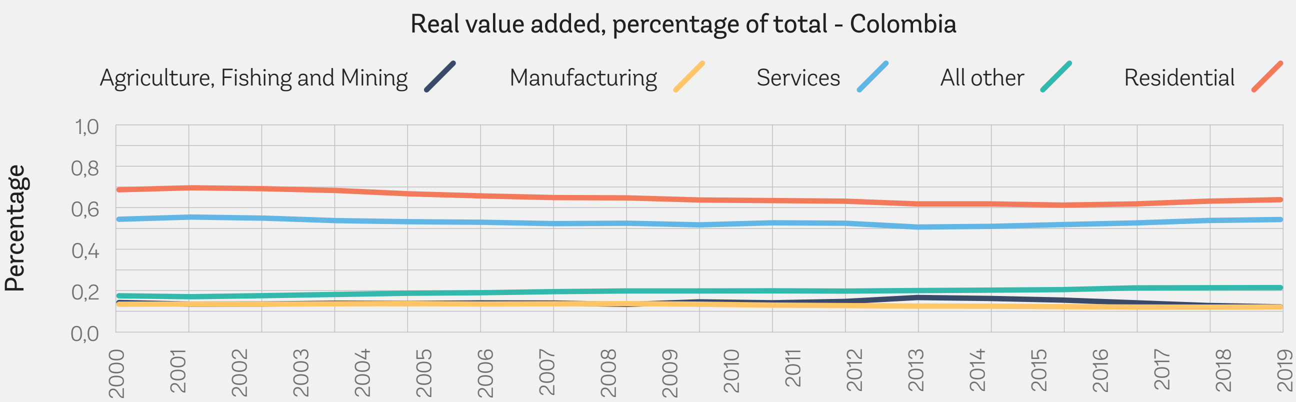
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



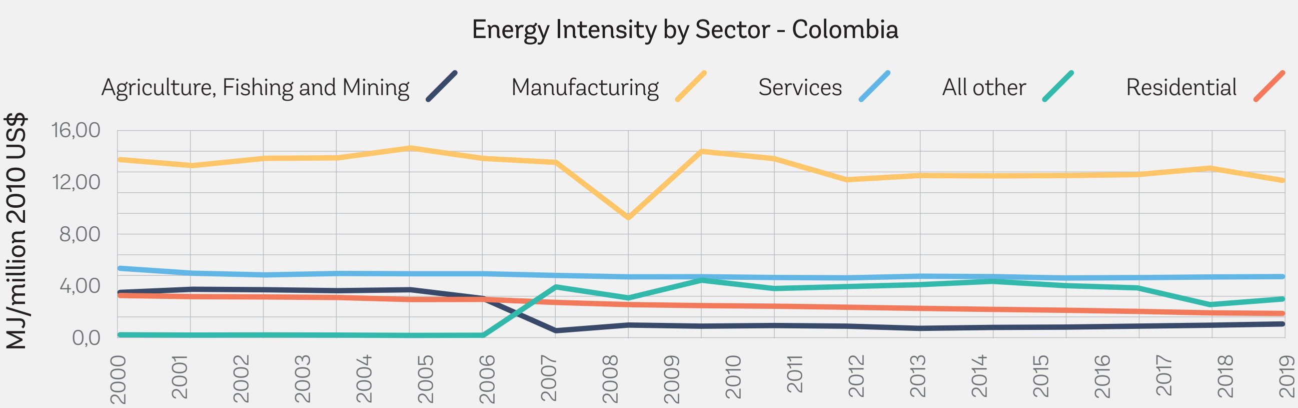
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.7
Fisher indices, sectoral composition, and energy efficiency - Colombia





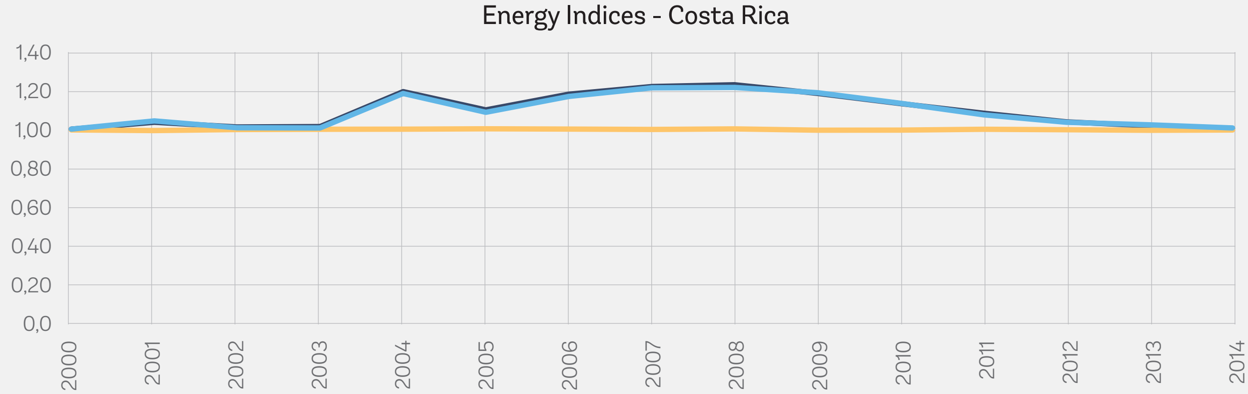
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

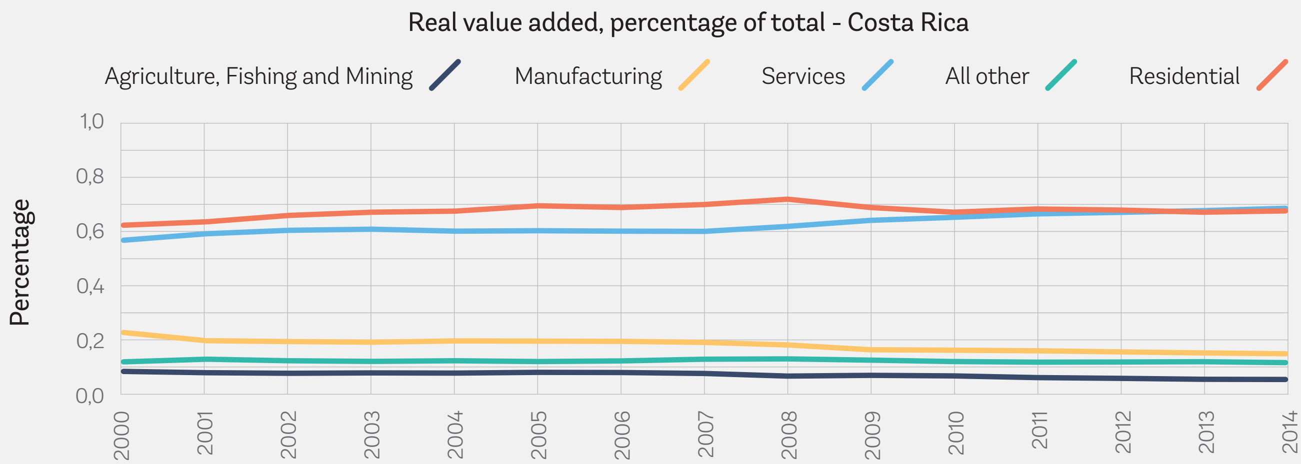


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

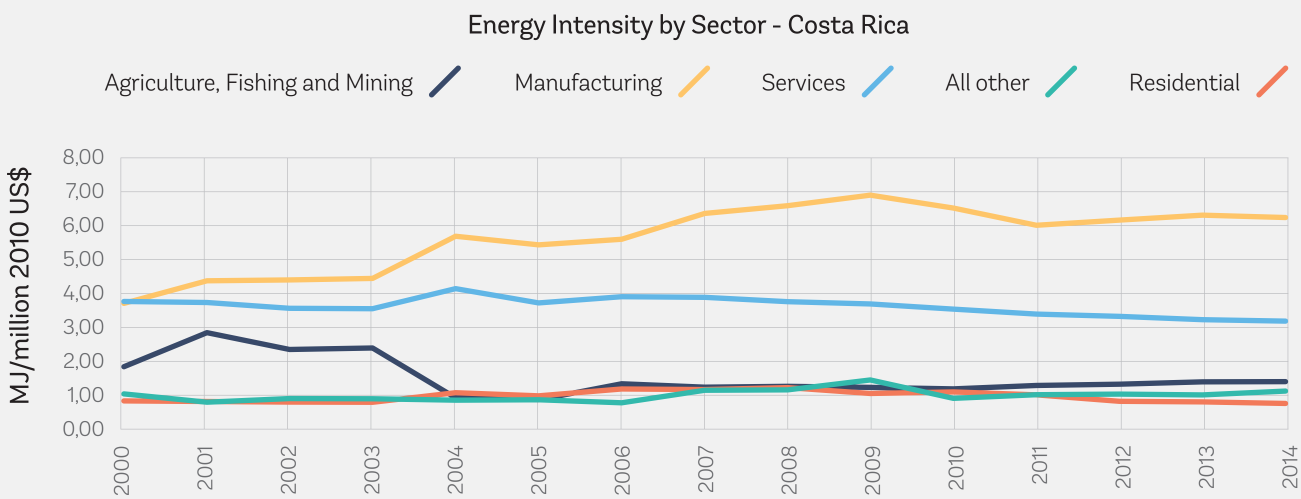
Colombia's energy efficiency improvements can be largely attributed to the manufacturing, residential, agriculture, and mining sectors, which saw considerable reductions in energy intensity. In small part, they can also be attributed to the reduced weight of the manufacturing sector relative to the rest of the economy.

Figure A.8
Fisher indices, sectoral composition, and energy efficiency - Costa Rica



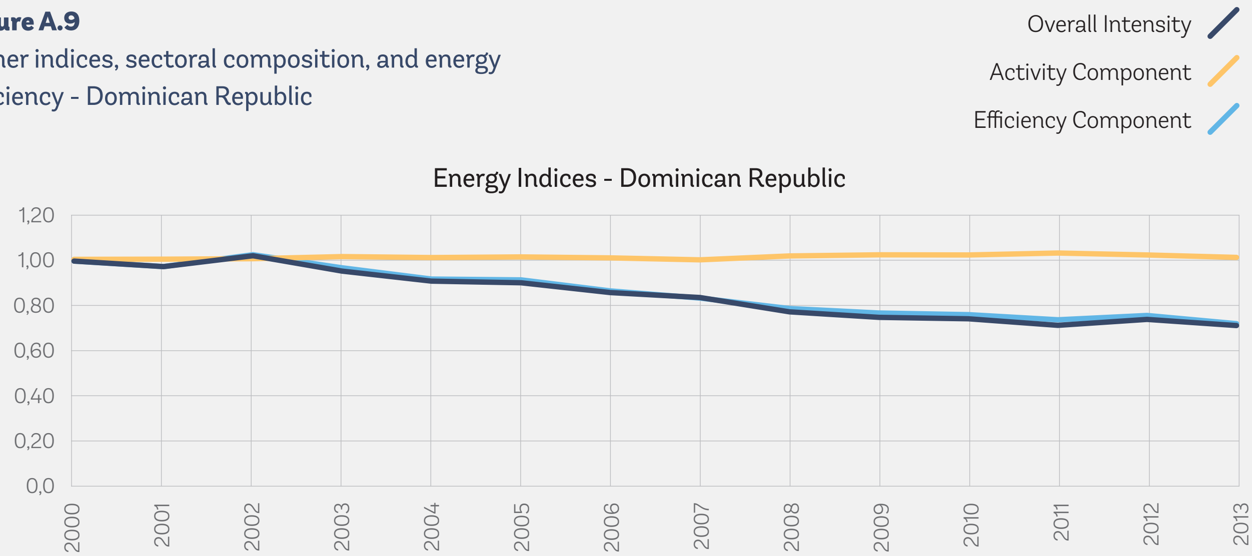


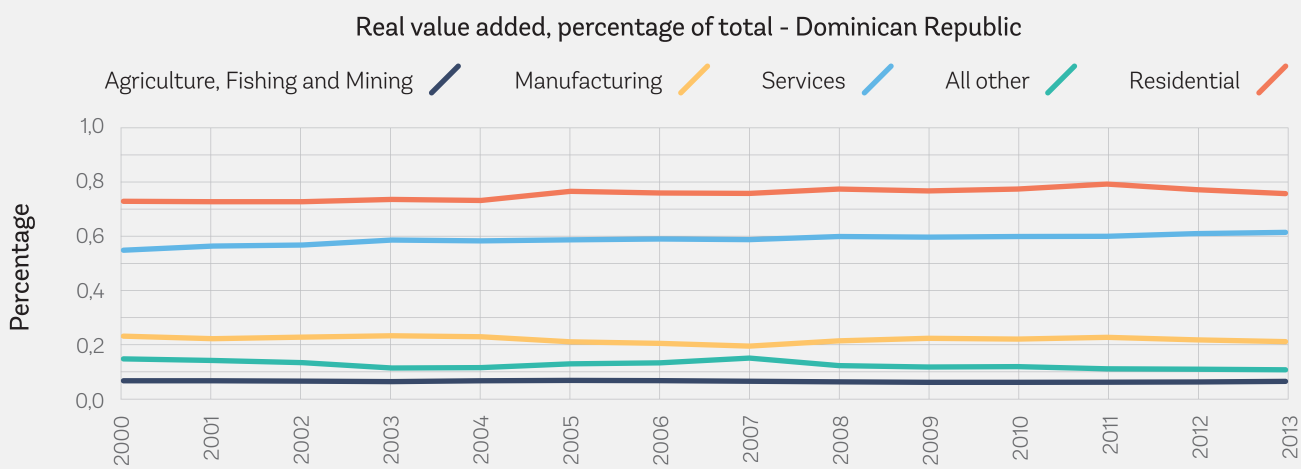
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



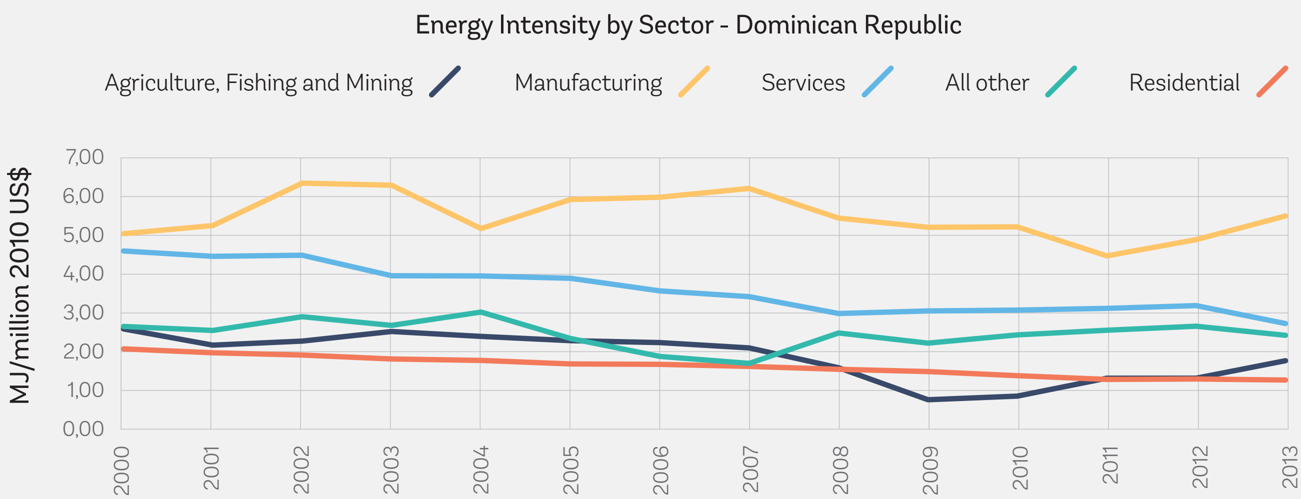
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.9
Fisher indices, sectoral composition, and energy efficiency - Dominican Republic





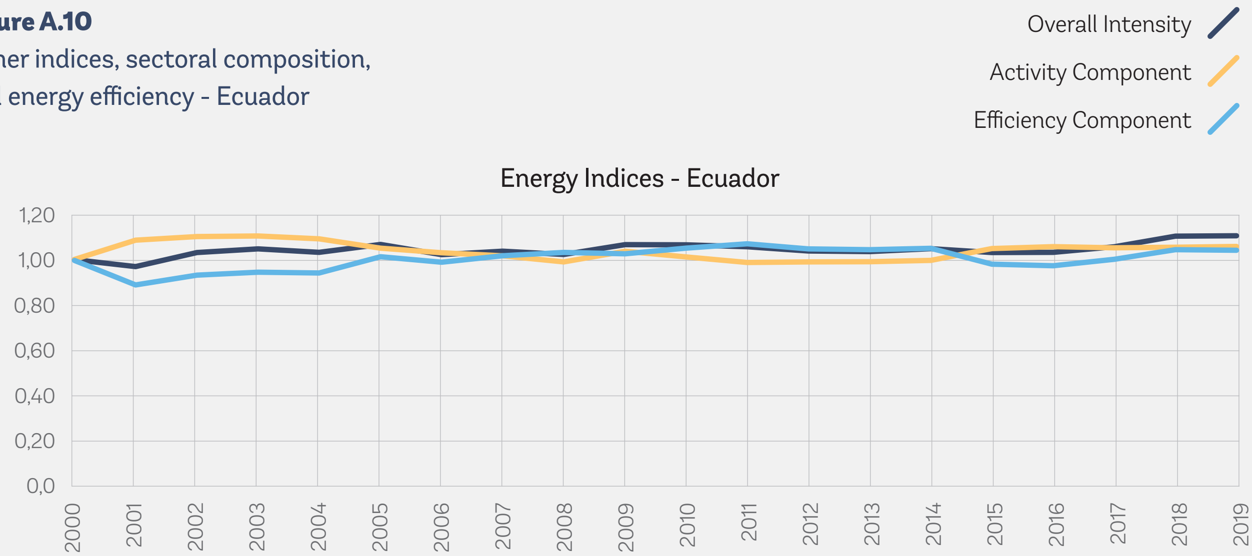
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



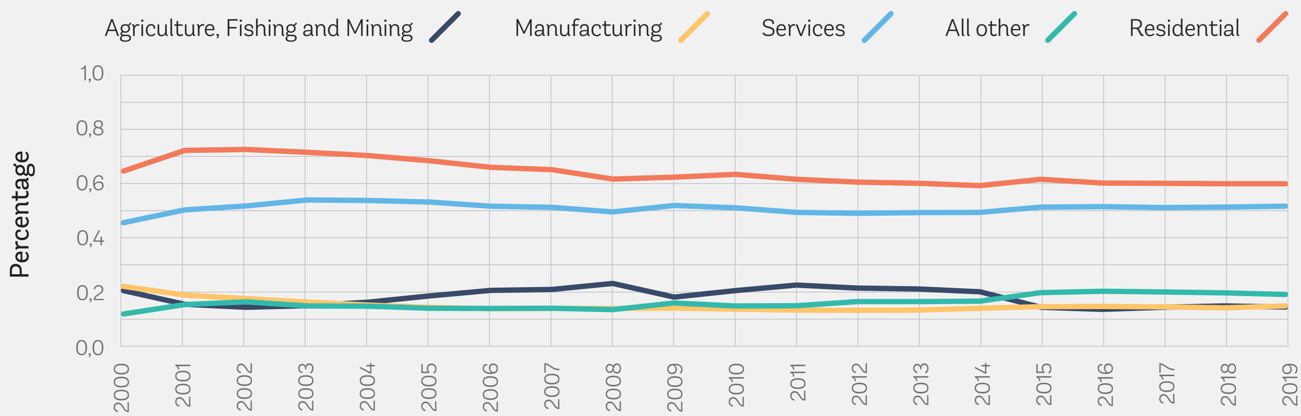
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.10
Fisher indices, sectoral composition, and energy efficiency - Ecuador

Energy Indices - Ecuador

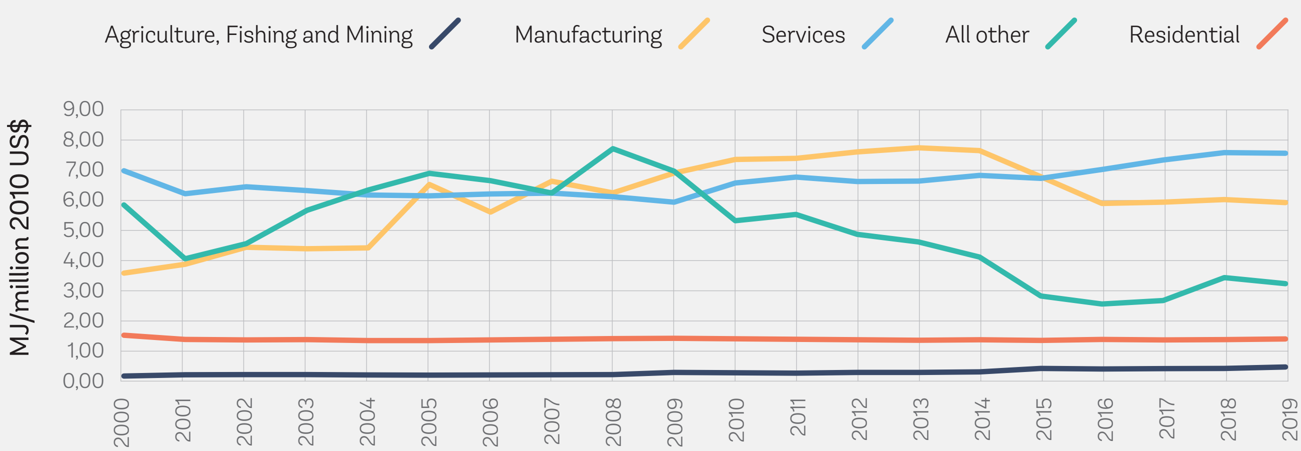


Real value added, percentage of total - Ecuador



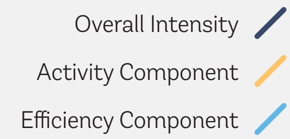
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

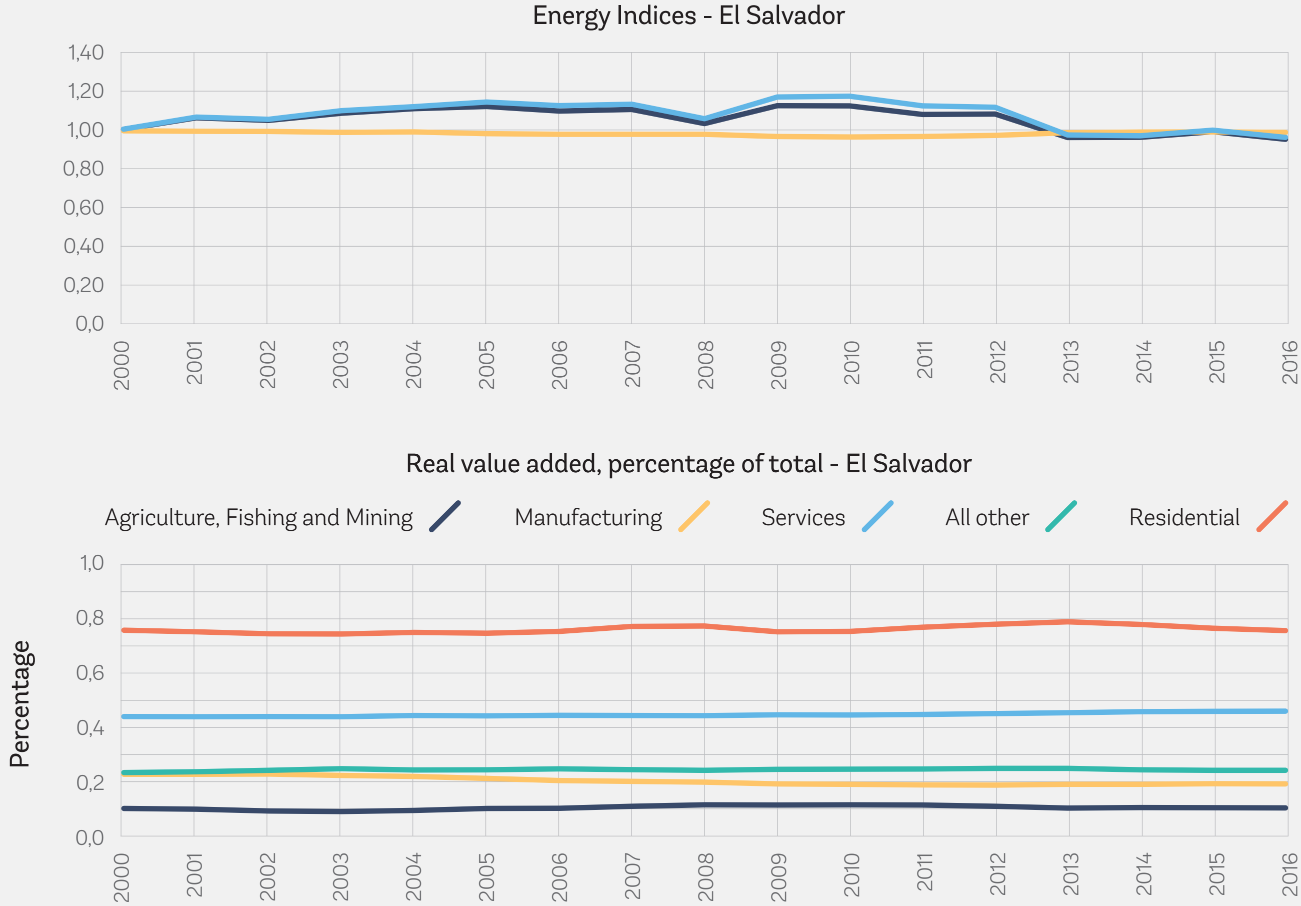
Energy Intensity by Sector - Ecuador



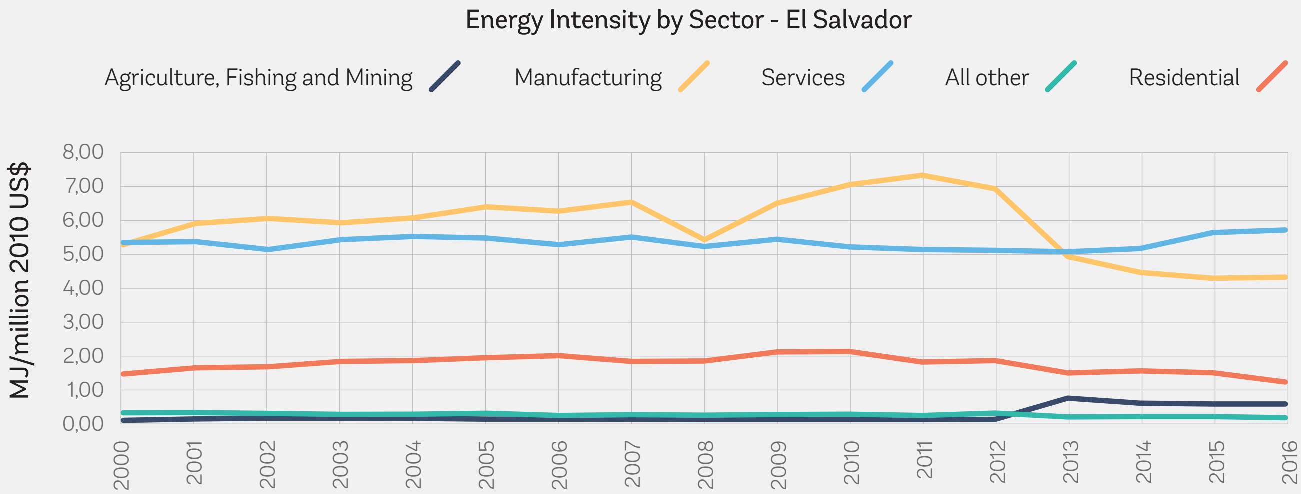
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.11
Fisher indices, sectoral composition, and energy efficiency - El Salvador





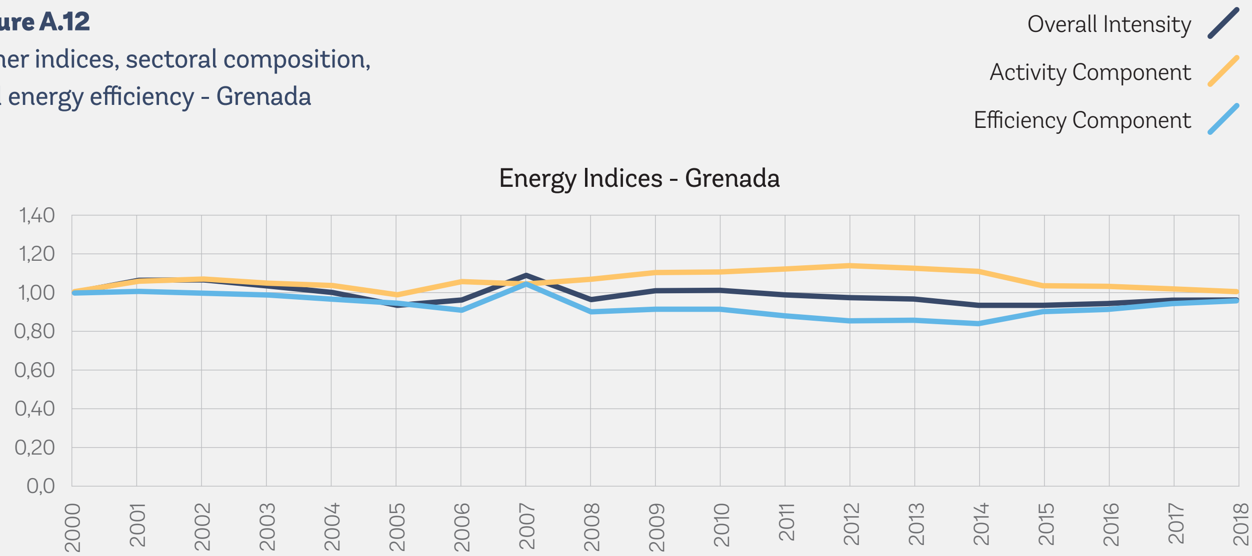
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

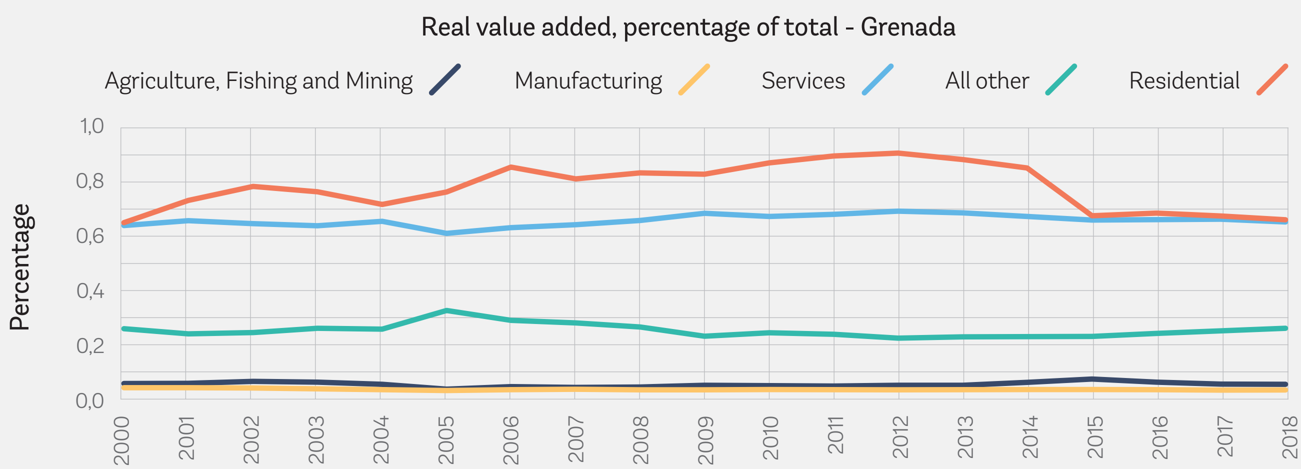


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

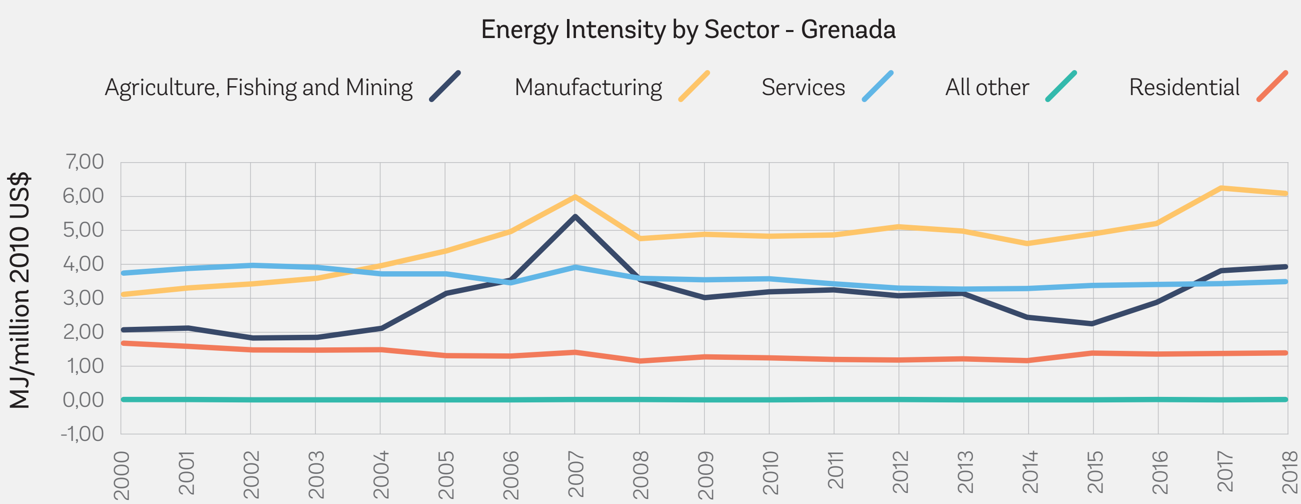
Figure A.12

Fisher indices, sectoral composition, and energy efficiency - Grenada



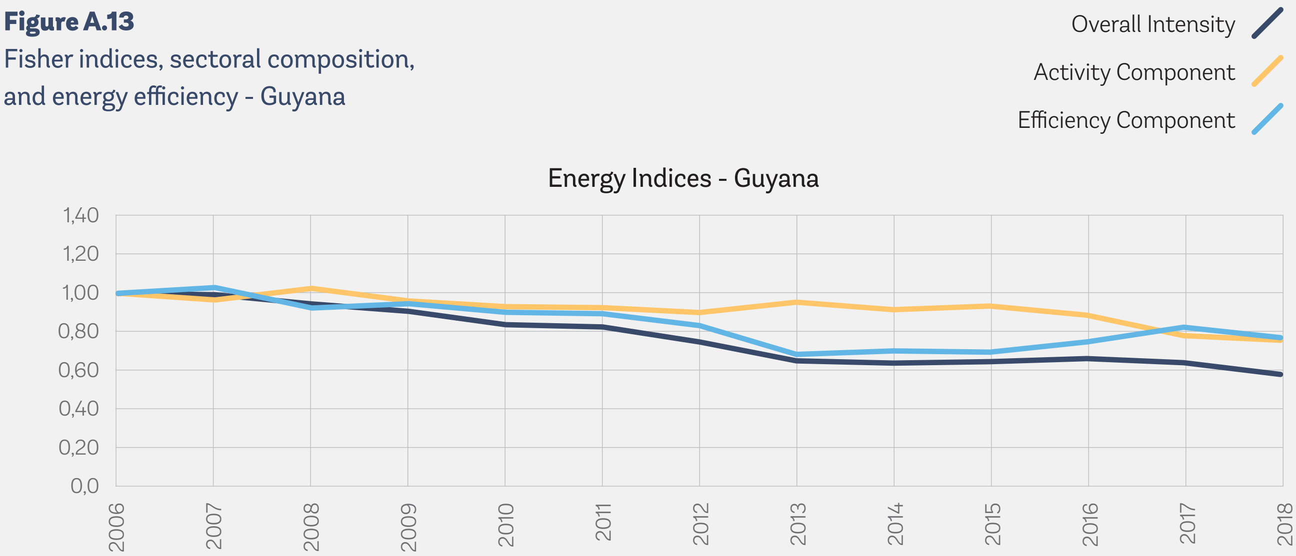


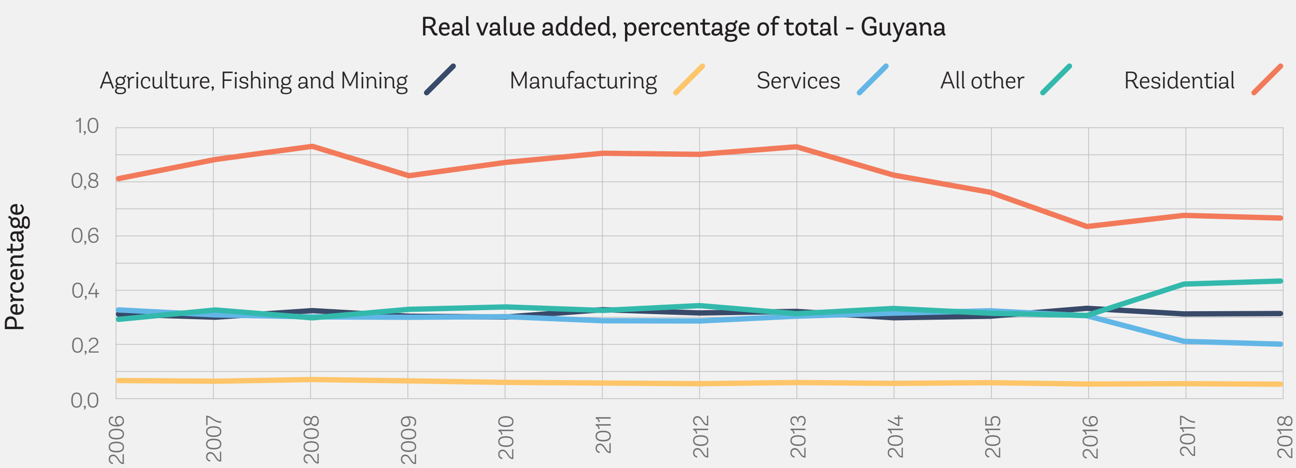
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



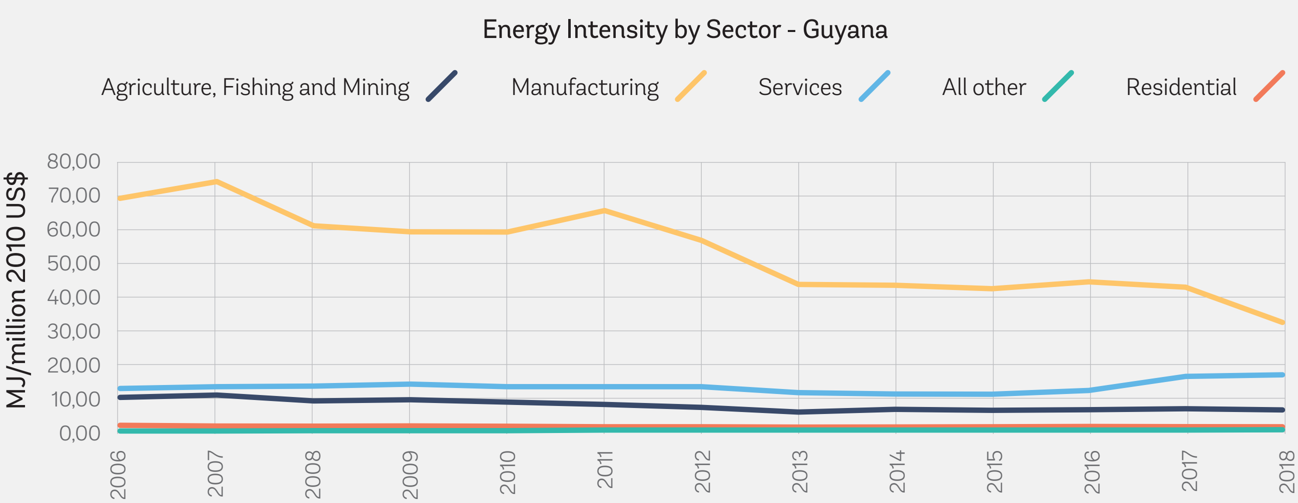
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.13
Fisher indices, sectoral composition, and energy efficiency - Guyana



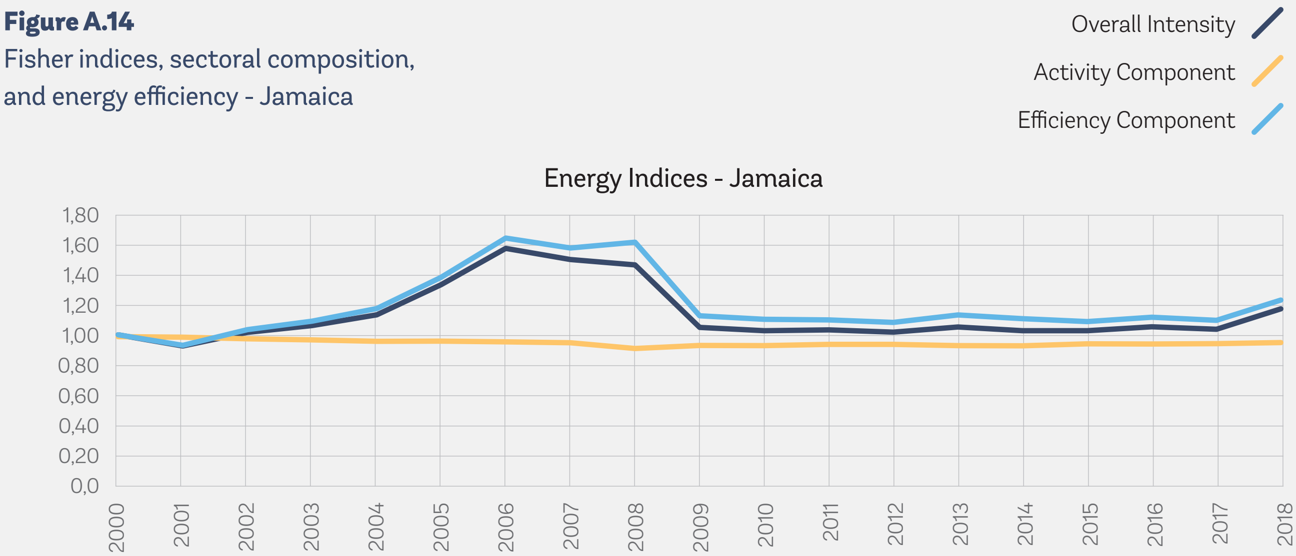


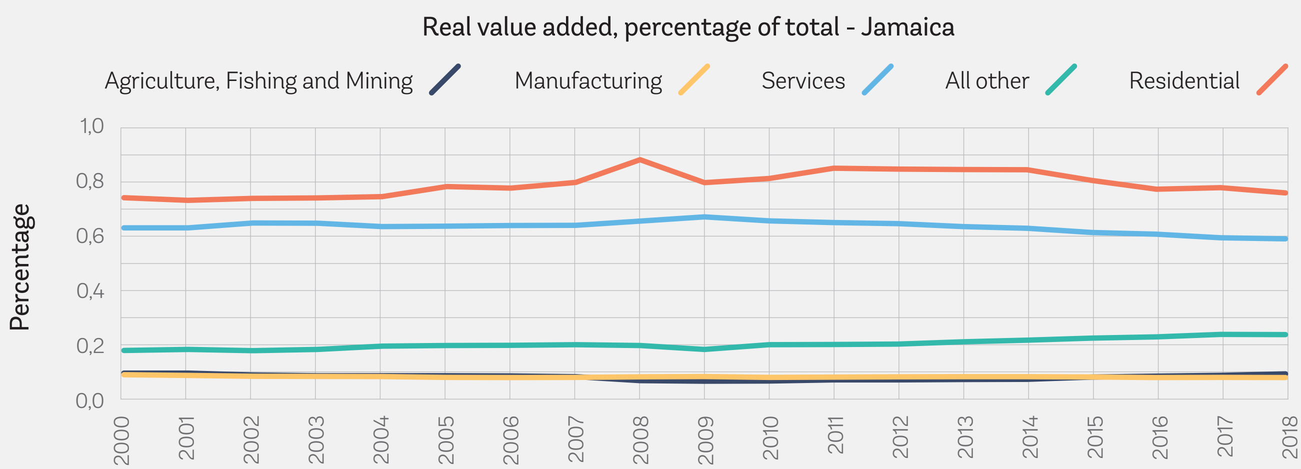
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



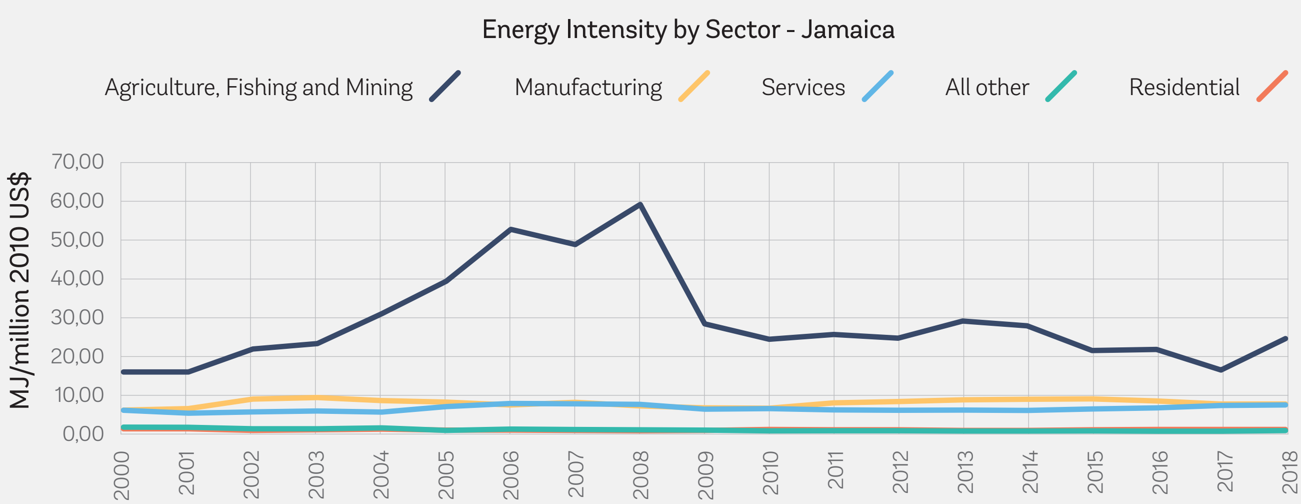
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.14
Fisher indices, sectoral composition, and energy efficiency - Jamaica



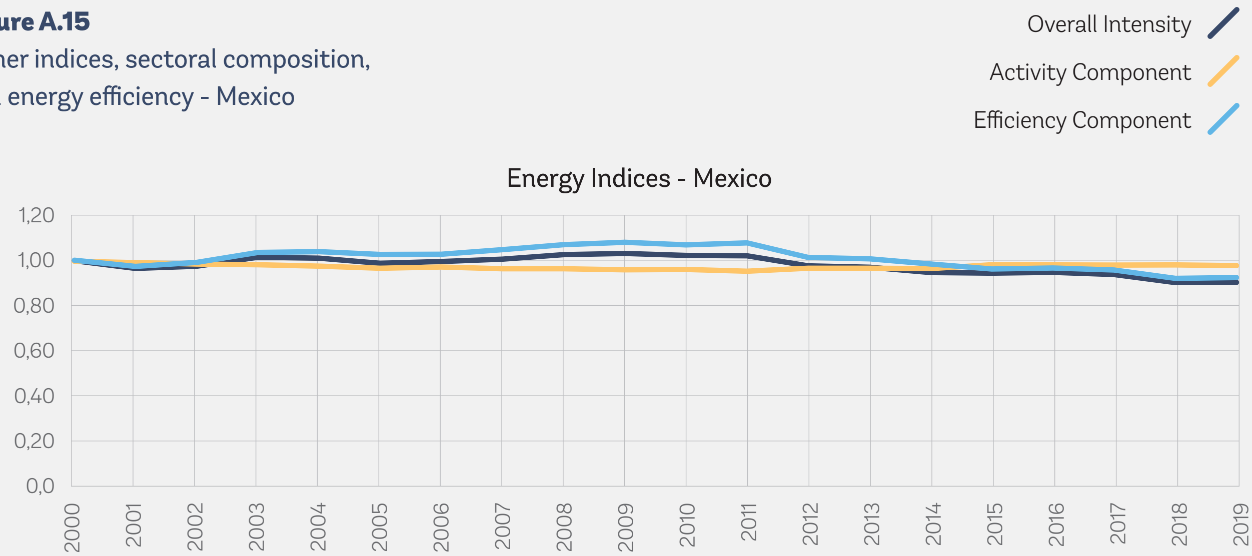


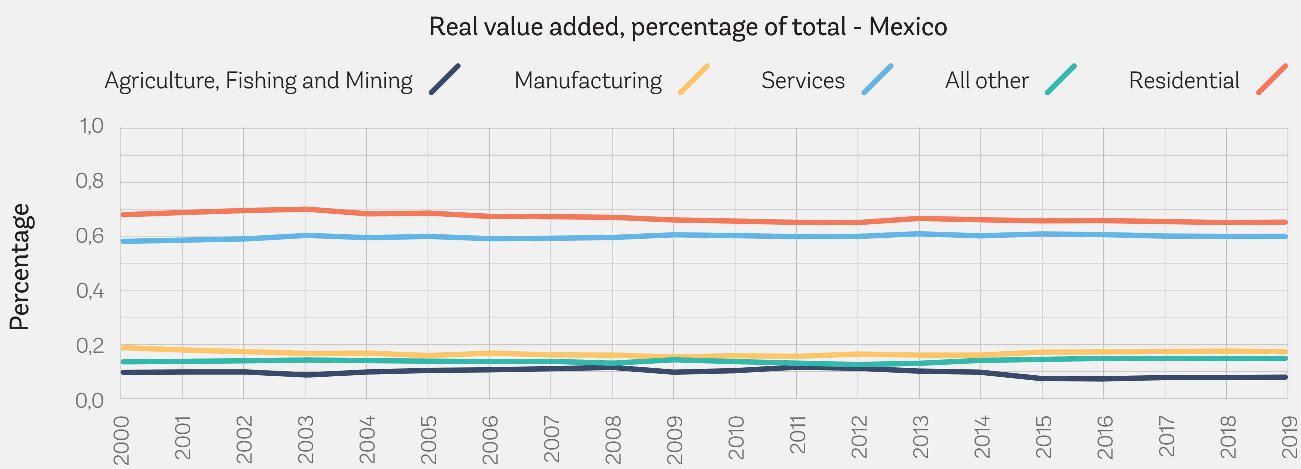
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



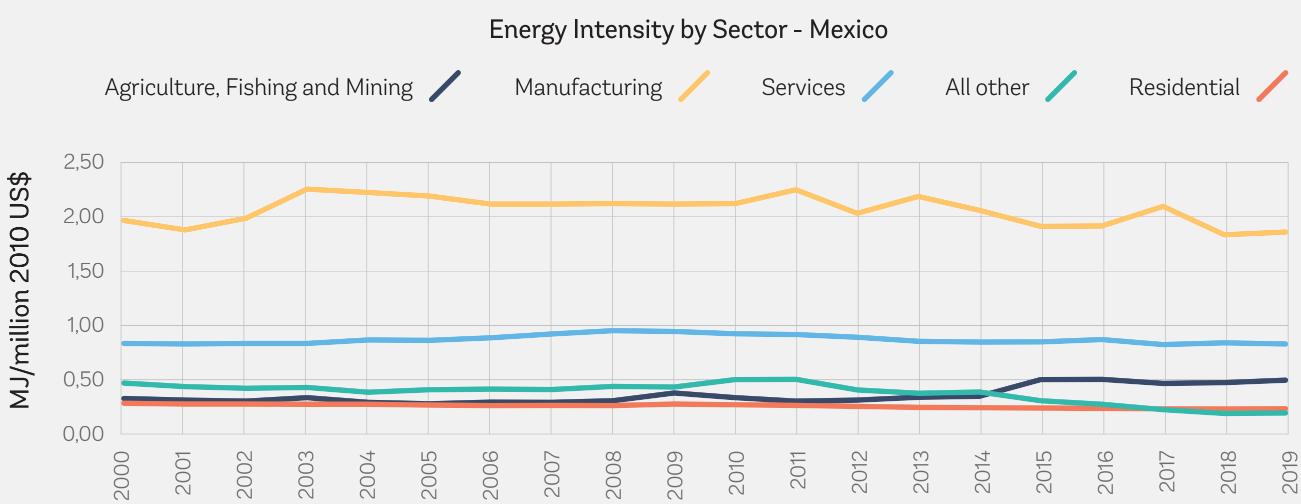
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.15
Fisher indices, sectoral composition, and energy efficiency - Mexico





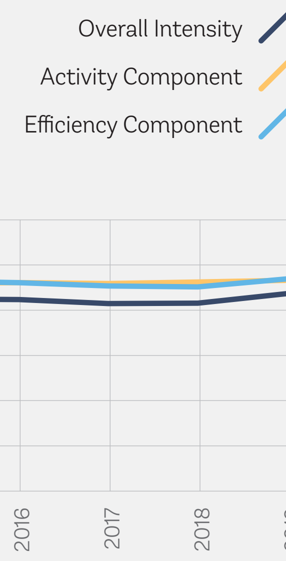
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

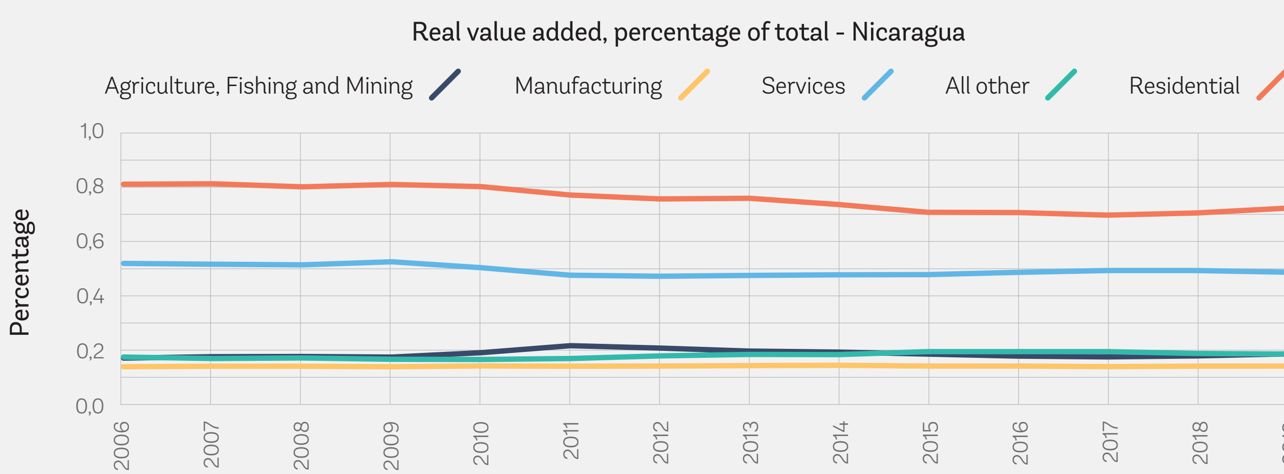


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

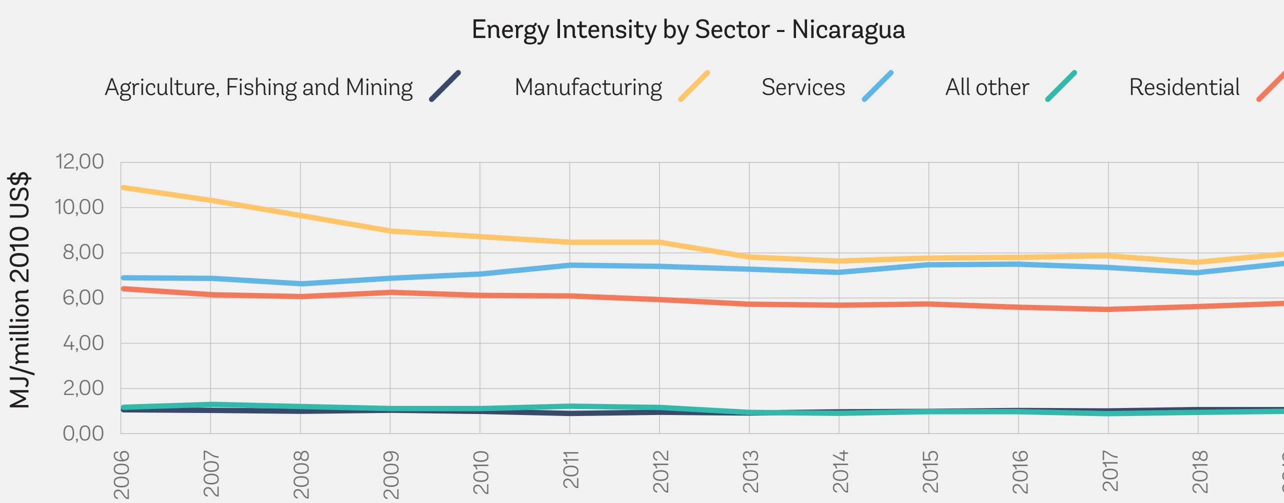
Figure A.16

Fisher indices, sectoral composition, and energy efficiency - Nicaragua



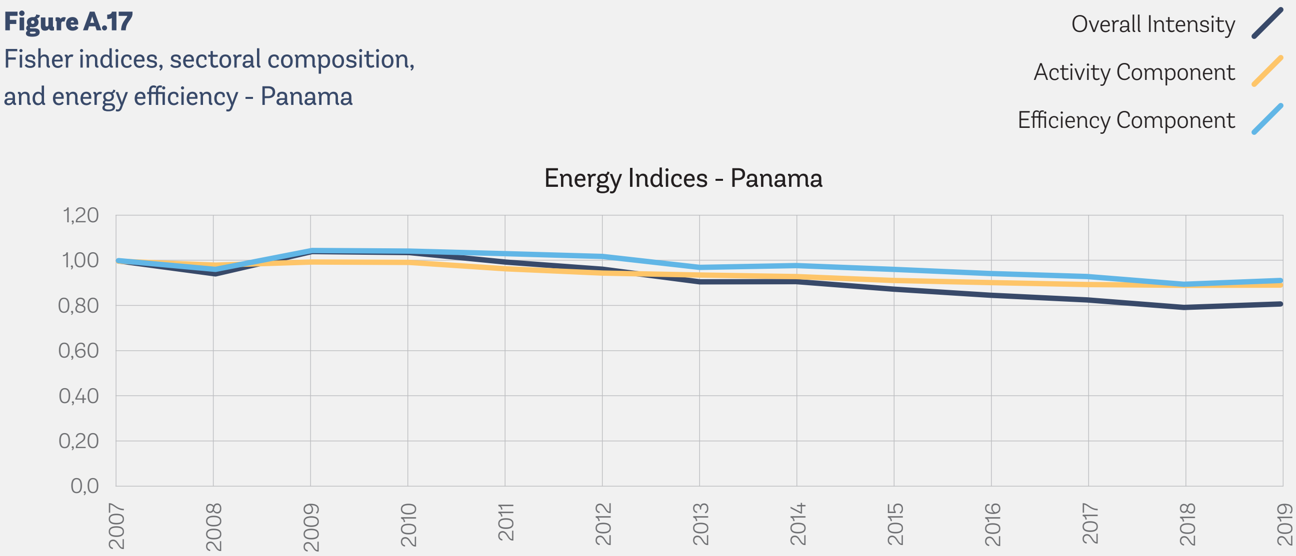


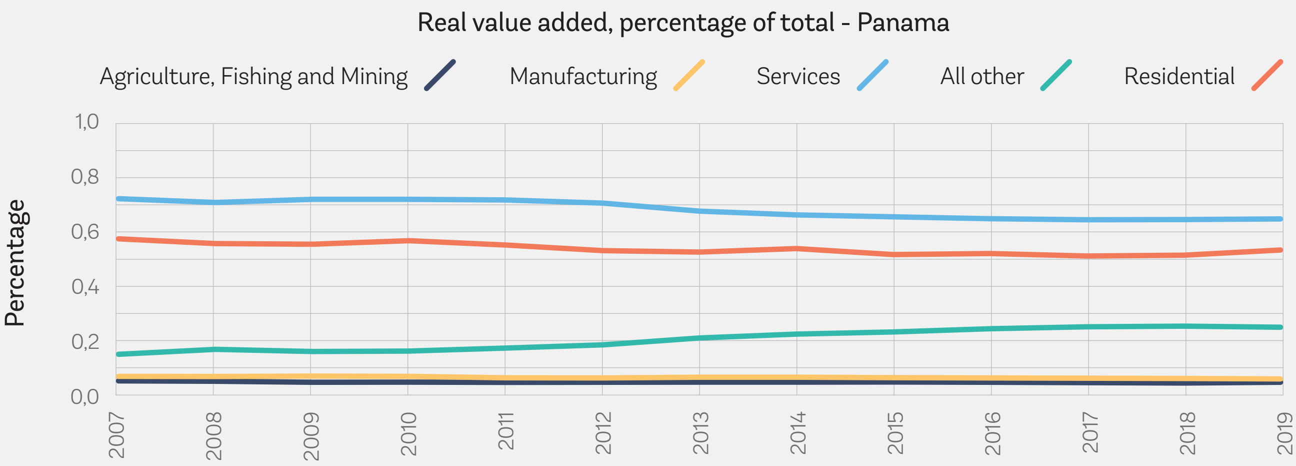
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



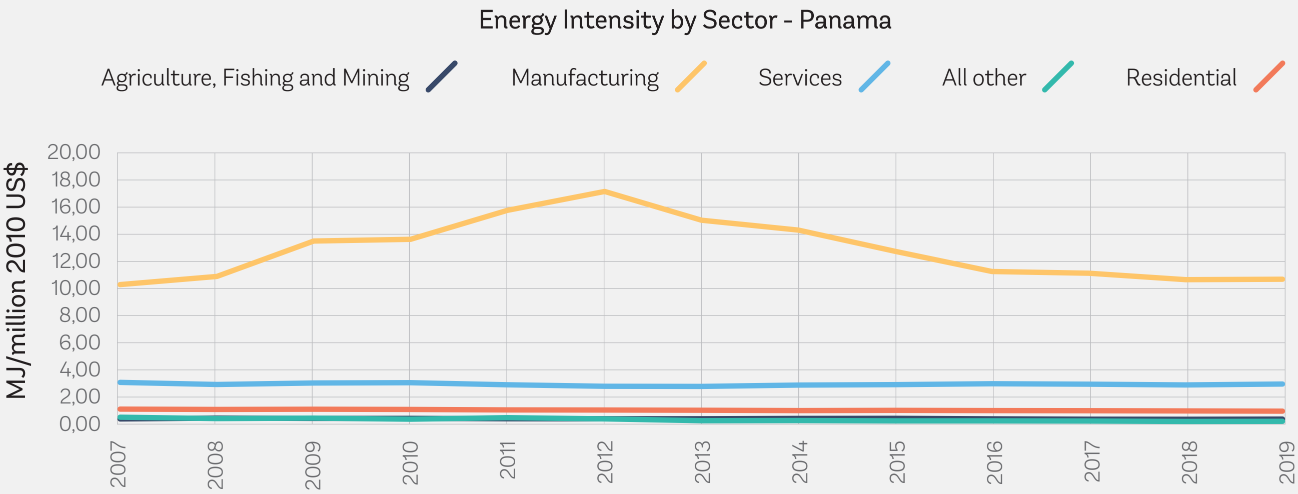
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.17
Fisher indices, sectoral composition, and energy efficiency - Panama





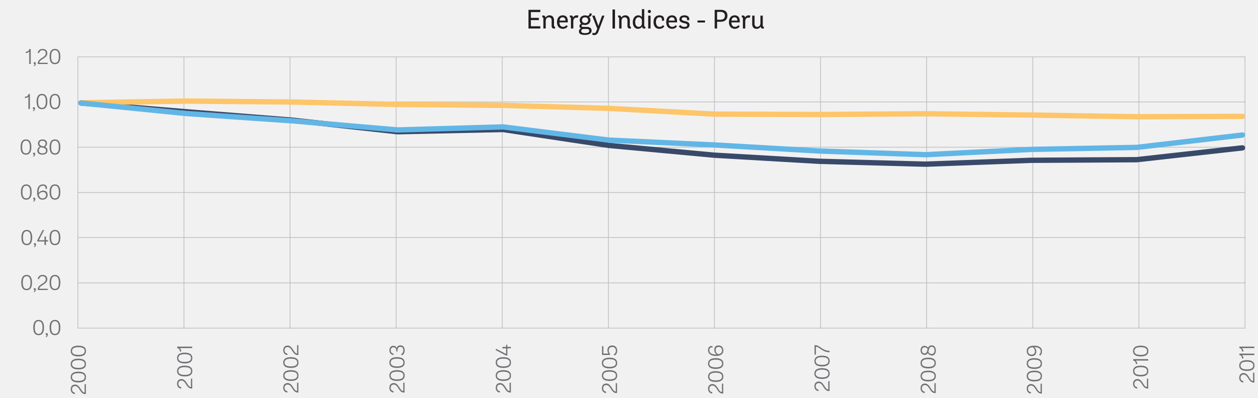
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

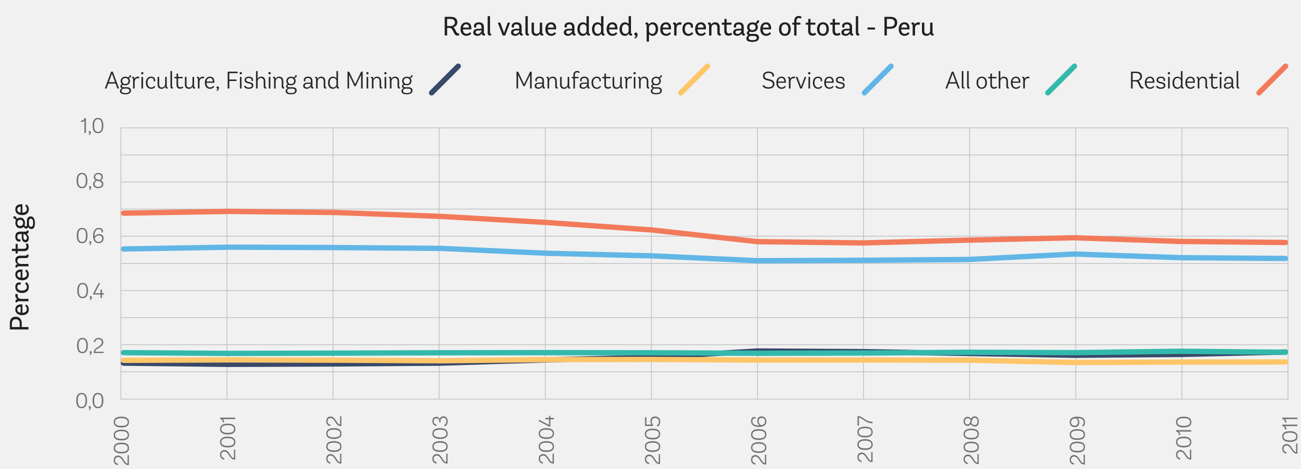


Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

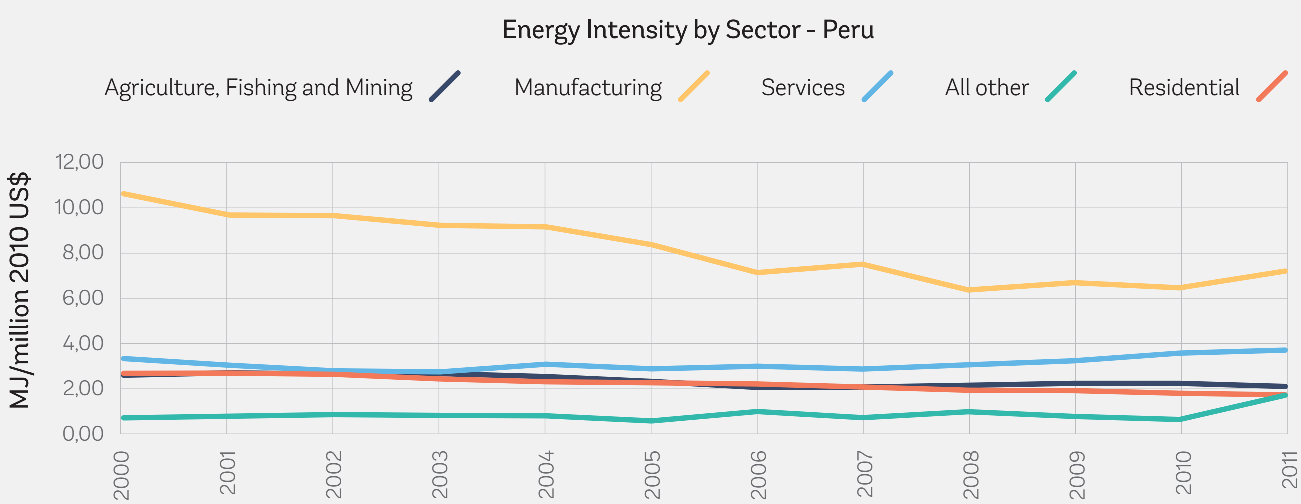
Figure A.18
Fisher indices, sectoral composition, and energy efficiency - Peru

Overall Intensity
Activity Component
Efficiency Component





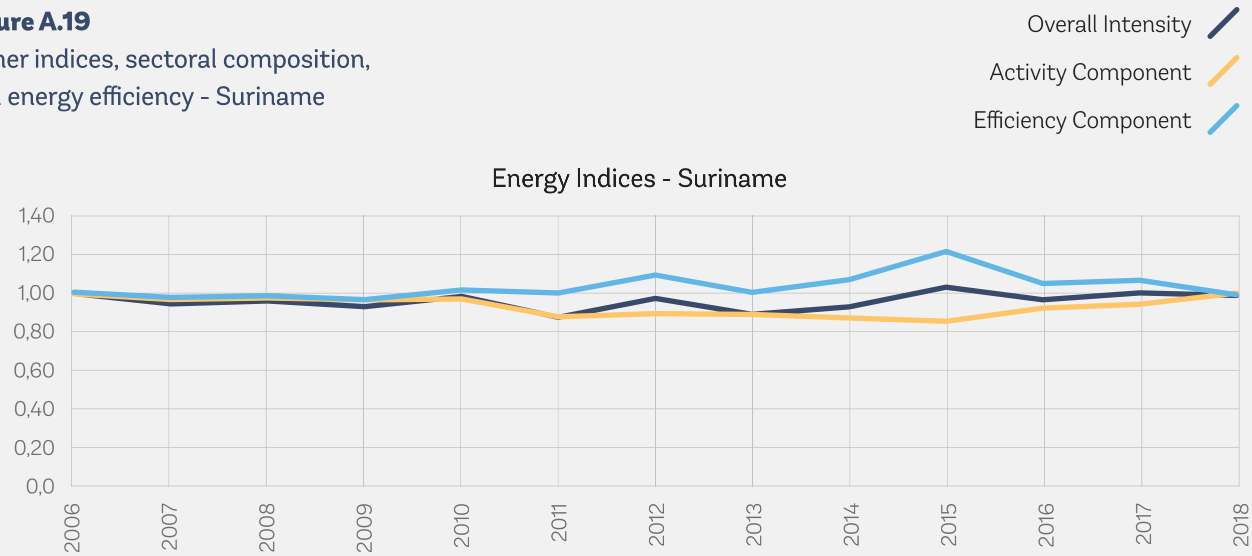
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



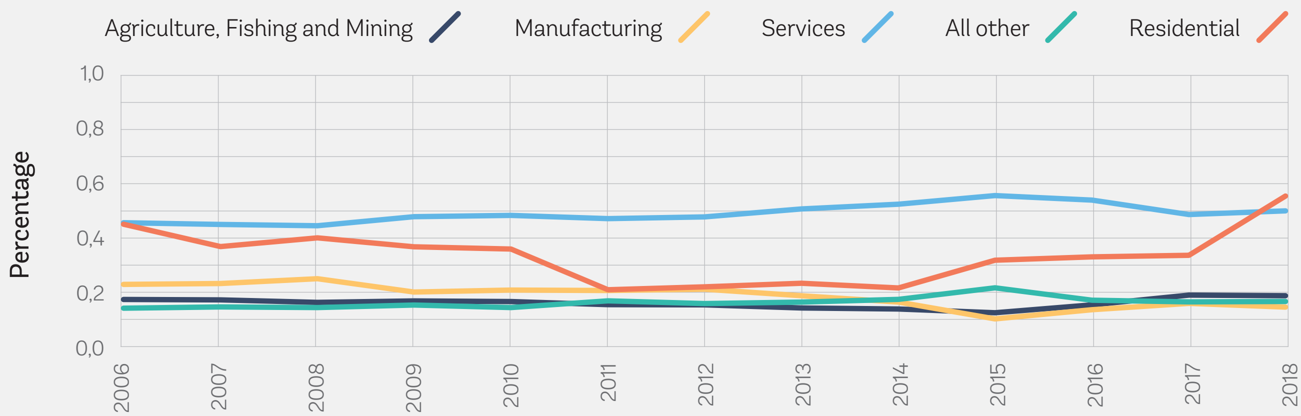
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.19
Fisher indices, sectoral composition, and energy efficiency - Suriname

Energy Indices - Suriname

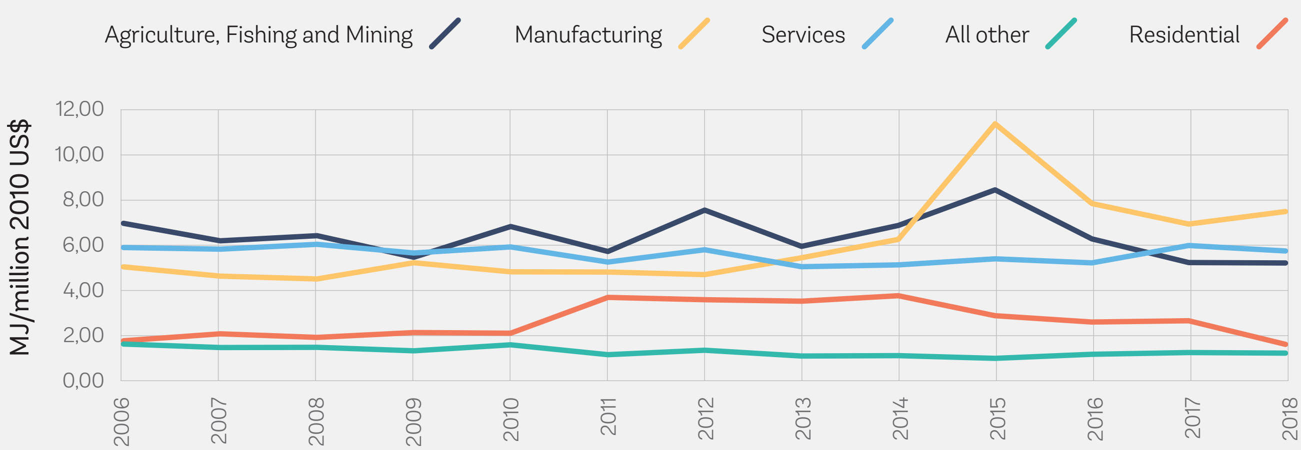


Real value added, percentage of total - Suriname



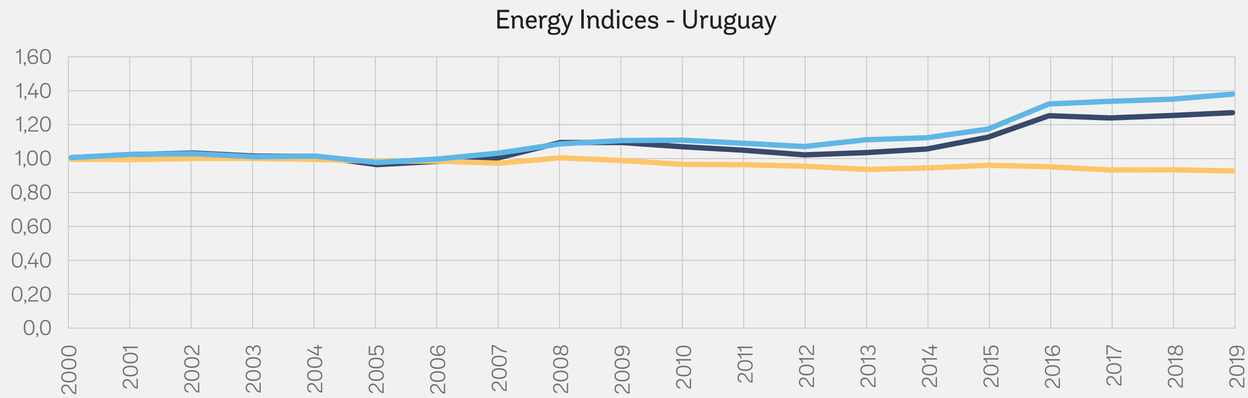
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

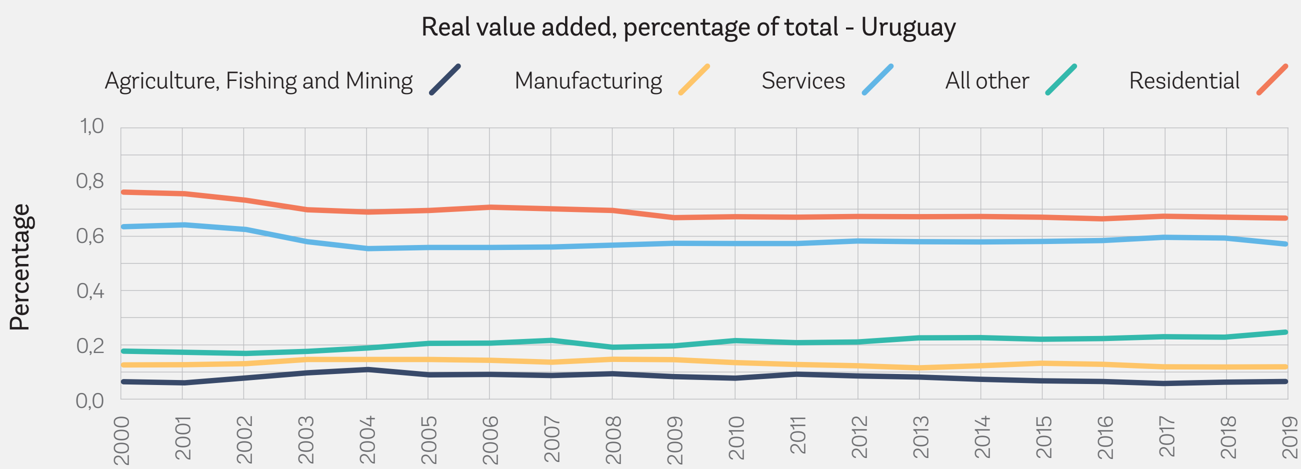
Energy Intensity by Sector - Suriname



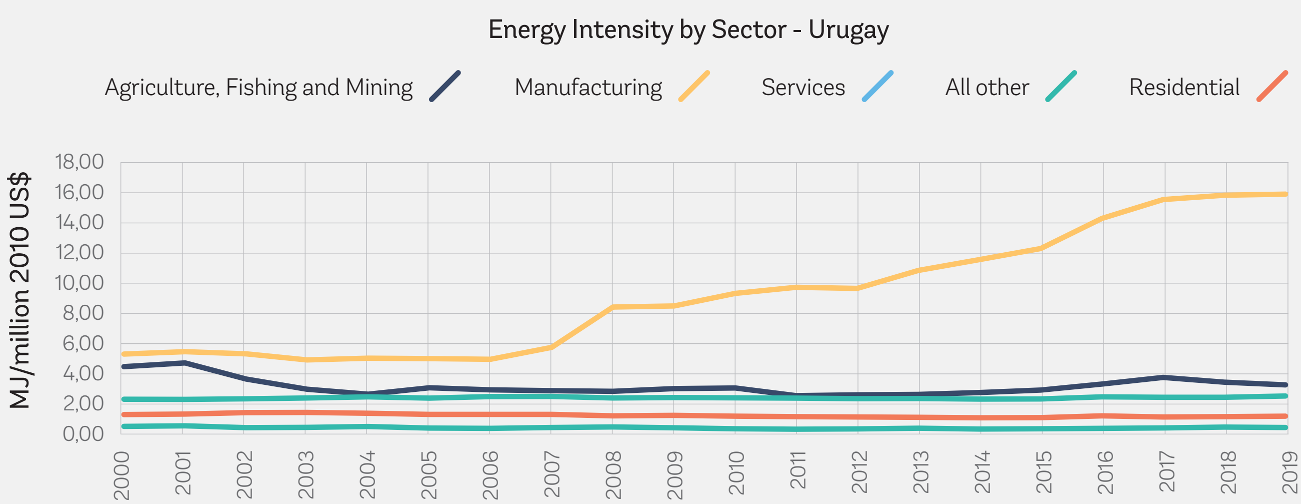
Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

Figure A.20
Fisher indices, sectoral composition, and energy efficiency - Uruguay





Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Agriculture, Fishing and Mining correspond to (ISIC Rev.3, A-C); Services corresponds to (ISIC Rev.3, G-O and 41); Manufacturing corresponds to (ISIC Rev.3, D). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



Note : Agriculture, Fishing and Mining (ISIC Rev 3, A-C); Manufacturing (ISIC Rev 3, D), Services (ISIC Rev 3, G-O and 41)

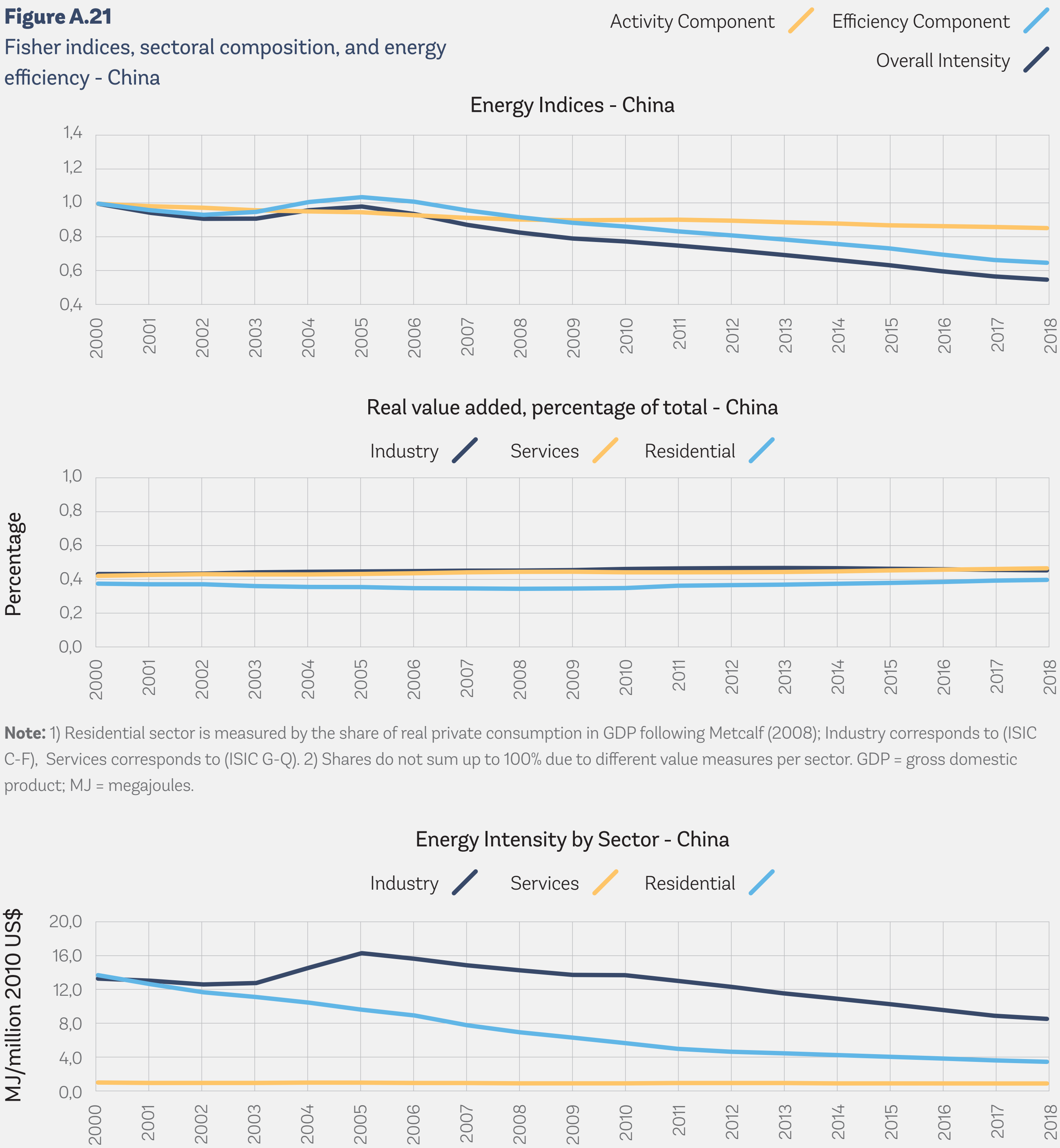
Benchmark countries

Results of a Fisher decomposition of benchmark countries are shown in this section. Countries and regions selected as benchmarks in this exercise include the United States, the European Union (EU28 and EU12), China, India, and the Russian Federation.

Because of a lack of data on the energy consumption of the agriculture and fishing sectors in the IEA database, as well as a lack of value-added data on manufacturing from the WDI, the exercise focused on four sectors: industry, services, residential, and a residual category called "all others."

For the sake of comparison, a Fisher decomposition of 19 LAC countries is also presented. These countries are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, and Uruguay.

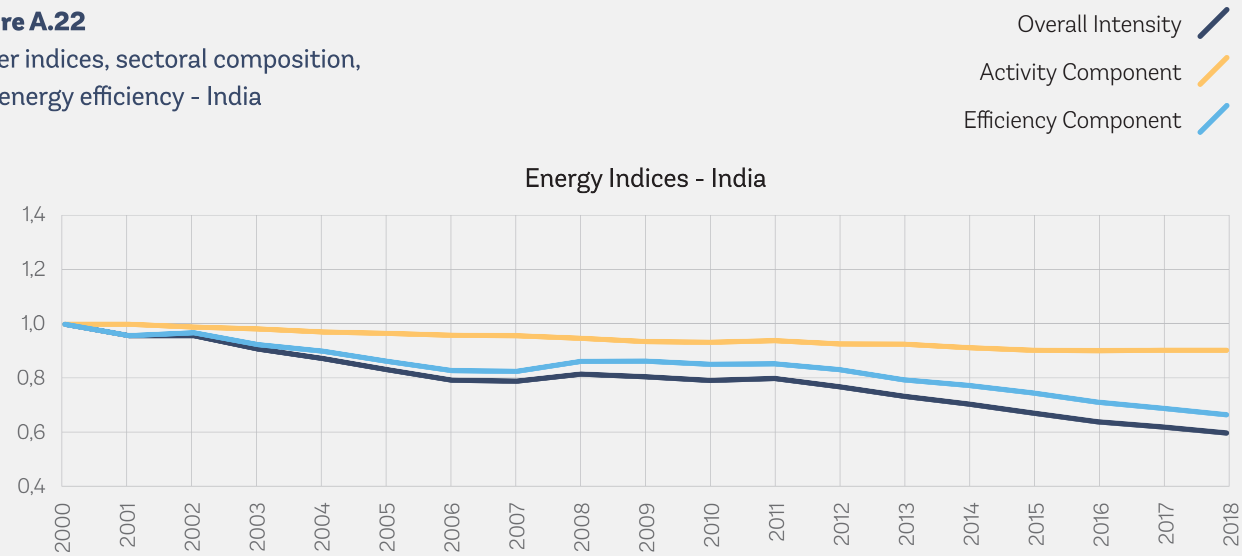
Figure A.21
Fisher indices, sectoral composition, and energy efficiency - China

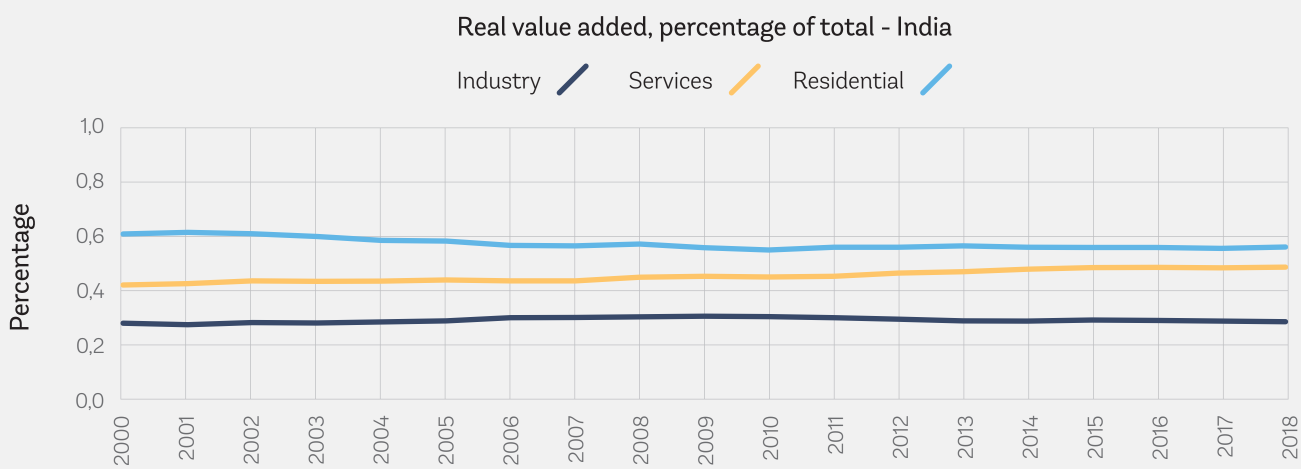


Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

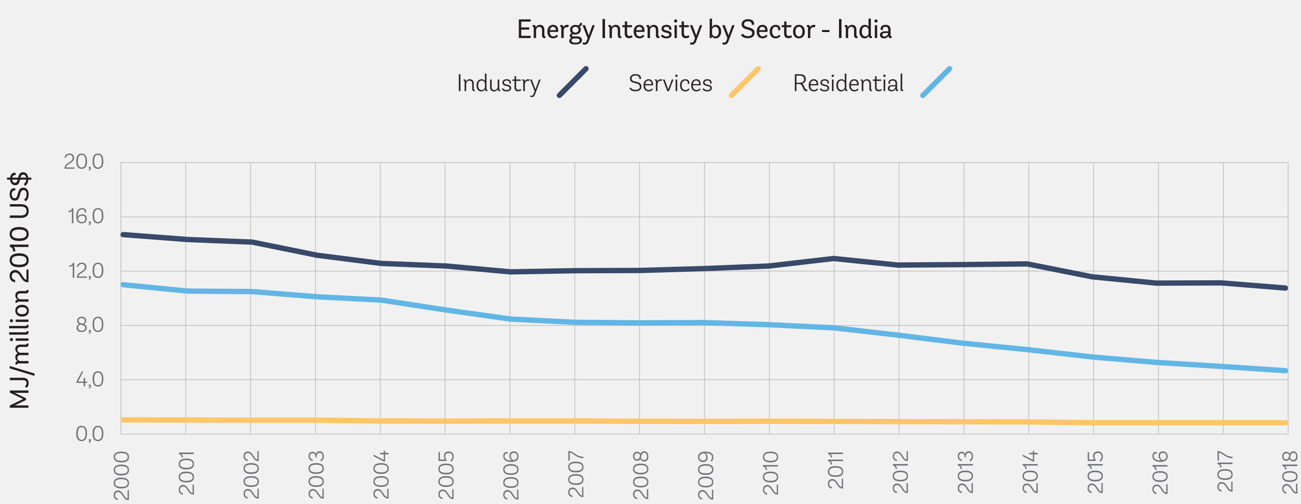
Note : Industry (ISIC C-F), Services (ISIC G-Q)

Figure A.22
Fisher indices, sectoral composition, and energy efficiency - India



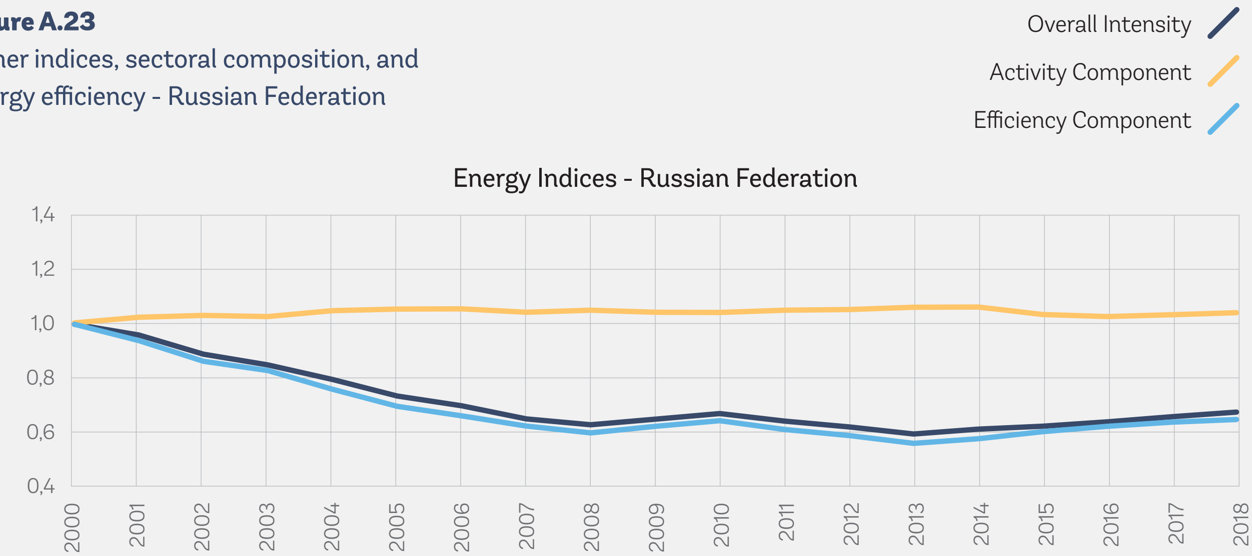


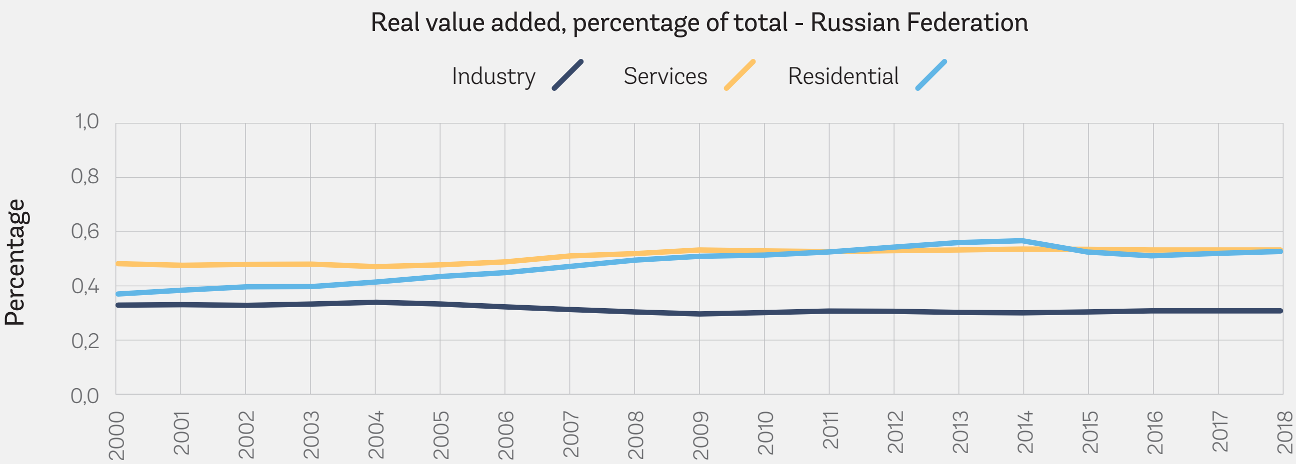
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



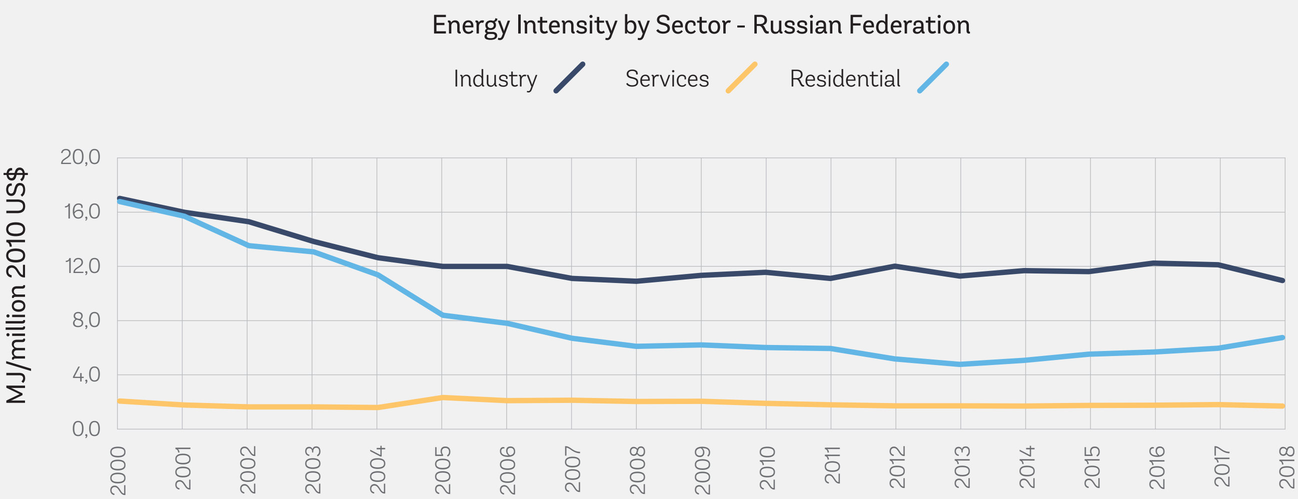
Note : Industry (ISIC C-F), Services (ISIC G-Q)

Figure A.23
Fisher indices, sectoral composition, and energy efficiency - Russian Federation



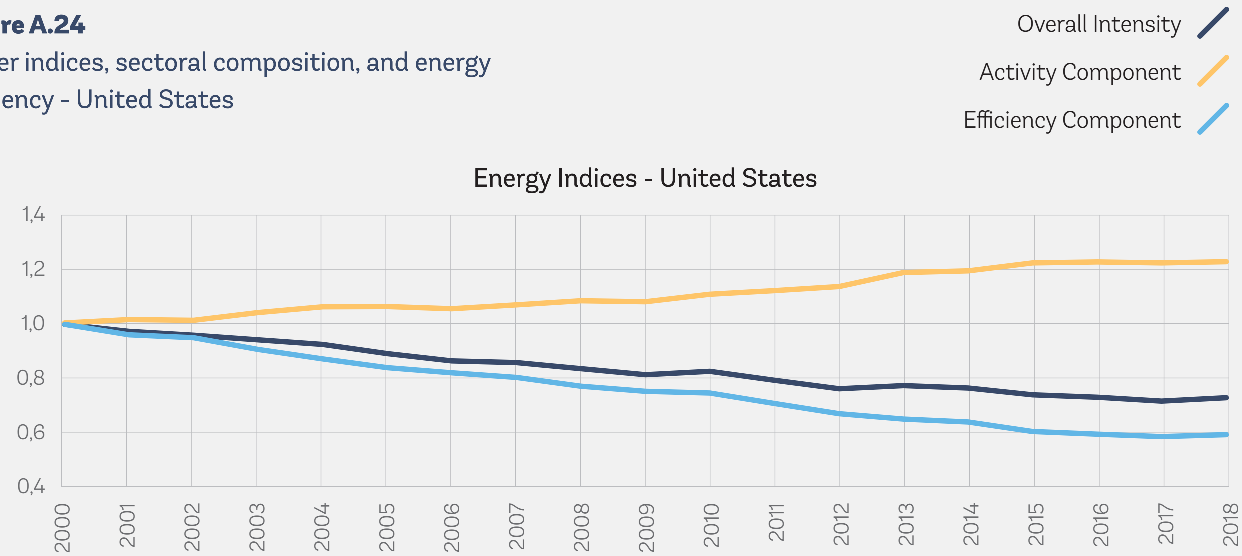


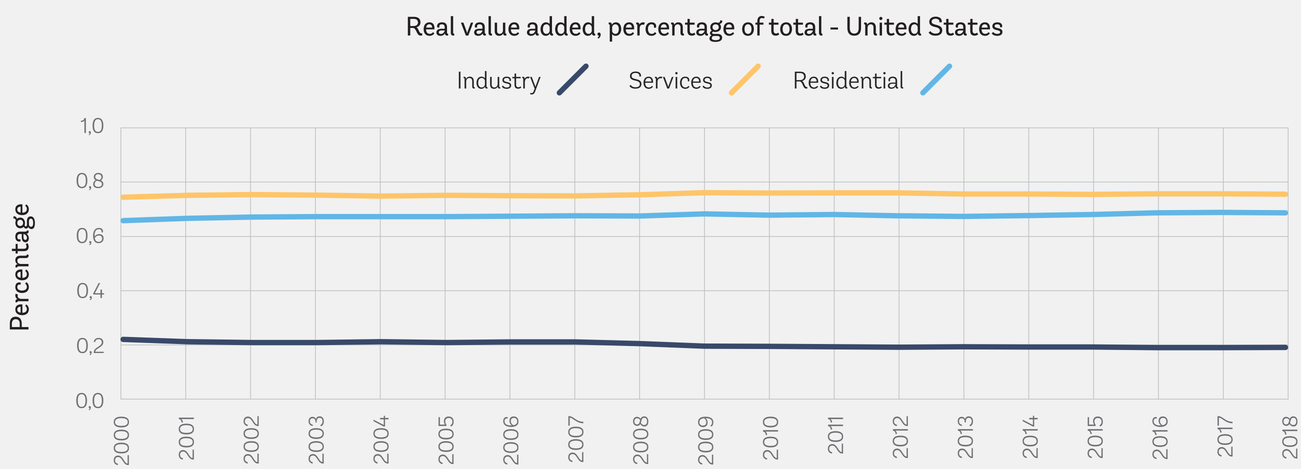
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



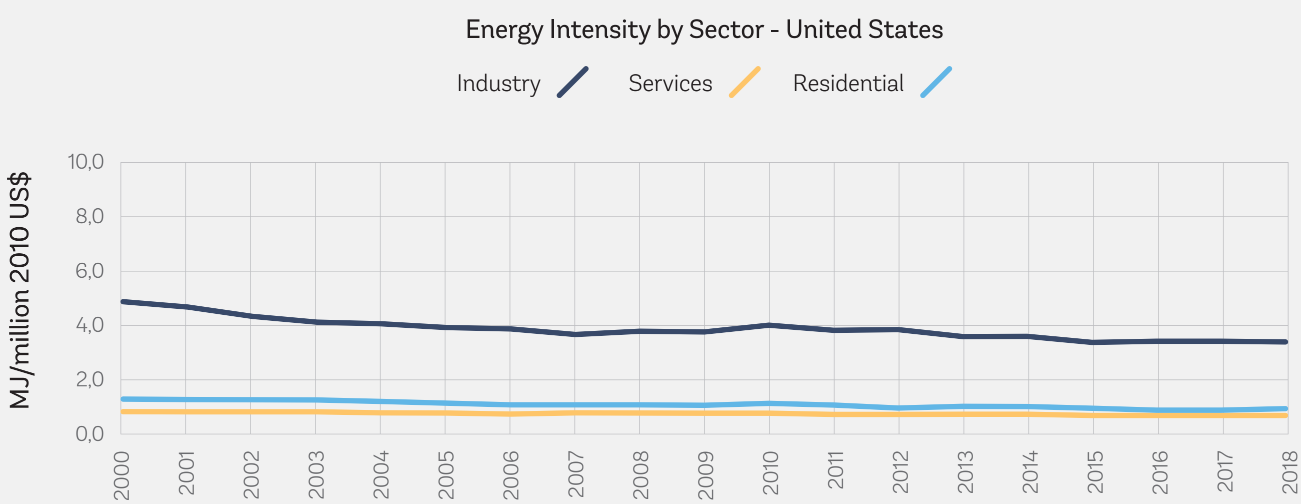
Note : Industry (ISIC C-F), Services (ISIC G-Q)

Figure A.24
Fisher indices, sectoral composition, and energy efficiency - United States





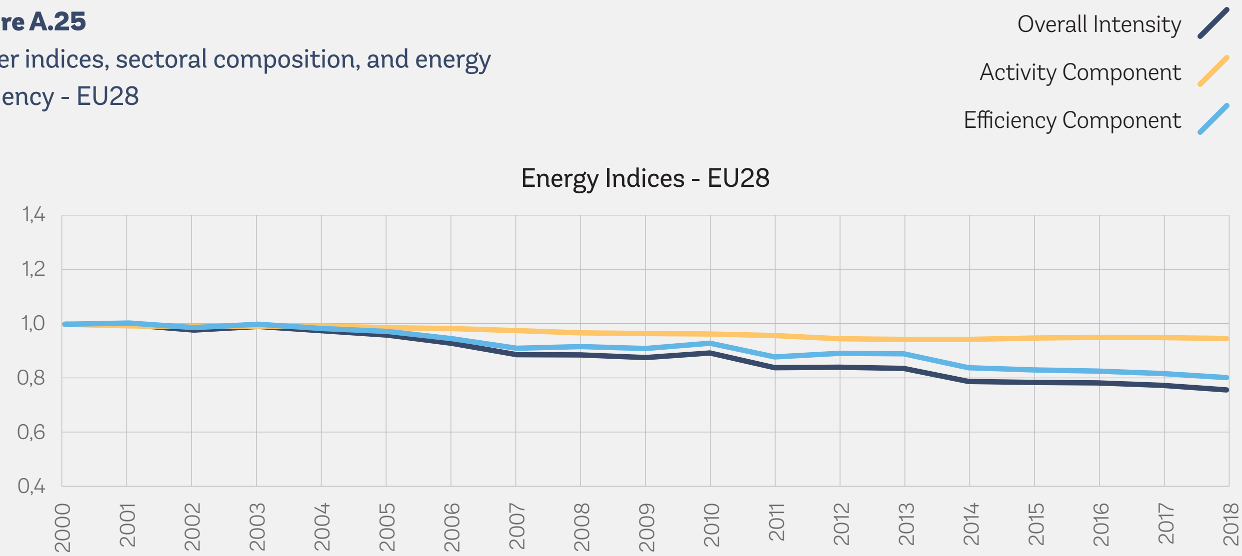
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.

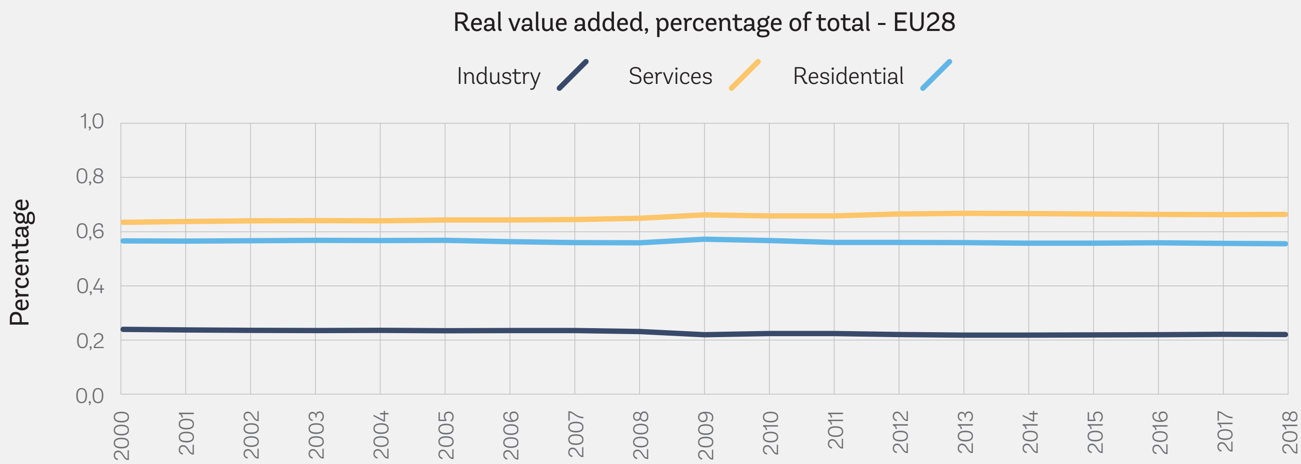


Note : Industry (ISIC C-F), Services (ISIC G-Q)

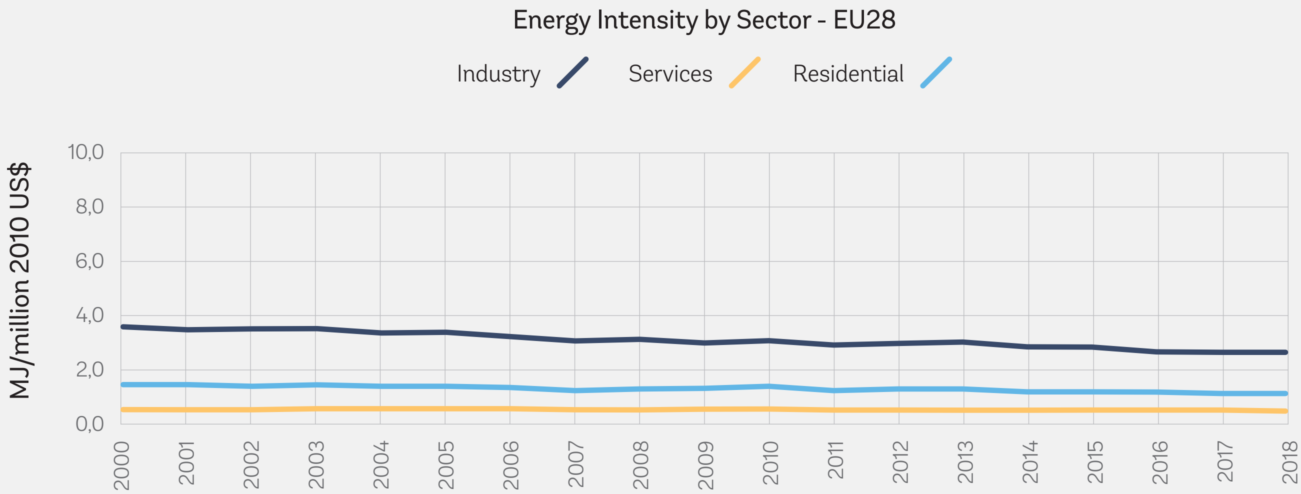
Figure A.25

Fisher indices, sectoral composition, and energy efficiency - EU28



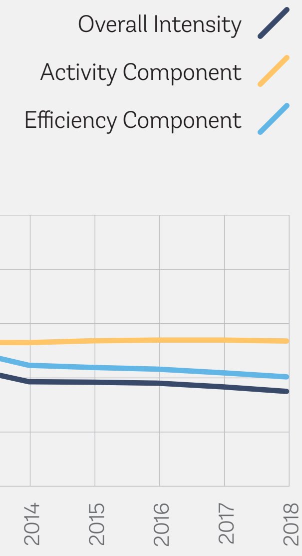


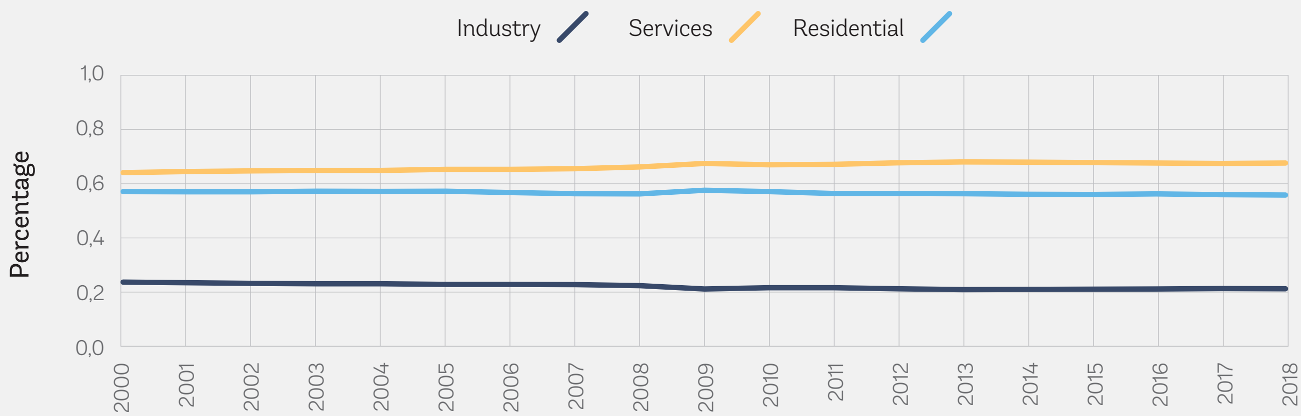
Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



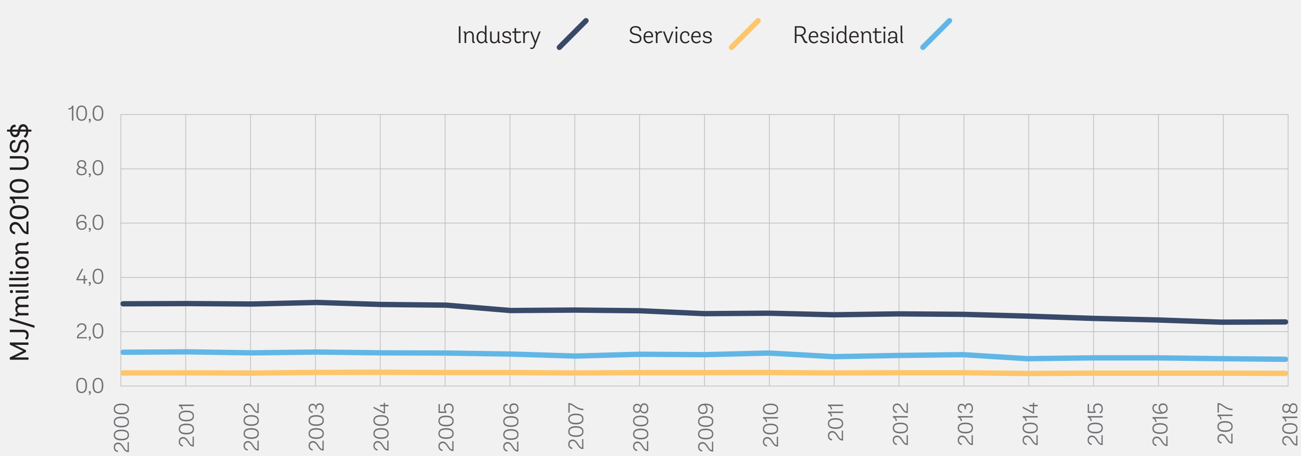
Note : Industry (ISIC C-F), Services (ISIC G-Q)

Figure A.26
Fisher indices, sectoral composition, and energy efficiency - EU12





Note: 1) Residential sector is measured by the share of real private consumption in GDP following Metcalf (2008); Industry corresponds to (ISIC C-F), Services corresponds to (ISIC G-Q). 2) Shares do not sum up to 100% due to different value measures per sector. GDP = gross domestic product; MJ = megajoules.



Note : Industry (ISIC C-F), Services (ISIC G-Q)

Table A.3. Effect of removing energy subsidies on energy intensity

Country	Years	Δ Energy intensity (%)	Δ Simulated (%)	Avg. subsidy (%)
Argentina	2004–19	-11.3	-13.7	19.1
Bolivia	2000–18	4.7	3.0	10.8
Brazil	2000–19	-4.4	-4.5	0.4
Chile	2003–15	-19.8	-20.8	7.8
Colombia	2000–16	-24.7	-25.1	3.3
Costa Rica	2000–14	0.4	0.4	0.1
Dominican Republic	2000–13	-28.6	-28.6	0.0
Ecuador	2000–19	11.3	9.5	11.2
El Salvador	2000–16	-5.4	-7.8	18.1
Guatemala	2001–18	-21.6	-21.7	0.8
Haiti	2005–18	-9.5	-9.5	0.0
Honduras	2000–19	-27.9	-27.9	0.0
Jamaica	2000–18	17.6	17.6	0.0
Mexico	2000–19	-10.3	-10.7	3.3
Nicaragua	2006–19	-12.9	-12.9	0.0
Panama	2007–19	-19.8	-19.8	0.0
Paraguay	2000–17	-4.8	-4.8	0.0
Peru	2000–11	-20.6	-20.6	0.0
Uruguay	2000–19	27.5	27.5	0.0

Table A.4. Effect of removing energy subsidies on energy efficiency

Country	Years	Δ Energy efficiency (%)	Δ Simulated (%)	Avg. subsidy (%)
Argentina	2004–19	-6.0	-9.3	19.1
Bolivia	2000–18	15.4	13.0	10.8
Brazil	2000–19	1.5	1.4	0.4
Chile	2003–15	-15.4	-16.6	7.8
Colombia	2000–16	-19.9	-20.4	3.3
Costa Rica	2000–14	0.6	0.6	0.1
Dominican Republic	2000–13	-29.4	-29.4	0.0
Ecuador	2000–19	4.8	2.6	11.2
El Salvador	2000–16	-4.4	-7.5	18.1
Guatemala	2001–18	-24.6	-24.7	0.8
Haiti	2005–18	2.3	2.3	0.0
Honduras	2000–19	-32.1	-32.1	0.0
Jamaica	2000–18	23.4	23.4	0.0
Mexico	2000–19	-8.1	-8.7	3.3
Nicaragua	2006–19	-6.2	-6.2	0.0
Panama	2007–19	-9.4	-9.4	0.0
Paraguay	2000–17	7.3	7.3	0.0
Peru	2000–11	-14.7	-14.7	0.0
Uruguay	2000–19	38.6	38.6	0.0

Table A.5. Effects of policies on energy intensity

Country	Years	Δ Energy intensity (%)	RISE: Aggregate (%)	RISE: National planning (%)	RISE: EE entities (%)	RISE: Financing (%)
Argentina	2004–19	-11.3	-18.6	-12.8	-12.7	-12.9
Bolivia	2000–18	4.7	-3.1	3.1	3.1	2.9
Brazil	2000–19	-4.4	-6.6	-4.8	-4.8	-4.9
Chile	2003–15	-19.8	-23.0	-20.5	-20.5	-20.5
Colombia	2000–16	-24.7	-27.4	-25.3	-25.2	-25.3
Costa Rica	2000–14	0.4	-3.0	-0.3	-0.2	-0.3
Dominican Republic	2000–13	-28.6	-34.6	-29.8	-29.8	-29.9
Ecuador	2000–19	11.3	7.9	10.6	10.6	10.6
El Salvador	2000–16	-5.4	-12.9	-6.9	-6.9	-7.1
Guatemala	2001–18	-21.6	-28.5	-23.0	-22.9	-23.1
Haiti	2005–18	-9.5	-22.9	-12.3	-12.3	-12.6
Honduras	2000–19	-27.9	-36.5	-29.7	-29.7	-29.9
Jamaica	2000–18	17.6	12.6	16.6	16.6	16.5
Mexico	2000–19	-10.3	-10.3	-10.3	-10.3	-10.3
Nicaragua	2006–19	-12.9	-19.4	-14.2	-14.2	-14.4
Panama	2007–19	-19.8	-21.4	-20.1	-20.1	-20.1
Paraguay	2000–17	-4.8	-13.0	-6.5	-6.5	-6.7
Peru	2000–11	-20.6	-28.5	-22.2	-22.1	-22.4
Uruguay	2000–19	27.5	22.2	25.1	25.1	25.0

EE = energy efficiency; RISE = Regulatory Indicators for Sustainable Energy.

Table A.6. Effects of policies on energy efficiency

Country	Years	Δ Energy Efficiency (%)	RISE: Aggregate	RISE: National planning	RISE: EE entities	RISE: Financing
Argentina	2004–19	-6.0	-0.1470	-0.0841	-0.0744	-0.0884
Bolivia	2000–18	15.4	0.0581	0.1248	0.1492	0.1490
Brazil	2000–19	1.5	-0.0104	0.0075	0.0149	0.0119
Chile	2003–15	-15.4	-0.1912	-0.1848	-0.1605	-0.1585
Colombia	2000–16	-19.9	-0.2306	-0.2019	-0.2011	-0.1989
Costa Rica	2000–14	0.6	-0.0330	-0.0041	-0.0024	-0.0082
Dominican Republic	2000–13	-29.4	-0.3601	-0.2937	-0.3097	-0.2995
Ecuador	2000–19	4.8	0.0121	0.0479	0.0380	0.0425
El Salvador	2000–16	-4.4	-0.1283	-0.0535	-0.0606	-0.0574
Guatemala	2001–18	-24.6	-0.3200	-0.2514	-0.2522	-0.2564
Haiti	2005–18	2.3	-0.1451	-0.0437	0.0039	0.0135
Honduras	2000–19	-32.1	-0.4108	-0.3385	-0.3295	-0.3826
Jamaica	2000–18	23.4	0.1748	0.2179	0.2300	0.2341
Mexico	2000–19	-8.1	-0.0815	-0.0824	-0.0826	-0.0828
Nicaragua	2006–19	-6.2	-0.1401	-0.0768	-0.0733	-0.0692
Panama	2007–19	-9.4	-0.1141	-0.0959	-0.0935	-0.0935
Paraguay	2000–17	7.3	-0.0299	0.0665	0.0649	-0.0246
Peru	2000–11	-14.7	-0.2422	-0.1686	-0.1534	-0.2232
Uruguay	2000–19	38.6	0.3108	0.3546	0.3512	0.3435

EE = energy efficiency; RISE = Regulatory Indicators for Sustainable Energy.

Energy price

The energy price is statistically significant and negatively correlated with energy intensity. The coefficients on energy price in columns (1)–(5) of table A.7 are stable and suggest that a 1 percent increase in energy price is associated with a 16 percent drop in energy intensity. An increase in energy price could be achieved through the elimination of various types of supply- or demand-side energy subsidies.

Further regression analyses of the two components of energy intensity—energy efficiency and economic activity—reveal that the effect of energy price on energy intensity mainly acts through reductions in energy efficiency. As table A.8 shows, a 1 percent increase in energy price is correlated with a 20 percent decrease in the Fisher Efficiency Index, indicating a 20 percent improvement in energy efficiency when holding economic activity constant.

Surprisingly, energy price is positively correlated with economic activity. Table A.9 shows that a 1 percent increase in energy price is associated with a 3–4 percent increase in the Fisher Activity Index. This positive correlation indicates that as energy prices (inclusive of government taxes and subsidies) increase, economic activities become more concentrated in energy-intensive industries such as manufacturing, and vice versa. This relationship could be due to more energy-intensive economic activities creating more demand for energy and thus raising energy prices.

Population growth

As tables A.7–A.9 show, population growth is statistically significant and positively correlated with energy intensity and energy efficiency. Overall, a 1 percentage point increase in the population growth rate is associated with a roughly 13–15 percent increase in energy intensity and a 15–17 percent increase in the Fisher Energy Efficiency Index (indicating a worsening of energy efficiency). As Metcalf (2008) argues, LAC countries with fast-growing populations could suffer from congestion-induced energy costs by being overly reliant on existing energy generation technologies that are relatively inefficient. In addition, countries with fast population growth rates could also attract more energy-intensive activities.

Thus, without investments in more efficient energy production and consumer technologies, these factors could lead to increased energy intensity.

Capital-labor ratio and investment-capital ratio (vintage of capital)

We measure the overall capital intensity of LAC economies using the capital-labor ratio, and also allow for a potentially nonlinear relationship between the capital-labor ratio and energy intensity, energy efficiency, and economic activity. We guess that a more capital-intensive energy is likely to be more reliant on energy consumption.

In addition, we also try to capture the vintage of a country's capital by introducing the investment-capital ratio into our empirical models as a control variable. Under the assumption that newer capital is more energy efficient, we expect to see a negative relationship between the investment-capital ratio and energy intensity and efficiency.

However, we do not find a statistically significant relationship between the capital-labor ratio, the investment-capital ratio, and Fisher indices for energy intensity, efficiency, and economic activity, as is shown in tables A.7–A.9.

Weather

To control for variations in weather patterns by country and over years, we also include CDDs and HDDs in our regression models. As is typical in studies of energy demand, changes in local weather, as captured by CDDs and HDDs, may drive seasonal changes in energy demand, as hotter temperatures may prompt people to increase their use of air conditioning, electric fans, and other cooling equipment. Similarly, cold days may increase households' demand for heating. In our analyses, however, we find that the relationships among CDD, HDD, and energy intensity, efficiency, or activity are not statistically significant. This result could be explained by the fact that temperatures vary less in the tropical climates typical of the majority of LAC countries in our sample, compared to temperate zones.

Exogenous technological advances

To capture any exogenous technological advances common to all countries in the LAC region, we also include linear and nonlinear time trends in our empirical models. These trends not only capture technological innovations and improvements available for all LAC countries, but also any shocks to energy supply or demand and macroeconomic shocks experienced by the whole region. Comparing tables A.7–A.9, we find that exogenous technological progress plays an important role in explaining the reductions in energy intensity and the shift of economic activities toward less-energy-intensive industries such as services.

On average, the energy intensity of the LAC countries decreases by about 1 percent per year and most of this decline can be attributed to the structural change of the economies toward less-energy-intensive industries. This could be due to new and better technologies being adopted, the increased efficiency of energy and other resource use, improvements in productivity, and other macroeconomic factors that enhance energy efficiency across the entire region.

It is also worth noting that the average annual decline in energy intensity masks the decreasing return effect. The statistically significant and positive coefficients on the square terms of time trends suggest that the decline in energy intensity is slowing across the LAC region.

Policy (RISE)

A highlight of our analyses is our ability to measure changes in EE policies, albeit imperfectly. We rely on the Regulatory Indicators for Sustainable Energy (RISE) index to capture changes in EE policies in 19 LAC countries over time.

Tables A.7–A.9 reveal two patterns concerning the role of government policies in reducing energy intensity and improving energy efficiency. First, more government EE policies are negatively correlated with energy intensity and energy efficiency, suggesting that policies may have played a role in explaining the reduction in energy intensity and improvements in energy efficiency in the LAC countries. Second, we examine whether past policy changes have led to the observed changes in energy intensity and efficiency by appealing to Granger causality. As is shown in the last three rows of tables A.7 and A.8, changes in the RISE index from one, three, and five years ago are significantly associated with decreases in Fisher energy intensity and EE indices. Moreover, this relationship is remarkable stable across the models using different lagged RISE scores.

Furthermore, we reestimate our models using disaggregated categories of RISE scores and present the results of this exercise in tables A.10–A.12. We identify three sets of government policies, national plans, energy efficiency entities, and financing mechanisms, to be significantly correlated with reductions in energy intensity and efficiency.

Table A.7. Relationship between energy prices, regulatory policies, and energy intensity index

	(1)	(2)	(3)	(4)	(5)
Log(energy price)	-0.16*** (0.042)	-0.16*** (0.041)	-0.16*** (0.044)	-0.15*** (0.049)	-0.19*** (0.054)
Log(K/L)	0.19 (0.22)	0.11 (0.19)	0.045 (0.20)	-0.11 (0.25)	-0.31 (0.36)
Log(K/L)^2	-0.0099 (0.010)	-0.0055 (0.0090)	-0.0038 (0.0093)	0.0019 (0.011)	0.0097 (0.016)
Log(I/K)	-0.023 (0.033)	-0.0099 (0.032)	-0.023 (0.032)	0.0023 (0.034)	0.012 (0.041)
Population growth rate	0.15*** (5.00)	0.13*** (4.89)	0.15*** (5.10)	0.14** (6.12)	0.11 (8.17)
Log(CDD18)	-0.094 (0.082)	-0.10 (0.079)	-0.11 (0.079)	-0.10 (0.082)	-0.12 (0.091)
Log(HDD16)	-0.037 (0.031)	-0.042 (0.029)	-0.034 (0.030)	-0.019 (0.030)	-0.041 (0.033)
Time trend	-0.013*** (0.0049)	-0.0087* (0.0049)	-0.0075 (0.0055)	-0.011 (0.0072)	-0.0063 (0.010)
(Time trend)^2	0.00093*** (0.00023)	0.0011*** (0.00022)	0.00100*** (0.00024)	0.0011*** (0.00029)	0.00078** (0.00038)
Log(RISE EE Scores)		-0.080*** (0.016)			
Log(RISE EE Scores)$_{t-1}$			-0.072*** (0.017)		
Log(RISE EE Scores)$_{t-3}$				-0.069*** (0.020)	
Log(RISE EE Scores)$_{t-5}$					-0.078*** (0.027)
N	319	319	300	262	224
R-Square	0.7140	0.7467	0.7680	0.8073	0.8388
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Dependent Var. = Log Energy Intensity

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

Table A.8. Relationship between energy prices, regulatory policies, and energy efficiency index

	(1)	(2)	(3)	(4)	(5)
Log(energy price)	-0.20*** (0.043)	-0.20*** (0.042)	-0.20*** (0.046)	-0.18*** (0.051)	-0.22*** (0.058)
Log(K/L)	0.073 (0.26)	-0.0086 (0.23)	-0.12 (0.24)	-0.42 (0.30)	-0.84** (0.41)
Log(K/L)^2	-0.0044 (0.012)	0.00057 (0.010)	0.0045 (0.011)	0.016 (0.014)	0.033* (0.019)
Log(I/K)	0.030 (0.037)	0.045 (0.038)	0.028 (0.037)	0.022 (0.040)	-0.0058 (0.048)
Population growth rate	0.16*** (5.43)	0.15*** (5.32)	0.17*** (5.53)	0.16** (6.58)	0.11 (8.59)
Log(CDD18)	-0.13 (0.097)	-0.14 (0.096)	-0.100 (0.095)	-0.075 (0.11)	-0.041 (0.11)
Log(HDD16)	-0.041 (0.034)	-0.046 (0.032)	-0.035 (0.033)	-0.022 (0.033)	-0.038 (0.034)
Time trend	-0.00037 (0.0054)	0.0043 (0.0055)	0.0058 (0.0059)	0.0048 (0.0077)	0.016 (0.012)
(Time trend)^2	0.00053** (0.00025)	0.00067*** (0.00025)	0.00060** (0.00025)	0.00050 (0.00032)	-0.000073 (0.00045)
Log(RISE EE Score)		-0.090*** (0.017)			
Log(RISE EE Scores)$_{t-1}$			-0.081*** -0.019		
Log(RISE EE Scores)$_{t-3}$				-0.070*** -0.022	
Log(RISE EE Scores)$_{t-5}$					-0.075*** -0.028
N	319	319	300	262	224
R-Square	0.7202	0.7533	0.7759	0.8082	0.8441
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Dependent Var. = Log Efficiency Index

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

Table A.9. Relationship between energy prices, regulatory policies, and economic activity index

	(1)	(2)	(3)	(4)	(5)
Log(energy price)	0.043*** (0.015)	0.043*** (0.015)	0.037** (0.014)	0.027* (0.015)	0.028** (0.014)
Log(K/L)	0.11 (0.088)	0.12 (0.086)	0.17* (0.098)	0.31** (0.12)	0.53*** (0.15)
Log(K/L)^2	-0.0055 (0.0041)	-0.0061 (0.0040)	-0.0083* (0.0045)	-0.014** (0.0056)	-0.023*** (0.0070)
Log(I/K)	-0.053*** (0.017)	-0.055*** (0.018)	-0.052*** (0.018)	-0.020 (0.018)	0.018 (0.018)
Population growth rate	-0.02 (1.62)	-0.02 (1.63)	-0.02 (1.62)	-0.02 (1.62)	-0.00 (1.76)
Log(CDD18)	0.039 (0.046)	0.040 (0.047)	-0.0072 (0.045)	-0.030 (0.046)	-0.083** (0.037)
Log(HDD16)	0.0040 (0.0094)	0.0045 (0.0095)	0.0017 (0.0089)	0.0026 (0.0086)	-0.0026 (0.0069)
Time trend	-0.013*** (0.0022)	-0.013*** (0.0021)	-0.013*** (0.0027)	-0.016*** (0.0038)	-0.023*** (0.0052)
(Time trend)^2	0.00041*** (0.000094)	0.00039*** (0.000097)	0.00039*** (0.00012)	0.00055*** (0.00016)	0.00085*** (0.00021)
Log(RISE EE Score)		0.0097* (0.0056)			
Log(RISE EE Scores)$_{t-1}$			0.0089 (0.0056)		
Log(RISE EE Scores)$_{t-3}$				0.00055 (0.0076)	
Log(RISE EE Scores)$_{t-5}$					-0.0027 (0.0089)
N	319	319	300	262	224
R-Square	0.7483	0.7505	0.7806	0.8286	0.8800
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Dependent Var. = Log Activity Index

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

Table A.10. The role of national planning (RISE score)

	Log(Energy intensity)	Log(Efficiency index)	Log(Composition index)
Log(price)	-0.17*** (0.041)	-0.21*** (0.043)	0.043*** (0.015)
Log(K/L)	-0.029 (0.24)	-0.12 (0.28)	0.096 (0.092)
Log(K/L)^2	0.0011 (0.011)	0.0058 (0.013)	-0.0047 (0.0043)
Log(I/K)	-0.016 (0.031)	0.037 (0.036)	-0.053*** (0.018)
Population growth rate	15.9*** (5.06)	17.8*** (5.47)	-1.85 (1.63)
Log(CDD18)	-0.12 (0.082)	-0.16 (0.098)	0.037 (0.047)
Log(HDD16)	-0.047 (0.032)	-0.051 (0.035)	0.0032 (0.0096)
Time trend	-0.015*** (0.0049)	-0.0025 (0.0055)	-0.013*** (0.0022)
(Time trend)^2	0.0012*** (0.00025)	0.00077*** (0.00028)	0.00043*** (0.000099)
ln(National planning scores)	-0.016*** (0.0051)	-0.015*** (0.0056)	-0.0013 (0.0019)
N	319	319	319
R-Square	0.7240	0.7271	0.7486
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

Table A.11. The role of entities responsible for promoting energy efficiency (RISE score)

	Log(Energy intensity)	Log(Efficiency index)	Log(Composition index)
Log(energy price)	-0.15*** (0.041)	-0.20*** (0.042)	0.044*** (0.015)
Log(K/L)	0.16 (0.22)	0.050 (0.26)	0.11 (0.087)
Log(K/L)^2	-0.0077 (0.0100)	-0.0024 (0.012)	-0.0053 (0.0040)
Log(I/K)	-0.0046 (0.031)	0.047 (0.037)	-0.052*** (0.018)
Population growth rate	15.8*** (4.96)	17.6*** (5.42)	-1.83 (1.63)
Log(CDD18)	-0.11 (0.080)	-0.15 (0.098)	0.037 (0.046)
Log(HDD16)	-0.038 (0.030)	-0.042 (0.033)	0.0039 (0.0095)
Time trend	-0.0095* (0.0049)	0.0027 (0.0055)	-0.012*** (0.0022)
(Time trend)^2	0.00088*** (0.00023)	0.00048* (0.00025)	0.00040*** (0.000093)
ln(EE entities scores)	-0.015*** (0.0051)	-0.014** (0.0055)	-0.0016 (0.0019)
N	319	319	319
R-Square	0.7248	0.7272	0.7489
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

Table A.12. The role of financing mechanisms (RISE score)

	Log(Energy Intensity)	Log(Efficiency index)	Log(Composition index)
Log(energy price)	-0.15*** (0.043)	-0.19*** (0.044)	0.042*** (0.015)
Log(K/L)	0.35 (0.22)	0.26 (0.25)	0.086 (0.089)
Log(K/L)^2	-0.017* (0.0099)	-0.013 (0.011)	-0.0043 (0.0041)
Log(I/K)	-0.045 (0.033)	0.0048 (0.037)	-0.050*** (0.018)
Population growth rate	14.9*** (4.95)	17.0*** (5.41)	-2.04 (1.63)
Log(CDD18)	-0.089 (0.084)	-0.13 (0.099)	0.038 (0.047)
Log(HDD16)	-0.034 (0.032)	-0.037 (0.035)	0.0033 (0.0095)
Time trend	-0.010** (0.0050)	0.0027 (0.0055)	-0.013*** (0.0021)
(Time trend)^2	0.00084*** (0.00024)	0.00041 (0.00026)	0.00042*** (0.000091)
Log(Financial mechanism scores)	-0.018*** (0.0063)	-0.021*** (0.0068)	0.0031 (0.0027)
N	319	319	319
R-Square	0.7227	0.7299	0.7495
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: CDD = cooling degree day; CDD18 uses 18 degrees Celsius as the temperature threshold for counting degree days. For example, a day with average temperature of 19 degrees Celsius counts as one degree day, a day with average temperature of 20 degrees Celsius counts as 2 degree days, and a day with average temperature below 18 degrees Celsius counts as zero degree days. HDD = heating degree day; HDD16 uses 16 degrees Celsius as the temperature threshold. EE = energy efficiency; FE = Fixed Effects; I/K = investment-capital ratio; K/L = capital-labor ratio; RISE = Regulatory Indicators for Sustainable Energy.

A.3. Key questions informing RISE energy efficiency scores used for this report[21]

EE1: National energy efficiency planning

1. Is there legislation or a national action plan that aims to increase energy efficiency?
2. Is there an EE goal or target at the national level?
3. Are there targets defined for any of the following sectors?
   - Residential
   - Commercial services
   - Transport
   - Industrial
   - Power
4. Are targets derived from detailed analysis that is publicly available?
5. Is there a requirement for periodic progress reports tracking data related to the efficiency target(s)?

EE2: Energy efficiency entities

1. Are there governmental and/or independent bodies that carry out the roles listed below
   - Setting EE strategy
   - Setting EE standards
   - Regulating EE activities of energy consumers
   - Certifying compliance with equipment EE standards
   - Certifying compliance with building EE standards
   - Selecting and/or approving third-party auditors tasked with certifying EE standards
2. Are EE programs developed based on market analysis with plans open to public consultation and periodic evaluation?
3. Are there professional certification/accreditation programs mandated for EE activities? Select all that apply:
   - Energy auditing/energy management
   - Monitoring and verification of energy consumption/ savings
   - Building EE construction/design
   - Other

21 https://rise.esmap.org/indicators.

EE3: Incentives and mandates—industrial and commercial end users

1. Are there any of the following EE mandates for large energy users?
   - Targets (e.g., kilowatt-hour savings or lower energy intensity or carbon dioxide reductions, etc.)
   - Mandatory audits
   - Energy management system (computer technologies to optimize energy use)
   - Energy manager in the facility
2. Are there penalties in place for noncompliance with EE programs for large energy users?
3. Is there a requirement for periodic reporting of energy consumption in order to enforce and/or track progress of energy efficiency in large consumers' facilities?
4. Is there a measurement and verification program in place?
5. Is there a program to publicly recognize end users who have achieved significant energy savings measures?
6. Are there awareness programs or publicized case study examples of significant energy savings measures?
7. Does the program offer technical assistance (from a government or independent entity) to end users to identify energy savings investment opportunities?
8. Is there an EE mandate or incentive program for small and medium enterprises?

EE4: Incentives and mandates—public sector

1. Are there binding energy savings obligations for public buildings and/or other public facilities (may include water supply, wastewater services, municipal solid waste, street lighting, transportation, and heat supply)?
2. Is there a reporting mechanism to track and enforce energy savings in public sector facilities (either in-house or by a third party)?
3. Are there specific policies or mandated guidelines for public procurement of energy-efficient products and services at the following levels?
   - National
   - Region/state/province
   - Municipal/city/county

4. Are there guidelines or tools to help identify energy-efficient options for procurement (e.g., EE calculators, technical specifications, product rating catalogs)?

5. Do public budgeting regulations and practices allow public entities to retain energy savings at the following levels? Tick all applicable levels:

   - National
   - Region/state/province
   - Municipal/city/county

EE5: Incentives and mandates—utilities

1. Generation

   - Are utilities required to carry out EE activities in this area?
   - Are there penalties in place for noncompliance with EE requirements?

2. Transmission and distribution networks

   - Are utilities required to carry out EE activities in this area?
   - Are there penalties in place for noncompliance with EE requirements?

3. Demand-side management/demand-response

   - Are utilities required to carry out EE activities in this area?
   - Are there penalties in place for noncompliance with EE requirements?

4. Are any of the following mechanisms available for utilities to recover costs associated with or revenue lost from mandated EE activities:

   - Public budget financing
   - Consumer surcharge
   - Decoupling

5. Are electricity tariffs cost reflective?

6. Are any of the following time-of-use rate structures applied to the residential, commercial services, or industrial sectors?

   - Real-time pricing
   - Variable peak pricing
   - Critical peak pricing
   - Seasonal rate
   - Peak-time rebates and/or time of day tariffs

7. Do customers receive a bill or report that compares them to other users in the same region and/or usage class? Tick all that apply:

   - Residential
   - Commercial
   - Industrial

8. Do customers receive a bill or report that shows their energy usage compared to previous bills or reports over time? Tick all that apply:

   - Residential
   - Commercial
   - Industrial

9. Which of the following charges do electricity customers pay in the commercial services sector and in the industrial sector?

   - Commercial services sector
     - Demand (kilowatt)
     - Reactive power (kVAr)
   - Industrial sector
     - Demand (kilowatt)
     - Reactive power (kVAr)

EE6: Financing mechanisms for energy efficiency

1. Are any of the following financing mechanisms for EE activities available in the (R) residential sector, (C) commercial services sector, or (I) industrial sector?

   - Discounted “green” mortgages
   - On-bill financing/repayment
   - Credit lines and/or revolving funds with banks for EE activities
   - Energy services agreements (pay-for-performance contracts)
   - Green or EE bonds
   - Vendor credit and/or leasing for EE activities
   - Partial risk guarantees
   - Other

2. How many financial and/or nonfinancial institutions offer financial products for EE investments in each sector?

   - Residential
   - Commercial
   - Industrial

EE7: Minimum energy efficiency performance standards

1. Have minimum energy performance standards been adopted for:

- Refrigerators
- Heating, ventilation and/or air conditioning (HVAC)
- Lighting equipment
- Industrial electric motors
- Other industrial equipment and/or domestic appliances
- Light vehicles

2. Verification and penalties for noncompliance:

- Are the standards mandatory?
- Is there a requirement for periodic reporting to verify compliance with standards?
- Is the verification of compliance with standards carried out by a third party?
- Is there a penalty for noncompliance with EE standards?
- Is there a periodic update of standards to reflect technological advances and changes in best practices for EE standards?

EE8: Energy labeling systems

1. Have EE labeling schemes been adopted for?

- Refrigerators
- HVAC
- Lighting equipment
- Industrial electric motors
- Other industrial equipment and/or domestic appliances
- Transport vehicles

2. Mandatory vs voluntary labeling system

- Are any of the above labeling schemes mandatory?
- Is there a periodic update of standards to reflect technological advances and changes in best practices for EE labels?

EE9: Building energy codes

1. New residential and commercial buildings

- Are there EE codes for new residential buildings?
- Are there EE codes for new commercial buildings?
- Are the building EE standards required to be updated on a regular basis to reflect technological advances and changes in best practices for building energy efficiency?
  - Residential sector
  - Commercial sector

2. Compliance system

- Is commission testing for energy efficiency required for final building acceptance documentation?
- Is there a requirement for periodic reporting to verify compliance with building EE requirements?
- Is verification carried out by a third party?

3. Renovated buildings

- Are renovated buildings required to meet a building energy code, in residential and commercial sectors?
  - Residential sector
  - Commercial sector
- Are the building EE standards required to be updated on a regular basis to reflect technological advances and changes in best practices for building energy efficiency?
  - Residential sector
  - Commercial sector

4. Building energy information

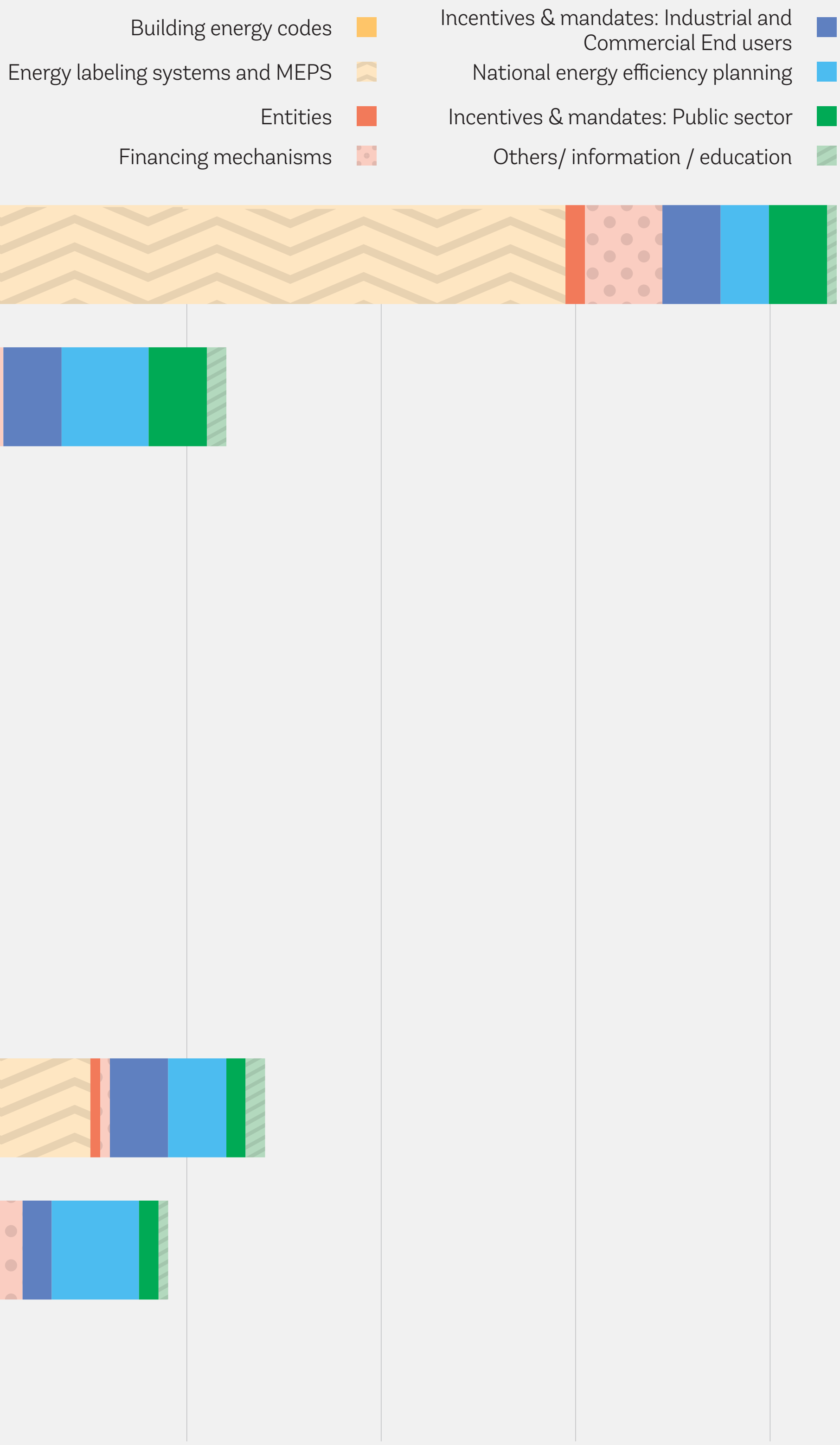
- Is there a mandatory standardized rating or labeling system for the energy performance of existing buildings?
- Are commercial and residential buildings required to disclose property energy usage at the point of sale or when leased?
- Are large commercial and residential buildings required to disclose property energy usage annually?

5. Building EE incentives

- Are there mandates or targets for new buildings to achieve high-quality EE certifications, such as Leadership in Energy & Environmental Design (LEED) (e.g., percentage of new building stock that must be LEED certified)?

A.4. Types of energy efficiency policies and regulations in LAC

Figure A.27
Energy efficiency policies and regulations of various types across the LAC region



Source: IEA, BIEE, and RISE databases.
MEPS = minimum energy performance standard.

Realizing the Potential of Energy Efficiency in Latin America and the Caribbean responds to the urgent need to relaunch the energy efficiency agenda on the continent in the context of post-COVID recovery, the challenges of climate change mitigation, and high energy prices. The report assesses the current state of energy efficiency policies and measures in the region, identifies key challenges and drivers for improvement, and proposes ways forward. Starting with a high-level review of how energy efficiency policies have evolved in the region over the past two decades, the report proceeds to disaggregate broad trends into discrete efficiency improvements and changes in economic activity. It then identifies key drivers of energy intensity reductions at the sector level. Finally, it provides recommendations on policy instruments to support energy efficiency improvements.